JEE Main & NEET

PHYSICS

QUESTION BANK

PART-2

ADVANCED QUESTION BANK

With Instant Solutions

Practice Oriented Categorisations

Chapterwise And Topicwise Reference With Each Question

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PART 1. PHYSICS QUESTION BANK

Q51. A 5000 kg rocket is set for vertical firing. The exhaust speed is 800 ms^{-1}. To give an initial upward acceleration of 20 ms^{-2}, the amount of gas ejected per second to supply the needed thrust will be (g = 10 ms^{-2})

(a) 127.5 kg s^{-1} (b) 187.5 kg s^{-1}
(c) 185.5 kg s^{-1} (d) 137.5 kg s^{-1}

Ans: (b)

Solution: Given : Mass of rocket (m) = 5000 kg
Exhaust speed (v) = 800 m/s
Acceleration of rocket (a) = 20 m/s^2
Gravitational acceleration (g) = 10 m/s^2
We know that upward force
F = m (g + a) = 5000 (10 +20)
= 5000 × 30 = 150000 N.
We also know that amount of gas ejected
$\left(\frac{dm}{dt}\right) = \frac{F}{v} = \frac{150000}{800}$ =187.5kg/s

Chapter: Dynamics Laws of Motion
[Topic: Ist, IInd & IIIrd Laws of Motion]

Q52. Assuming the sun to have a spherical outer surface of radius r, radiating like a black body at temperature t°C, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the sun is

(a) $\frac{r^2\sigma(t+273)^4}{4\pi R^2}$
(b) $\frac{16\pi^2 r^2\sigma t^4}{R^2}$
(c) $\frac{r^2\sigma(t+273)^4}{R^2}$
(d) $\frac{4\pi r^2\sigma t^4}{R^2}$

where σ is the Stefan's constant.

Ans: (c)

Solution: Power radiated by the sun at t°C
$= \sigma(t+273)^4 4\pi r^2$
Power received by a unit surface
$= \frac{\sigma(t+273)^4 4\pi r^2}{4\pi R^2} = \frac{r^2\sigma(t+273)^4}{R^2}$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q53. A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect ?

(a) The energy stored in the capacitor decreases K times.
(b) The chance in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$
(c) The charge on the capacitor is not conserved.
(d) The potential difference between the plates decreases K times.

Ans: (c)

Solution: Capacitance of the capacitor, $C = \frac{Q}{V}$
After inserting the dielectric, new capacitance
C^1 = K.C
New potential difference
$V^1 = \frac{V}{K}$
$u_i = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$ ($\because$ Q = CV)
$u_f = \frac{Q^2}{2f} = \frac{Q^2}{2K} = \frac{C^2V^2}{2KC} = \left(\frac{u_i}{K}\right)$
$\Delta u = u_f - u_i = \frac{1}{2}CV^2\left\{\frac{1}{K}-1\right\}$
As the capacitor is isolated, so change will remain conserved p.d. between two plates of the capacitor
$L = \frac{Q}{KC} = \frac{V}{K}$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q54. A transformer is used to light a 100 W and 110 V lamp from a 220 V mains. If the main current is 0.5 amp, the efficiency of the transformer is approximately

(a) 50% (b) 90%
(c) 10% (d) 30%.

Ans: (b)

Solution: Efficiency of the transformer
$\eta = \frac{P_{output}}{P_{input}} \times 100 = \frac{100}{220 \times 0.5} \times 100 = 90.9\%$

Chapter: Alternating Current
[Topic: Transformers & LC Oscillations]

Q55. Complete the equation for the following fission process : ${}^{235}_{92}U + {}^{1}_{0}n_{38}Sr^{90} + \cdots$

(a) ${}_{54}X^{143} + 3\,{}_{0}n^1$ (b) ${}_{54}X^{145} + 3\,{}_{0}n^1$
(c) ${}_{57}X^{142} + 3\,{}_{0}n^1$ (d) ${}_{54}X^{142} + {}_{0}n^1$

Ans: (a)

Solution: ${}_{92}U^{235} + {}_{0}n^1 \rightarrow {}_{38}Sr^{90} + {}_{54}Xe^{143} + 3\,{}_{0}n^1 +$ energy

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

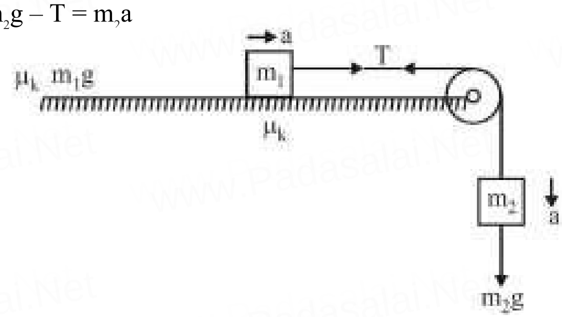
Q56. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is

(a) $\frac{(m_2-\mu k m_1)g}{(m_1+m_2)}$
(b) $\frac{m_1m_2(1+\mu_k)g}{(m_1+m_2)}$
(c) $\frac{m_1m_2(1-\mu_k)g}{(m_1+m_2)}$
(d) $\frac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

Ans: (b)

Solution: For the motion of both the blocks
$m_1a = T - \mu_k m_1 g$

$m_2g - T = m_2a$



$a = \frac{m_2g - \mu_k m_1 g}{m_1 + m_3}$

$m_2g - T = (m_2)\left(\frac{m_2g - \mu_k m_1 g}{m_1 m_2}\right)$

solving we get tension in the string

$T = \frac{m_1 m_2 g(1+\mu_k)g}{m_1 + m_2}$

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q57. First law of thermodynamics is consequence of conservation of
(a) work
(b) energy
(c) heat
(d) all of these

Ans: (b)

Solution: The first law of thermodynamics is just a conservation of energy.

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q58. A wire of a certain material is stretched slowly by ten per cent. Its new resistance and specific resistance become respectively:
(a) 1.2 times, 1.3 times (b) 1.21 times, same
(c) both remain the same (d) 1.1 times, 1.1 times

Ans: (b)

Solution: Resistance of a wire is given by $R = \rho\frac{l}{a}$

If the length is increased by 10% then new length $l' = l + \frac{1}{10} = \frac{11}{10}l$

In that case, area of cross-section of wire would decrease by 10%

∴ New area of cross-section

$A' = A - \frac{A}{10} = \frac{9}{10}A$

$\therefore R' = r\frac{\ell'}{A'} = r\frac{\frac{11}{10}l}{\frac{9}{10}A}$

$R' = \frac{11}{9}\rho\frac{l}{R}\ R = 1.21R$

Thus the new resistance increases by 1.21 times. The specific resistance (resistivity) remains unchanged as it depends on the nature of the material of the wire.

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q59. The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is
(a) microwave, infrared, ultraviolet, gamma rays
(b) gamma rays, ultraviolet, infrared, micro-waves
(c) microwaves, gamma rays, infrared, ultraviolet
(d) infrared, microwave, ultraviolet, gamma rays

Ans: (a)

Solution: The decreasing order of the wavelengths is as given below :
microwave, infrared, ultraviolet, gamma rays.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q60. Two radioactive materials X_1 and X_2 have decay constants 5λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be $\frac{1}{e}$after a time
(a) λ
(b) $\frac{1}{2}\lambda$
(c) $\frac{1}{4\lambda}$
(d) $\frac{e}{\lambda}$

Ans: (c)

Solution: Let the required time be t. Then

$N_1 = N_0e^{-\lambda_1 t}$; $N_2 = N_0e^{-\lambda_2 t}$

Where
N_1 = number of nuclei of X_1 after time t
N_2 = number of nuclei of X_2 after time t
N_0 = initial number of nuclei of X_1 and X_2 each.

Now, $\frac{N_1}{N_2} = \frac{N_0e^{-\lambda_1 t}}{N_0e^{-\lambda_2 t}}$ Here $\frac{N_1}{N_2} = \frac{1}{e}$

$\lambda_1 = 5\lambda$; $\lambda_2 = \lambda$

$\therefore \frac{1}{e} = \frac{e^{-5\lambda t}}{e^{-\lambda t}} \Rightarrow e^{-1} = e^{-4\lambda t} \Rightarrow 4\lambda t = 1$

$\therefore t = \frac{1}{4}$

Chapter: Nuclei
[Topic: Radioactivity]

Q61. Two similar springs P and Q have spring constants K_P and K_Q, such that $K_P > K_Q$. They are stretched, first by the same amount (case a,) then by the same force (case b). The work done by the springs W_P and W_Q are related as, in case (a) and case (b) , respectively
(a) $W_P = W_Q$; $W_P = W_Q$
(b) $W_P > W_Q$; $W_Q > W_P$
(c) $W_P < W_Q$; $W_Q < W_P$
(d) $W_P = W_Q$; $W_P > W_Q$

Ans: (b)

Solution: As we know work done in stretching spring

$w = \frac{1}{2}kx^2$

where k = spring constant
x = extension
Case (a) If extension (x) is same,

$W = \frac{1}{2}Kx^2$

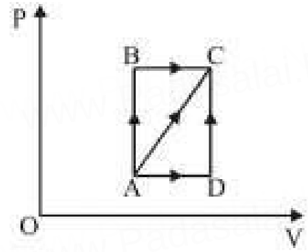
So, $W_P > W_Q$($\because K_P > K_Q$)

Case (b) If spring force (F) is same $W = \frac{F^2}{2K}$

So, $W_Q > W_P$

Chapter: Work, Energy and Power
[Topic: Work]

Q62. A thermodynamic process is shown in the figure. The pressures and volumes corresponding to some points in the figure are



$P_A = 3 \times 10^4$ Pa
$V_A = 2 \times 10^{-3} m^3$
$P_B = 8 \times 10^4$ Pa
$V_D = 5 \times 10^{-3}$ m^3.

In process AB, 600 J of heat is added to the system and in process BC, 200 J of heat is added to the system. The change in internal energy of the system in process AC would be

(a) 560 J (b) 800 J
(c) 600 J (d) 640 J

Ans: (a)

Solution: Since AB is an isochoric process, so, no work is done. BC is isobaric process,

$\therefore W = P_B \times (V_D - V_A) = 240$ J
$\Delta Q = 600 + 200 = 800$ J
Using $\Delta Q = \Delta U + \Delta W$
$\Rightarrow \Delta U = \Delta Q - \Delta W = 800 - 240 = 560$ J

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q63. Three resistances each of 4 Ω are connected to form a triangle. The resistance between any two terminals is

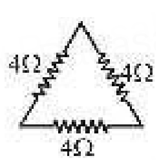
(a) 12 Ω (b) 2 Ω
(c) 6Ω (d) 8/3Ω

Ans: (d)

Solution: The two resistances are connected in series and the resultant is connected in parallel with the third resistance.

$\therefore R' = 4\,\Omega + 4\,\Omega = 8\Omega$ and $\frac{1}{R''} = \frac{1}{8} + \frac{1}{4} = \frac{3}{8}$

or $R'' \frac{8}{3} \Omega$



Chapter: Current Electricity
[Topic: Combination of Resistances]

Q64. The reddish appearance of the sun at sunrise and sunset is due to

(a) the colour of the sky
(b) the scattering of light
(c) the polarisation of light
(d) the colour of the sun

Ans: (b)

Solution: It is due to scattering of light. Scattering $\propto \frac{1}{\lambda^4}$. Hence the light reaches us is rich in red.

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q65. Curie is a unit of

(a) energy of gamma-rays
(b) half-life
(c) radioactivity
(d) intensity of gamma-rays

Ans: (c)

Solution: Curie is a unit of radioactivity.

Chapter: Nuclei
[Topic: Radioactivity]

Q66. Two bodies of masses m and 4 m are moving with equal K.E. The ratio of their linear momenta is

(a) 4 : 1 (b) 1 : 1
(c) 1 : 2 (d) 1 : 4

Ans: (c)

Solution: $m_1 = m$, $m_2 = 4$ m

$K.E_1 = K.E_2$

$\frac{1}{2}m_1v_1^2 = \frac{1}{2}m_2v_2^2$; $\frac{1}{2}mv_1^2 = \frac{1}{2}4mv_2^2$

$\frac{v_1}{v_2} = 2 \Rightarrow v_1 = 2v_2$

$$\frac{\text{Linear momntum of first body}}{\text{Linear momentum of second body}}$$

$$= \frac{m_1v_1}{m_2v_2} = \frac{m.2v_2}{4mv_2} = \frac{1}{2}$$

Chapter: Work, Energy and Power
[Topic: Energy]

Q67. At constant volume, temperature is increased then

(a) collision on walls will be less
(b) number of collisions per unit time will increase
(c) collisions will be in straight lines
(d) collisions will not change.

Ans: (b)

Solution: As the temperature increases, the average velocity increases. So, the collisions are faster.

Chapter: Kinetic Theory
[Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q68. In electrolysis, the amount of mass deposited or liberated at an electrode is directly proportional to

(a) square of electric charge
(b) amount of charge
(c) square of current
(d) concentration of electrolyte

Ans: (b)

Solution: By Faraday's Ist Law

Amount deposited (m) = Zit = Zq

$m \propto q$

Amount deposited is directly proportional to charge.

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q69. A plano-convex lens is made of material of refractive index 1.6. The radius of curvature of the curved surface is 60 cm. The focal length of the lens is

(a) 50 cm (b) 100 cm
(c) 200 cm (d) 400 cm

Ans: (b)

Solution: $R_1 = 60$ cm, $R_2 = \infty$, $\mu = 1.6$

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$\frac{1}{f} = (1.6 - 1)\left(\frac{1}{60}\right) \Rightarrow f = 100$ cm.

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q70. Choose the only **false** statement from the following

(a) In conductors, the valence and conduction bands may overlap
(b) Substances with energy gap of the order of 10 eV are insulators
(c) The resistivity of a semiconductor increases with increase in temperature
(d) The conductivity of a semiconductor increases with increase in temperature

Ans: (c)

Solution: (a) is true as in case of conductors either the conduction & valence band overlap or conduction band is partially filled.
(b) is true as insulators have energy gap of the order of 5 to 10 eV.
(c) is false as resistivity (opposite of conductivity) decreases with increase in temperature.
(d) is true as with increase in temperature more and more electrons jump to the conduction band. So, conductivity increases.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q71. An explosion blows a rock into three parts. Two parts go off at right angles to each other. These two are, 1 kg first part moving with a velocity of 12 ms^{-1} and 2 kg second part moving with a velocity of 8 ms^{-1}. If the third part flies off with a velocity of 4 ms^{-1}, its mass would be:

(a) 7 kg (b) 17 kg
(c) 3 kg (d) 5 kg

Ans: (d)

Solution: Let two parts of the rock move along x-axis and y-axis respectively.
If M and v be the mass and velocities of third part then

Mv cos θ = 12

Mv sin θ =16

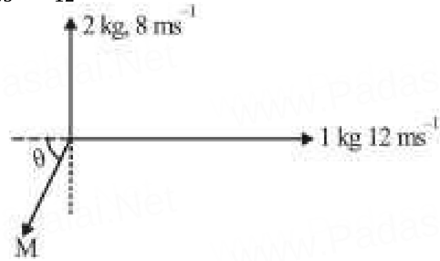
$\tan\theta = \frac{16}{12} = \frac{4}{3}$

$\cos\theta = \frac{3}{5}$

v = 4 m/s

$M = \frac{12}{v\cos\theta}$

$M = \frac{12\times5}{4\times3} = \frac{60}{12}$=5kg



Chapter: Work, Energy and Power
[Topic: Collisions]

Q72. A polyatomic gas with n degrees of freedom has a mean energy per molecule given by

(a) $\frac{nkT}{N}$
(b) $\frac{nkT}{2N}$
(c) $\frac{nkT}{2}$
(d) $\frac{3kT}{2}$

Ans: (c)

Solution: According to law of equipartition of energy, the energy per degree of freedom is $\frac{1}{2}kT$.
For a polyatomic gas with n degrees of freedom, the mean energy per molecule $= \frac{1}{2}nkT$

Chapter: Kinetic Theory
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q73. A 5ºC rise in temperature is observed in a conductor by passing a current. When the current is doubled the rise in temperature will be approximately

(a) 10ºC (b) 16ºC
(c) 20ºC (d) 12ºC

Ans: (c)

Solution: Since $H \propto I^2$, doubling the current will produce 4 times heat. Hence, the rise in temperature will also be 4 times i.e., rise in temperature = 4 × 5 = 20ºC.

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q74. The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are :

(a) 10 cm, 10 cm (b) 15 cm, 5 cm
(c) 18 cm, 2 cm (d) 11 cm, 9 cm

Ans: (c)

Solution: M.P. $= 9 = \frac{f_0}{f_e}$

$\Rightarrow f_0 = 9f_e$... (1)

$f_0 + f_e = 20$... (2)

on solving

f_0 = 18 cm = focal length of the objective

f_e = 2 cm = focal length of the eyepiece

Chapter - Ray Optics and Optical

[Topic: Optical Instruments]

Q75. A piece of copper and other of germanium are cooled from the room temperature to 80 K, then
(a) resistance of each will increase
(b) resistance of copper will decrease
(c) resistance of copper will increase while that of germanium will decrease
(d) resistance of copper will decrease while that of germanium will increase

Ans: (d)

Solution: Copper is a conductor, so, its resistance decreases on decreasing temperature as thermal agitation decreases whereas germanium is semiconductor, therefore, on decreasing temperature resistance increases.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q76. Two racing cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 respectively. Their speeds are such that each makes a complete circle in the same time t. The ratio of the angular speeds of the first to the second car is
(a) 1 : 1 (b) $m_1 : m_2$
(c) $r_1 : r_2$ (d) $m_1 m_2 : r_1 r_2$

Ans: (a)

Solution: As time taken by both car to complete one revolution is same.
As $\omega = \frac{2\pi}{T} \Rightarrow \omega \propto \frac{1}{T}$, as T is same in both cases. Hence 'ω' will also be same.

Chapter: System of Particles and Rotational Motion [Topic: Angular Displacement, Velocity and Acceleration]

Q77. The potential energy of a simple harmonic oscillator when the particle is half way to its end point is
(a) $\frac{1}{2}$E
(b) $\frac{2}{3}$E
(c) $\frac{1}{8}$E
(d) $\frac{1}{4}$E
where E is the total energy

Ans: (d)

Solution: $PE. = \frac{1}{2}kx^2 = E$
At half way
$$PE. = \frac{1}{2}k\left(\frac{x}{2}\right)^2 = \frac{\frac{1}{2}kx^2}{4} = \frac{E}{4}$$

Chapter: Oscillation [Topic: Energy in Simple Harmonic Motion]

Q78. A proton and an alpha particle both enter a region of uniform magnetic field B, moving at right angles to field B. If the radius of circular orbits for both the particles is equal and the kinetic energy acquired by proton is 1 MeV the energy acquired by the alpha particle will be:
(a) 0.5 MeV (b) 1.5 MeV
(c) 1 MeV (d) 4 MeV

Ans: (c)

Solution: As we know, $F = qvB = \frac{mv^2}{R}$
$\therefore R = \frac{mv}{qB} = \frac{\sqrt{2m(kE)}}{qB}$
Since R is same so, KE • $\frac{q^2}{m}$
Therefore KE of α particle
$= \frac{q^2}{m} = \frac{(2)^2}{4} = 1$ MeV

Chapter: Moving Charges and Magnetic Field [Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q79. In a diffraction pattern due to a single slit of width 'a', the first minimum is observed at an angle 30° when light of wavelength 5000 Å is incident on the slit. The first secondary maximum is observed at an angle of :
(a) $\sin^{-1}\left(\frac{1}{4}\right)$
(b) $\sin^{-1}\left(\frac{2}{3}\right)$
(c) $\sin^{-1}\left(\frac{1}{2}\right)$
(d) $\sin^{-1}\left(\frac{3}{4}\right)$

Ans: (d)

Solution: For the first minima,
$\theta = \frac{\eta\lambda}{a} \Rightarrow \sin 30° = \frac{\lambda}{a} = \frac{1}{2}$
First secondary maxima will be at
$\sin\theta = \frac{3\lambda}{2a} = \frac{3}{2\left(\frac{1}{2}\right)} \Rightarrow \theta = \sin^{-1}\left(\frac{3}{4}\right)$

Chapter - Wave Optics [Topic: Diffraction, Polarization of Light & Resolving Power]

Q80. In the study of transistor as amplifier, if $\alpha = \frac{I_C}{I_E}$ and $\beta = \frac{I_C}{I_B}$, where, I_C, I_B and I_E are the collector, base and emitter currents, then
[2000]
(a) $\beta = \frac{(1+\alpha)}{\alpha}$
(b) $\beta = \frac{(1-\alpha)}{\alpha}$
(c) $\beta = \frac{\alpha}{(1-\alpha)}$
(d) $\beta = \frac{\alpha}{(1+\alpha)}$

Ans: (c)

Solution: As we know that $I_e = I_c + I_b$
Divide both side by I_e
$$\frac{I_e}{I_c} = 1 + \frac{I_b}{I_c} = \frac{1}{\alpha} = 1 + \frac{1}{\beta}$$
$$\beta = \frac{\alpha}{1-\alpha}$$

Chapter: Semiconductor Electronics Materials, Devices [Topic: Junction Transistor]

Q81. Which two of the following five physical parameters have the same dimensions?
(A) Energy density
(B) Refractive index

(C) Dielectric constant
(D) Young's modulus
(E) Magnetic field
(a) (B) and (D)
(b) (C) and (E)
(c) (A) and (D)
(d) (A) and (E)

Ans: (c)

Solution: [Energy density] = $\frac{[\text{Workdone}]}{[\text{Volume}]}$

$= \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$

[Young's Modulus] = $\left[\frac{F}{A} \times \frac{l}{\Delta l}\right]$

$= \frac{MLT^{-2}}{L^2}\frac{L}{L} = ML^{-1}T^{-2}$.

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q82. A wheel having moment of inertia 2 kg-m^2 about its vertical axis, rotates at the rate of 60 rpm about this axis. The torque which can stop the wheel's rotation in one minute would be
(a) $\frac{\pi}{18}$N-m
(b) $\frac{2\pi}{15}$N-m
(c) $\frac{\pi}{12}$N-m
(d) $\frac{\pi}{15}$N-m

Ans: (d)

Solution: $\tau \times \Delta t = L_0$ {∵since $L_f = 0$}
$\Rightarrow \tau \times \Delta t = I\omega$
or, $\tau \times 60 = 2 \times 2 \times 60\pi/60$
$\tau = \frac{\pi}{15}$N-m

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q83. A mass m is vertically suspended from a spring of negligible mass; the system oscillates with a frequency n. What will be the frequency of the system, if a mass 4 m is suspended from the same spring?
(a) $\frac{n}{4}$ (b) 4n
(c) $\frac{n}{2}$ (d) 2n

Ans: (c)

Solution: $n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$$n' = \frac{1}{2\pi}\sqrt{\frac{k}{4m}} = \frac{1}{2} \times \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

On putting the value of n we get $n' = \frac{n}{2}$

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q84. A uniform magnetic field acts at right angles to the direction of motion of electron. As a result, the electron moves in a circular path of radius 2cm. If the speed of electron is doubled, then the radius of the circular path will be
(a) 2.0 cm (b) 0.5 cm
(c) 4.0 cm (d) 1.0 cm

Ans: (c)

Solution: $r = \frac{mv}{qB}$ or $r \propto v$

As v is doubled, the radius also becomes double. Hence, radius = 2 × 2 = 4 cm

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q85. The wavelength associated with an electron, accelerated through a potential difference of 100 V, is of the order of
(a) 1000 Å (b) 100 Å
(c) 10.5 Å (d) 1.2 Å

Ans: (d)

Solution: Potential difference = 100 V
K.E. acquired by electron = e (100)

$$\frac{1}{2}mv^2 = e(100) \Rightarrow v = \sqrt{\frac{2e(100)}{m}}$$

According to de Broglie's concept

$$\lambda = \frac{h}{mv}$$

$$\Rightarrow \lambda = \frac{h}{m\sqrt{\frac{2e(100)}{m}}}$$

$$= \frac{h}{\sqrt{2me(100)}} = 1.2 \times 10^{-10} = 1.2A$$

Chapter - Dual Nature of Radiation and Matter
[Topic: Matter Waves, Cathode & Positive Rays]

Q86. A gate has the following truth tablePQR111100010000
The gate is
(a) AND
(b) NOR
(c) OR
(d) NAND

Ans: (a)

Solution: P, Q and R are related as $R = P.\ Q$ which is relation of AND gate.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q87. If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be:
(a) 4% (b) 6%
(c) 8% (d) 2%

Ans: (b)

Solution: Error in the measurement of radius of a sphere = 2%

Volume of the sphere = $\frac{4}{3}\pi r^3$

∴ Error in the volume = $3.\frac{\Delta r}{r}$ = 3 × 2% = 6%

Chapter: Units and Measurement
[Topic: Errors in Measurements]

Q88. A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is K. If radius of the ball be R, then the fraction of total energy associated with its rotational energy will be

(a) $\frac{R^2}{K^2+R^2}$

(b) $\frac{K^2+R^2}{R^2}$

(c) $\frac{K^2}{R^2}$

(d) $\frac{K^2}{K^2+R^2}$

Ans: (d)

Solution: Rotational energy $= \frac{1}{2}I(\omega)^2 = \frac{1}{2}(mK^2)\omega^2$

Linear kinetic energy $= \frac{1}{2}(mK^2)\omega^2$

∴ Required fraction

$= \frac{\frac{1}{2}(mK^2)\omega^2}{\frac{1}{2}(mK^2)\omega^2 + \frac{1}{2}m\omega^2R^2} = \frac{K^2}{K^2+R^2}$

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q89. A transverse wave is represented by the equation $= y_0 \sin\frac{2\pi}{\lambda}(vt - x)$

For what value of λ is the maximum particle velocity equal to two times the wave velocity?

(a) $\lambda = 2\pi y_0$

(b) $\lambda = \frac{\pi y_0}{3}$

(c) $\lambda = \frac{\pi y_0}{2}$

(d) $\lambda = \pi y_0$

Ans: (d)

Solution: $y = y_0 \sin\frac{2\pi}{\lambda}(vt - x)$

Particle velocity

$\frac{dy}{dt} = y_0 \times \frac{2\pi}{\lambda} v \cos\frac{2\pi}{\lambda}(vt - x)$

Maximum particle velocity $= y_0 \times \frac{2\pi v}{\lambda}$

Wave velocity = v[given]

So, $y_0 \times \frac{2\pi v}{\lambda} = 2v$

$\lambda = \pi . y_0$

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q90. Tesla is the unit of

(a) magnetic flux

(b) magnetic field

(c) magnetic induction

(d) magnetic moment

Ans: (b)

Solution: Tesla is the unit of magnetic field.

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q91. Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} ω. The number of photons emitted, on the average, by the sources per second is

(a) 5×10^{16} (b) 5×10^{17}

(c) 5×10^{14} (d) 5×10^{15}

Ans: (d)

Solution: Since *p* = *nh*ν

$= n = \frac{p}{h} = \frac{2 \times 10^{-3}}{6.6 \times 10^{-34} \times 6 \times 10^{14}} = 5 \times 10^{15}$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q92. A particle moving along x-axis has acceleration f, at time t, given by $f = f_0\left(1 - \frac{t}{T}\right)$, where f_0 and T are constants. The particle at t = 0 has zero velocity. In the time interval between t = 0 and the instant when f = 0, the particle's velocity (v_x) is

(a) $\frac{1}{2}f_0T^2$ (b) f_0T^2

(c) $\frac{1}{2}f_0T$ (d) f_0T.

Ans: (c)

Solution: Here, $f = f_0\left(1 - \frac{t}{T}\right)$ or, $\frac{dv}{dt} = f_0\left(1 - \frac{t}{T}\right)$

or, $dv = f_0\left(1 - \frac{t}{T}\right)dt$

$v = \int dv = \int\left[f_0\left(1 - \frac{t}{T}\right)\right]dt$

or, $v = f_0\left(f - \frac{t^2}{2T}\right) + C$

where C is the constant of integration.

At t = 0, v = 0.

$0 = f_0\left(0 - \frac{0}{2T}\right) + C \Rightarrow C = 0$

$\therefore v = f_0\left(f - \frac{t^2}{2T}\right)$

If f = 0, then

$0 = f_0\left(1 - \frac{t}{T}\right) = t = T$

Hence, particle's velocity in the time interval t = 0 and t = T is given by

$v_x = \int_{t=0}^{t=T} dv = \int_{t=0}^{T}\left[f_0\left(1 - \frac{t}{T}\right)\right]dt$

$= f_0\left[t - \frac{t^2}{2T}\right]_0^T$

$= f_0\left(T - \frac{T^2}{2T}\right) == f_0\left(T - \frac{T}{2}\right) = \frac{1}{2}f_0T.$

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q93. A satellite A of mass m is at a distance of r from the surface of the earth. Another satellite B of mass 2m is at a distance of 2r from the earth's centre. Their time periods are in the ratio of

(a) 1 : 2 (b) 1 : 16

(c) 1 : 32 (d) $1 : 2\sqrt{2}$

Ans: (d)

Solution: Time period does not depend on the mass. Also, $T^2 \propto r^3$.

Chapter: Gravitation
[Topic: Kepler's Laws of Planetary Motion]

Q94. A uniform rope of length L and mass m_1 hangs vertically from a rigid support. A block of mass m_2 is attached to the free end of the rope. A transverse pulse of wavelength λ_1 is produced at the lower end of the rope. The wavelength of the pulse when it reaches the top of the rope is λ_2 the ratio λ_2/λ_1 is

(a) $\sqrt{\frac{m_1}{m_2}}$

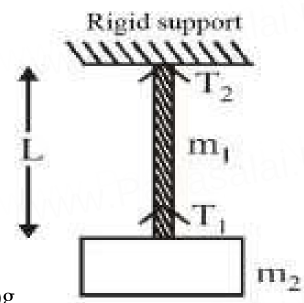
(b) $\sqrt{\frac{m_1+m_2}{m_2}}$

(c) $\sqrt{\frac{m_2}{m_1}}$

(d) $\sqrt{\frac{m_1+m_2}{m_1}}$

Ans: (b)

Solution: From figure, tension $T_1 = m_2 g$



$T_2 = (m_1 + m_2)g$
As we know
Velocity $\propto \sqrt{T}$ So,
$\lambda \propto \sqrt{T}$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{\sqrt{T_1}}{\sqrt{T_2}}$

$\Rightarrow \frac{\lambda_2}{\lambda_1} = \sqrt{\frac{m_1+m_2}{m_2}}$

Chapter: Waves
[Topic: Vibration of String & Organ Pipe]

Q95. The resistance of an ammeter is 13 Ω and its scale is graduated for a current upto 100 amps. After an additional shunt has been connected to this ammeter it becomes possible to measure currents upto 750 amperes by this meter. The value of shunt-resistance is

(a) 2 Ω (b) 0.2 Ω
(c) 2 k Ω (d) 20 Ω

Ans: (a)

Solution: We know

$\frac{I}{I_S} = 1 + \frac{G}{s}$

$\frac{750}{100} = 1 + \frac{13}{S}$

$S = 2\Omega$

Chapter: Moving Charges and Magnetic Field
[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q96. Number of ejected photoelectron increases with increase

(a) in intensity of light
(b) in wavelength of light
(c) in frequency of light
(d) never

Ans: (a)

Solution: Photoelectric current is directly proportional to the intensity of incident light.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q97. Three different objects of masses m_1, m_2 and m_3 are allowed to fall from rest and from the same point O along three different frictionless paths. The speeds of the three objects on reaching the ground will be in the ratio of

(a) $m_1 : m_2 : m_3$
(b) $m_1 : 2m_2 : 3m_3$
(c) 1:1:1 (d) $\frac{1}{m_1} : \frac{1}{m_2} : \frac{1}{m_3}$

Ans: (c)

Solution: The speed of an object, falling freely due to gravity, depends only on its height and not on its mass. Since the paths are frictionless and all the objects fall through the same height, therefore, their speeds on reaching the ground will be in the ratio of 1 : 1 : 1.

Chapter: Kinematics Motion in a Straight Line
[Topic: Motion Under Gravity]

Q98. Assuming the radius of the earth as R, the change in gravitational potential energy of a body of mass m, when it is taken from the earth's surface to a height 3R above its surface, is
[2002]

(a) 3 mg R
(b) $\frac{3}{4}$ mgR
(c) 1 mg R
(d) $\frac{3}{2}$ mgR

Ans: (b)

Solution: Gravitational potential energy (GPE) on the surface of earth,

$E_1 = -\frac{GMm}{R}$

GPE at 3R, $E_2 = -\frac{GMm}{(R+3R)} = -\frac{GMm}{4R}$

∴ Change in GPE

$= E_2 - E_1 = -\frac{GMm}{4R} + \frac{GMm}{R} = \frac{3GMm}{4R}$

$= \frac{3gR^2m}{4R} \left(g = \frac{GM}{R^2}\right)$

$= \frac{3}{4}$ mgR

Chapter: Gravitation
[Topic: Gravitational Field, Potential and Energy]

Q99. A wave has S.H.M whose period is 4 seconds while another wave which also possess SHM has its period 3 seconds. If both are combined, then the resultant wave will have the period equal to

(a) 4 seconds (b) 5 seconds

(c) 12 seconds (d) 3 seconds

Ans: (c)

Solution: Beats are produced. Frequency of beats will be $\frac{1}{3}-\frac{1}{4}=\frac{1}{12}$. Hence time period = 12 s.

Chapter: Waves

[Topic: Musical Sound & Doppler's Effect]

Q100. According to Curie's law, the magnetic susceptibility of a substance at an absolute temperature T is proportional to

(a) T^2 *(b)* $1/T$

(c) T *(d)* $1/T^2$

Ans: (b)

Solution: According to Curie's law, $\chi_m \propto \frac{1}{T}$

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

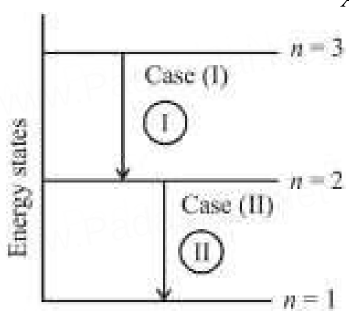
PART 2. PHYSICS QUESTION BANK

Q1. Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ratio of the wavelength $\lambda_1 : \lambda_2$ emitted in the two cases is

(a) 7/5 (b) 27/20

(c) 27/5 (d) 20/7

Ans: (c)



Solution:

The wave number $(\bar{v})$ of the radiation $= \frac{1}{\lambda}$

$= \left|R_\infty\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]\right|$

Now for case (I) $n_1 = 3$, $n_2 = 2$

$\left|\frac{1}{\lambda_1}\right| = \left|R_\infty\left[\frac{1}{9}\frac{-1}{4}\right]\right|$, R_∞ = Rydberg constant

$\left|\frac{1}{\lambda_1}\right| = \left|R_\infty\left[\frac{4-9}{36}\right]\right| = \left|\frac{-5R_\infty}{36}\right|$

$\Rightarrow |\lambda_1| = \left|\frac{-36}{5R_\infty}\right| = \frac{36}{5R_\infty}$

$\left|\frac{1}{\lambda_2}\right| = \left|R_\infty\left[\frac{1}{4} - \frac{1}{1}\right]\right| = \left|\frac{-3R_\infty}{4}\right|$

$|\lambda_2| = \left|\frac{-4}{3R_\infty}\right| = \frac{4}{3R_\infty}$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{36}{5R_\infty} \times \frac{3R_\infty}{4}$

$\frac{\lambda_1}{\lambda_2} = \frac{27}{5}$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q2. The angle between $\vec{A}$ and $\vec{A}$ is θ. The value of the triple product $\vec{A}.(\vec{B} \times \vec{A})$ is

(a) A^2B

(b) zero

(c) $A^2B \sin\theta$

(d) $A^2B \cos\theta$

Ans: (b)

Solution: Note that $(\vec{B} \times \vec{A}) \perp \vec{A}$. Hence their dot product is zero.

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q3. A planet is moving in an elliptical orbit around the sun. If T, V, E and L stand respectively for its kinetic energy, gravitational potential energy, total energy and magnitude of angular momentum about the centre of force, which of the following is correct ?

(a) T is conserved

(b) V is always positive

(c) E is always negative

(d) L is conserved but direction of vector L changes continuously

Ans: (c)

Solution: In a circular or elliptical orbital motion, torque is always acting parallel to displacement or velocity. So, angular momentum is conserved. In attractive field, potential energy is negative. Kinetic energy changes as velocity increase when distance is less. So, option (c) is correct.

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q4. An electric dipole of moment $'p'$ is placed in an electric field of intensity $'E'$. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when = 90°, the torque and the potential energy of the dipole will respectively be :

(a) $pE\sin\theta, -pE\cos\theta$

(b) $pE\sin\theta, -2pE\cos\theta$

(c) $pE\sin\theta, 2pE\cos\theta$

(d) $pE\cos\theta, -pE\cos\theta$

Ans: (a)

Solution: The torque on the dipole is given as

$\tau = pE\sin\theta$

The potential energy of the dipole in the electric field is given as

$U = -pE\cos\theta$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q5. A long solenoid has 500 turns. When a current of 2 ampere is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self- inductance of the solenoid is

(a) 2.5 henry (b) 2.0 henry

(c) 1.0 henry (d) 40 henry

Ans: (c)

Solution: Total number of turns in the solenoid, N = 500

Current, I = 2A.

Magnetic flux linked with each turn

$= 4 \times 10^{-3}$ Wb

As, $\varphi = LI$ or $N\varphi = LI \Rightarrow L = \frac{N\phi}{I}$

$= \frac{500 \times 4 \times 10^{-3}}{2}$ henry = 1 H.

Chapter: Electromagnetic

[Topic: Motional and Static EMI & Applications of EMI]

Q6. In terms of Bohr radius a_0, the radius of the second Bohr orbit of a hydrogen atom is given by

(a) $4\,a_0$ (b) $8\,a_0$

(c) $\sqrt{2}a_0$ (d) $2\,a_0$

Ans: (a)

Solution: As $r \propto n^2$, therefore, radius of 2nd Bohr's orbit $= 4\,a_0$.

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q7. Two boys are standing at the ends A and B of a ground where AB = a. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy in a time t, where t is

(a) $\frac{a}{\sqrt{v^2+v_1^2}}$

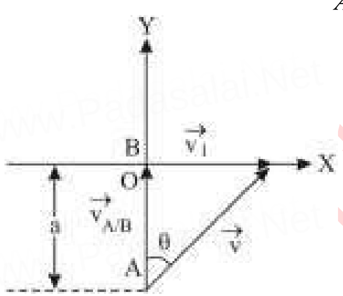
(b) $a/(v + v_1)$

(c) $a/(v-v_1)$

(d) $\sqrt{\frac{a^2}{v^2-v_1^2}}$

Ans: (d)

Solution:



Velocity of A relative to B is given by

$\vec{v}_{\frac{A}{B}} = \vec{v}_A - \vec{v}_B = \vec{v} - \vec{v}_1$ .... (1)

By taking x-components of equation (1) , we get

$0 = \sin\theta - v_1 \Rightarrow \sin\theta = \frac{v_1}{v}$ .... (2)

By taking Y-components of equation (1) , we get

$v_y = v\cos\theta$ .....(3)

Time taken by boy at A to catch the boy at B is given by

$$t = \frac{\text{Relative displacement along Y} - \text{axis}}{\text{Relative velocity along Y} - \text{axis}}$$

$$= \frac{a}{v\cos\theta} = \frac{a}{v\sqrt{1-\sin^2\theta}} = \frac{a}{v\sqrt{1-\left(\frac{v_1}{v}\right)^2}}$$

[From equation (1)]

$$= \frac{a}{v\sqrt{\frac{v^2-v_1^2}{v^2}}} = \frac{a}{\sqrt{v^2-v_1^2}} = \sqrt{\frac{a^2}{v^2-v_1^2}}$$

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in2D & Circular Motion]

Q8. The density of water at 20°C is 998 kg/m³ and at 40°C 992 kg/m³. The coefficient of volume expansion of water is

(a) 10^{-4}/°C (b) 3×10^{-4}/°C

(c) 2×10^{-4}/°C (d) 6×10^{-4}/°C

Ans: (b)

Solution: From question,

$\Delta\rho = (998 - 992)$ kg/m³ = 6 kg/m³

$\rho = \frac{998+992}{2}$kg/m³=995kg/m³

$\rho = \frac{m}{V}$

$\Rightarrow \frac{\Delta\rho}{\rho} = -\frac{\Delta V}{V} \Rightarrow \left|\frac{\Delta\rho}{\rho}\right| = \left|\frac{\Delta V}{V}\right|$

∴ Coefficient of volume expansion of water,

$\frac{1}{V}\frac{\Delta V}{\Delta t} = \frac{1}{\rho}\frac{\Delta\rho}{t} = \frac{6}{995\times 20} \approx 3 \times 104$/°C

Chapter: Thermal Properties

[Topic: Thermometry, Thermocouple& Thermal Expansion]

Q9. A point charge $+q$ is placed at mid point of a cube of side 'L'. The electric flux emerging from the cube is

(a) $\frac{q}{\varepsilon_0}$

(b) $\frac{6qL^2}{\varepsilon_0}$

(c) $\frac{q}{6L^2\varepsilon_0}$

(d) zero

Ans: (a)

Solution: By Gauss theorem

Total electric flux = $\frac{\text{Total charge inside cube}}{\varepsilon_0}$

$\Rightarrow \phi = \frac{q}{\varepsilon_0}$

Chapter: Electrostatic Potential and capacitance

[Topic: Electrostatic Potential & Equipotential Surfaces]

Q10. An inductor 20 mH, a capacitor 50 μF and a resistor 40Ω are connected in series across a source of emf V = 10 sin 340 t. The power loss in A.C. circuit is :

(a) 0.51 W (b) 0.67 W

(c) 0.76 W (d) 0.89 W

Ans: (a)

Solution: Given: L = 20 mH; C = 50 μF; R = 40 ΩV = 10 sin 340 t

$\therefore V_{runs} = \frac{10}{\sqrt{2}}$

$X_C = \frac{1}{\omega C} = \frac{1}{340\times 50\times 10^{-6}} = 58.8\ \Omega$

$X_L = \omega L = 340 \times 20 \times 10^{-3} = 6.8\ \Omega$

Impedance, $Z = \sqrt{R^2 + (X_C - X_L)^2}$

$= \sqrt{40^2 + (58.8 - 6.8)^2} = \sqrt{4304}\Omega$

Power loss in A.C. circuit,

$P = i_{rms}^2 R = \left(\frac{V_{rms}}{z}\right)^2 R$

$= \left(\frac{\frac{10}{\sqrt{2}}}{\sqrt{4304}}\right)^2 \times 40 = \frac{50\times 40}{4304} \simeq 0.51$W

Chapter: Alternating Current

[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q11. The ratio of the radii of the nuclei ${}_{13}Al^{27}$ and ${}_{52}Te^{125}$ is approximately

(a) 6 : 10 (b) 13 : 52

(c) 40 : 177 (d) 14 : 73

Ans: (a)

Solution: $R \propto (A)^{13}$

$\therefore R_{Al} \propto (27)^{13}$ and $R_{Te} \propto (125)^{13}$

$\therefore \frac{R_{Al}}{R_{Te}} = \frac{3}{5} = \frac{6}{10}$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q12. A 10 N force is applied on a body produces an acceleration of 1 m/s^2. The mass of the body is

(a) 5 kg (b) 10 kg
(c) 15 kg (d) 20 kg

Ans: (b)

Solution: By Newton's IInd law of motion, F = ma
= 10 = m (1) = m = 10 kg.

Chapter: Dynamics Laws of Motion
[Topic: Ist, IInd & IIIrd Laws of Motion]

Q13. A black body at 1227°C emits radiations with maximum intensity at a wavelength of 5000Å. If the temperature of the body is increased by 1000°C, the maximum intensity will be observed at

(a) 5000Å (b) 6000Å
(c) 3000Å (d) 4000Å

Ans: (c)

Solution: Applying Wein's displacement law,

$\lambda_m T$ = constant

5000 Å × (1227 + 273) = (2227 + 273) × λ_m

$$\lambda_m = \frac{5000 \times 1500}{1000} = 3000A$$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q14. A parallel plate air capacitor has capacity 'C' distance of separation between plates is 'd' and potential difference 'V' is applied between the plates. Force of attraction between the plates of the parallel plate air capacitor is :

(a) $\frac{CV^2}{2d}$

(b) $\frac{CV^2}{d}$

(c) $\frac{C^2V^2}{2d^2}$

(d) $\frac{C^2V^2}{2d^2}$

Ans: (a)

Solution: Force of attraction between the plates,

F = qE

$= q \times \frac{\sigma}{2\epsilon_0} = q\frac{q}{2A\epsilon_0}$

$= \frac{q^2}{2\left(\frac{\epsilon_0 A}{d}\right)\times d} = \frac{C^2V^2}{2cd} = \frac{CV^2}{2d}$

Here, $C = \frac{\epsilon_0 A}{d}$, q=CV, A=area

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q15. The core of a transformer is laminated because [2006]

(a) the weight of the transformer may be reduced
(b) rusting of the core may be prevented
(c) ratio of voltage in primary and secondary may be increased
(d) energy losses due to eddy currents may be minimised

Ans: (d)

Solution: When there is change of flux in the core of a transformer due to change in current around it, eddy current is produced. The direction of this current is opposite to the current which produces it, so it will reduce the main current. We laminate the core so that flux is reduced resulting in the reduced production of eddy current.

Chapter: Alternating Current
[Topic: Transformers & LC Oscillations]

Q16. In a fission reaction

$${}^{235}_{92}U \rightarrow {}^{117}X + {}^{117}Y + n + n$$

the binding energy per nucleon of *X* and *Y* is 8.5 MeV whereas of ${}^{236}U$ is 7.6 MeV. The total energy liberated will be about

(a) 2000 MeV (b) 200 MeV
(c) 2 MeV (d) 200 keV

Ans: (b)

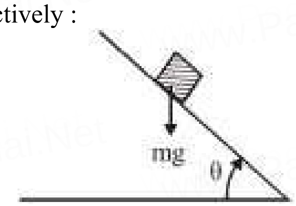
Solution: Binding energy

= 117 × 8.5 + 117 × 8.5 – 236 × 7.6
= 234 × 8.5 – 236 × 7.6
= 1989 – 1793.6 = 200 MeV

Thus, in per fission of Uranium nearly 200 MeV energy is liberated

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q17. A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30º the box starts to slip and slides 4.0 m down the plank in 4.0s. The coefficients of static and kinetic friction between the box and the plank will be, respectively :



(a) 0.6 and 0.5 (b) 0.5 and 0.6
(c) 0.4 and 0.3 (d) 0.6 and 0.6

Ans: (a)

Solution: Coefficient of static friction,

$\mu_s = \tan 30° = \frac{1}{\sqrt{3}} = 0.577 \cong 0.6$

$S = ut + \frac{1}{2}at^2$

$4 = \frac{1}{2}a(4)^2 \Rightarrow a = \frac{1}{2} = 0.5$

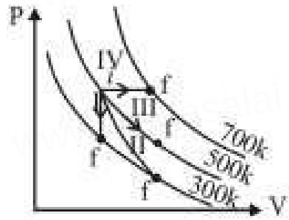
[$\because$ s = 4m and t = 4s given]

$a = g\sin\theta - \mu_k(g)\cos\theta$

$\Rightarrow \mu_k = \frac{0.9}{\sqrt{3}} = 0.5$

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q18. Thermodynamic processes are indicated in the following diagram :



Match the following
Column-1Column-2P. Process I A. AdiabaticQ. Process II B. IsobaricR. Process III C. IsochoricS. Process IV D. Isothermal
(a) P → C, Q → A, R → D, S → B
(b) P → C, Q → D, R → B, S → A
(c) P → D, Q → B, R → A, S → C
(d) P → A, Q → C, R → D, S → B

Ans: (a)

Solution: Process I volume is constant hence, it is isochoric
In process IV, pressure is constant hence, it is isobaric

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q19. The electric resistance of a certain wire of iron is *R*. If its length and radius are both doubled, then
(a) the resistance and the specific resistance, will both remain unchanged
(b) the resistance will be doubled and the specific resistance will be halved
(c) the resistance will be halved and the specific resistance will remain unchanged
(d) the resistance will be halved and the specific resistance will be doubled

Ans: (c)

Solution: $R = \frac{\rho \ell_1}{A_1}$, now $l_2 = 2l_1$
$A_2 = \pi(r_2)^2 = \pi(2r_1)^2 = 4\pi r_1^2 = 4A_1$
$R_2 = \frac{\rho(2\ell_1)}{4A_1} = \frac{\rho l_1}{2A_1} = \frac{R}{2}$
∴ Resistance is halved, but specific resistance remains the same.

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q20. If λ_v, λ_x and λ_m represent the wavelengths of visible light, *X*–rays and microwaves respectively, then
(a) $\lambda_m > \lambda_x > \lambda_v$
(b) $\lambda_m > \lambda_v > \lambda_x$
(c) $\lambda_v > \lambda_x > \lambda_m$
(d) $\lambda_v > \lambda_m > \lambda_x$

Ans: (b)

Solution: We know $E = \frac{hc}{\lambda} \Rightarrow E \propto \frac{1}{\lambda}$
$\Rightarrow E_m < E_v < E_x$
$\therefore \lambda_m > \lambda_v > \lambda_x$

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q21. Two radioactive substances A and B have decay constants 5λ and λ respectively. At *t* = 0 they have the same number of nuclei. The ratio of number of nuclei of A to those of B will be $(1/e)^2$ after a time interval
(a) 4λ (b) 2λ
(c) 1/2λ(d) 1/4λ

Ans: (c)

Solution: $\lambda_A = 5\lambda$ and $\lambda_B = \lambda$
At *t* = 0, $(N_0)_A = (N_0)_B$
Given, $\frac{N_A}{N_B} = \left(\frac{1}{e}\right)^2$
According to radioactive decay,
$\frac{N}{N_0} = e^{-\lambda t}$
$\frac{N_A}{(N_0)_A} = e^{-\lambda_A t}$ ..... (1)
$\frac{N_B}{(N_0)_B} = e^{-\lambda_B t}$ ..... (2)
From (1) and (2) ,
$\frac{N_A}{N_B} = e^{-(5\lambda-\lambda)t}$
$= \left(\frac{1}{e}\right)^2 = e^{-4\lambda t} = \left(\frac{1}{e}\right)^{4\lambda t}$
$= 4\lambda t = 2$
$t = \frac{1}{2\lambda}$.

Chapter: Nuclei
[Topic: Radioactivity]

Q22. A uniform force of $(3\hat{i} + \hat{j})$ newton acts on a particle of mass 2 kg. The particle is displaced from position $(2\hat{i} + k)$ meter to position $(4\hat{i} + 3\hat{j} - \hat{k})$ meter. The work done by the force on the particle is
(a) 6 J (b) 13 J
(c) 15 J (d) 9 J

Ans: (d)

Solution: Given : $\vec{F} = 3\hat{i} + \hat{j}$
$\vec{r_1} = (2\hat{i} + \vec{k})$, $\vec{r_2} = (4\hat{i} + 3\hat{j} - \vec{k})$
$\vec{r} = \vec{r_2} - \vec{r_1} = (4\hat{i} + 3\hat{j} - \hat{k}) - (2\hat{i} + \hat{k})$
or $\vec{r} = 2\hat{i} + 3\hat{j} - 2\hat{k}$
So work done by the given force $w = \vec{f}.\vec{r}$
$= (3\hat{i} + \hat{j}).(2\hat{i} + 3\hat{j} - 2\hat{k}) = 6 + 3 = 9J$

Chapter: Work, Energy and Power
[Topic: Work]

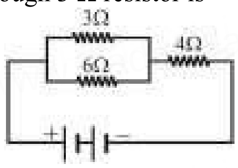
Q23. At 27° C a gas is compressed suddenly such that its pressure becomes (1/8) of original pressure. Final temperature will be (γ = 5/3)
(a) 420 K (b) 300K
(c) – 142°C (d) 327°C

Ans: (c)

Solution: $T_1^{\gamma} P_1^{1-} = T_2^{\gamma} P_2^{1-\gamma}$
$= \left(\frac{T_2}{T_1}\right)^{\gamma} = \left(\frac{P_1}{P_2}\right)^{1-\gamma}$
$\Rightarrow T_2 = T_1.\left(\frac{P_1}{P_2}\right)^{\frac{1-\gamma}{\gamma}} = 300 \times (8)^{-2/5} = 142°C$

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q24. Current through 3 Ω resistor is



0.8 amp., then potential drop through 4Ω resistor is

(a) 9.6 V (b) 2.6 V
(c) 4.8 V (d) 1.2 V

Ans: (c)

Solution: Voltage across 3 Ω resistance = 3 × 0.8 = 2.4V

This voltage is the same across 6 Ω resistance. Hence current through this resistance

$i = \frac{V}{R} = \frac{2.4}{6} = 0.4\text{amp}$

Total current in the circuit

= 0.8 + 0.4 = 1.2 amp

Voltage across 4 Ω resistance

= 4 × 1.2 = 4.8 volts

Chapter: Current Electricity
[Topic: Combination of Resistances]

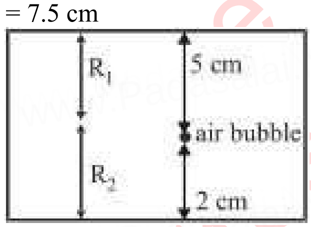
Q25. An air bubble in a glass slab (μ = 1.5) is 5 cm deep when viewed from one face and 2 cm deep when viewed from the opposite face. The thickness of the slab is

(a) 7.5 cm (b) 10.5 cm
(c) 7 cm (d) 10 cm

Ans: (b)

Solution: $5 = \frac{\text{Real depth}(R_1)}{\text{Appaent depth}(5\text{cm})}$

∴ $R_1 = 1.5 \times 5 = 7.5$ cm



For opposite face,

$1.5 = \frac{R_2}{2} \Rightarrow R_2 = 3.0$ cm

∴ Thickness of the slab = $R_1 + R_2$

= 7.5 + 3 = 10.5 cm

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q26. A radioactive sample with a half life of 1 month has the label : 'Activity = 2 micro curies on 1–8–1991. What would be its activity two months earlier ?

(a) 1.0 micro curie (b) 0.5 micro curie
(c) 4 micro curie (d) 8 micro curie

Ans: (d)

Solution: In two half lives, the activity becomes one fourth.

Activity on 1–8–91 was 2 micro–curie

∴ Activity before two months,

4 × 2 micro-curie = 8 micro curie

Chapter: Nuclei
[Topic: Radioactivity]

Q27. The kinetic energy acquired by a mass (m) in travelling distance (s) starting from rest under the action of a constant force is directly proportional to

(a) $\frac{1}{\sqrt{m}}$ (b) 1/m
(c) $\sqrt{m}$
(d) m^0

ANS: (D)

Solution: K.E. $= \frac{1}{2}mv^2$

Further, $v^2 = u^2 + 2as = 0 + 2ad = 2ad$

$= 2\left(\frac{F}{m}\right)d$

Hence, K.E. $= \frac{1}{2}m \times 2\left(\frac{F}{m}\right)d = Fd$

or, K.E. acquired = Work done

= F × d = constant.

i.e., it is independent of mass m.

Chapter: Work, Energy and Power
[Topic: Energy]

Q28. The molecules of a given mass of a gas have r.m.s. velocity of 200 ms^{-1} at 27°C and 1.0×10^5 Nm^{-2} pressure. When the temperature and pressure of the gas are respectively, 127°C and 0.05×10^5 Nm^{-2}, the r.m.s. velocity of its molecules in ms^{-1} is :

(a) $100\sqrt{2}$
(b) $\frac{400}{\sqrt{3}}$
(c) $\frac{100\sqrt{2}}{3}$
(d) $\frac{100}{3}$

Ans: (b)

Solution: Here v_1 = 200 m/s;

temperature T_1 = 27°C = 27 + 273 = 300 k

temperature T_2 = 127° C = 127 + 273 = 400 k, V = ?

R.M.S. Velocity, $V \propto \sqrt{T}$

$\Rightarrow \frac{v}{200} = \sqrt{\frac{400}{300}}$

$\Rightarrow v = \frac{200 \times 2}{\sqrt{3}}$m/s $\Rightarrow v = \frac{400}{\sqrt{3}}$m/s

Chapter: Kinetic Theory
[Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q29. A car battery has e.m.f. 12 volt and internal resistance 5×10^{-2} ohm. If it draws 60 amp current, the terminal voltage of the battery will be

(a) 15 volt (b) 3 volt
(c) 5 volt (d) 9 volt

Ans: (d)

Solution: $E = V + Ir$

$12 = V + 60 \times 5 \times 10^{-2}$

$12 = V + 3$

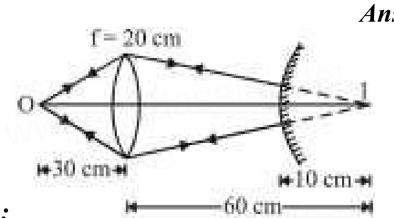
$\Rightarrow V = 9$ volt

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q30. A luminous object is placed at a distance of 30 cm from the convex lens of focal length 20 cm. On the other side of the lens, at what distance from the lens a convex mirror of radius of curvature 10 cm be placed in order to have an upright image of the object coincident with it?

(a) 12 cm (b) 30 cm
(c) 50 cm (d) 60 cm

Ans: (c)



Solution:

For the lens,

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}; \frac{1}{v} - \frac{1}{-30} = \frac{1}{20} \Rightarrow v = 60$ cm

Coincidence is possible when the image is formed at the centre of curvature of the mirror. Only then the rays refracting through the lens will fall normally on the convex mirror and retrace their path to form the image at O. So, the distance between lens and mirror = 60 – 10 = 50 cm.

Chapter - Ray Optics and Optical [Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q31. Carbon, silicon and germanium atoms have four valence electrons each. Their valence and conduction bands are separated by energy band gaps represented by $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$ respectively. Which one of the following relationships is true in their case?

(a) $(E_g)_{si} > (E_g)_{Ge} < (E_g)_C$
(b) $(E_g)_C < (E_g)_{Si}$
(c) $(E_g)_C = (E_g)_{Si}$
(d) $(E_g)_C < (E_g)_{Ge}$

Ans: (a)

Solution: Due to strong electronegativity of carbon.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q32. A shell of mass 200 gm is ejected from a gun of mass 4 kg by an explosion that generates 1.05 kJ of energy. The initial velocity of the shell is:

(a) 100 ms^{-1} (b) 80 ms^{-1}
(c) 40 ms^{-1} (d) 120 ms^{-1}

Ans: (a)

Solution: Let the initial velocity of the shell be v, then by the conservation of momentum mv = Mv'

where v' = velocity of gun.

$v^1 = \left(\frac{m}{M}\right) v$

Now, total K.E. $= \frac{1}{2}mv^2 + \frac{1}{2}Mv^2$

$= \frac{1}{2}mv^2 + \frac{1}{2}M\left(\frac{m}{M}\right)^2 v^2$

$= \frac{1}{2}mv^2\left[1 + \frac{m}{M}\right]$

$= \left(\frac{1}{2} \times 0.2\right)\left(1 + \frac{0.2}{4}\right) v^2 = (0.1 \times 1.05)v^2$

But total K.E. = 1.05 kJ = 1.05×10^3 J

$\therefore 1.05 \times 10^3 = 0.1 \times 1.05 \times v^2$

$\Rightarrow v^2 = \frac{1.05'10^3}{0.1'1.05} = 10^4$

$\therefore v = 10^2 = 100\ ms^{-1}$.

Chapter: Work, Energy and Power [Topic: Collisions]

Q33. When two displacements represented by $y_1 = a \sin(\omega t)$ and $y_2 = b \cos(\omega t)$ are super-imposed the motion is:

(a) simple harmonic with amplitude $\frac{a}{b}$
(b) simple harmonic with amplitude $\sqrt{a^2 + b^2}$
(c) simple harmonic with amplitude $\frac{(a+b)}{2}$
(d) not a simple harmonic

Ans: (b)

Solution: The two displacements equations are $y_1 = a \sin(\omega t)$

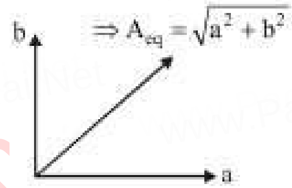
and $y_2 = b\cos(\omega t) = b \sin\left(\omega t + \frac{\pi}{2}\right)$

$y_{eq} = y_1 + y_2$

$= a \sin\omega t + b \cos\omega t = a \sin\omega t + b \sin\left(\omega t + \frac{\pi}{2}\right)$

Since the frequencies for both SHMs are same, resultant motion will be SHM.

Now $A_{eq} = \sqrt{a^2 + b^2 + 2ab\cos\frac{\pi}{2}}$



Chapter: Oscillation [Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q34. A (100 W, 200 V) bulb is connected to a 160V power supply. The power consumption would be

(a) 125 W (b) 100 W
(c) 80 W (d) 64 W

Ans: (d)

Solution: Power = 100 W, Voltage = 200 V

Resistance of bulb

$= \frac{V^2}{P} = \frac{200 \times 200}{100} = 400\Omega$

When bulb is applied across 160 V,

Current in bulb $= \frac{160}{400}$A

Power consumption = VI $= 160 \times \frac{160}{400} = 64$W

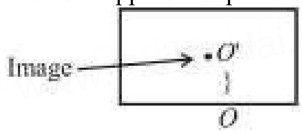
Chapter: Current Electricity [Topic: Heating Effects of Current]

Q35. A microscope is focussed on a mark on a piece of paper and then a slab of glass of thickness 3 cm and refractive index 1.5 is placed over the mark. How should the microscope be moved to get the mark in focus again ?

(a) 4.5 cm downward (b) 1 cm downward
(c) 2 cm upward (d) 1 cm upward

Ans: (d)

Solution: In the later case microscope will be focussed for *O*'. So, it is required to be lifted by distance *OO*'.
OO' = real depth of O – apparent depth of *O*.



$$= 3 - \frac{3}{1.5}\left[\mu = \frac{\text{real depth}}{\text{apparent depth}}\right]$$
$$= 3\left[\frac{1.5-1}{1.5}\right] = \frac{3 \times .5}{1.5} = 1\text{cm}$$

Chapter - Ray Optics and Optical [Topic: Optical Instruments]

Q36. Diamond is very hard because
(a) it is a covalent solid
(b) it has large cohesive energy
(c) high melting point
(d) insoluble in all solvents

Ans: (b)

Solution: Diamond is very hard due to large cohesive energy.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q37. If a flywheel makes 120 revolutions/minute, then its angular speed will be
(a) 8 π rad/sec (b) 6 π rad/sec
(c) 4 π rad/sec (d) 2 π rad/s

Ans: (c)

Solution: Angular speed, $\omega = \frac{120 \times 2\pi}{60} = 4\pi$ rad/sec

Chapter: System of Particles and Rotational Motion [Topic: Angular Displacement, Velocity and Acceleration]

Q38. A particle is executing a simple harmonic motion of amplitude a. Its potential energy is maximum when the displacement from the position of the maximum kinetic energy is
(a) 0 (b) $\pm$a
(c) $\pm\frac{a}{2}$ (d) – a/2

Ans: (b)

Solution: P.E. of particle executing S.H.M. $= \frac{1}{2}m\omega^2x^2$
At x = a, P.E. is maximum i.e. $= \frac{1}{2}m\omega^2a^2$
K.E. $= \frac{1}{2}m\omega(a^2 - x^2)2$
At x = 0, K.E. is maximum. Hence, displacement from position of maximum Kinetic energy = $\pm$ a.

Chapter: Oscillation [Topic: Energy in Simple Harmonic Motion]

Q39. An alternating electric field, of frequency *v*, is applied across the dees (radius = *R*) of a cyclotron that is being used to accelerate protons (mass = *m*). The operating magnetic field (*B*) used in the cyclotron and the kinetic energy (*K*) of the proton beam, produced by it, are given by :
(a) $B = \frac{mv}{e}$ and $K = 2m\pi^2v^2R^2$
(b) $B = \frac{2\pi mv}{e}$ and $K = m^2\pi vR^2$
(c) $B = \frac{2\pi mv}{e}$ and $K = 2m\pi^2v^2R$
(d) $B = \frac{mv}{e}$ and $K = m^2\pi vR^2$

Ans: (c)

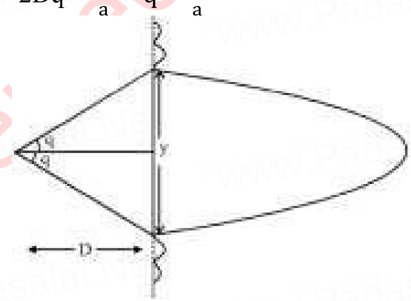
Solution: Time period of cyclotron is
$T = \frac{1}{\upsilon} = \frac{2\pi m}{eB}$; $B = \frac{2\pi m}{e}\upsilon$; $= \frac{m\upsilon}{eB} = \frac{p}{eB}$
$\Rightarrow P = eBR = e \times \frac{2\pi m\upsilon}{e}R = 2\pi m\upsilon R$
K.E. $= \frac{p^2}{2m} = \frac{(2\pi m\upsilon R)^2}{2m} = 2\pi^2 m\upsilon^2R^2$

Chapter: Moving Charges and Magnetic Field [Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q40. For a parallel beam of monochromatic light of wavelength 'λ', diffraction is produced by a single slit whose width 'a' is of the wavelength of the light. If 'D' is the distance of the screen from the slit, the width of the central maxima will be :
(a) $\frac{D\lambda}{a}$
(b) $\frac{Da}{\lambda}$
(c) $\frac{2Da}{\lambda}$
(d) $\frac{2D\lambda}{a}$

Ans: (d)

Solution: Linear width of central maxima y
$= D(2q) = 2Dq = \frac{2D\lambda}{a} \therefore q = \frac{\lambda}{a}$



Chapter - Wave Optics [Topic: Diffraction, Polarization of Light & Resolving Power]

Q41. The transfer ratio β of a transistor is 50. The input resistance of the transistor when used in the common emitter configuration is 1 kΩ. The peak value of the collector A.C. current for an A.C. input voltage of 0.01 V peak is
(a) 100 μA (b) 0.01 mA
(c) 0.25 mA (d) 500 μA

Ans: (d)

Solution: $i_c = \beta\frac{V_s}{R_{in}} = 50 \times \frac{0.01}{1000} = 500 \times 10^{-6}$A
= 500 μA

Chapter: Semiconductor Electronics Materials, Devices [Topic: Junction Transistor]

Q42. Dimensions of resistance in an electrical circuit, in terms of dimension of mass M, of length L, of time T and of current I, would be

(a) ML^2T^{-2}
(b) $ML^2T^{-1}I^{-1}$
(c) $ML^2T^{-3}I^{-2}$
(d) $ML^2T^{-3}I - 1$

Ans: (c)

Solution: Dimensions of Resistance,

$R = \frac{[V]}{[I]} = \frac{[ML^2T^{-3}I^{-1}]}{[I]} = [ML^2T^{-3}I^{-2}]$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q43. Consider a system of two particles having masses m_1 and m_2. If the particle of mass m_1 is pushed towards the centre of mass of particles through a distance d, by what distance would the particle of mass m_2 move so as to keep the centre of mass of particles at the original position?

(a) $\frac{m_2}{m_1}d$
(b) $\frac{m_1}{m_1+m_2}d$
(c) $\frac{m_1}{m_2}d$
(d) d

Ans: (c)

Solution: m1d1 = m2 d2 = $d_2 = \frac{m_1d_1}{m_2} = \frac{m_1}{m_2}d$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q44. If the length of a simple pendulum is increased by 2%, then the time period

(a) increases by 2%
(b) decreases by 2%
(c) increases by 1%
(d) decreases by 1%

Ans: (c)

Solution: We know that $T = 2\pi\sqrt{\frac{l}{g}}$

$\frac{\Delta T}{T} \times 100 = \frac{1}{2}\frac{\Delta l}{l} \times 100$

If length is increased by 2%., time period increases by 1%.

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q45. A current carrying coil is subjected to a uniform magnetic field. The coil will orient so that its plane becomes

(a) inclined at 45° to the magnetic field
(b) inclined at any arbitrary angle to the magnetic field
(c) parallel to the magnetic field
(d) perpendicular to the magnetic field

Ans: (d)

Solution: The plane of coil will orient itself so that area vector aligns itself along the magnetic field.So, the plane will orient perpendicular to the magnetic field.

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q46. Gases begin to conduct electricity at low pressure because

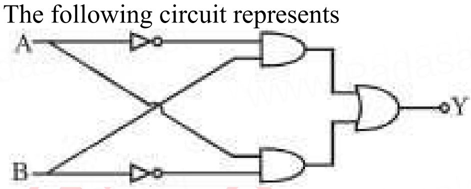
(a) at low pressures gases turn of plasma
(b) colliding electrons can acquire higher kinetic energy due to increased mean free path leading to ionisation of atoms
(c) atoms break up into electrons and protons
(d) the electrons in atoms can move freely at low pressures

Ans: (b)

Solution: The ionisation requires high energy electrons.

Chapter - Dual Nature of Radiation and Matter
[Topic: Matter Waves, Cathode & Positive Rays]

Q47. The following circuit represents



(a) OR gate
(b) XOR gate
(c) AND gate
(d) NAND gate

Ans: (b)

Solution: Output of upper AND gate = $\overline{A}.B$

Output of lower AND gate = $\overline{A}.B$

∴ Output of OR gate, $= A.\overline{B} + B.\overline{A}$

This is Boolean expression for XOR gate.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q48. The density of a cube is measured by measuring its mass and length of its sides. If the maximum error in the measurement of mass and length are 4% and 3% respectively, the maximum error in the measurement of density will be

(a) 7%
(b) 9%
(c) 12%
(d) 13%

Ans: (d)

Solution: Density = $\frac{\text{Mass}}{\text{Volume}}$

$\rho = \frac{M}{L^3} \therefore \frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + 3\frac{\Delta L}{L}$

% error in density = % error in Mass
+ 3 (% error in length)
= 4 + 3(3) = 13%

Chapter: Units and Measurement
[Topic: Errors in Measurements]

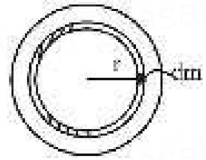
Q49. A composite disc is to be made using equal masses of aluminium and iron so that it has as high a moment of inertia as possible. This is possible when

(a) the surfaces of the discs are made of iron with aluminium inside
(b) the whole of aluminium is kept in the core and the iron at the outer rim of the disc
(c) the whole of the iron is kept in the core and the aluminium at the outer rim of the disc

(d) the whole disc is made with thin alternate sheets of iron and aluminium

Ans: (b)

Solution: Density of iron > density of aluminium
moment of inertia = $\int r^2\, dm$.



∴ Since, $\rho_{iron} > \rho_{aluminium}$
So, whole of aluminium is kept in the core and the iron at the outer rim of the disc.

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q50. A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21 Å between them. The wavelength of the standing wave is

(a) 1.21 Å (b) 2.42 Å
(c) 6.05 Å (d) 3.63 Å

Ans: (a)

Solution: Let l be length of string

$\ell = \left(\frac{\lambda}{2}\right)2 \Rightarrow \lambda = \ell$

Hence, the wave length of standing wave = $\lambda = \ell$ = 1.21A

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

PART 3. PHYSICS QUESTION BANK

Q51. A 250-turn rectangular coil of length 2.1 cm and width 1.25 cm carries a current of 85 μA and subjected to magnetic field of strength 0.85 T. Work done for rotating the coil by 180º against the torque is

(a) 4.55 μJ (b) 2.3 μJ
(c) 1.15 μJ (d) 9.1 μJ

Ans: (d)

Solution: Work done, $W = MB(\cos\theta_1 - \cos\theta_2)$
When it is rotated by angle 180° then
$W = MB(\cos 0° - \cos 180°) = MB(1 + 1)$
$W = 2MB$
$W = 2 (NIA) B$
$= 2 \times 250 \times 85 \times 10^{-6}[1.25 \times 2.1 \times 10^{-4}] \times 85 \times 10^{-2}$
$= 9.1$ μJ

Chapter: Moving Charges and Magnetic Field [Topic: Force & Torque on a Current Carrying Conductor]

Q52. A 5 watt source emits monochromatic light of wavelength 5000 Å. When placed 0.5 m away, it liberates photoelectrons from a photosensitive metallic surface. When the source is moved to a distance of 1.0 m, the number of photoelectrons liberated will be reduced by a factor of

(a) 8 (b) 16
(c) 2 (d) 4

Ans: (d)

Solution: Number of emitted electrons N_E
$\propto$ Intensity
$\propto \frac{1}{(\text{Distance})^2}$
Therefore, as distance is doubled, N_E decreases by (1/4) times.

Chapter - Dual Nature of Radiation and Matter [Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q53. A particle moves along a straight line OX. At a time t (in seconds) the distance x (in metres) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest?

(a) 40 m (b) 56 m
(c) 16 m (d) 24 m

Ans: (b)

Solution: $x = 40 + 12t - t^3$
$v = \frac{dx}{dt} = 12 - 3t^2$
For v = 0; $t = \sqrt{\frac{12}{3}} = 2\text{sec}$
So, after 2 seconds velocity becomes zero.
Value of x in 2 secs $= 40 + 12 \times 2 - 2^3$
$= 40 + 24 - 8 = 56$ m

Chapter: Kinematics Motion in a Straight Line [Topic: Non-uniform motion]

Q54. The distance of two planets from the sun are 10^{13} and 10^{12} metres respectively. The ratio of time periods of these two planets is

(a) $\frac{1}{\sqrt{10}}$ (b) 100
(c) $10\sqrt{10}$
(d) $\sqrt{10}$

Ans: (c)

Solution: $T^2 \propto R^3$ (Kepler's law)
$\frac{T_1^2}{T_2^2} = \left(\frac{10^{13}}{10^{12}}\right)^3 = \frac{T_1}{T_2} = 10\sqrt{10}$

Chapter: Gravitation [Topic: Kepler's Laws of Planetary Motion]

Q55. The fundamental frequency of a closed organ pipe of length 20 cm is equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is

(a) 100 cm (b) 120 cm
(c) 140 cm (d) 80 cm

Ans: (b)

Solution: Fundamental frequency of closed organ pipe
$V_c = \frac{V}{4l_c}$
Fundamental frequency of open organ pipe
$V_0 = \frac{V}{2l_0}$
Second overtone frequency of open organ pipe $= \frac{3V}{2l_0}$
From question,
$\frac{V}{4l_c} = \frac{3V}{2l_0}$
$\Rightarrow l_0 = 6l_c = 6 \times 20 = 120$ cm

Chapter: Waves [Topic: Vibration of String & Organ Pipe]

Q56. A galvanometer acting as a voltmeter will have [2004, 2002]

(a) a low resistance in series with its coil.
(b) a high resistance in parallel with its coil
(c) a high resistance in series with its coil
(d) a low resistance in parallel with its coil

Ans: (c)

Solution: A galvanometer can be converted into a voltmeter by connecting *the high ressistance in series* with the galvanometer so that only a small amount of current passes through it.

Chapter: Moving Charges and Magnetic Field [Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q57. Momentum of a photon of wavelength λ is [1993]

(a) $\frac{h}{\lambda}$
(b) zero
(c) $\frac{h\lambda}{c^2}$

(d) $\frac{h\lambda}{c}$

Ans: (a)

Solution: According to de Brogie wave equation,

$\lambda = \frac{h}{mv} = \frac{h}{p}$ $p = \frac{h}{\lambda}$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q58. The water drops fall at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap at an instant when the first drop touches the ground. How far above the ground is the second drop at that instant ? (Take $g = 10\ m/s^2$)

(a) 1.25 m (b) 2.50 m
(c) 3.75 m (d) 5.00 m

Ans: (c)

Solution: Height of tap = 5m and (g) = 10 m/sec^2.

For the first drop, $5 = ut + \frac{1}{2}gt^2$

$= (0 \times t) + \frac{1}{2} \times 10t^2 = 5t^2$ or $t^2 = 1$ or t = 1 sec.

It means that the third drop leaves after one second of the first drop. Or, each drop leaves after every 0.5 sec.

Distance covered by the second drop in 0.5 sec

$= ut + \frac{1}{2}t^2 = (0 \times 0.5) + \frac{1}{2} \times 10 \times (0.5)^2$

= 1.25 m.

Therefore, distance of the second drop above the ground = 5 – 1.25 = 3.75 m.

Chapter: Kinematics Motion in a Straight Line
[Topic: Motion Under Gravity]

Q59. The potential energy of a satellite, having mass m and rotating at a height of 6.4×10^6 m from the earth surface, is

(a) $-mgR_e$ (b) $-0.67\ mgR_e$
(c) $-0.5\ mgR_e$ (d) $-0.33\ mgR_e$

Ans: (c)

Solution: Mass of the satellite = m and height of satellite from earth (h) = 6.4×10^6 m.

We know that gravitational potential energy of the satellite at height

$h = -\frac{GM_em}{R_e+h} = -\frac{gR_e^2m}{2R_e}$

$= -\frac{gR_em}{2} = -0.5mgR_e$

(where, $GM_e = gR_e^2$ and $h = R_e$)

Chapter: Gravitation
[Topic: Gravitational Field, Potential and Energy]

Q60. If the amplitude of sound is doubled and the frequency is reduced to one fourth, the intensity of sound at the same point will be

(a) increasing by a factor of 2 (b) decreasing by a factor of 2
(c) decreasing by a factor of 4 (d) unchanged

Ans: (c)

Solution: Intensity is proportional to (amplitude)^2 and also intensity α (frequency)^2. Therefore, intensity becomes $\frac{2^2}{4^2} = \frac{1}{4}$th

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q61. A diamagnetic material in a magnetic field moves

(a) perpendicular to the field
(b) from stronger to the weaker parts of the field
(c) from weaker to the stronger parts of the field
(d) in none of the above directions

Ans: (b)

Solution: A diamagnetic material in a magnetic field moves from stronger to the weaker parts of the field.

Chapter: Magnetism and Matter
[Topic: Magnetic Equipments]

Q62. An electron of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be :

(a) $\frac{24hR}{25m}$
(b) $\frac{25hR}{24m}$
(c) $\frac{25m}{24hR}$
(d) $\frac{24m}{25hR}$

(*m* is the mass of the electron, *R*, Rydberg constant and *h* Planck's constant)

Ans: (a)

Solution: For emission, the wave number of the radiation is given as

$\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

R = Rydberg constant, *Z* = atomic number

$= R\left(\frac{1}{1^2} - \frac{1}{5^2}\right) = R\left(1 - \frac{1}{25}\right) \Rightarrow \frac{1}{\lambda} = R\frac{24}{25}$

linear momentum

$P - \frac{h}{\lambda} = h \times R \times \frac{24}{25}$ (de-Broglie hypothesis)

$\Rightarrow mv = \frac{24hR}{25} \Rightarrow V = \frac{24hR}{25m}$

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q63. The magnitudes of vectors $\vec{A}, \vec{B}$ and $\vec{C}$ are 3, 4 and 5 units respectively. If $\vec{A} + \vec{B} = \vec{C}$, then the angle between $\vec{A}$ and $\vec{A}$ is

(a) π/2 (b) $\cos^{-1} 0.6$
(c) $\tan^{-1} 7/5$ (d) π/4

Ans: (a)

Solution: $(\vec{A} + \vec{B})^2 = (\vec{C})^2$

$\Rightarrow A^2 + B^2 + 2\vec{A}.\vec{B} = C^2$

$\Rightarrow 3^2 + 4^2 + 2\vec{A}.\vec{B} = 5^2$

$= 2\vec{A}.\vec{B} = 0$

or $\Rightarrow \vec{A}.\vec{B} = 0$

$\vec{A} \perp \vec{B}$

Here $A^2 + B^2 = C^2$. Hence, $\vec{A} \perp \vec{B}$

Chapter: Kinematics Motion in a Plane

[Topic: Motion in a Plane with Constant acceleration]

Q64. If the gravitational force between two objects were proportional to 1/R (and not as $1/R^2$) where R is separation between them, then a particle in circular orbit under such a force would have its orbital speed v proportional to
[1989]

(a) $1/R^2$ (b) R^0
(c) R^1 (d) $1/R$

Ans: (b)

Solution: $F = \frac{k}{R} = \frac{Mv^2}{R}$. Hence $v \propto R^0$

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q65. The electric potential V at any point (x, y, z), all in meters in space is given by $V = 4x^2$ volt. The electric field at the point (1, 0, 2) in volt/meter is

(a) 8 along positive X-axis (b) 16 along negative X-axis
(c) 16 along positive X-axis (d) 8 along negative X-axis

Ans: (d)

Solution: $\vec{E} = -\left[\frac{dv}{dx}\hat{\imath} + \frac{dv}{dy}\hat{\jmath} + \frac{dv}{dz}\hat{k}\right]$

$= -8\times\hat{\imath}$ volt/meter

$\vec{E}_{(1,0,2)} = -8\hat{\imath}$ V/m

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q66. Two coils of self inductances 2 mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is
[2006]

(a) 6 mH (b) 4 mH
(c) 16 mH (d) 10 mH

Ans: (b)

Solution: Mutual Inductance of two coils

$M = \sqrt{M_1 M_2} = \sqrt{2mH \times 8mH} = 4mH$

Chapter: Electromagnetic

[Topic: Motional and Static EMI & Applications of EMI]

Q67. The ionization energy of hydrogen atom is 13.6 eV. Following Bohr's theory, the energy corresponding to a transition between 3rd and 4th orbit is

(a) 3.40 eV (b) 1.51 eV
(c) 0.85 eV (d) 0.66 eV

Ans: (d)

Solution: $E = E_4 - E_3$

$= -\frac{13.6}{4^2} - \left(-\frac{13.6}{3^2}\right) = -0.85 + 1.51$

= 0.66 eV

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q68. A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 seconds, what is the magnitude and direction of acceleration of the stone?

(a) π^2m s^{-2} and direction along the radius towards the centre
(b) π^2m s^{-2} and direction along the radius away from the centre
(c) π^2m s^{-2} and direction along the tangent to the circle
(d) $\pi^2/4$m s^{-2} and direction along the radius towards the centre

Ans: (a)

Solution: $a_r = \omega^2 R$ & $a_t = \frac{dv}{d} = 0$

or, $a_r = (2\pi n)^2 R = 4\pi^2 n^2 R^2 = 4\pi^2 \left(\frac{22}{44}\right)^2 (1)^2$

$a_{net} = a_r = \pi^2$ms^{-2} and direction along the radius towards the centre.

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in2D & Circular Motion]

Q69. On a new scale of temperature (which is linear) and called the W scale, the freezing and boiling points of water are 39° W and 239° W respectively. What will be the temperature on the new scale, corresponding to a temperature of 39° C on the Celsius scale?

(a) 78° W (b) 117° W
(c) 200° W (d) 139° W

Ans: (b)

Solution: For different temperature scales, we have

$\frac{x - LFP}{UFP - LFP}$ =constant

Where L.F.P ⇒ Lower Fixed point

U.H.F. ⇒ Upper fixed point

where x is the measurement at that scale. Here, if C and W be the measurements on Celsius and W scale then,

$\frac{C - 0}{100 - 0} = \frac{W - 39}{(239 - 39)(c = 39°C)}$

$\Rightarrow W = \frac{39\times200}{100} + 39 = 78 + 39 = 117°$ W

Chapter: Thermal Properties

[Topic: Thermometry, Thermocouple& Thermal Expansion]

Q70. A nucleus of uranium decays at rest into nuclei of thorium and helium. Then :

(a) the helium nucleus has less momentum than the thorium nucleus.
(b) the helium nucleus has more momentum than the thorium nucleus.
(c) the helium nucleus has less kinetic energy than the thorium nucleus.
(d) the helium nucleus has more kinetic energy than the thorium nucleus.

Ans: (d)

Solution: In an explosion a body breaks up into two pieces of unequal masses both part will have numerically equal momentum and lighter part will have more velocity.

U → Th + He

KETh = $\frac{P^2}{2m_{Th}}$, KEHe = $\frac{P^2}{2m_{He}}$
since m_{He} is less so KE_{He} will be more.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q71. A ball of mass 150 g, moving with an acceleration 20 m/s^2, is hit by a force, which acts on it for 0.1 sec. The impulsive force is
(a) 0.5 N
(b) 0.1 N
(c) 0.3 N
(d) 1.2 N

Ans: (c)

Solution: Mass = 150 gm = $\frac{150}{1000}$kg
Force = Mass × acceleration
= $\frac{150}{1000} \times 20N = 3N$
Impulsive force = $F.\Delta t = 3 \times 0.1 = 0.3N$

Chapter: Dynamics Laws of Motion
[Topic: Ist, IInd & IIIrd Laws of Motion]

Q72. Which of the following circular rods (given radius r and length l), each made of the same material and whose ends are maintained at the same temperature will conduct most heat?
(a) $r = r_0$; $l = l_0$
(b) $r = 2r_0$; $l = l_0$
(c) $r = r_0$; $l = 2l_0$
(d) $r = 2r_0$; $l = 2l_0$

Ans: (b)

Solution: We know that Q = $\frac{T_H - T_L}{R}$
Also, Thermal resistance R = $\frac{l}{KA} = \frac{l}{K\pi r^2}$
Heat flow will be maximum when thermal resistance is minimum.
From given option
(i) $r = 2r_0$, $l = 2l_0$
$$R = \frac{2\ell_0}{K\pi(2r_0)^2} = \frac{\ell_0}{2K\pi r_0^2}$$
(ii) $r = 2r_0$, $l = l_0$
$$R = \frac{l_0}{K\pi(2r_0)^2} = \frac{l_0}{4K\pi r_0^2}$$
(iii) $r = r_0$, $l = 2l_0$
$$R = \frac{2l_0}{K\pi r_0^2} = \frac{2l_0}{K\pi r_0^2}$$
(iv) $r = r_0$, $l = l_0$
$$R = \frac{\ell_0}{K\pi r_0^2} = \frac{\ell_0}{K\pi r_0^2}$$
It is clear that for option (2) resistance is minimum, hence, heat flow will be maximum.
(i) Rate of heat flow is directly proportional to area
(ii) inversely proportional to length.
∴ Heat flow will be maximum when r is maximum and l is minimum.

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q73. A transistor-oscillator using a resonant circuit with an inductor L (of negligible resistance) and a capacitor C in series produce oscillations of frequency f. If L is doubled and C is changed to 4C, the frequency will be
(a) 8f
(b) $\frac{f}{2\sqrt{2}}$
(c) f/2
(d) f/4

Ans: (b)

Solution: We know that frequency of electrical oscillation in L.C. circuit is
$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$$
Now, L = 2L&C = 4C
$$f' = \frac{1}{2\pi}\sqrt{\frac{1}{2L.4C}} = \frac{1}{2\pi}\sqrt{\frac{1}{LC}} \times \frac{1}{2\sqrt{2}}$$
$\Rightarrow f' = \frac{1}{2\sqrt{2}} \times f$

Chapter: Alternating Current
[Topic: Transformers & LC Oscillations]

Q74. Which of the following is used as a moderator in nuclear reactors?
(a) Plutonium
(b) Cadmium
(c) Heavy water
(d) Uranium

Ans: (c)

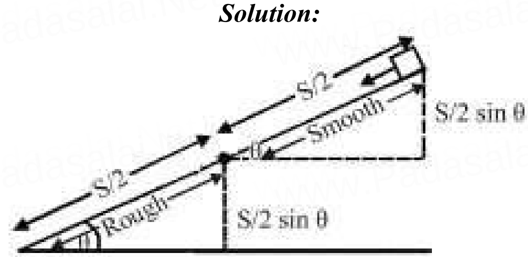
Solution: Moderator used in nuclear reactor are graphite and heavy water.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q75. The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by
(a) $\mu = \frac{2}{\tan\theta}$
(b) $\mu = 2\tan\theta$
(c) $\mu = \tan\theta$
(d) $\mu = \frac{1}{\tan\theta}$

Ans: (b)

Solution:



For upper half of inclined plane
$v^2 = u^2 + 2a\, S/2 = 2(g\sin\theta) S/2 = gS\sin\theta$
For lower half of inclined plane
$0 = u^2 + 2g(\sin\theta - \mu\cos\theta) S/2$
$\Rightarrow -gS\sin\theta = gS(\sin\theta - \mu\cos\theta)$
$\Rightarrow 2\sin\theta = \mu\cos\theta$
$\Rightarrow \mu = \frac{2\sin\theta}{\cos\theta} = 2\tan\theta$

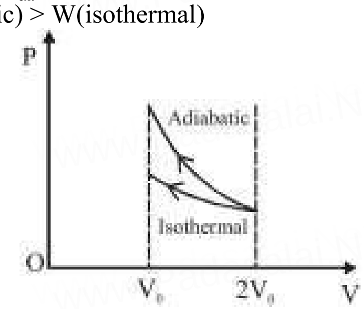
Chapter: Dynamics Laws of Motion

[Topic: Friction]

Q76. A gas is compressed isothermally to half its initial volume. The same gas is compressed separately through an adiabatic process until its volume is again reduced to half. Then :
(a) Compressing the gas isothermally will require more work to be done.
(b) Compressing the gas through adiabatic process will require more work to be done.
(c) Compressing the gas isothermally or adiabatically will require the same amount of work.
(d) Which of the case (whether compression through isothermal or through adiabatic process) requires more work will depend upon the atomicity of the gas.

Ans: (b)

Solution: W_{ext} = negative of area with volume-axis
W(adiabatic) > W(isothermal)



Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q77. A 6 volt battery is connected to the terminals of the three metre long wire of uniform thickness and resistance of 100 ohm. The difference of potential between two points on the wire separated by a distance of 50 cm will be
(a) 1.5 volt (b) 3 volt
(c) 3 volt (d) 1 volt

Ans: (d)

Solution: R α

For 300 cm, R = 100 Ω
For 50 cm, $R' = \frac{100}{300} \times 50 = \frac{50}{3} \Omega$
∴ IR = 6
$= IR' = \frac{6}{R} \times R' = \frac{6}{100} \times \frac{50}{3} = 1$volt.

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q78. Which one of the following rays is not electromagnetic wave ?
(a) heat rays
(b) X-*rays*
(c) γ-rays
(d) β-rays

Ans: (d)

Solution: β ray is not electromagnetic ray

Chapter - Electromagnetic Waves

[Topic: Electromagnetic Spectrum]

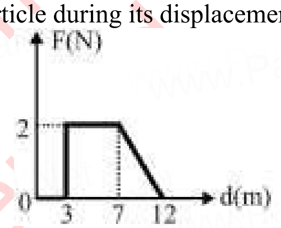
Q79. In a radioactive decay process, the negatively charged emitted β-particles are
(a) the electrons produced as a result of the decay of neutrons inside the nucleus
(b) the electrons produced as a result of collisions between atoms
(c) the electrons orbiting around the nucleus
(d) the electrons present inside the nucleus

Ans: (a)

Solution: In beta minus decay (β^-), a neutron is transformed into a proton, and an electron is emitted from the nucleus along with antineutrino.
$n = p + e^- + \bar{\nu}$

Chapter: Nuclei
[Topic: Radioactivity]

Q80. Force F on a particle moving in a straight line varies with distance d as shown in the figure. The work done on the particle during its displacement of 12 m is



(a) 18 J (b) 21 J
(c) 26 J (d) 13 J

Ans: (d)

Solution: Work done = area under F-d graph
$= [2 \times (7-3)] + \left[\frac{1}{2} \times 2 \times (12-7)\right]$
= 8 + 5
= 13 J.

Chapter: Work, Energy and Power
[Topic: Work]

Q81. A carnot engine having an efficiency of $\frac{1}{10}$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is :-
(a) 90 J (b) 99 J
(c) 100 J (d) 1 J

Ans: (a)

Solution: Given, efficiency of engine, $\eta = \frac{1}{10}$
work done on system W = 10J
Coefficient of performance of refrigerator
$\beta = \frac{Q_2}{w} = \frac{1-\eta}{\eta} = \frac{1-\frac{1}{10}}{\frac{1}{10}} = \frac{\frac{9}{10}}{\frac{1}{10}} = 9$
Energy absorbed from reservoir
$Q_2 = \beta w$
$Q_2 = 9 \times 10 = 90$ J

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q82. You are given several identical resistances each of value $R = 10\Omega$ and each capable of carrying a maximum current of one ampere. It is required to make a suitable combination of these resistances of 5Ω which can carry a current of 4 ampere. The minimum number of resistances of the type *R* that will be required for this job is

(a) 4 (b) 10
(c) 8 (d) 20

Ans: (c)

Solution: To carry a current of 4 ampere, we need four paths, each carrying a current of one ampere. Let r be the resistance of each path. These are connected in parallel. Hence, their equivalent resistance will be r/4. According to the given problem $\frac{r}{4} = 5$ or $r = 20\Omega$.

For this propose two resistances should be connected. There are four such combinations. Hence, the total number of resistance = 4 × 2 = 8.

Chapter: Current Electricity
[Topic: Combination of Resistances]

Q83. Wavelength of light of frequency 100 Hz

(a) 2×16^6 m (b) 3×10^6 m
(c) 4×10^6 m (d) 5×10^6 m

Ans: (b)

Solution: Frequency (n) = 100 Hz

$v = n\lambda$

$$\lambda = \frac{3 \times 10^8}{100}$$

[where, velocity of light (v) = 3×10^8m/s]

$\lambda = 3 \times 10^6$m

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q84. The nucleus $^{115}_{48}Cd$, after two successive β– decay will give

(a) $^{115}_{46}Pa$
(b) $^{114}_{49}In$
(c) $^{113}_{50}Sn$
(d) $^{113}_{50}Sn$

Ans: (d)

Solution: Two successive β decay increases the atomic number by 2. Therefore, (d) is correct.

Chapter: Nuclei
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q85. If the momentum of a body is increased by 50%, then the percentage increase in its kinetic energy is

(a) 50% (b) 100%
(c) 125% (d) 200%

Ans: (c)

Solution: Initial momentum (p_1) = p; Final momentum (p_2) = 1.5 p and initial kinetic energy (K_1) = K.

Kinetic energy (K) $= \frac{p^2}{2m} \propto p^2$

or, $\frac{K_1}{K_2} = \left(\frac{p_1}{p_2}\right) = \left(\frac{p}{1.5p}\right)^2 = \frac{1}{2.25}$

or, K_2 = 2.25 K.

Therefore, increase in kinetic energy is 2.25 K – K = 1.25 K or 125%.

Chapter: Work, Energy and Power
[Topic: Energy]

Q86. In a vessel, the gas is at a pressure P. If the mass of all the molecules is halved and their speed is doubled, then the resultant pressure will be

[NEET Kar. 2013]

(a) 4P (b) 2P
(c) P
(d) P/2

Ans: (b)

Solution: ∵ $P = \frac{1}{3}\frac{mn}{V}V^2_{Rms}$

When mass is halved and speed is doubled then

Resultant pressure, $P' = \frac{1}{3} \times \frac{m}{2} \times \frac{n}{V}(2v_{rms})^2$

= 2 P.

Chapter: Kinetic Theory
[Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q87. If nearly 10^5 coulombs liberate 1 gm-equivalent of aluminium, then the amount of aluminium (equivalent weight 9), deposited through electrolysis in 20 minutes by a current of 50 amp. will be

(a) 0.6 gm (b) 0.09 gm
(c) 5.4 gm (d) 10.8 gm

Ans: (c)

Solution: $m = Zit$, $9 = Z \times 10^5$, $Z = 9 \times 10^{-5}$

Again,

$m = Zit = 9 \times 10^{-5} \times 50 \times 20 \times 60 = 5.4$ gm

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q88. The focal length of converging lens is measured for violet, green and red colours. It is respectively f_v, f_g, f_r. We will get

(a) $f_v = f_g$
(b) $f_g > f_r$
(c) $f_v < f_r$
(d) $f_v > f_r$

Ans: (c)

Solution: According to Cauchy relation

$\mu = A + \frac{B}{\lambda^2} + \frac{c}{\lambda^4}$ ... Hence $f \propto \lambda$.

∴ Red light has wavelength greater than violet light. Therefore focal length of lens for red is greater than for violet. ($f_r > f_v$)

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q89. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of 18 kg mass is 6 ms^{-1}. The kinetic energy of the other mass is

(a) 324 J (b) 486 J
(c) 256 J (d) 524 J

Ans: (b)

Solution: From conservation of linear momentum

$m_1v_1 + m_2v_2 = 0$

$$v_2 = \left(\frac{-m_1}{m_2}\right)v_1 = \left(\frac{-18}{12}\right)6 = -9ms^{-1}$$

K.E. $= \frac{1}{2}m_2v_2^2 = \frac{1}{2} \times 12 \times 9^2 = 486J$

Chapter: Work, Energy and Power
[Topic: Collisions]

Q90. A heating coil is labelled 100 W, 220 V. The coil is cut in half and the two pieces are joined in parallel to the same source. The energy now liberated per second is

(a) 25 J (b) 50 J
(c) 200 J (d) 400 J

Ans: (d)

Solution: Power of heating coil = 100 W and voltage (V) = 220 volts. When the heating coil is cut into two equal parts and these parts are joined in parallel, then the resistance of the coil is reduced to one-fourth of the previous value. Therefore energy liberated per second becomes 4 times i.e., 4 × 100 = 400 J.

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q91. A telescope has an objective lens of 10 cm diameter and is situated at a distance of one kilometer from two objects. The minimum distance between these two objects, which can be resolved by the telescope, when the mean wavelength of light is 5000 Å, is of the order of

(a) 5 cm (b) 0.5 m
(c) 5 m (d) 5 mm

Ans: (d)

Solution: Here, $\frac{x}{1000} = \frac{1.22\lambda}{D}$

or, $x = \frac{1.22 \times 5 \times 10^3 \times 10^{-10} \times 10^3}{10 \times 10^{-2}}$

or, $x = 1.22 \times 5 \times 10^{-3}$ m = 6.1 mm

∴ x is of the order of 5 mm.

Chapter - Ray Optics and Optical
[Topic: Optical Instruments]

Q92. Which one of the following is the weakest kind of bonding in solids

(a) ionic
(b) metallic
(c) Vander Waal's
(d) covalent

Ans: (c)

Solution: Vander Waal's bonding is the weakest bonding in solids.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q93. The angular speed of an engine wheel making 90 revolutions per minute is

(a) 1.5 π rad/s (b) 3π rad/s
(c) 4.5 π rad/s (d) 6π rad/s

Ans: (b)

Solution: Number of revolutions made by the engine wheel (n) = 90 per minute.

Angular speed of the engine wheel

$(\omega) = \frac{2\pi n}{60} = \frac{2\pi \times 90}{60} = 3\pi$ rad/s.

Chapter: System of Particles and Rotational Motion
[Topic: Angular Displacement, Velocity and Acceleration]

Q94. There is a body having mass m and performing S.H.M. with amplitude a. There is a restoring force F = –kx. The total energy of body depends upon

(a) k, x
(b) k, a
(c) k, a, x
(d) k, a, v

Ans: (b)

Solution: Total Energy of body performing simple harmonic motion $= \frac{1}{2}m\omega^2a^2 = \frac{1}{2}ka^2$

where $k = m\omega^2$

$$\left[TE. = KE. + PE. = \frac{1}{2}m(a^2 - x^2)\omega^2 + \frac{1}{2}mw^2x^2\right]$$

Hence energy depends upon amplitude and k (spring constant).

Chapter: Oscillation
[Topic: Energy in Simple Harmonic Motion]

Q95. An α-particle moves in a circular path of radius 0.83 cm in the presence of a magnetic field of 0.25 Wb/m². The wavelength associated with the particle will be :

(a) 1 Å (b) 0.1 Å
(c) 10 Å (d) 0.01 Å

Ans: (d)

Solution: Wavelength

$\lambda = \frac{h}{p} \Rightarrow \lambda = \frac{h}{mv}$,

h = plank's constant = 6.63×10^{-34}J.S

For circular motion = $F_c = qvB$

$\Rightarrow \frac{mv^2}{r} = qvB \Rightarrow \frac{mv}{qB} = r$

$r = \frac{mv}{qB} \Rightarrow mv = qrB$

$\Rightarrow (2e)\ (0.83 \times 10^{-2}) \left(\frac{1}{4}\right)$

$$\lambda = \frac{6.6 \times 10^{-34} \times 4}{2 \times 1.6 \times 10^{-19} \times 0.83 \times 10^{-2}}$$

$\lambda = 9.93 \times 10^{-34+21} \approx 0.01$ Å

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q96. At the first minimum adjacent to the central maximum of a single-slit diffraction pattern, the phase difference between the Huygen's wavelet from the edge of the slit and the wavelet from the midpoint of the slit is :

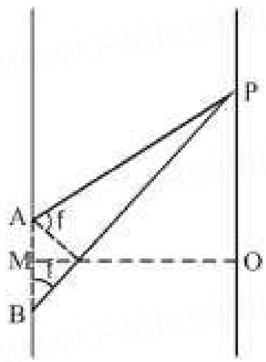
(a) $\frac{\pi}{2}$ radian
(b) π radian
(c) $\frac{\pi}{8}$ radian
(d) $\frac{\pi}{4}$radian

Ans: (b)

Solution: For first minima at P

AP – BP = λ

AP – MP = $\frac{\lambda}{2}$



So phase difference, $\varphi = \frac{2\pi}{\lambda} \times \frac{\lambda}{2} = \pi$ radian

Chapter - Wave Optics
[Topic: Diffraction, Polarization of Light & Resolving Power]

Q97. The current gain for a transistor working as common-base amplifier is 0.96. If the emitter current is 7.2 mA, then the base current is
[1996]
(a) 0.29 mA (b) 0.35 mA
(c) 0.39 mA (d) 0.43 mA

Ans: (a)

Solution: Current gain (α) = 0.96
$I_e = 7.2$ mA
$\frac{I_c}{I_e} = \alpha = 0.96$
$I_c = 0.96 \times 7.2\text{mA} = 6.91\text{mA}$
$I_e = I_c + I_b$
$\Rightarrow I_b = I_e - I_c = 7.2 - 6.91 = 0.29$ mA

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q98. The velocity v of a particle at time t is given by $v = at + \frac{b}{t+c}$, where a, b and c are constant. The dimensions of a, b and c are respectively
(a) L^2, T and LT^2 (b) LT^2, LT and L
(c) L, LT and T^2 (d) LT^{-2}, L and T

Ans: (d)

Solution: Dimension of a. t = dimension of velocitya. t = $LT^{-1} \Rightarrow a = LT^{-2}$
Dimension of c = dimension of t
(two physical quantity of same dimension can only be added)
So, dimension of c = T
Dimension of $\frac{b}{t+c}$ = Dimension of v $\frac{b}{T+T} = LF^{-1} \Rightarrow$
$b.T^{-1} = LT^{-1} \Rightarrow b = L$
So, answer is LT^{-2}, L & T

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q99. A round disc of moment of inertia I_2 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_1 rotating with an angular velocity ω about the same axis. The final angular velocity of the combination of discs is
(a) $\frac{(I_1+I_2)\omega}{I_1}$
(b) $\frac{I_2\omega}{I_1+I_2}$
(c) ω
(d) $\frac{I_1\omega}{I_1+I_2}$

Ans: (d)

Solution: Angular momentum will be conserved
$I_1\omega = I_1\omega' + I_2\omega' \Rightarrow \omega' = \frac{I_1\omega}{I_1+I_2}$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q100. A hollow sphere is filled with water. It is hung by a long thread. As the water flows out of a hole at the bottom, the period of oscillation will
(a) first increase and then decrease
(b) first decrease and then increase
(c) go on increasing
(d) go on decreasing

Ans: (a)

Solution: Time period of simple pendulum $T = 2\pi\sqrt{\left(\frac{l}{g}\right)} \propto \sqrt{l}$ where l is effective length.
[i.e distance between centre of suspension and centre of gravity of bob]
Initially, centre of gravity is at the centre of sphere. When water leaks the centre of gravity goes down until it is half filled; then it begins to go up and finally it again goes at the centre. That is effective length first increases and then decreases. As $T \propto \sqrt{l}$, so time period first increases and then decreases.

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

PART 4. PHYSICS QUESTION BANK

Q1. A long straight wire of radius a carries a steady current I. The current is uniformly distributed over its cross-section. The ratio of the magnetic fields B and B', at radial distances $\frac{a}{2}$ and 2a respectively, from the axis of the wire is :

(a) $\frac{1}{4}$
(b) $\frac{1}{2}$
(c) 1 (d) 4

Ans: (c)

Solution: For points inside the wire i.e., ($r < R$)

Magnetic field $B = \frac{\mu_0 Ir}{2\pi R^2}$

For points outside the wire ($r > R$)

Magnetic field, $B' = \frac{\mu_0 I}{2\pi R}$

$\therefore \frac{B}{B'} = \frac{\frac{\mu_0 I\left(\frac{a}{2}\right)}{2\pi a^2}}{\frac{\mu_0 I}{2\pi(2a)}} = 1:1$

Chapter: Moving Charges and Magnetic Field [Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q2. An ionization chamber with parallel conducting plates as anode and cathode has 5×10^7 electrons and the same number of singly charged positive ions per cm^3. The electrons are moving towards the anode with velocity 0.4 m/s. The current density from anode to cathode is $4\mu A/m^2$. The velocity of positive ions moving towards cathode is

(a) 0.4 m/s (b) 1.6 m/s
(c) zero (d) 0.1 m/s

Ans: (d)

Solution: Current = $I_e + I_p$

I_e and I_p are current due to electrons and positively charged ions.

$I = neAV_d$

$[n = 5 \times 10^7 cm^3 = 5 \times 10^7 \times 10^6 m^3 = 5 \times 10^{13} m^3]$

$I_e = 5 \times 10^{13} \times 1.6 \times 10^{-19} \times A \times 0.4$

$I_p = 5 \times 10^{13} \times 1.6 \times 10^{19} \times A \times v$

$I = I_e + I_p$

$= 5 \times 10^{13} \times 1.6 \times 10^{-19} \times A(v + 0.4)$

Given, $I/A = 4\times10^{-6} A/m^2$

$4 \times 10^{-6} \times A = 5 \times 10^{-6} \times 1.6 \times A(v + 0.4)$

$\frac{4}{8} = v + 04 \Rightarrow 05 = v + 04 \Rightarrow v = 0.1 m/s$

Chapter - Dual Nature of Radiation and Matter [Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q3. The percentage errors in the measurement of mass and speed are 2% and 3% respectively. The error in kinetic energy obtained by measuring mass and speed will be

(a) 12% (b) 10%
(c) 8% (d) 2%

Ans: (c)

Solution: Percentage error in mass $\left(\frac{\Delta m}{m} \times 100\right) = 2$ and percentage error in speed $\left(\frac{\Delta v}{v} \times 100\right) = 3$.

$= \frac{\Delta v}{v} = \frac{3}{100}$ and $\frac{\Delta m}{m} = \frac{2}{100}$

Kinetic energy $= \frac{1}{2} mv^2 \propto mv^2$.

$\therefore$ Error in measurement of kinetic energy= $\frac{\Delta m}{m} + 2\left(\frac{\Delta v}{v}\right)$

By Binomial Function ,

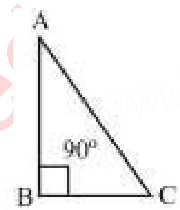
Reqd. error $= \left(\frac{\nabla m}{m}\right) + \left(2 \times \frac{\Delta v}{v}\right)$

$= \left(\frac{2}{100}\right) + \left(2 \times \frac{3}{100}\right) = \frac{8}{100} = 8\%$

$\therefore$ %age error = 8%.

Chapter: Units and Measurement [Topic: Errors in Measurements]

Q4. There is a flat uniform triangular plate ABC such that AB = 4 cm, BC = 3 cm and angle ABC = 90º. The moment of inertia of the plate about AB, BC and CA as axis is respectively I_1, I_2 and I_3. Which one of the following is true?



(a) $I_3 > I_2$ (b) $I_2 > I_1$
(c) $I_3 > I_1$ (d) $I_1 > I_2$

Ans: (b)

Solution: Moment of Inertia depend upon mass and distribution of masses as $I = \Sigma mr^2$.

Further, as the distance of masses is more , more is the moment of Inertia.

If we choose BC as axis. Distance is maximum. Hence, Moment of Inertia is maximum.

$\therefore I_2 > I_1, I_2 > I_3$

Chapter: System of Particles and Rotational Motion [Topic: Moment of Inertia, Rotational K.E. and Power]

Q5. In a sinusoidal wave, the time required for a particular point to move from maximum displacement to zero displacement is 0.170 sec. The frequency of the wave is

(a) 1.47 Hz (b) 0.36 Hz
(c) 0.73 Hz (d) 2.94 Hz

Ans: (a)

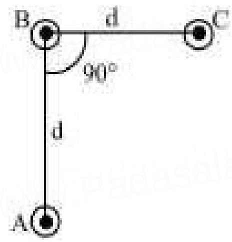
Solution: Time taken to move from maximum to zero displacement $= \frac{T}{4}$

$\therefore$ Time period T = 4 × 0.170 second

$\therefore$ Frequency, $n = \frac{1}{T} = \frac{1}{4 \times 0.170} = 1.47$ Hz

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q6. An arrangement of three parallel straight wires placed perpendicular to plane of paper carrying same current 'I' along the same direction is shown in fig. Magnitude of force per unit length on the middle wire 'B' is given by



(a) $\frac{2\mu_0 i^2}{\pi d}$
(b) $\frac{\sqrt{2}\mu_0 i^2}{\pi d}$
(c) $\frac{\mu_0 i^2}{\sqrt{2}\pi d}$
(d) $\frac{\mu_0 i^2}{2\pi d}$

Ans: (c)

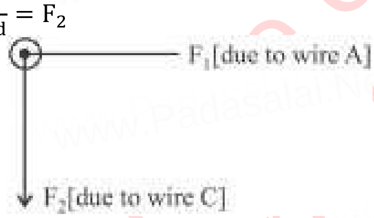
Solution: Force per unit length between two parallel current carrying conductors,

$F = \frac{\mu_0 i_1 i_2}{2\pi d}$

Since same current flowing through both the wires

$i_1 = i_2 = i$

so $F_1 = \frac{\mu_0 i^2}{2\pi d} = F_2$



$\therefore$ Magnitude of force per unit length on the middle wire 'B'

$F_{net} = \sqrt{F_1^2 + F_2^2} = \frac{\mu_0 i^2}{\sqrt{2}\pi d}$

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q7. When photons of energy hν fall on an aluminium plate (of work function E_0), photoelectrons of maximum kinetic energy K are ejected. If the frequency of the radiation is doubled, the maximum kinetic energy of the ejected photoelectrons will be

(a) 2K
(b) K
(c) $K + h\nu$
(d) $K + E_0$

Ans: (c)

Solution: Applying Einstein's formula for photo-electricity

$h\nu = \phi + \frac{1}{2}mv^2$;$h\nu = \phi + K$

$\phi = h\nu - K$

If we use 2ν frequency then let the kinetic energy becomes K'

So, $h \cdot 2\nu = \varphi + K'$

$2h\nu = h\nu - K + K'$

$K' = h\nu + K$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q8. The displacement x of a particle varies with time t as $x = ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will

(a) be independent of α and β
(b) drop to zero when α = β
(c) go on decreasing with time
(d) go on increasing with time

Ans: (d)

Solution: Given $x = ae^{-\alpha t} + be^{\beta t}$

Velocity, $v = \frac{dx}{t} = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$

$= -\frac{a\alpha}{e^{\alpha t}} + b\beta e^{\beta t}$

i.e., go on increasing with time.

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

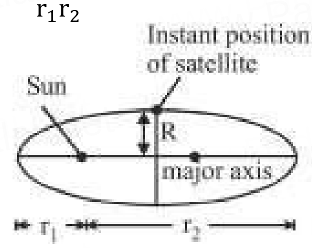
Q9. The largest and the shortest distance of the earth from the sun are r_1 and r_2. Its distance from the sun when it is at perpendicular to the major-axis of the orbit drawn from the sun is

(a) $\frac{r_1+r_2}{4}$
(b) $\frac{r_1+r_2}{r_1-r_2}$
(c) $\frac{2r_1r_2}{r_1+r_2}$
(d) $\frac{r_1+r_2}{3}$

Ans: (c)

Solution: Applying the properties of ellipse, we have

$$\frac{2}{R} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{r_1 + r_2}{r_1 r_2}$$



$$R = \frac{2r_1r_2}{r_1 + r_2}$$

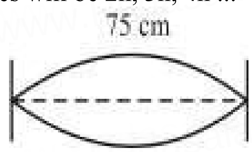
Chapter: Gravitation
[Topic: Newton's Universal Law of Gravitation]

Q10. A string is stretched between two fixed points separated by 75.0 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. The lowest resonant frequency for this string is :

(a) 205 Hz (b) 10.5 Hz
(c) 105 Hz (d) 155 Hz

Ans: (c)

Solution: In a stretched string all multiples of frequencies can be obtained i.e., if fundamental frequency is n then higher frequencies will be 2n, 3n, 4n ...



So, the difference between any two successive frequencies will be 'n'

According to question, n = 420 – 315

= 105 Hz

So the lowest frequency of the string is105 Hz.

Chapter: Waves
[Topic: Vibration of String & Organ Pipe]

Q11. A galvanometer of 50 ohm resistance has 25 divisions. A current of 4×10^{-4} ampere gives a deflection of one per division. To convert this galvanometer into a voltmeter having a range of 25 volts, it should be connected with a resistance of

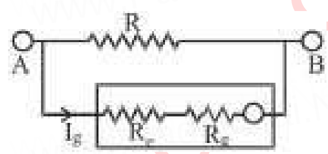
(a) 2450 Ω in series (b) 2500 Ω in series.
(c) 245 Ω in series. (d) 2550 Ω in series.

Ans: (a)

Solution: $R_g = 50\Omega$, $I_g = 25 \times 4 \times 10^{-4}\Omega = 10^{-2}$ ARange of $V = 25$ volts

$V = I_g(R_e + R_g)$

$\therefore R_e = \frac{y}{I_g} - R_g = 2450\Omega$



Chapter: Moving Charges and Magnetic Field
[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q12. The cathode of a photoelectric cell is changed such that the work function changes from W_1 to W_2 ($W_2 > W_1$). If the current before and after changes are I_1 and I_2, all other conditions remaining unchanged, then (assuming $h\nu > W_2$)

[1992]

(a) $I_1 = I_2$ (b) $I_1 < I_2$
(c) $I_1 > I_2$ (d) $I_1 < I_2 < 2I_1$

Ans: (a)

Solution: The work function has no effect on photoelectric current so long as $h\nu > W_0$. The photoelectric current is proportional to the intensity of incident light. Since there is no change in the intensity of light, hence $I_1 = I_2$.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q13. A body dropped from top of a tower fall through 40 m during the last two seconds of its fall. The height of tower is (g = 10 m/s^2)

(a) 60 m (b) 45 m
(c) 80 m (d) 50 m

Ans: (b)

Solution: Let the body fall through the height of tower in t seconds. From,

$D_n = u + \frac{a}{2}(2n-1)$ we have, total distance travelled in last 2 seconds of fall is

$D = D_t + D_{(t-1)}$

$= \left[0 + \frac{g}{2}(2t-1)\right] + \left[0 + \frac{g}{2}\{2(t-1)-1\}\right]$

$= \frac{g}{2}(2t-1) + \frac{g}{2}(2t-3) = \frac{g}{2}(4t-4)$

$= \frac{10}{2} \times 4(t-1)$

or, 40 = 20 (t – 1) or t = 2 + 1 = 3s

Distance travelled in t seconds is

$s = u + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 10 \times 3^2 = 45m$

Chapter: Kinematics Motion in a Straight Line
[Topic: Motion Under Gravity]

Q14. With what velocity should a particle be projected so that its height becomes equal to radius of earth?

(a) $\left(\frac{GM}{R}\right)^{\frac{1}{2}}$

(b) $\left(\frac{8GM}{R}\right)^{\frac{1}{2}}$

(c) $\left(\frac{2GM}{R}\right)^{\frac{1}{2}}$

(d) $\left(\frac{4GM}{R}\right)^{\frac{1}{2}}$

Ans: (a)

Solution: From conservation of energy

$\frac{1}{2}mu^2 - \frac{GMm}{R} = \frac{1}{2}m \times (0)^2 - \frac{Gm}{R+R}$

$\Rightarrow u^2 = \frac{2GM}{R} - \frac{2GM}{2R} = \frac{GM}{R}$

$\Rightarrow u = \sqrt{\frac{GM}{R}}$

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q15. Two cars moving in opposite directions approach each other with speed of 22 m/s and 16.5 m/s respectively. The driver of the first car blows a horn having a frequency 400 Hz. The frequency heard by the driver of the second car is [velocity of sound 340 m/s] :-

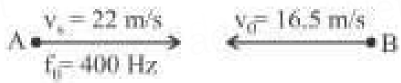
(a) 361 Hz (b) 411 Hz
(c) 448 Hz (d) 350 Hz

Ans: (c)

Solution: As we known from Doppler's Effect

$f_{apprent} = f_0\left[\frac{v+v_0}{v-v_s}\right] = 400\left[\frac{340+16.5}{340-22}\right]$

$f_{apprent} = 448$ Hz



Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q16. A compass needle which is allowed to move in a horizontal plane is taken to a geomagnetic pole. It :
(a) will become rigid showing no movement
(b) will stay in any position
(c) will stay in north-south direction only
(d) will stay in east-west direction only

Ans: (b)

Solution: Since magnetic field is in vertical direction and needle is free to totate in horizontal plane only so magnetic force cannot rotate the needle in horizontal plane so needle can stay in any position.

Chapter: Magnetism and Matter
[Topic: Magnetic Equipments]

Q17. The transition from the state $n = 3$ to $n = 1$ in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from :
(a) $2 \to 1$ (b) $3 \to 2$
(c) $4 \to 2$ (d) $4 \to 3$

Ans: (d)

Solution: ∵ The frequency of the transition $\nu \propto \frac{1}{n^2}$, when $n = 1, 2, 3$.

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q18. The x and y coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$ respectively, where x and y are in meters and t in seconds. The acceleration of the particle at t = 2s is
[2017]
(a) 5 m/s^2 (b) –4 m/s^2
(c) –8 m/s^2 (d) 0

Ans: (b)

Solution: Given:
$x = 5t - 2t^2 y = 10t$
$v_x = \frac{dx}{dt} = 5 - 4t v_y = \frac{dy}{dt} = 10$
$a_x = \frac{dv_x}{dt} = -4 a_y = \frac{dv_y}{dt} = 0$
$\vec{a} = a_x i + a_y j$ $\vec{a} = -4i$ m/s^2
Hence, acceleration of particle at (t = 2 s) = –4m/s^2

Chapter: Kinematics Motion in a Plane
[Topic: Motion in a Plane with Constant acceleration]

Q19. For a satellite escape velocity is 11 km/s. If the satellite is launched at an angle of 60° with the vertical, then escape velocity will be
(a) 11 km/s (b) $11\sqrt{3}$ km/s
(c) $\frac{11}{\sqrt{3}}$km/s (d) 33 km/s

Ans: (a)

Solution: Since, escape velocity $\left(v_e = \sqrt{2gR_e}\right)$ is independent of angle of projection, so it will not change.

Chapter: Gravitation
[Topic: Hooke's Law & Young's Modulus of Elasticity]

Q20. The electric field at a distance $\frac{3R}{2}$ from the centre of a charged conducting spherical shell of radius R is E. The electric field at a distance $\frac{R}{2}$ from the centre of the sphere is
(a) $\frac{E}{2}$
(b) zero
(c) E
(d) $\frac{E}{2}$

Ans: (b)

Solution: Electric field at a point inside a charged conducting spherical shell is zero.

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q21. In an inductor of self-inductance $L = 2$ mH, current changes with time according to relation $i = t^2e^{-t}$. At what time emf is zero?
(a) 4s (b) 3s
(c) 2s (d) 1s

Ans: (c)

Solution: $L = 2$mH, $i = t^2e^{-t}$
$E = -L\frac{di}{dt} = -L[-t^2e^{-t} + 2te^{-t}]$
when $E = 0$,
$-e^{-t}t^2 + 2te^{-t} = 0$
or, $2t e^{-t} = e^{-t}t^2$
$\Rightarrow t = 2$ sec.

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q22. The ground state energy of H-atom 13.6 eV. The energy needed to ionize H-atom from its second excited state.
(a) 1.51 eV (b) 3.4 eV
(c) 13.6 eV (d) 12.1 eV

Ans: (a)

Solution: Second excited state corresponds to $n = 3$
$E = \frac{13.6}{3^2}$ eV $= 1.51$eV

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q23. The circular motion of a particle with constant speed is
(a) periodic but not simple harmonic
(b) simple harmonic but not periodic
(c) periodic and simple harmonic
(d) neither periodic nor simple harmonic

Ans: (a)

Solution: In circular motion of a particle with constant speed, particle repeats its motion after a regular interval of time but does not oscillate about a fixed point. So, motion of particle is periodic but not simple harmonic.

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q24. If the cold junction of a thermo-couple is kept at 0°C and the hot junction is kept at T°C then the relation between neutral temperature (T_n) and temperature of inversion (T_i) is

(a) $T_n = 2T_i$
(b) $T_n = T_i - T$
(c) $T_n = T_i + T$
(d) $T_n = T_i/2$

Ans: (d)

Solution: Since $T_n = \frac{T_i + T_c}{2}$ =Neutral temperature

$$T_n = \frac{T_i + 0}{2} = \frac{T_i}{2}$$

[T_c = 0°C = temperature of cold junction]

Chapter: Thermal Properties
[Topic: Thermometry, Thermocouple& Thermal Expansion]

Q25. If potential (in volts) in a region is expressed as V(x, y, z) = 6 xy – y + 2yz, the electric field (in N/C) at point (1, 1, 0) is :

(a) $-(6\hat{i} + 5\hat{j} + 2\hat{k})$
(b) $-(2\hat{i} + 3\hat{j} + \hat{k})$
(c) $-(6\hat{i} + 9\hat{j} + \hat{k})$
(d) $-(3\hat{i} + 5\hat{j} + 3\hat{k})$

Ans: (a)

Solution: Potential in a region

V = 6xy – y + 2yz

As we know the relation between electric potential and electric field is $\vec{E} = \frac{-dV}{dx}$

$$\vec{E} = \left(\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right)$$

$$\vec{E} = \left[6y\hat{i} + (6x - 1 + 2z)\hat{j} + (2y)\hat{k}\right]$$

$$\vec{E}(1,1,0) = -(6\hat{i} + 5\hat{j} + 2\hat{k})$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electrostatic Potential & Equipotential Surfaces]

Q26. A series R-C circuit is connected to an alternating voltage source. Consider two situations:

(A) When capacitor is air filled.
(B) When capacitor is mica filled.

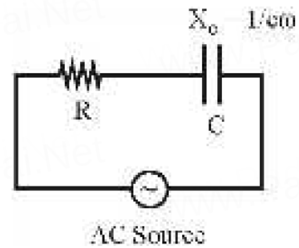
Current through resistor is i and voltage across capacitor is V then :

(a) $V_a > V_b$
(b) $i_a > i_b$
(c) $V_a = V_b$
(d) $V_a < V_b$

Ans: (a)

Solution: For series R – C circuit, capacitive reactance,

$$Z_c = \sqrt{R^2 + \left(\frac{1}{C\omega}\right)^2}$$



Current $i = \frac{V}{Z_c} = \frac{V}{\sqrt{R^2 + \left(\frac{1}{C\omega}\right)^2}}$

$V_c = iX_c = \frac{V}{\sqrt{R^2 + \left(\frac{1}{C\omega}\right)^2}} \times \frac{1}{C\omega}$

$V_c = \frac{V}{\sqrt{(RC\omega)^2 + 1}}$

If we fill a di-electric material like mica instead of air then capacitance C↑ ⇒ V_c↓

So, $V_a > V_b$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q27. The Binding energy per nucleon of ^7_3Li and ^4_2He nuclei are 5.60 MeV and 7.06 MeV, respectively.

In the nuclear reaction $^7_3Li + ^1_1H \rightarrow ^4_2He + Q$, the value of energy Q released is :

(a) 19.6 MeV (b) – 2.4 MeV
(c) 8.4 MeV (d) 17.3 MeV

Ans: (d)

Solution: BE of $_2He^4$ = 4 × 7.06 = 28.24 MeV

BE of ^7_3Li = 7 × 5.60 = 39.20 MeV

$$^7_3Li + ^1_1H \rightarrow {_2He^4} + {_2He^4} + Q$$

39.20   28.24 × 2(= 56.48 MeV)

Therefore, Q = 56.48 – 39.20 = 17.28 MeV.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q28. If the force on a rocket moving with a velocity of 300 m/sec is 345 N, then the rate of combustion of the fuel, is

(a) 0.55 kg/sec (b) 0.75 kg/sec
(c) 1.15 kg/sec (d) 2.25 kg/sec

Ans: (c)

Solution: Velocity of the rocket (u) = 300 m/s and force (F) = 345N. Rate of combustion of fuel

$\left(\frac{dm}{dt}\right) = \frac{F}{u}$ =1.15 kg/sec

Chapter: Dynamics Laws of Motion
[Topic: Ist, IInd & IIIrd Laws of Motion]

Q29. If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature T K is maximum, then

(a) $\lambda_m \propto T^{-1}$
(b) $\lambda_m \propto T^4$
(c) λ_m is independent of T
(d) $\lambda_m \propto T$

Ans: (a)

Solution: From Wein's displacement law

$\lambda_m T$ = constant

$\Rightarrow \lambda_m \propto T^{-1}$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q30. A parallel plate capacitor has a uniform electric field E in the space between the plates. If the distance between the plates is d and area of each plate is A, the energy stored in the capacitor is :
[2012M, 2011, 2008]

(a) $\frac{1}{2}\varepsilon_0 E^2$
(b) E^2Ad/ε_0
(c) $\frac{1}{2}\varepsilon_0 E^2$ Ad
(d) $\varepsilon_0 EAd$

Ans: (c)

Solution: The energy stored by a capacitor

$U = \frac{1}{2}CV^2$ ...(i)

V is the p.d. between two plates of the capacitor.
The capacitance of the parallel plate capacitor
V = E.d.

$C = \frac{A\varepsilon_0}{d}$

Substituting the value of C in equation (i)

$U = \frac{1}{2}\frac{A\varepsilon_0}{d}(Ed)^2 = \frac{1}{2}A\varepsilon_0 E^2 d$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q31. A step-up transformer operates on a 230 V line and supplies a load of 2 ampere. The ratio of the primary and secondary windings is 1 : 25. The current in the primary is

(a) 25 A
(b) 50 A
(c) 15 A
(d) 12.5 A

Ans: (b)

Solution: $\frac{N_p}{N_s} = \frac{E_p}{E_s} = \frac{1}{25}$

$\therefore E_s = 25 E_p$

But $E_sI_s = E_pI_p$

$25E_p \times 2 = E_p \times I_p \Rightarrow I_p = 50$ A

Chapter: Alternating Current
[Topic: Transformers & LC Oscillations]

Q32. If the binding energy per nucleon in ${}_3Li^7$ and ${}_2He^4$ nuclei are respectively 5.60 MeV and 7.06 MeV, then the energy of proton in the reaction ${}_3Li^7 + p \rightarrow 2\,{}_2He^4$ is

(a) 19.6 MeV
(b) 2.4 MeV
(c) 8.4 MeV
(d) 17.3 MeV

Ans: (d)

Solution: Applying principle of energy conservation,
Energy of proton
= total B.E. of 2α – energy of Li^7
= 8 × 7.06 – 7 × 5.6
= 56.48 – 39.2 = 17.28 MeV

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q33. A conveyor belt is moving at a constant speed of 2m/s. A box is gently dropped on it. The coefficient of friction between them is μ = 0.5. The distance that the box will move relative to belt before coming to rest on it taking g = 10 ms^{-2}, is

(a) 1.2 m
(b) 0.6 m
(c) zero
(d) 0.4 m

Ans: (d)

Solution: Frictional force on the box f = μmg

∴ Acceleration in the box

a = μg = 5 ms^{-2}

$v^2 = u^2 + 2as$

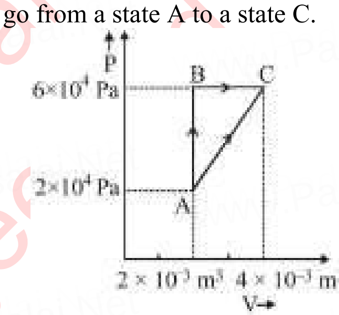
$\Rightarrow 0 = 2^2 + 2 \times (5)$ s

$\Rightarrow s = -\frac{2}{5}$ w.r.t. belt

⇒ distance = 0.4 m

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q34. Figure below shows two paths that may be taken by a gas to go from a state A to a state C.



In process AB, 400 J of heat is added to the system and in process BC, 100 J of heat is added to the system. The heat absorbed by the system in the process AC will be

(a) 500 J
(b) 460 J
(c) 300 J
(d) 380 J

Ans: (b)

Solution: In cyclic process ABCA

$Q_{cycle} = W_{cycle}$

$Q_{AB} + Q_{BC} + Q_{CA}$ = ar. of ΔABC

$+ 400 + 100 + Q_{C\rightarrow A} = \frac{1}{2}(2 \times 10^{-3})(4 \times 10^4)$

$\Rightarrow Q_{C\rightarrow A} = -460$ J

$\Rightarrow Q_{A\rightarrow C} = +460$ J

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q35. The resistivity (specific resistance) of a copper wire

(a) increases with increase in its temperature
(b) decreases with increase in its cross-section
(c) increases with increase in its length
(d) increases with increase in its cross-section

Ans: (a)

Solution: Resistivity of copper wire increases with increase in temprature as $\rho_t = \rho_0(1 + \alpha t)$

Copper being a metal has positive coefficient of resistivity.

Chapter: Current Electricity

[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q36. We consider the radiation emitted by the human body. Which of the following statements is true?
[2003]
(a) the radiation emitted lies in the ultraviolet region and hence is not visible.
(b) the radiation emitted is in the infra-red region.
(c) the radiation is emitted only during the day.
(d) the radiation is emitted during the summers and absorbed during the winters.

Ans: (b)

Solution: Depends on the magnitude of frequency

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q37. In a radioactive material the activity at time t_1 is R_1 and at a later time t_2, it is R_2. If the decay constant of the material is λ, then

(a) $R_1 = R_2 e^{\lambda(t_1-t_2)}$ (b) $R_1 = R_2 e^{\left(\frac{t_2}{t_1}\right)}$
(c) $R_1 = R_2$ (d) $R_1 = R_2 e^{-\lambda(t_1-t_2)}$

Ans: (d)

Solution: Let at time t_1 & t_2, number of particles be N_1 & N_2. So,

$$R_1 = \frac{dN_1}{dt} = -\lambda N_1; R_2 = \frac{dN_2}{dt} = -\lambda N_2$$

$$\frac{R_1}{R_2} = \frac{\lambda N_1}{\lambda N_2} = \frac{N_1}{N_1 e^{-\lambda(t_2-t_1)}} = e^{\lambda(t_2-t_1)}$$

$$R_1 = R_2 e^{\lambda(t_2-t_1)} = R_2 e^{-\lambda(t-t_2)}$$

Chapter: Nuclei
[Topic: Radioactivity]

Q38. A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d. The net work done in the process is

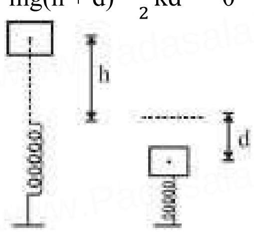
(a) $mg(h + d) - \frac{1}{2}kd^2$
(b) $mg(h - d) - \frac{1}{2}kd^2$
(c) $mg(h - d) + \frac{1}{2}kd^2$
(d) $mg(h + d) + \frac{1}{2}kd^2$

Ans: (a)

Solution: Gravitational potential energy of ball gets converted into elastic potential energy of the spring.

$mg(h + d) = \frac{1}{2}kd^2$

Net work done $= mg(h + d) - \frac{1}{2}kd^2 = 0$



Chapter: Work, Energy and Power
[Topic: Work]

Q39. A refrigerator works between 4°C and 30°C. It is required to remove 600 calories of heat every second in order to keep the temperature of the refrigerated space constant. The power required is:(Take 1 cal = 4.2 joules)
(a) 2.365 W (b) 23.65 W
(c) 236.5 W (d) 2365 W

Ans: (c)

Solution: Coefficient of performance of a refrigerator,

$\beta = \frac{Q_2}{w} = \frac{T_2}{T_1 - T_2}$

(Where Q_2 is heat removed)
Given: $T_2 = 4°C = 4 + 273 = 277$ k
$T_1 = 30°C = 30 + 273 = 303$ k

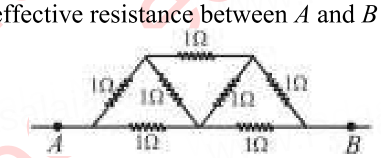
$\therefore \beta = \frac{600 \times 4.2}{W} = \frac{277}{303-277}$

$\Rightarrow W = 236.5$ joule

Power $P = \frac{W}{t} = \frac{236.5 joule}{1 sec} = 236.5$ watt.

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q40. In the network shown in the Fig, each resistance is 1Ω. The effective resistance between *A* and *B* is



(a) $\frac{4}{3}\Omega$
(b) $\frac{3}{2}\Omega$
(c) 7 Ω
(d) $\frac{8}{7}\Omega$

Ans: (d)

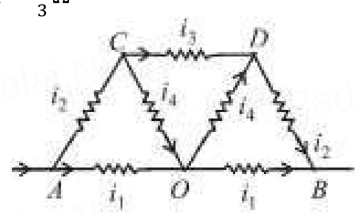
Solution: At *A* current is distributed and at *B* currents are collected. Between *A* and *B*, the distribution is symmetrical. It has been shown in the figure. It appears that current in *AO* and *OB* remains same. At *O*, current i_4 returns back without any change. If we detach *O* from *AB* there will not be any change in distribution.

Now, *CO* & *OD* will be in series hence its total resistance = 2Ω

It is in parallel with *CD*, so, equivalent resistance = $\frac{2\times1}{2+1} = \frac{2}{3}\Omega$

This equivalent resistance is in series with *AC* & *DB*, so, total resistance

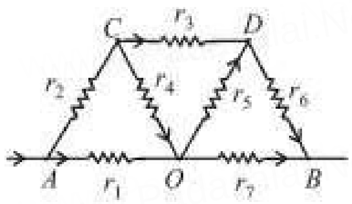
$= \frac{2}{3} + 1 + 1 = \frac{8}{3}\Omega$



Now $\frac{8}{3}\Omega$ is parallel to *AB*, that is, 2Ω, so total resistance

$$= \frac{\frac{8}{3}\times 2}{\frac{8}{3}+2} = \frac{\frac{16}{3}}{\frac{14}{3}} = \frac{16}{14} = \frac{8}{7}\Omega$$

[Alt :



Between *C* & *D*, the equivalent resistance is given by

$$\frac{1}{r} = \frac{1}{r_3} + \frac{1}{(r_4+r_5)} = 1 + \frac{1}{2} = \frac{3}{2}$$

Equivalent resistance along

$ACDB = 1 + \frac{2}{3} + 1 = \frac{8}{3}$

∴ Effective resistance between *A* and *B* is

$\frac{1}{R} = \frac{3}{8} + \frac{1}{2} = \frac{7}{8}$ or $R = \frac{8}{7}\Omega$]

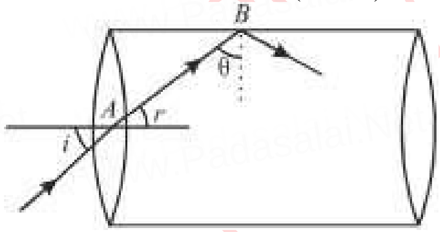
Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q41. Light enters at an angle of incidence in a transparent rod of refractive index *n*. For what value of the refractive index of the material of the rod the light once entered into it will not leave it through its lateral face whatsoever be the value of angle of incidence?

(a) $n > \sqrt{2}$ (b) $n = 1$
(c) $n = 1.1$ (d) $n = 1.3$

Ans: (a)

Solution: Let a ray of light enter at A and the refracted beam is *AB*. This is incident at an angle θ. For no refraction at the lateral face, θ > *C* or,
sin θ > sin *C* But θ + *r* = 90° ⇒ θ = (90° – *r*)



∴ sin (90° – *r*) > sin *C*
or cos *r* > sin *C*7.. (1)

From Snell's law, $n = \frac{\sin i}{\sin r} = \sin r = \frac{\sin i}{n}$

$$\cos r = \sqrt{1-\sin^2 r} = \sqrt{\left(1-\frac{\sin^2 i}{n^2}\right)}$$

∴ equation (1) gives

$$\sqrt{1-\frac{\sin^2 i}{n^2}} > \sin C \;= 1-\frac{\sin^2 i}{n^2} > \sin^2 C$$

Also, $\sin C = \frac{1}{n}$

$1-\frac{\sin^2 i}{n^2} > \frac{1}{n^2}$ or $1 > \frac{\sin^2 i}{n^2} + \frac{1}{n}$

or $\frac{1}{n^2}(\sin^2 i + 1) < 1$ or $n^2 > (\sin^2 i + 1)$

Maximum value of sin i = 1

$n^2 > 2 = n > \sqrt{2}$

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q42. Consider a car moving along a straight horizantal road with a speed of 72 km/h. If the coefficient of static friction between road and tyres is 0.5, the shortest distance in which the car can be stopped is

(a) 30 m (b) 40 m
(c) 72 m (d) 20 m

Ans: (b)

Solution: Force due to friction = kinetic energy

$\mu mgs = \frac{1}{2}mv^2$

[Here, v = 72 km/h

$\frac{72000}{60\times 60} = 20$m/s]

or , $s = \frac{v^2}{2\mu g} = \frac{20\times 20}{2\times 0.5\times 10} = 40$m

Chapter: Work, Energy and Power
[Topic: Energy]

Q43. At 0 K, which of the following properties of a gas will be zero?

(a) Kinetic energy
(b) Potential energy
(c) Density
(d) Mass

Ans: (a)

Solution: At 0 K, molecular motion stops. Hence, kinetic energy of molecules becomes zero.

Chapter: Kinetic Theory
[Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q44. Kirchoff's first law, i.e. Σ*i* = 0 at a junction, deals with the conservation of

(a) charge
(b) energy
(c) momentum
(d) angular momentum

Ans: (a)

Solution: We know from the Kirchhoff 's first law that the algebraic sum of the current meeting at any junction in the circuit is zero (i.e. Σ*i* = 0) or the total charge remains constant. Therefore, Kirchhoff's first law at a junction deals with the conservation of charge.

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q45. A convex lens of focal length 80 cm and a concave lens of focal length 50 cm are combined together. What will be their resulting power?
[1996]

(a) + 6.5 D (b) – 6.5 D
(c) + 7.5 D (d) – 0.75 D

Ans: (d)

Solution: We know that $\frac{1}{f} = \sum_{i=1}^{n}\frac{1}{f_i}$

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$; $f_1 = 80$ cm, $f_2 = -50$ cm

$\frac{1}{f} = \frac{1}{\frac{80}{100}} - \frac{1}{\frac{50}{100}}$

$= P = \frac{1}{f} = 1.25 - 2 = -0.75D$

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

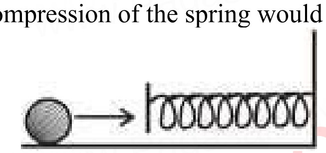
Q46. Zener diode is used for
(a) amplification
(b) rectification
(c) stabilisation
(d) producing oscillations in an oscillator

Ans: (c)

Solution: At a certain reverse bias voltage, zener diode allows current to flow through it and hence maintains the voltage supplied to any load Hence, it is used for stabilisation.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q47. A mass of 0.5 kg moving with a speed of 1.5 m/s on a horizontal smooth surface, collides with a nearly weightless spring of force constant k = 50 N/m. The maximum compression of the spring would be



(a) 0.5 m (b) 0.15 m
(c) 0.12 m (d) 1.5 m

Ans: (b)

Solution: $\frac{1}{2}mv^2 = \frac{1}{2}kx^2$
$\Rightarrow mv^2 = kx^2$
or $0.5 \times (1.5)^2 = 50 \times x^2$
$\therefore x = 0.15$ m

Chapter: Work, Energy and Power
[Topic: Collisions]

Q48. A particle of mass m oscillates along x-axis according to equation x = a sin ωt. The nature of the graph between momentum and displacement of the particle is
(a) straight line passing through origin
(b) circle
(c) hyperbola
(d) ellipse

Ans: (d)

Solution: As $\frac{v^2}{a^2\omega^2} + \frac{y^2}{a^2} =$ This is the equation of ellipse. Hence the graph is an ellipse. P versus x graph is similar to V versus x graph.

Chapter: Oscillation
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q49. A 4 μF capacitor is charged to 400 volts and then its plates are joined through a resistance of 1k Ω. The heat produced in the resistance is
[1994]
(a) 0.16 J (b) 1.28 J
(b) 0.64 J (d) 0.32 J

Ans: (d)

Solution: The energy stored in the capacitor
$= \frac{1}{2}CV^2 = \frac{1}{2} \times 4 \times 10^{-4} \times 400 \times 400 = 0.32J$;
This energy will be converted into heat in the resistor.

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q50. An astronomical telescope has a length of 44 cm and tenfold magnification. The focal length of the objective lens is
(a) 4 cm (b) 40 cm
(c) 44 cm (d) 440 cm

Ans: (b)

Solution: Given : Length of astronomical telescope ($f_0 + f_e$) = 44 cm and magnification $\left(\frac{f_0}{f_e}\right) = 10$

From the given magnification, we find that $f_0 = 10f_e$. Therefore, $10f_e + f_e = 44$ or $11f_e = 44$ or $f_e = 4$. And focal length of the objective (f_0) = $44 - f_e = 44 - 4 = 40$ cm.

Chapter - Ray Optics and Optical
[Topic: Optical Instruments]

PART 5. PHYSICS QUESTION BANK

Q51. For an electronic valve, the plate current I and plate voltage V in the space charge limited region are related as

(a) I is proportional to $V^{3/2}$ (b) I is proportional to $V^{2/3}$
(c) I is proportional to V (d) I is proportional to V^2

Ans: (a)

Solution: According to Child's Law,

$I_a = KV_a^{3/2}$

Thus, $I \propto V^{\frac{3}{2}}$

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q52. Two racing cars of masses m and 4m are moving in circles of radii r and 2r respectively. If their speeds are such that each makes a complete circle in the same time, then the ratio of the angular speeds of the first to the second car is
[1995]

(a) 8 : 1 (b) 4 : 1
(c) 2 : 1 (d) 1 : 1

Ans: (d)

Solution: We know that both the cars take the same time to complete the circle, therefore ratio of angular speeds of the cars will be 1 : 1.

Chapter: System of Particles and Rotational Motion [Topic: Torque, Couple and Angular Momentum]

Q53. In a simple harmonic motion, when the displacement is one-half the amplitude, what fraction of the total energy is kinetic?

(a) 0 (b) $\frac{1}{4}$
(c) $\frac{1}{2}$
(d) $\frac{3}{4}$

Ans: (d)

Solution: Total energy of particle executing S.H.M. of amplitude (A) .

$E = \frac{1}{2}m\omega^2A^2$

K.E.of the particle

$= \frac{1}{2}m\omega^2\left(A^2 - \frac{A^2}{4}\right)\left(\text{when } x = \frac{A}{2}\right)$

$= \frac{1}{2}m\omega^2 \times \frac{3}{4}A^2 = \frac{1}{2} \times \frac{3}{4}m\omega^2A^2$

Clearly , $\frac{KE}{\text{Total energy}} = \frac{3}{4}$

Chapter: Oscillation [Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q54. A proton carrying 1 MeV kinetic energy is moving in a circular path of radius *R* in uniform magnetic field. What should be the energy of an α-particle to describe a circle of same radius in the same field?

(a) 2 MeV (b) 1 MeV
(c) 0.5 MeV (d) 4 MeV

Ans: (b)

Solution: According to the principal of circular motion in a magnetic field

$F_c = F_m \Rightarrow \frac{mv^2}{R} = qVB$

$\Rightarrow R = \frac{mv}{qB} = \frac{P}{qB} = \frac{\sqrt{2m.k}}{qB}$

$R_\alpha = \frac{\sqrt{2(4m)K'}}{2qB}$

$\frac{R}{R_\alpha} = \sqrt{\frac{K}{K'}}$

but $R = R_\alpha$ (given)

Thus $K = K' = 1$ MeV

Chapter: Moving Charges and Magnetic Field [Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q55. A beam of light of λ = 600 nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between first dark fringes on either side of the central bright fringe is:

(a) 1.2 cm (b) 1.2 mm
(c) 2.4 cm (d) 2.4 mm

Ans: (d)

Solution: Given: D = 2m; d = 1 mm = 1×10^{-3} m

$\lambda = 600$ nm $= 600 \times 10^{-6}$ m

Width of central bright fringe (= 2β)

$= \frac{2\lambda D}{d} = \frac{2\times600\times10^{-6}\times2}{1\times10^{-3}}$ m

$= 2.4 \times 10^{-3}$ m = 2.4 mm

Chapter - Wave Optics [Topic: Diffraction, Polarization of Light & Resolving Power]

Q56. When an *n–p–n* transistor is used as an amplifier then

(a) the electrons flow from emitter to collector
(b) the holes flow from emitter to collector
(c) the electrons flow from collector to emitter
(d) the electrons flow from battery to emitter

Ans: (a)

Solution: In an *n-p-n* transistor, the charge carriers, are free electrons in the transistor as well as in external circuit; these electrons flow from emitter to collector.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Junction Transistor]

Q57. The ratio of the dimension of Planck's constant and that of the moment of inertia is the dimension of

(a) time
(b) frequency
(c) angular momentum
(d) velocity

Ans: (b)

Solution: $\frac{\text{Plank's constant}}{\text{Moment of inertia}} = \frac{\frac{2\pi I\omega}{n}}{I}$

$[\text{As } \frac{nh}{2\pi} = I\omega\ ]$

$= \frac{2\pi I(2\pi f)}{nI} = \left(\frac{4\pi^2}{n}\cdot f\right) = [T^{-1}]$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q58. A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Four objects each of mass m, are kept gently to the opposite ends of two perpendicular diameters of the ring. The angular velocity of the ring will be

(a) $\frac{(M-4m)\omega}{M+4m}$

(b) $\frac{M\omega}{4m}$

(c) $\frac{M\omega}{M+4m}$

(d) $\frac{(M+4m)\omega}{M}$

Ans: (c)

Solution: Applying conservation law of angular momentum, $I_1\omega_1 = I_2\omega_2$

$I_2 = (Mr^2) + 4\ (m)\ (r^2) = (M + 4m)r^2$

(Taking $\omega_1 = \omega$ and $\omega_2 = \omega_1$)

$= Mr^2\ \omega = (M + 4m)r^2\omega_1$

$= \omega_1 = \frac{Mco}{M+4m}$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q59. If a simple harmonic oscillator has got a displacement of 0.02 m and acceleration equal to 2.0 m/s^2 at any time, the angular frequency of the oscillator is equal to

(a) 10 rad/s (b) 0.1 rad/s
(c) 100 rad/s (d) 1 rad/s

Ans: (a)

Solution: $\omega^2 = \frac{\text{acceleration}}{\text{displacement}} = \frac{2.0}{0.02}$

$\omega^2 = 100$ or $\omega = 10$ rad/s

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q60. An electron moving in a circular orbit of radius r makes n rotations per second. The magnetic field produced at the centre has magnitude:

(a) Zero

(b) $\frac{\mu_0 n^2 e}{r}$

(c) $\frac{\mu_0 ne}{2r}$

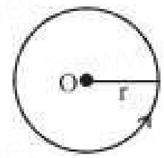
(d) $\frac{\mu_0 ne}{2\pi r}$

Ans: (c)

Solution: Radius of circular orbit = r

No. of rotations per second = n

i.e., $T = \frac{1}{n}$



Magnetic field at its centre, B_c =?

As we know, current

$i = \frac{e}{T} = \frac{e}{\left(\frac{1}{n}\right)} = en$ = equivalent current

Magnetic field at the centre of circular orbit,

$B_c = \frac{\mu_0 i}{2r} = \frac{\mu_0 ne}{2r}$

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q61. The photoelectric threshold wavelength of silver is 3250×10^{-10}m. The velocity of the electron ejected from a silver surface by ultraviolet light of wavelength 2536×10^{-10} m is

(Given $h = 4.14 \times 10^{-15}$ eVs and $c = 3 \times 10^8\ ms^{-1}$)

(a) $\approx 0.6 \times 10^6\ ms^{-1}$ (b) $\approx 61 \times 10^3\ ms^{-1}$
(c) $\approx 0.3 \times 10^6\ ms^{-1}$ (d) $\approx 6 \times 10^5\ ms^{-1}$ ***Solution:***

(a, d) Both answers are correct

Given,

$\lambda_0 = 3250 \times 10^{-10}$ m

$\lambda = 2536 \times 10^{-10}$ m

$\varphi = \frac{hc}{\lambda_0} = \frac{4.14\times10^{-15}\times3\times10^8}{3250\times10^{-10}} = 3.82\text{eV}$

$h\nu = \frac{hc}{\lambda} = \frac{4.14\times10^{-15}\times3\times10^8}{2536\times10^{-10}} = 4.89\text{eV}$

According to Einstein's photoelectric equation,

$K_{max} = h\nu - \varphi$

$KE_{max} = (4.89–3.82)\text{eV}=1.077$ eV

$\frac{1}{2}mv^2 = 1.077 \times 1.6 \times 10^{-19}$

$\Rightarrow v = \sqrt{\frac{2\times1.077\times1.6\times10^{-19}}{9.1\times10^{-31}}}$

or, $v = 0.6 \times 10^6$ m/s or 6×10^5 m/s

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q62. The following truth table belongs to which of the following four gates?

A	B	Y
1	1	0
1	0	0
0	1	0
0	0	1

(a) NOR
(b) XOR
(c) NAND
(d) OR

Ans: (a)

Solution: The given truth table is of

(OR gate + NOT gate) ≡ NOR gate

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q63. In a vernier calliper N divisions of vernier scale coincides with (N – 1) divisions of main scale (in which length of one division is 1 mm). The least count of the instrument should be

(a) N (b) N – 1
(c) 1/10 N (d) 1/N – 1

Ans: (c)

Solution: Least count = 1MSD – 1 VSD

$= 1\text{MSD} - \left(\frac{N-1}{N}\right)\text{MSD}$

$(\because \text{NVSD} = (N-1)\text{MSD} \therefore 1\text{ VSD} = \frac{N-1}{N}\text{MSD})$

$= \frac{1}{N}\text{MSD} = \frac{1}{N} \times \frac{1}{10}\text{cm} = \frac{1}{10N}$

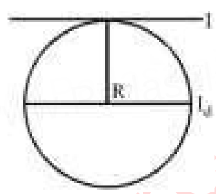
Chapter: Units and Measurement
[Topic: Errors in Measurements]

Q64. The moment of inertia of a disc of mass M and radius R about an axis, which is tangential to the circumference of the disc and parallel to its diameter, is

(a) $\frac{3}{2}MR^2$
(b) $\frac{2}{3}MR^2$
(c) $\frac{5}{4}MR^2$
(d) $\frac{4}{5}MR^2$

Ans: (c)

Solution: Moment of inertia of disc about its diameter is $I_d = \frac{1}{4}MR^2$



MI of disc about a tangent passing through rim and in the plane of disc is $I = I_d + MR^2 = \frac{1}{4}MR^2 + MR^2 = \frac{5}{4}MR^2$

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q65. The speed of a wave in a medium is 960 m/s. If 3600 waves are passing through a point in the medium in 1 min., then the wavelength of the wave is

(a) 8 m (b) 12 m
(c) 16 m (d) 20 m

Ans: (c)

Solution: Given speed of wave (v) = 960m/s

Frequency of wave (f) = 3600/ min

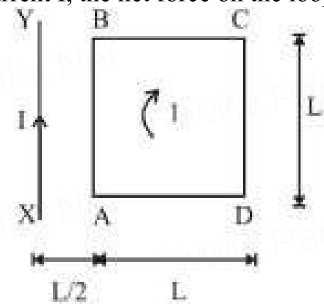
$= \frac{3600}{60}$ rev/sec = 60 rev per sec.

Wavelength of waves $(\lambda) = \frac{v}{f} = \frac{960}{60} = 16$m.

[Alt : $\lambda = \frac{ct}{w}$, where c = velocity of wave
t = time in second
w = no. of waves]

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

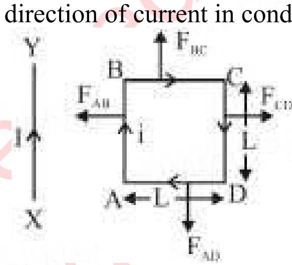
Q66. A square loop ABCD carrying a current i, is placed near and coplanar with a long straight conductor XY carrying a current I, the net force on the loop will be :



(a) $\frac{2\mu_0 Ii}{3\pi}$
(b) $\frac{\mu_0 Ii}{2\pi}$
(c) $\frac{2\mu_0 IiL}{3\pi}$
(d) $\frac{\mu_0 IiL}{2\pi}$

Ans: (a)

Solution: The direction of current in conductor



XY and AB is same

$\therefore F_{AB} = i$

B (attractive)

$F_{AB} = i(L).\frac{\mu_0 I}{2\pi\left(\frac{L}{2}\right)}(\leftarrow) = \frac{\mu_0 iI}{\pi}(\leftarrow)$

F_{BC} opposite to F_{AD}

F_{BC} (↑) and F_{AD} (↓)

⇒ cancels each other

$F_{CD} = i$

B (repulsive)

$F_{CD} = i(L)\frac{\mu_0 I}{2\pi\left(\frac{3L}{2}\right)}(\rightarrow) = \frac{\mu_0 iI}{3\pi}(\rightarrow)$

Therefore the net force on the loop

$F_{net} = F_{AB} + F_{BC} + F_{CD} + F_{AD}$

$\Rightarrow F_{net} = \frac{\mu_0 iI}{\pi} - \frac{\mu_0 iI}{3\pi} = \frac{2\mu_0 iI}{3\pi}$

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q67. A photo-cell employs photoelectric effect to convert

(a) change in the intensity of illumination into a change in photoelectric current
(b) change in the intensity of illumination into a change in the work function of the photocathode
(c) change in the frequency of light into a change in the electric current

(d) change in the frequency of light into a change in electric voltage

Ans: (a)

Solution: A photo-cell employs photoelectric effect to convert light energy into photoelectric current.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q68. The displacement of a particle is represented by the following equation : $s = 3t^3 + 7t^2 + 5t + 8$ where s is in metre and t in second. The acceleration of the particle at t = 1s is

(a) 14 m/s^2 (b) 18 m/s^2
(c) 32 m/s^2 (d) zero

Ans: (c)

Solution: Displacement
$s = 3t^3 + 7t^2 + 5t + 8$;
Velocity $= \frac{ds}{dt} = 9t^2 + 14t + 5$
Acceleration $= \frac{d^2s}{dt^2} = 18t + 14$
Acceleration at (t = 1s)
$= 18\times1+14 = 18 + 14 = 32$ m/s^2

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q69. Two astronauts are floating in gravitation free space after having lost contact with their spaceship. The two will

(a) move towards each other.
(b) move away from each other.
(c) become stationary
(d) keep floating at the same distance between them.

Ans: (a)

Solution: Both the astronauts are in the condition of weightlessness. Gravitational force between them pulls towards each other. Hence Astronauts move towards each other under mutual gravitional force.

Chapter: Gravitation
[Topic: Newton's Universal Law of Gravitation]

Q70. If n_1, n_2 and n_3 are the fundamental frequencies of three segments into which a string is divided, then the original fundamental frequency n of the string is given by :

(a) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$
(b) $\frac{1}{\sqrt{n}} = \frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}} + \frac{1}{\sqrt{n_3}}$
(c) $\sqrt{n} = \sqrt{n_1} + \sqrt{n_2} + \sqrt{n_3}$
(d) $n = n_1 + n_2 + n_3$

Ans: (a)

Solution:

$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$

or, $n \propto \frac{1}{l}$ or nl = constant, K
$\therefore n_1l_1 = K$,
$n_2l_2 = K$, $n_3l_3 = K$
Also, $l = l_1 + l_2 + l_3$
or, $\frac{K}{n} = \frac{K}{n_1} + \frac{K}{n_2} + \frac{K}{n_3}$
or, $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$

Chapter: Waves
[Topic: Vibration of String & Organ Pipe]

Q71. A galvanometer having a resistance of 8 ohms is shunted by a wire of resistance 2 ohms. If the total current is 1 amp, the part of it passing through the shunt will be

(a) 0.25 amp (b) 0.8 amp
(c) 0.2 amp (d) 0.5 amp

Ans: (b)

Solution: $I_s = I \times \frac{G}{S+G} = 1 \times \frac{8}{2+8}$
$= \frac{8}{10} = 0.8$amp

Chapter: Moving Charges and Magnetic Field
[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q72. The wavelength of a 1 keV photon is 1.24×10^{-9}m. What is the frequency of 1 MeV photon?
[1991]

(a) 1.24×10^{15} (b) 2.4×10^{20}
(c) 1.24×10^{18} (d) $2 \times 4 \times 10^{23}$

Ans: (b)

Solution: Here, $\frac{hc}{\lambda} = 10$ eV and $h\nu = 10^6$ eV
Hence, $\nu = \frac{10^3 c}{\lambda} = \frac{10^3\times3\times10^8}{1.24\times10^{-9}}$
$= 2.4 \times 10^{20}$ Hz

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q73. What will be the ratio of the distances moved by a freely falling body from rest in 4th and 5th seconds of journey?

(a) 4 : 5 (b) 7 : 9
(c) 16 : 25 (d) 1 : 1

Ans: (b)

Solution: $\frac{x(4)}{x(5)} = \frac{\frac{g}{2}(2\times4-1)}{\frac{g}{2}(2\times5-1)} = \frac{7}{9}$
$[\because S_{n^{th}} = u + \frac{a}{2}(2n-1)$ and $u = 0, a = g]$

Chapter: Kinematics Motion in a Straight Line
[Topic: Vectors]

Q74. The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_p) whose radius and mean density are twice as that of earth is :

(a) 1 : 2 (b) $1 : 2\sqrt{2}$
(c) 1 : 4 (d) 1 : 2

Ans: (b)

Solution: As we know, escape velocity,
$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2G}{R}\left(\frac{4}{3}\pi R^3 p\right)} \propto R\sqrt{p}$
$\therefore \frac{V_e}{V_p} = \frac{R_e}{R_p}\sqrt{\frac{\rho_e}{\rho_p}}$

$\Rightarrow \frac{V_e}{V_p} = \frac{R_e}{2R_e}\sqrt{\frac{\rho_e}{2\rho_e}}$

$\therefore$Ratio $\frac{V_e}{V_p} = 1 : 2\sqrt{2}$

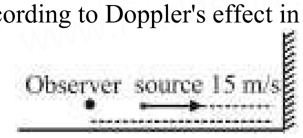
Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q75. A siren emitting a sound of frequency 800 Hz moves away from an observer towards a cliff at a speed of $15ms^{-1}$. Then, the frequency of sound that the observer hears in the echo reflected from the cliff is :
(Take velocity of sound in air = $330\ ms^{-1}$)

(a) 765 Hz (b) 800 Hz
(c) 838 Hz (b) 885 Hz

Ans: (c)

Solution: According to Doppler's effect in sound



Apparent frequency,

$n' = \frac{v}{v-v_s} n_0$

$= \frac{330}{(330-15)(800)} = \frac{330\times800}{315} = 838$ Hz

The frequency of sound observer hears in the echo reflected from the cliff is 838 Hz.

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q76. A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of 2 sec in earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be

(a) 1 *s* (b) 2 *s*
(c) 3 *s* (d) 4 *s*

Ans: (d)

Solution: Time period of a vibration magnetometer,

$T \propto \frac{1}{\sqrt{B}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{B_2}{B_1}}$

$\Rightarrow T_2 = T_1\sqrt{\frac{B_1}{B_2}} = 2\sqrt{\frac{24\times10^{-6}}{6\times10^{-6}}} = 4s$

Chapter: Magnetism and Matter
[Topic: Magnetic Equipments]

Q77. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is
[2011]

(a) 3 (b) 4
(c) 1 (d) 2

Ans: (d)

Solution: For first line of Lyman series of hydrogen

$\frac{hc}{\lambda_1} = Rhc\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

For second line of Balmer series of hydrogen like ion

$\frac{hc}{\lambda_2} = Z^2 Phc\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$

By question, $\lambda_1 = \lambda_2$

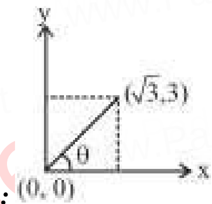
$\Rightarrow \left(\frac{1}{1} - \frac{1}{2}\right) = Z^2\left(\frac{1}{4} - \frac{1}{16}\right)$ or Z = 2

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q78. A particle starting from the origin (0, 0) moves in the (x, y) plane. Its coordinates at a later time are $(\sqrt{3}, 3)$. The path of the particle makes with the x-axis an angle of

(a) 45° (b) 60°
(c) 0° (d) 30°

Ans: (b)



Solution:

Let θ be the angle which the particle makes with x axis.

From figure, $\tan\theta = \frac{3}{\sqrt{3}} = \sqrt{3}$

$\Rightarrow \theta = \tan^{-1}(\sqrt{3}) = 60^o$

Chapter: Kinematics Motion in a Plane
[Topic: Motion in a Plane with Constant acceleration]

Q79. The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of :
[2015 RS]

(a) 2 : 1 (b) 4 : 1
(c) 1 : 1 (d) 1 : 2

Ans: (a)

Solution: Young's modulus $Y = \frac{W}{A}.\frac{l}{\Delta l}$

$\frac{W_1}{Y_1} = \frac{W_2}{Y_2}$

[∵ A, l, Δl same for both brass and steel]

$\frac{w_1}{w_2} = \frac{Y_1}{Y_2} = 2$ [$Y_{steel}/Y_{brass} = 2$ given]

Chapter: Mechanical Propertiesof Solids
[Topic: Hooke's Law & Young's Modulus of Elasticity]

Q80. The mean free path of electrons in a metal is 4×10^{-8} m. The electric field which can give on an average 2 eV energy to an electron in the metal will be in units of V/m

(a) 5×10^{-11} (b) 8×10^{-11}
(c) 5×10^{7} (d) 8×10^{7}

Ans: (c)

Solution: $E = \frac{V}{d} = \frac{2}{4\times10^{-8}}$

$= 0.5\times10^8 = 5\times10^7\ Vm^{-1}$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q81. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 10A$ and $\omega = 100\pi$ radian/sec. The maximum value of e.m.f. in the second coil is

(a) 2π (b) 5π
(c) π (d) 4π

Ans: (b)

Solution: $e = -M\frac{di}{dt} = -0.005 \times \frac{d(i_0 \sin\omega t)}{dt}$
$= -0.005 \times i_0 \times (\omega \cos \omega t)$
$e_{max} = 0.005 \times i_0 \times \omega$ (when $\cos \omega t = -1$)
$= 0.005 \times 10 \times 100\pi = 5\pi$ V

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q82. To explain his theory, Bohr used
(a) conservation of linear momentum
(b) conservation of angular momentum
(c) conservation of quantum frequency
(d) conservation of energy

Ans: (b)

Solution: Bohr used conservation of angular momentum.

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q83. A stone is tied to a string of length l and is whirled in a vertical circle with the other end of the string as the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in velocity as it reaches a position where the string is horizontal (g being acceleration due to gravity) is
(a) $\sqrt{2gl}$
(b) $\sqrt{2(u^2 - g\ell)}$
(c) $\sqrt{u^2 - g\ell}$
(d) $u - \sqrt{u^2 - 2g\ell}$

Ans: (b)

Solution: $W_{mg} = \Delta K$
$\Rightarrow -mg\,l = ½\, mv^2 - ½\, mu^2$
or, $mv^2 = m(u^2 - 2\,g\,l)$
or, $v = \sqrt{u^2 - 2g\ell}\hat{j}$
$\vec{u} = u\hat{i}$
$\vec{v} - \vec{u} = \sqrt{u^2 - 2g\ell}\hat{j} - u\hat{i}\vec{v} - \vec{u}| = [u^2 + 2gl) + u^2]^{\frac{1}{2}}$
$= \sqrt{2(u^2 - gl)}$

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q84. The temperature of inversion of a thermo-couple is 620°C and the neutral temperature is 300°C. What is the temperature of cold junction?
(a) 320°C (b) 20°C
(c) –20°C (d) 40°C

Ans: (c)

Solution: $\theta_n = \frac{\theta_c + \theta_i}{2}$
$\therefore \theta_c = 2\theta_n - \theta_i = 2(300) - 620 = -20°C$

Chapter: Thermal Properties
[Topic: Thermometry, Thermocouple& Thermal Expansion]

Q85. In a region, the potential is represented by V(x, y, z) = 6x – 8xy – 8y + 6yz, where V is in volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1, 1, 1) is :
(a) $6\sqrt{5}$ N (b) 30 N
(c) 24 N (d) $4\sqrt{35}$ N

Ans: (d)

Solution: $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$
$= -[(6 - 8y)\hat{i} + (-8x - 8 + 6z)\hat{j} + (6y)\hat{k}]$
At (1, 1, 1), $\vec{E} = 2\hat{i} + 10\hat{j} - 6\hat{k}$
$\Rightarrow (\vec{E}) = \sqrt{2^2 + 10^2 + 6^2} = \sqrt{140} = 2\sqrt{35}$
$\therefore F = q\vec{E} = 2 \times 2\sqrt{35} = 4\sqrt{35}$

Chapter: Electrostatic Potential and capacitance
[Topic: Electrostatic Potential & Equipotential Surfaces]

Q86. A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb decreases when
(a) number of turns in the coil is reduced
(b) a capacitance of reactance $X_C = X_L$ is included in the same circuit
(c) an iron rod is inserted in the coil
(d) frequency of the AC source is decreased

Ans: (c)

Solution: By inserting iron rod in the coil,
L ↑ z ↑ I ↓ so brightness ↓

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q87. A certain mass of Hydrogen is changed to Helium by the process of fusion. The mass defect in fusion reaction is 0.02866 a.m.u. The energy liberated per a.m.u. is
(Given : 1 a.m.u = 931 MeV)
(a) 26.7 MeV (b) 6.675 MeV
(c) 13.35 MeV (d) 2.67 MeV

Ans: (b)

Solution: Mass defect Δm = 0.02866 a.m.u.
Energy = 0.02866 × 931 = 26.7 MeV
As ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4$
Energy liberated per a.m.u = 13.35/2 MeV
= 6.675 MeV

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q88. A satellite in a force free space sweeps stationary interplanetary dust at a rate (dM/dt) = αv. The acceleration of satellite is
(a) $\frac{-2\alpha v^2}{M}$
(b) $\frac{-\alpha v^2}{M}$

(c) $\frac{-\alpha v^2}{2M}$
(d) $-\alpha v^2$

Ans: (b)

Solution: Thrust on the satellite,

$$F = \frac{-vdM}{dt} = -v(\alpha v) = -\alpha v^2$$

Acceleration $= \frac{F}{M} = \frac{-\alpha v^2}{M}$

Chapter: Dynamics Laws of Motion
[Topic: Ist, IInd & IIIrd Laws of Motion]

Q89. Consider a compound slab consisting of two different materials having equal thicknesses and thermal conductivities K and 2K, respectively. The equivalent thermal conductivity of the slab is
[2003]

(a) $\frac{4}{3}K$
(b) $\frac{2}{3}K$
(c) $\sqrt{3}K$
(d) 3 K

Ans: (a)

Solution: In series, equivalent thermal conductivity

$K_{eq} = \frac{2K_1K_2}{K_1+K_2}$

or, $K_{eq} = \frac{2\times K\times 2K}{K+2K} = \frac{4}{3}K$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q90. A series combination of n_1 capacitors, each of value C_1, is charged by a source of potential difference 4 V. When another parallel combination of n_2 capacitors, each of value C_2, is charged by a source of potential difference V, it has the same (total) energy stored in it, as the first combination has. The value of C_2 , in terms of C_1, is then

(a) $\frac{2C_1}{n_1n_2}$
(b) $16\frac{n_2}{n_1}C_1$
(c) $2\frac{n_2}{n_1}C_1$
(d) $\frac{16C_1}{n_1n_2}$

Ans: (d)

Solution: In series, $C_{eff} = \frac{C_1}{n_1}$

∴ Energy stored,

$E_S = \frac{1}{2}C_{eff}V_S^2 = \frac{1}{2}\frac{C_1}{n_1}16V^2$

$= 8V^2\frac{C_1}{n_1}$

In parallel, $C_{eff} = n_2 C_2$

∴ Energy stored, $E_p = \frac{1}{2}n_2C_2V^2$

∴ $\frac{8V^2C_1}{n_1} = \frac{1}{2}n_2C_2V^2$

$= C_2 = \frac{16C_1}{n_1n_2}$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q91. The primary winding of a transformer has 500 turns whereas its secondary has 5000 turns. The primary is connected to an A.C. supply of 20 V, 50 Hz. The secondary will have an output of

(a) 2 V, 5 Hz
(b) 200 V, 500 Hz
(c) 2V, 50 Hz
(d) 200 V, 50 Hz

Ans: (d)

Solution: The transformer converts A.C. high voltage into A.C. low voltage, but it does not cause any change in frequency. The formula for voltage is

$\frac{E_s}{E_p} = \frac{N_s}{N_p}$

$\Rightarrow E_s = \frac{N_s}{N_p}\times E_p$

$= \frac{5000}{500}\times 20 = 200V$

Thus, output has voltage 200 V and frequency 50 Hz.

Chapter: Alternating Current
[Topic: Transformers & LC Oscillations]

Q92. Heavy water is used as a moderator in a nuclear reactor. The function of the moderator is

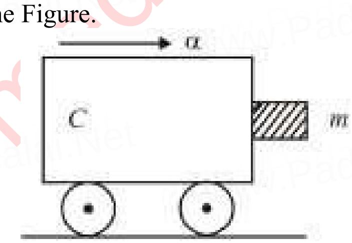
(a) to control energy released in the reactor
(b) to absorb neutrons and stop chain reaction
(c) to cool the reactor
(d) to slow down the neutrons to thermal energies.

Ans: (d)

Solution: Moderator slows down the neutrons to thermal energies.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q93. A block of mass m is in contact with the cart C as shown in the Figure.



The coefficient of static friction between the block and the cart is μ. The acceleration α of the cart that will prevent the block from falling satisfies:

(a) $\alpha > \frac{mg}{\mu}$
(b) $\alpha > \frac{g}{\mu m}$
(c) $\alpha \geq \frac{g}{\mu}$
(d) $\alpha < \frac{g}{\mu}$

Ans: (c)

Solution: Forces acting on the block are as shown in the fig. Normal reaction N is provided by the force mα due to acceleration α

$$N = m\alpha$$

For the block not to fall, frictional force, $F_f > mg$

$= \mu N > mg$

$= \mu m\alpha > mg$

$= \alpha > g/\mu$

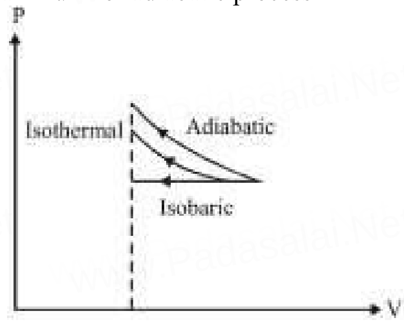
Chapter: Dynamics Laws of Motion

[Topic: Friction]

Q94. An ideal gas is compressed to half its initial volume by means of several processes. Which of the process results in the maximum work done on the gas?
(a) Isobaric
(b) Isochoric
(c) Isothermal
(d) Adiabatic

Ans: (d)

Solution: Since area under the curve is maximum for adiabatic process so, work done (W = PdV) on the gas will be maximum for adiabatic process



Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q95. Si and Cu are cooled to a temperature of 300 K, then resistivity?
(a) For Si increases and for Cu decreases
(b) For Cu increases and for Si decreases
(c) Decreases for both Si and Cu
(d) Increases for both Si and Cu

Ans: (b)

Solution: Conductivity of semiconductor increases with increase in temperature while conductivity of metal decreases with increase in temperature.

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q96. Which of the following electromagnetic radiations has the least wavelength?
(a) gamma rays
(b) infra-red
(c) ultraviolet
(d) X-rays

Ans: (a)

Solution: Gamma ray has highest frequency and lowest wavelength.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q97. The half life of radium is about 1600 years. Of 100 g of radium existing now, 25 g will remain unchanged after
(a) 3200 years (b) 4800 years
(c) 6400 years (d) 2400 years

Ans: (a)

Solution: 100 g will become 25 g in two half lives, so, it is 3200 years.

Chapter: Nuclei
[Topic: Radioactivity]

Q98. A body of mass 3 kg is under a constant force which causes a displacement s in metres in it, given by the relation $s = \frac{1}{3}t^2$, where t is in seconds. Work done by the force in 2 seconds is
[2006]
(a) $\frac{3}{8}$J
(b) $\frac{8}{3}$J
(c) $\frac{19}{5}$J
(d) $\frac{5}{19}$J

Ans: (b)

Solution: Acceleration $= \frac{d^2s}{dt^2} = \frac{2}{3}$ m/s^2

Force acting on the body

$= 3 \times \frac{2}{3} = 2$newton

Displacement in 2 secs $= \frac{1}{3} \times 2 \times 2 = \frac{4}{3}$m

Work done $= 2 \times \frac{4}{3} = \frac{8}{3}$j

Chapter: Work, Energy and Power
[Topic: Work]

Q99. The coefficient of performance of a refrigerator is 5. If the inside temperature of freezer is –20°C, then the temperature of the surroundings to which it rejects heat is
(a) 41°C (b) 11°C
(c) 21°C (d) 31°C

Ans: (d)

Solution: Coefficient of performance,

Cop $= \frac{T_2}{T_1 - T_2}$

$5 = \frac{273-20}{T_1-(273-20)} = \frac{253}{T_1-253}$

$5T_1 - (5 \times 253) = 253$

$5T_1 = 253 + (5 \times 253) = 1518$

$\therefore T_1 = \frac{1518}{5} = 303.6$

or, $T_1 = 303.6 - 273 = 30.6 \cong 31$°C

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q100. *n* equal resistors are first connected in series and then connected in parallel. What is the ratio of the maximum to the minimum resistance ?
(a) n *(b) 1/n^2*
(c) n^2 (d) 1/ *n*

Ans: (c)

Solution: In series, $R_s = nR$

In parallel, $\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \cdots$ nterms

$\therefore R_s/R_p = n^2/1 = n^2$

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

PART 6. PHYSICS QUESTION BANK

Q1. An electromagnetic radiation of frequency n, wavelength λ, travelling with velocity v in air enters in a glass slab of refractive index (μ) . The frequency, wavelength and velocity of light in the glass slab will be respectively

(a) $n, \frac{\lambda}{\mu}$ and $\frac{v}{\mu}$

(b) $n, 2\lambda$ and $\frac{v}{\mu}$

(c) $\frac{n}{\mu}, \frac{\lambda}{\mu}$ and $\frac{v}{\mu}$

(d) $\frac{2\pi}{\mu}, \frac{\lambda}{\mu}$ and v

Ans: (a)

Solution: When electromagnetic wave enters in other medium, frequency reamains unchanged while wavelength and velocity become $\frac{1}{\mu}$ times.

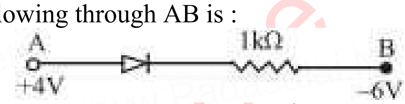
So, For e.m. wave entering from air to glass slab (μ) , frequency remains *n*,

wavelength, $\lambda' = \frac{\lambda}{\mu}$

and velocity, $v' = \frac{v}{\mu}$

Chapter - Ray Optics and Optical [Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q2. Consider the junction diode as ideal. The value of current flowing through AB is :



(a) 0 A
(b) 10^{-2} A
(c) 10^{-1} A
(d) 10^{-3} A

Ans: (b)

Solution: Since diode is in forward bias, so the value of current flowing through AB

$i = \frac{\Delta V}{R} = \frac{4-(-6)}{1\times10^3} = \frac{10}{10^3} = 10^{-2}A$

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q3. Two masses of 1g and 9g are moving with equal kinetic energies. The ratio of the magnitudes of their respective linear momenta is

(a) 1 : 9
(b) 9 : 1
(c) 1 : 3
(d) 3 : 1

Ans: (c)

Solution: $\frac{1}{2(1)v_1^2} = \frac{1}{2(9)v_2^2}$

$\Rightarrow \frac{v_1^2}{v_2^2} = 9 \text{ or } \frac{v_1}{v_2} = 3$

Ratio of their linear momenta

$= \frac{m_1v_1}{m_2v_2} = \frac{1}{9} \times (3) = \frac{1}{3}$

Chapter: Work, Energy and Power [Topic: Energy]

Q4. The pressure of a gas is raised from 27°C to 927°C. The root mean square speed is

(a) $\sqrt{\left(\frac{927}{27}\right)}$ times the earlier value
(b) remain the same
(c) gets halved
(d) get doubled

Ans: (d)

Solution: $c_{rms} \propto \sqrt{T}$

As temperature increases from 300 K to 1200 K that is four times, so, c_{rms} will be doubled.

Chapter: Kinetic Theory [Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q5. Direct current is passed through a copper sulphate solution using platinum electrodes. The elements liberated at the electrodes are

(a) copper at anode and sulphur at cathode
(b) sulphur at anode and copper at cathode
(c) oxygen at anode and copper at cathode
(d) copper at anode and oxygen at cathode

Ans: (c)

Solution: In the electrolysis of $CuSO_4$, oxygen is liberated at anode and copper is deposited at cathode.

Chapter: Current Electricity [Topic: Heating Effects of Current]

Q6. If f_V and f_R are the focal lengths of a convex lens for violet and red light respectively and F_V and F_R are the focal lengths of concave lens for violet and red light respectively, then we have

(a) $f_V < f_R$ and $F_V > F_R$
(b) $f_V < f_R$ and $F_V < F_R$
(c) $f_V > f_R$ and $F_V > F_R$
(d) $f_V > f_R$ and $F_V < F_R$

Ans: (a)

Solution: $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

According to Cauchy relation

$\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4}$ ... Hence $f \propto \lambda$.

Hence, red light having maximum wavelength has maximum focal length.

$\therefore f_v < f_r$ and also $F_v > F_r$ as focal length is negative for a concave lens.

Chapter - Ray Optics and Optical [Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q7. In semiconductors, at room temperature

(a) the conduction band is completely empty
(b) the valence band is partially empty and the conduction band is partially filled
(c) the valence band is completely filled and the conduction band is partially filled
(d) the valence band is completely filled

Ans: (c)

Solution: In semiconductors, the conduction band is empty and the valence band is completely filled at 0 K. No electron from valence band can cross over to conduction band at 0K. But at room temperature some electrons in the valence band jump over to the conduction band due to the small forbidden gap, i.e. 1 eV.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q8. A stationary particle explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2. The ratio of their kinetic energies E_1/E_2 is

(a) m_1v_2/m_2v_1 (b) m_2/m_1
(c) m_1/m_2 (d) 1

Ans: (b)

Solution: From conservation law of momentum, before collision and after collision linear momentum (p) will be same. That is,
initial momentum = final momentum.

$\Rightarrow 0 = m_1v_1 - m_2v_2 \Rightarrow m_1v_1 = m_2v_2$

$p_1 = p_2$

Now, $E = \frac{p^2}{2m}$

$\therefore \frac{E_1}{E_2} = \frac{p_1^2}{2m_1} \times \frac{2m_2}{p_2^2}$

$\Rightarrow \frac{E_1}{E_2} = \frac{m_2}{m_1}$ [$p_1 = p_2$]

Chapter: Work, Energy and Power [Topic: Collisions]

Q9. The equation of a simple harmonic wave is given by

$y = \frac{3\sin\pi}{2(50t - x)}$

Where x and y are in meters and t is in seconds. The ratio of maximum particle velocity to the wave velocity is

(a) 2π
(b) $\frac{3}{2}\pi$
(c) 3π
(d) $\frac{2}{3}\pi$

Ans: (b)

Solution: $y = \frac{3\sin\pi}{2(50t-x)}$

$y = 3\sin\left(25\pi t - \frac{\pi}{2}x\right)$ on comparing with the standard wave equation

$y = a \sin(\omega t - kx)$

Wave velocity $v = \frac{\omega}{k} = \frac{25\pi}{\frac{\pi}{2}} = 50$ m/sec.

The velocity of particle

$v_p = \frac{\partial y}{\partial t} = 75\pi\cos\left(25\pi t - \frac{\pi}{2}x\right)$

$v_{pmax} = 75\pi$

then $\frac{v_{p_{max}}}{v} = \frac{75\pi}{50} = \frac{3\pi}{2}$

Chapter: Oscillation [Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q10. Two identical batteries each of e.m.f 2V and internal resistance 1Ω are available to produce heat in an external resistance by passing a current through it. The maximum power that can be developed across R using these batteries is
[1990]

(a) 3.2 W (b) 2.0 W
(c) 1.28 W (d) $\frac{8}{9}$ w

Ans: (b)

Solution: For maximum current, the two batteries should be connected in series. The current will be maximum when external resistance is equal to the total internal resistance of cells i.e. 2Ω. Hence power devloped across the resistacne R will be

$I^2R = \left(\frac{2E}{R+2r}\right)^2 R = \left(\frac{2\times 2}{2+2}\right) \times 2 = 2W$

Chapter: Current Electricity [Topic: Wheatstone Bridge & Different Measuring Instruments]

Q11. The hypermetropia is a

(a) short-sight defect
(b) long-sight defect
(c) bad vision due to old age
(d) none of these

Ans: (b)

Solution: A person suffering from hyper metropia can see objects beyond a particular point called the near point. If the object lies at a point nearer than this point, then image is not formed at the retina. This is also known as long-sight defect.

Chapter - Ray Optics and Optical [Topic: Wavefront, Interference of Light, Coherent & Incoherent Sources]

Q12. The depletion layer in the *p-n* junction region is caused by

(a) drift of holes
(b) diffusion of charge carriers
(c) migration of impurity ions
(d) drift of electrons

Ans: (b)

Solution: The depletion layer in the *p-n* junction region is caused by diffusion of charge carriers.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q13. A rope is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N ?

(a) 0.25 rad/s^2 (b) 25 rad/s^2
(c) 5 m/s^2 (d) 25 m/s^2

Ans: (b)

Solution: Given, mass of cylinder m = 3kg

R = 40 cm = 0.4 m
F = 30 N ; α = ?
As we know, torque τ = Iα
$F \times R = MR^2\alpha$
$$\alpha = \frac{F \times R}{MR^2}$$
$\alpha = \frac{30\times(04)}{3\times(04)^2}$ or, $\alpha = 25 rad/s^2$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q14. A linear harmonic oscillator of force constant 2×10^6 N/m and amplitude 0.01 m has a total mechanical energy of 160 J. Its
(a) potential energy is 160 J
(b) potential energy is 100 J
(c) potential energy is zero
(d) potential energy is 120 J

Ans: (b)

Solution: Force constant $k = 2 \times 10^6$ N/m
Amplitude (x) = 0.01 m
Potential Energy $= \frac{1}{2}kx^2$
$= \frac{1}{2} \times (2 \times 10^6) \times (0.01)^2 = 100$ J

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q15. A uniform electric field and uniform magnetic field are acting along the same direction in a certain region. If an electron is projected in the region such that its velocity is pointed along the direction of fields, then the electron
(a) will turn towards right of direction of motion
(b) speed will decrease
(c) speed will increase
(d) will turn towards left direction of motion

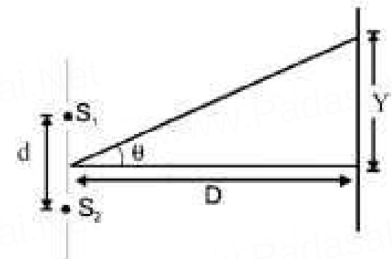
Ans: (b)

Solution: $\vec{v}$ and $\vec{B}$ are in same direction so that magnetic force on electron becomes zero, only electric force acts. But force on electron due to electric field is opposite to the direction of velocity.

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q16. A parallel beam of fast moving electrons is incident normally on a narrow slit. A fluorescent screen is placed at a large distance from the slit. If the speed of the electrons is increased, which of the following statements is correct ?
(a) The angular width of the central maximum of the diffraction pattern will increase.
(b) The angular width of the central maximum will decrease.
(c) The angular width of the central maximum will be unaffected.
(d) Diffraction pattern is not observed on the screen in case of electrons.

Ans: (b)



Solution:
Angular width, $\theta = \frac{Y}{D} = \frac{n\lambda D}{dD}$ $\left[\because Y = \frac{D\lambda}{d}\right]$
so, $\theta = \frac{\lambda}{d}$, v ↑λ ↓ θ ↓
[For central maxima n = 1]
Hence, with increase in speed of electrons angular width of central maximum decreases.

Chapter - Wave Optics
[Topic: Diffraction, Polarization of Light & Resolving Power]

Q17. An oscillator is nothing but an amplifer with [1994]
(a) positive feedback
(b) negative feedback
(c) large gain
(d) no feedback

Ans: (a)

Solution: A positive feed back from output to input in an amplifier provides oscillations of constant amplitude.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q18. The dimensions of universal gravitational constant are
(a) $M^{-2} L^2T^{-1}$
(b) $M^{-1} L^3T^{-2}$
(c) $M L^2T^{-1}$
(d) $M^{-2} L^3T^{-2}$

Ans: (b)

Solution: $F = \frac{GM_1m_1}{r^2} \Rightarrow G = \frac{Fr^2}{M_1m_2}$
∴dimension of G is $\frac{[MLT^{-2}][L^2]}{[M][M]}$
$= M^{-1}L^3T^{-2}$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q19. A disc is rotating with angular velocity ω. If a child sits on it, what is conserved ?
(a) Linear momentum
(b) Angular momentum
(c) Kinetic energy
(d) Moment of inertia

Ans: (b)

Solution: If external torque is zero, angular momentum remains conserved.

[External torque is zero because the weight of child acts downward]

L = Iω = constant

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q20. A simple harmonic oscillator has an amplitude A and time period T. The time required by it to travel from x = A to x = A/2 is

(a) T/6 (b) T/4
(c) T/3 (d) T/2

Ans: (a)

Solution: For S.H.M., $x = A\sin\left(\frac{2\pi}{T}\right)$

When x = A, $A = A\sin\left(\frac{2\pi}{T}.t\right)$

$\sin\left(\frac{2\pi}{T}t\right) = 1$

$\Rightarrow \sin\left(\frac{2\pi}{T}.t\right) = \sin\left(\frac{\pi}{2}\right) \Rightarrow t = (T/4)$

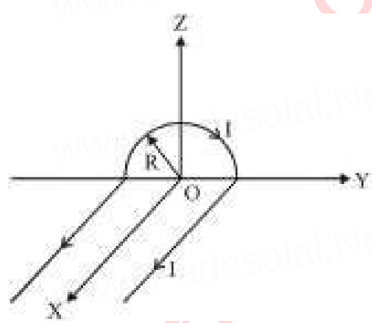
When $x = \frac{A}{2}, \frac{A}{2} = A\sin\left(\frac{2\pi}{T}.t\right)$

or, $\frac{\sin\pi}{6} = \sin\left(\frac{2\pi}{T}t\right)$ or t = (T/12)

Now, time taken to travel from x = A tox = A/2 is (T/4 – T/12) = T/6

Chapter: Oscillation
[Topic: Damped SHM, Forced Ocillations & Resonance]

Q21. A wire carrying current I has the shape as shown in adjoining figure. Linear parts of the wire are very long and parallel to X-axis while semicircular portion of radius R is lying in Y-Z plane. Magnetic field at point O is :



(a) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{1}{R}(\mu\hat{i} \times 2\hat{k})$

(b) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{1}{R}(\pi\hat{i} + 2\hat{k})$

(c) $\vec{B} = \frac{\mu_0}{4\pi}\frac{1}{R}(\pi\hat{i} - 2\hat{k})$

(d) $\vec{B} = \frac{\mu_0}{4\pi}\frac{1}{R}(\pi\hat{i} + 2\hat{k})$

Ans: (b)

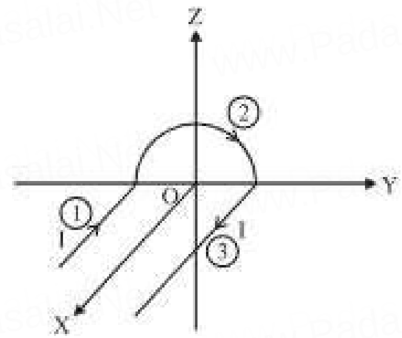
Solution: Magnetic field due to segment '1'

$\vec{B_1} = \frac{\mu_0 I}{4\pi R}[\sin 90^o + \sin 0^o](-\hat{k})$

$= \frac{-\mu_0 I}{4\pi R}(\hat{k}) = \vec{B_3}$

Magnetic field due to segment 2

$B_2 = \frac{\mu_0 I}{4R}(-\hat{\imath}) = \frac{-\mu_0 I}{4\pi R}(\pi\hat{\imath})$



∴ $\vec{B}$ at centre

$\vec{B_c} = \vec{B_1} + \vec{B_2} + \vec{B_3} = \frac{-\mu_0 I}{4\pi R}(\pi\hat{\imath} + 2k)$

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q22. When a metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential is $\frac{V}{4}$. The threshold wavelength for the metallic surface is :

(a) 4λ (b) 5λ
(c) $\frac{5}{2}\lambda$ (d) 3λ

Ans: (d)

Solution: According to Einstein's photoelectric effect,

$eV = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$ …(i)

$eV/4 = \frac{hc}{2\lambda} - \frac{hc}{\lambda_0}$ …(ii)

Dividing equation (i) by (ii) by

$\Rightarrow 4 = \frac{\frac{1}{\lambda} - \frac{1}{\lambda_0}}{\frac{1}{2\lambda} - \frac{1}{\lambda_0}}$ on solving we get,

$\lambda_0 = 3\lambda$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q23. A certain body weighs 22.42 gm and has a measured volume of 4.7 cc. The possible error in the measurement of mass and volume are 0.01 gm and 0.1 cc. Then maximum error in the density will be

(a) 22% (b) 2%
(c) 0.2% (d) 0.02%

Ans: (b)

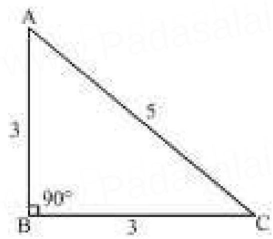
Solution: Density, D = M/V

$\therefore \frac{\Delta D}{D} = \frac{\Delta M}{M} + \frac{\Delta V}{V} = \left(\frac{00.1}{22.42} + \frac{0.1}{4.7}\right) \times 100 = 2\ \%$

Chapter: Units and Measurement
[Topic: Distance, Displacement & Uniform motion]

Q24. ABC is a triangular plate of uniform thickness. The sides are in the ratio shown in the figure. I_{AB}, I_{BC} and I_{CA} are the moments of inertia of the plate about AB, BC and CA as axes respectively. Which one of the following relations is correct?

[1995]



(a) $I_{AB} > I_{BC}$
(b) $I_{BC} > I_{AB}$
(c) $I_{AB} + I_{BC} = I_{CA}$
(d) 1_{CA} is maximum

Ans: (b)

Solution: The intersection of medians is the centre of mass of the triangle. Since distances of centre of mass from the sides are related as : $x_{BC} > x_{AB} > x_{AC}$, therefore, $I_{BC} > I_{AB} > I_{AC}$ or $I_{BC} > I_{AB.}$

Chapter: System of Particles and Rotational Motion [Topic: Moment of Inertia, Rotational K.E. and Power]

Q25. The equation of a travelling wave is
y = 60 cos (180 t – 6x)
where y is in microns, t in second and x in metres. The ratio of maximum particle velocity to velocity of wave propagation is
(a) 3.6 (b) 3.6×10^{-4}
(c) 3.6×10^{-6} (d) 3.6×10^{-11}

Ans: (b)

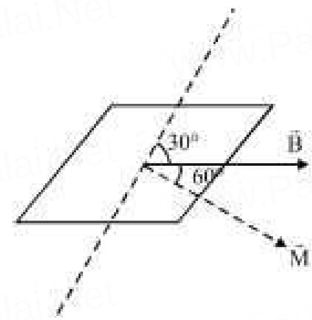
Solution: y = 60 cos (180t – 6x)....(1)
$\omega = 180, k = 6 \Rightarrow \frac{2\pi}{\lambda} = 6$
$v = \frac{\omega}{k} = \frac{2\pi}{T} \times \frac{\lambda}{2\pi} = \frac{180}{6} = 30$ m/s
Differentiating (1) w.r.t. t,
$v = \frac{dy}{dt} = -60 \times 180 \sin(180t - 6x)$
$v_{max} = 60\times180 \mu m/s$
$= 10800 \mu m/s = 0.0108 m/s$
$\frac{v_{max}}{v} = \frac{0.0108}{30} = 3.6 \times 10^{-4}$

Chapter: Waves [Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q26. A rectangular coil of length 0.12 m and width 0.1 m having 50 turns of wire is suspended vertically in a uniform magnetic field of strength 0.2 weber/m^2. The coil carries a current of 2A. If the plane of the coil is inclined at an angle of 30° with the direction of the field, the torque required to keep the coil in stable equilibrium will be :
(a) 0.20 Nm (b) 0.24 Nm
(c) 0.12 Nm (d) 0.15 Nm

Ans: (a)

Solution: Here, number of turns of coil, N = 50
Current through the coil I = 2A
Area $A = l \times b = 0.12 \times 0.1 m^2$
Magnetic field $\vec{B} = 0.2\ \omega/m^2$



Torque required to keep the coil in stable equilibrium.
$\tau = \vec{M} \times \vec{B}$ = MB sin 60° = Ni AB sin 60°
$= 50\times2\times0.12\times0.1\times0.2\times\frac{\sqrt{3}}{2}$
$= 12\sqrt{3} \times 10^{-2} = 0.20784$ Nm

Chapter: Moving Charges and Magnetic Field [Topic: Force & Torque on a Current Carrying Conductor]

Q27. The momentum of a photon of energy 1 MeV in kg m/s, will be
(a) 7×10^{-24} (b) 10^{-22}
(c) 5×10^{-22} (d) 0.33×10^{6}

Ans: (c)

Solution: 1 MeV = $10^6 \times 1.6 \times 10^{-19}$ joule
Momentum of photon
$= \frac{E}{c} = \frac{1.6 \times 10^{-13}}{3 \times 10^8}$
$= \frac{1.6}{3} \times 10^{-21} = \frac{16}{3} \times 10^{-22}$
$= 5 \times 10^{-22}$ kg m/sec

Chapter - Dual Nature of Radiation and Matter [Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q28. A car moving with a speed of 40 km/h can be stopped by applying brakes at least after 2 m. If the same car is moving with a speed of 80 km/h, what is the minimum stopping distance?
(a) 8 m (b) 6 m
(c) 4 m (d) 2 m

Ans: (a)

Solution: $v^2 - u^2 = 2as$
$\Rightarrow a = \frac{v^2-u^2}{2s}$
$= -\frac{u_1^2}{2s}$, where u_1 = 40 km/h
For same retarding force $s \propto u^2$
$\because \frac{s_2}{s_1} = \frac{u_2^2}{u_1^2} \Rightarrow \frac{s_2}{s_1} = \left(\frac{80}{40}\right)^2 = 4$
$\therefore s_2 = 4s_1 = 8$m
If F is retarding force and s the stopping distance, then $\frac{1}{2}mv^2 = Fs$
For same retarding force, $s \alpha v^2$
$\frac{s_2}{s_1} = \left(\frac{v_2}{v_1}\right)^2 = \left(\frac{80kmph}{40kmph}\right)^2 = 4$
$s_2 = 4s_1 = 4 \times 2 = 8$m

Chapter: Kinematics Motion in a Straight Line

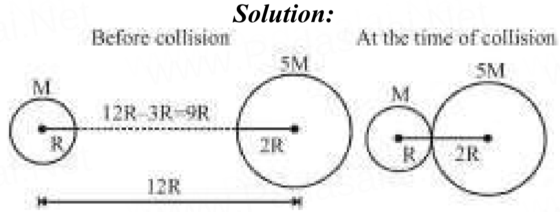
[Topic: Non-uniform motion]

Q29. Two spherical bodies of mass M and 5 M and radii R and 2 R released in free space with initial separation between their centres equal to 12 R. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is

(a) 4.5 R (b) 7.5 R
(c) 1.5 R (d) 2.5 R

Ans: (b)

Solution:



Let the distance moved by spherical body of mass M is x_1 and by spherical body of mass 5m is x_2

As their C.M. will remain stationary

So,(M) (x_1) = (5M) (x_2) or, $x_1 = 5x_2$

$x_1 + x_2 = 9R$

So,$x_1 = 7.5$ R

Chapter: Gravitation

[Topic: Newton's Universal Law of Gravitation]

Q30. The number of possible natural oscillation of air column in a pipe closed at one end of length 85 cm whose frequencies lie below 1250 Hz are : (velocity of sound = 340 ms^{-1})

(a) 4 (b) 5
(c) 7 (d) 6

Ans: (d)

Solution: In case of closed organ pipe frequency,

$f_n = (2n + 1)\frac{v}{4l}$

for n = 0, f_0 = 100 Hz

n = 1, f_1 = 300 Hz

n = 2, f_2 = 500 Hz

n = 3, f_3 = 700 Hz

n = 4, f_4 = 900 Hz

n = 5, f_5 = 1100 Hz

n = 6, f_6 = 1300 Hz

Hence possible natural oscillation whose frequencies < 1250 Hz = 6(n = 0, 1, 2, 3, 4, 5)

Chapter: Waves

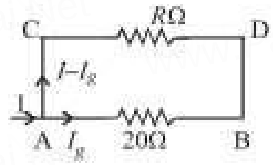
[Topic: Vibration of String & Organ Pipe]

Q31. A galvanometer of resistance 20 Ω gives full scale deflection with a current of 0.004 A. To convert it into an ammeter of range 1 A, the required shunt resistance should be

(a) 0.38Ω (b) 0.21Ω
(c) 0.08Ω (d) 0.05Ω

Ans: (c)

Solution: Maximum current which can pass through galvanometer, I_g = 0.004A



Let *R* be the resistance of shunt.

We know potential drop across *AB*

= Potential drop across *CD*

$R(I - I_g) = I_g(20)$

$\Rightarrow R(1 - 0.004) = 0.004 \times 20 \Rightarrow R = 0.08\ \Omega$

Chapter: Moving Charges and Magnetic Field

[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q32. Photoelectric work function of a metal is 1eV. Light of wavelength λ = 3000 Å falls on it. The photo electrons come out with velocity

(a) 10 metres/sec (b) 10^2 metres/sec
(c) 10^4 metres/sec (d) 10^6 metres/sec

Ans: (d)

Solution: $h\nu = W + \frac{1}{2}mv^2$ or $\frac{hc}{\lambda} = W + \frac{1}{2}mv^2$

Here λ = 3000 Å = 3000 × 10^{-10} m

and W = 1 eV = 1.6 × 10^{-19} joule

$$\frac{(6.6\times 10^{34})(3\times 10^{8})}{3000\times 10^{10}}$$

$$= (1.6\times 1019) + \frac{1}{2}\times(9.1\times 1031)v^2$$

Solving we get, $v \cong 10^6$m/s

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q33. If the magnitude of sum of two vectors is equal to the magnitude of difference of the two vectors, the angle between these vectors is :

(a) 0° (b) 90°
(c) 45° (d) 180°

Ans: (b)

Solution: $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$

Squaring on both sides

$|\vec{A} + \vec{B}|^2 = |\vec{A} - \vec{B}|^2$

$\Rightarrow \vec{A}.\vec{A} + 2\vec{A}.\vec{B} + \vec{B}.\vec{B}$

$= \vec{A}.\vec{A} - 2\vec{A}.\vec{B} + \vec{B}.\vec{B}$

$\Rightarrow 4\vec{A}.\vec{B} = 0 = 4AB\cos\theta = 0$

$\Rightarrow \cos\theta = 0 \Rightarrow \theta = 90°$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q34. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then,

(a) the total mechanical energy of S varies periodically with time.

(b) the linear momentum of S remains constant in magnitude.

(c) the acceleration of S is always directed towards the centre of the earth.

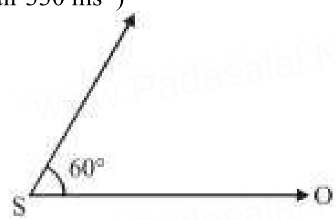
(d) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.

Ans: (c)

Solution: The gravitational force on the satellite will be aiming towards the centre of the earth so acceleration of the satellite will also be aiming towards the centre of the earth.

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

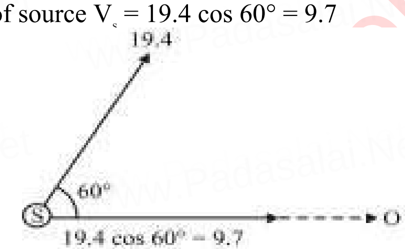
Q35. A source of sound S emitting waves of frequency 100 Hz and an observor O are located at some distance from each other. The source is moving with a speed of 19.4 ms^{-1} at an angle of 60° with the source observer line as shown in the figure. The observor is at rest. The apparent frequency observed by the observer is (velocity of sound in air 330 ms^{-1})



(a) 103 Hz (b) 106 Hz
(c) 97 Hz (d) 100 Hz

Ans: (a)

Solution: Here, original frequency of sound, f_0 = 100 Hz
Speed of source V_s = 19.4 cos 60° = 9.7



From Doppler's formula

$f^1 = f_0\frac{(V-V_0)}{(V-V_s)}$

$f^1 = 100\left(\frac{V-0}{V-(+9.7)}\right)$

$f^1 = 100\frac{V}{V\left(1-\frac{9.7}{V}\right)} = \frac{100}{\left(1-\frac{9.7}{330}\right)}$

= 103Hz

Apparent frequency f^1 = 103 Hz

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q36. Two magnets of magnetic moments M and 2M are placed in a vibration magnetometer, with the identical poles in the same direction. The time period of vibration is T_1. If the magnets are placed with opposite poles together and vibrate with time period T_2, then

(a) T_2 is infinite (b) $T_2 = T_1$
(c) $T_2 > T_1$ (d) $T_2 < T_1$

Ans: (c)

Solution: $T_1 = 2\pi\sqrt{\frac{I_1+I_2}{(M+2M)H}} = 2\pi\sqrt{\frac{I}{3MH}}$

$T_2 = 2\pi\sqrt{\frac{I_1+I_2}{(2M-M)H}} = 2\pi\sqrt{\frac{I}{MH}}$

Obviously, $T_2 > T_1$

Chapter: Magnetism and Matter
[Topic: Magnetic Equipments]

Q37. An electron in the hydrogen atom jumps from excited state n to the ground state. The wavelength so emitted illuminates a photosensitive material having work function 2.75 eV. If the stopping potential of the photoelectron is 10 V, the value of n is
[2011M]

(a) 3 (b) 4
(c) 5 (d) 2

Ans: (b)

Solution: KE_{max} = 10eV
φ = 2.75 eV
Total incident energy
E = φ + KE_{max} = 12.75 eV
∴ Energy is released when electron jumps from the excited state n to the ground state.
∵ $E_4 - E_1$ = {– 0.85 – (–13.6) ev}
= 12.75eV
∴ value of n = 4

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q38. A particle moves in a plane with constant acceleration in a direction different from the initial velocity. The path of the particle is
(a) an ellipse
(b) a parabola
(c) an arc of a circle
(d) a straight line

Ans: (b)

Solution: Chapter: Kinematics Motion in a Plane
[Topic: Motion in a Plane with Constant acceleration]

Q39. Copper of fixed volume 'V; is drawn into wire of length 'l'. When this wire is subjected to a constant force 'F', the extension produced in the wi re is 'Δl'. Which of the following graphs is a straight line?

(a) Δl versus $\frac{1}{l}$
(b) Δl versus l^2
(c) Δl versus $\frac{1}{l^2}$
(d) Δl versus l

Ans: (b)

Solution: AsY = $\frac{\frac{F}{A}}{\frac{\Delta l}{l}} = \Delta l = \frac{Fl}{AY}$

ButV = Al so A = $\frac{V}{l}$

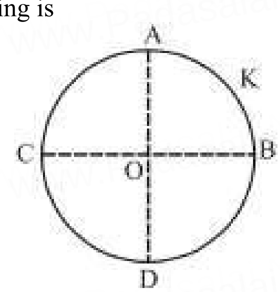
Therefore Δl = $\frac{Fl^2}{VY} \propto l^2$

Hence graph of Δl versus l^2 will give a straight line.

Chapter: Mechanical Propertiesof Solids

[Topic: Hooke's Law & Young's Modulus of Elasticity]

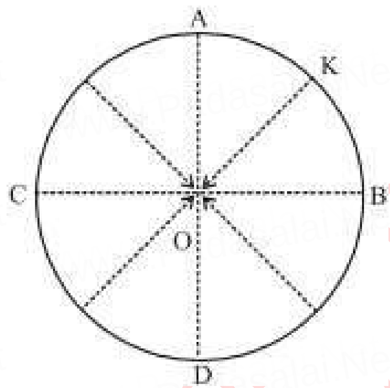
Q40. A thin conducting ring of radius R is given a charge + Q. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part ACDB of the ring is



(a) E along KO (b) E along OK
(c) E along KO (d) 3 E along OK

Ans: (b)

Solution: By the symmetry of the figure, the electric fields at O due to the portions AC and BD are equal in magnitude and opposite in direction. So, they cancel each other.



Similarly, the field at O due to CD and AKB are equal in magnitude but opposite in direction. Therefore, the electric field at the centre due to the charge on the part ACDB is E along OK.

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q41. A conductor of length 0.4 m is moving with a speed of 7 m/s perpendicular to a magnetic field of intensity 0.9 Wb/m^2. The induced e.m.f. across the conductor is

(a) 1.26 V (b) 2.52 V
(c) 5.04 V (d) 25.2 V

Ans: (b)

Solution: Length of conductor (l) = 0.4 m; Speed (v) = 7 m/s and magnetic field (B) = 0.9 Wb/ m^2. Induced e.m.f. (V) = Blv sin θ = 0.9 × 0.4 × 7 × sin 90º = 2.52 V.

Chapter: Electromagnetic

[Topic: Motional and Static EMI & Applications of EMI]

Q42. The ionisation energy of hydrogen atom is 13.6 eV, the ionisation energy of helium atom would be

(a) 13.6 eV (b) 27.2 eV
(c) 6.8 eV (d) 54.4 eV

Ans: (d)

Solution: $E \propto Z^2$ and Z for helium = 2

$(E)_{He} = 4 \times 13.6 = 54.4 eV$

Chapter: Atoms

[Topic: Composition and Size of the Nucleus]

Q43. A particle moves along a circle of radius $\left(\frac{20}{\pi}\right)$ m with constant tangential acceleration. If the velocity of the particle is 80 m/s at the end of the second revolution after motion has begun, the tangential acceleration is

(a) 40 π m/s^2 (b) 40 m/s^2
(c) 640 π m/s^2 (d) 160 π m/s^2

Ans: (b)

Solution: Circumference = 2πr =2π $\times = \frac{20}{\pi} = 40$m

Distance travelled in 2 revolutions
= 2 × 40 = 80 m
Initial velocity = u = 0
Final velocity v = 80m/sec
Applying the formula, v^2 = u^2 + 2as
(80)^2= 0^2+ 2 × a × 80= a = 40 m/sec^2

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in2D & Circular Motion]

Q44. Mercury thermometer can be used to measure temperature upto

(a) 260°C (b) 100°C
(c) 357°C (d) 500°C

Ans: (c)

Solution: Mercury thermometer is based on the principle of change of volume with rise of temperature and can measure temperatures ranging from –30°C to 357°C.

Chapter: Thermal Properties

[Topic: Thermometry, Thermocouple& Thermal Expansion]

Q45. A conducting sphere of radius R is given a charge Q. The electric potential and the electric field at the centre of the sphere respectively are:
[2014]

(a) Zero and $\frac{Q}{4\pi\varepsilon_0 R^2}$

(b) $\frac{Q}{4\pi\varepsilon_0 R}$ and Zero

(c) $\frac{Q}{4\pi\varepsilon_0 R}$ and $\frac{Q}{4\pi\varepsilon_0 R^2}$

(d) Both are zero

Ans: (b)

Solution: Due to conducting sphere
At centre, electric field E = 0
And electric potential V = $\frac{Q}{4\pi\epsilon_0 R}$

Chapter: Electrostatic Potential and capacitance

[Topic: Electrostatic Potential & Equipotential Surfaces]

Q46. In an electrical circuit R, L, C and an a.c. voltage source are all connected in series. When L is removed from the circuit, the phase difference between the voltage the current in the circuit is π/3. If instead, C is removed from the circuit, the phase difference is again π/3. The power factor of the circuit is :

(a) 1/2 (b) $\frac{1}{\sqrt{2}}$

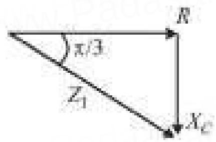
(c) 1 (d) $\frac{\sqrt{3}}{2}$

Ans: (c)

Solution:

when *L* is removed from the circuit

$\frac{X_C}{R} = \frac{\tan \pi}{3}$



$X_C = R \tan\frac{\pi}{3}$ .... (1)

when *C* is remove from the circuit

$\frac{X_L}{R} = \tan\frac{\pi}{3}$

$X_C = R \tan\frac{\pi}{3}$ ... (2)

net impedence $Z = \sqrt{R^2 + (X_L - X_C)^2} = R$

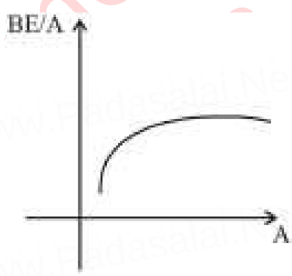
power factor $\cos \varphi = \frac{R}{Z} = 1$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q47. How does the binding energy per nucleon vary with the increase in the number of nucleons? [NEET Kar. 2013]

(a) Increases continuously with mass number
(b) Decreases continuously with mass number
(c) First decreases and then increases with increase in mass number
(d) First increases and then decreases with increase in mass number

Ans: (d)



Solution:

From the graph of *BE*/*A* versus mass number *A* it is clear that, *BE*/*A* first increases and then decreases with increase in mass number.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q48. Physical independence of force is a consequence of

(a) third law of motion
(b) second law of motion
(c) first law of motion
(d) all of these laws

Ans: (c)

Solution: Newton's first law of motion is related to physical independence of force.

Chapter: Dynamics Laws of Motion
[Topic: Ist, IInd & IIIrd Laws of Motion]

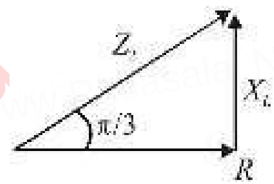
Q49. Wien's law is concerned with

(a) relation between emissivity and absorptivity of a radiating surface
(b) total radiation, emitted by a hot surface
(c) an expression for spectral distribution of energy of a radiation from any source
(d) a relation between the temperature of a black body and the wavelength at which there is maximum radiant energy per unit wavelength

Ans: (d)

Solution: According to Wein's displacement law, product of wavelength belonging to maximum intensity and temperature is constant i.e., $\lambda_m T$ = constant.

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]



Q50. Two parallel metal plates having charges + Q and –Q face each other at a certain distance between them. If the plates are now dipped in kerosene oil tank, the electric field between the plates will

(a) remain same
(b) become zero
(c) increases
(d) decrease

Ans: (d)

Solution: Electric field

$E = \frac{\sigma}{\varepsilon} = \frac{Q}{A\varepsilon}$

ε of kerosine oil is more than that of air.

As ε increases, E decreases.

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

PART 7. PHYSICS QUESTION BANK

Q51. Eddy currents are produced when
(a) a metal is kept in varying magnetic field
(b) a metal is kept in steady magnetic field
(c) a circular coil is placed in a magnetic field
(d) through a circular coil, current is passed

Ans: (a)

Solution: Eddy currents are produced when a metal is kept in a varying magnetic field.

Chapter: Alternating Current
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q52. Energy released in the fission of a single $^{235}_{92}U$ nucleus is 200 MeV. The fission rate of a $^{235}_{92}U$ filled reactor operating at a power level of 5 W is
(a) $1.56 \times 10^{-10} s^{-1}$ (b) $1.56 \times 10^{11} s^{-1}$
(c) $1.56 \times 10^{-16} s^{-1}$ (d) $1.56 \times 10^{-17} s^{-1}$

Ans: (b)

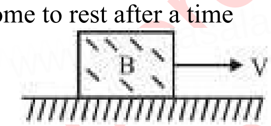
Solution: Fission rate

$$= \frac{\text{total power}}{\frac{\text{energy}}{\text{fission}}} = \frac{5}{200 \times 1.6 \times 10^{-13}}$$

$= 1.56 \times 10^{11} s^{-1}$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q53. A block B is pushed momentarily along a horizontal surface with an initial velocity V. If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time



(a) gμ /V
(b) g/V
(c) V/g
(d) V/(gμ).

Ans: (d)

Solution: Friction is the retarding force for the block
F = ma = μR = μmg
Therefore, from the first equation of motion
v = u – at
$0 = V - \mu g \times t \Rightarrow \frac{V}{\mu g} = t$

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q54. A monoatomic gas at a pressure P, having a volume V expands isothermally to a volume 2V and then adiabatically to a volume 16V. The final pressure of the gas is : (take $\gamma = \frac{5}{3}$)
(a) 64P (b) 32P
(c) $\frac{P}{64}$ (d) 16P

Ans: (c)

Solution: For isothermal process $P_1V_1 = P_2V_2$
$\Rightarrow PV = P_2(2V) \Rightarrow P_2 = \frac{P}{2}$
For adiabatic process
$P_2V_2^{\gamma} = P_3V_3^{\gamma}$
$\Rightarrow \left(\frac{P}{2}\right)(2v)^{\gamma} = P_3(16v)^{\gamma}$
$\Rightarrow P_3 = \frac{3}{2}\left(\frac{1}{8}\right)^{\frac{5}{3}} = \frac{P}{64}$

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q55. A wire has a resistance of 3.1Ω at 30ºC and a resistance 4.5Ω at 100ºC. The temperature coefficient of resistance of the wire
(a) $0.0064ºC^{-1}$ (b) $0.0034ºC^{-1}$
(c) $0.0025ºC^{-1}$ (d) $0.0012ºC^{-1}$

Ans: (a)

Solution: $R_1 = 3.1\ \Omega$ at $t = 30°C$
$R_2 = 4.5\ \Omega$ at $t = 100°C$
We have, $R = R_0(1 + \alpha t)$
$\therefore R_1 = R_0[1 + \alpha(30)]$
$R_2 = R_0[1 + \alpha(100)]$
$\Rightarrow \frac{R_1}{R_2} = \frac{1+30\alpha}{1+100\alpha}$
$\Rightarrow \frac{3.1}{4.5} = \frac{1+30\alpha}{1+100\alpha} \Rightarrow \alpha = 0.0064°C^{-1}$

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q56. Green-house effect is the heating up of earth's atmosphere due to
(a) green plants
(b) infra-red rays
(c) X-rays
(d) ultraviolet rays

Ans: (b)

Solution: Infrared rays is the cause of Green house effect. The glass transmits visible light and short infrared rays which are absorbed by plants. Then it emits long infrared rays, which are reflected back by glass.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q57. A nuclear reaction is given by ${}_{Z}X^{A} \rightarrow {}_{[Z+1]}Y^{A} + {}_{-1}e^{0} + \bar{v}$, represents
(a) fission
(b) β-decay
(c) γ-decay
(d) fusion

Ans: (b)

Solution: ${}_{-1}e^{0}$ represents a β-decay.

Chapter: Nuclei
[Topic: Radioactivity]

Q58. 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. Taking g = 10 m/s^2,work done against friction is

(a) 100 J
(b) zero
(c) 1000 J (d) 200 J

Ans: (a)

Solution: Work done against gravity = mg sin θ × d
= 2 × 10 × 10(d sin θ = 10)
= 200 J
Actual work done = 300 J
Work done against friction = 300 – 200 = 100 J

Chapter: Work, Energy and Power
[Topic: Work]

Q59. Two Carnot engines A and B are operated in series. The engine A receives heat from the source at temperature T_1 and rejects the heat to the sink at temperature T. The second engine B receives the heat at temperature T and rejects to its sink at temperature T_2. For what value of T the efficiencies of the two engines are equal?
[NEET Kar. 2013]

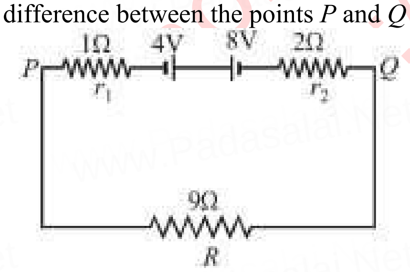
(a) $\frac{T_1+T_2}{2}$ (b) $\frac{T_1-T_2}{2}$
(c) T_1T_2 (d) $\sqrt{T_1T_2}$

Ans: (d)

Solution: Efficiency of engine A, $\eta_1 = 1 - \frac{T}{T_1}$,
Efficiency of engine B, $\eta_2 = 1 - \frac{T_2}{T}$
Here, $\eta_1 = \eta_2$
$\therefore \frac{T}{T_1} = \frac{T_2}{T} \Rightarrow T = \sqrt{T_1T_2}$

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q60. Two batteries of emf 4 V and 8V with internal resistance 1 Ω and 2 Ω are connected in a circuit with a resistance of 9 Ω as shown in figure. The current and potential difference between the points *P* and *Q* are



(a) $\frac{1}{3}$ A and 3 V
(b) $\frac{1}{6}$ A and 4 V
(c) $\frac{1}{9}$ A and 9 V
(d) $\frac{1}{12}$ A and 12 V

Ans: (a)

Solution: $I = \frac{8-4}{1+2+9} = \frac{4}{12} = \frac{1}{3}A$;
$V_P - V_Q = 4 - \frac{1}{3} \times 3 = 3\text{volt}$

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q61. Light travels through a glass plate of thickness t and refractive index μ. If *c* is the speed of light in vacuum, the time taken by light to travel this thickness of glass is
(a) μtc
(b) $\frac{tc}{\mu}$
(c) $\frac{tc}{\mu}$
(d) $\frac{\mu t}{c}$

Ans: (d)

Solution: Total thickness = *t*; Refrative index = μ
Speed of light in Glass plate = $\frac{c}{\mu}$
$\left[v = \frac{\text{Speed of light in vacuum}}{\text{R.I. ofmcdium}}\right]$
Time taken = $\frac{t}{\left(\frac{c}{\mu}\right)} = \frac{\mu t}{c}$.
[where, *t* = thickness of glass plate]

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q62. A 4 kg mass and 1 kg are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is
(a) 1 : 2 (b) 1 : 1
(c) 2 : 1 (d) 4 : 1

Ans: (c)

Solution: $E = \frac{1}{2}mv^2$. Hence, $mv = (2mE)^{1/2}$. For same KE, momentum $\propto \sqrt{m}$. Hence, the ratio is 2 : 1.

Chapter: Work, Energy and Power
[Topic: Energy]

Q63. If C_s be the velocity of sound in air and C be the r.m.s velocity, then
(a) $C_s < C$ (b) $C_s = C$
(c) $C_s = C\,(\gamma/3)^{1/2}$ (d) none of these

Ans: (c)

Solution: Velocity of sound (C_s) = $\sqrt{\frac{\gamma P}{\rho}}$
R.M.S. velocity of gas molecules = $\sqrt{\frac{3P}{\rho}}$
$\frac{c_s}{c} = \sqrt{\frac{\gamma P}{\rho} \times \frac{\rho}{3P}} = \sqrt{\frac{\gamma}{3}}$
$\Rightarrow C_s = C \times \sqrt{\frac{\gamma}{3}}$

Chapter: Kinetic Theory
[Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q64. Faraday's laws are consequence of conservation of
(a) energy
(b) energy and magnetic field
(c) charge
(d) magnetic field

Ans: (a)

Solution: Faraday's laws are based on the conversion of electrical energy into mechanical energy; which is in accordance with the law of conservation of energy.

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q65. An achromatic combination of lenses is formed by joining
(a) 2 convex lenses (b) 2 concave lenses
(c) 1 convex and 1 concave lens
(d) 1 convex and 1 plane mirror

Ans: (c)

Solution: If two or more lenses are combined together in such a way that this combination produces images of different colours at the same point and of the same size, then this property is called 'achromatism'. Concave and convex type of lenses are used for this combination.

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q66. The peak voltage in the output of a half-wave diode rectifier fed with a sinusoidal signal without filter is 10V. The d.c. component of the output voltage is
(a) 20/π V (b) 10/√2 V
(c) 10/π V (d) 10V

Ans: (c)

Solution: $V = \frac{V_0}{\pi} = \frac{10}{\pi}V$

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q67. A bomb of mass 1 kg is thrown vertically upwards with a speed of 100 m/s. After 5 seconds it explodes into two fragments. One fragment of mass 400 gm is found to go down with a speed of 25 m/s. What will happen to the second fragment just after the explosion? ($g = 10\ m/s^2$)
(a) It will go upward with speed 40 m/s
(b) It will go upward with speed 100 m/s
(c) It will go upward with speed 60 m/s
(d) It will also go downward with speed 40m/s

Ans: (b)

Solution: Speed of bomb after 5 second,
$v = u - gt = 100 - 10\times5 = 50 m/s$
Momentum of 400 g fragment
$= \frac{400}{1000} \times (-25)$ [downward]
Momentum of 600g fragment $= \frac{600}{1000}v$
Momentum of bomb = 1 × 50 = 50
From conservation of momentum
Total momentum before splitting = total momentum after splitting.
$\Rightarrow 50 = -\frac{400}{1000} \times 25 + \frac{600}{1000}v$
⇒ v = 100 m/s[upward]

Chapter: Work, Energy and Power
[Topic: Collisions]

Q68. Fourty electric bulbs are connected in series across a 220 V supply. After one bulb is fused the remaining 39 are connected again in series across the same supply. The illumination will be
(a) more with 40 bulbs than with 39
(b) more with 39 bulbs than with 40
(c) equal in both the cases
(d) in the ratio $40^2 : 39^2$

Ans: (b)

Solution: Since, the voltage is same for the two combinations, therefore $H \propto \frac{1}{R}$. Hence, the combination of 39 bulbs will glow more.

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q69. The periodic waves of intensities I_1 and I_2 pass through a region at the same time in the same direction. The sum of the maximum and minimum intensities is:
(a) $I_1 + I_2$ (b) $(\sqrt{I_1} + \sqrt{I_\lambda})^2$
(c) $(\sqrt{I_1} - \sqrt{I_\lambda})^2$ (d) $2(I_1 + I_2)$

Ans: (d)

Solution: The resultant intensity of two periodic waves at a point is given by
$I = I_1 + I_2 + 2\sqrt{I_1I_2}.\cos\phi$.
Resultant intensity is maximum if
cos φ = –1
i.e. $I_{max} = I_1 + I_2 + 2\sqrt{I_1I_2}$
Resultant intensity is minimum if
cos φ = +1
i.e, $I_{min} = I_1 + I_2 - 2\sqrt{I_1I_2}$
Therefore, the sum of the maximum and minimum intensities is $I_{max} + I_{min}$
$= I_1 + I_2 + 2\sqrt{I_1I_2} + I_1 + I_2 - 2\sqrt{I_1I_2}$
$= 2(I_1 + I_2)$

Chapter - Wave Optics
[Topic: Wavefront, Interference of Light, Coherent & Incoherent Sources]

Q70. When *n*-type semiconductor is heated
(a) number of electrons increases while that of holes decreases
(b) number of holes increases while that of electrons decreases
(c) number of electrons and holes remain same
(d) number of electrons and holes increases equally.

Ans: (d)

Solution: Due to heating, when a free electron is produced then simultaneously a hole is also produced.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q71. A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of 2.0 rad s^{-2}. Its net acceleration in ms^{-2} at the end of 2.0s is approximately :

(a) 8.0 (b) 7.0
(c) 6.0 (d) 3.0

Ans: (a)

Solution: Given: Radius of disc, R = 50 cm
angular acceleration $\alpha = 2.0$ rads^{-2}; time t = 2s
Particle at periphery (assume) will have both radial (one) and tangential acceleration
$a_t = R\alpha = 0.5 \times 2 = 1$ m/s^2
From equation,
$\omega = \omega_0 + \alpha t$
$\omega = 0 + 2 \times 2 = 4$ rad/sec
$a_c = \omega^2 R = (4)^2 \times 0.5 = 16 \times 0.5 = 8$m/s^2
Net acceleration,
$a_{total} = \sqrt{a_t^2 + a_c^2} = \sqrt{1^2 + 8^2} \approx 8$ m/s^2

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

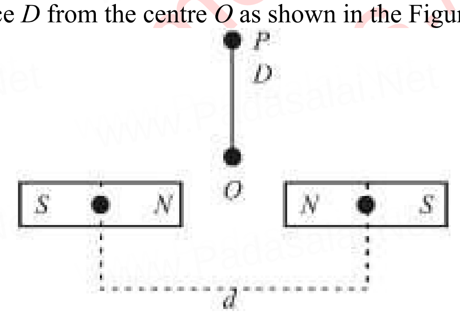
Q72. A body executes S.H.M with an amplitude A. At what displacement from the mean position is the potential energy of the body is one fourth of its total energy ?
(a) A/4 (b) A/2
(c) 3A/4 (d) Some other fraction of A.

Ans: (b)

Solution: PE $= \frac{1}{2}m\omega^2x^2$.
Total energy $E^2 = \frac{1}{2}m\omega^2A^2$
P.E. $= \frac{1}{4}E = \frac{1}{2}m\omega^2x^2 = \frac{1}{8}m\omega^2A^2$
$x = \frac{1}{2}A.$

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q73. Two identical bar magnets are fixed with their centres at a distance d apart. A stationary charge *Q* is placed at *P* in between the gap of the two magnets at a distance *D* from the centre *O* as shown in the Figure



The force on the charge *Q* is
(a) directed perpendicular to the plane of paper
(b) zero
(c) directed along *OP*
(d) directed along *PO*

Ans: (b)

Solution: Force on a charged particle is given by $F = qvB$. Here $v = 0$ and also resultant *B* is zero.
∴ Force = 0

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q74. A parallel beam of light of wavelength λ is incident normally on a narrow slit. A diffraction pattern is formed on a screen placed perpendicular to the direction of the incident beam. At the second minimum of the diffraction pattern, the phase difference between the rays coming from the two edges of slit is
[NEET Kar. 2013]
(a) πλ (b) 2π
(c) 3π (d) 4π

Ans: (d)

Solution: Conditions for diffraction minima are
Path diff. $\Delta x = n\lambda$ and Phase diff. $\delta\varphi = 2n\pi$
Path diff. $= n\lambda = 2\lambda$
Phase diff. $= 2n\pi = 4\pi$ ($\because n = 2$)

Chapter - Wave Optics
[Topic: Diffraction, Polarization of Light & Resolving Power]

Q75. The part of the transistor which is heavily doped to produce large number of majority carriers is
(a) emitter
(b) base
(c) collector
(d) any of the above depending upon the nature of transistor

Ans: (a)

Solution: The function of emitter is to supply the majority carriers. So, it is heavily doped.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q76. The dimensions of Planck's constant are same as
(a) energy
(b) power
(c) momentum
(d) angular momentum

Ans: (d)

Solution: We know that E = hν
$h = \frac{E}{v} = \frac{[ML^2T^{-2}]}{[T^{-1}]} = [ML^2T^{-1}]$
Angular momentum = Iω
$= [ML^2][T^{-1}] = [ML^2T^{-1}]$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q77. A boy suddenly comes and sits on a circular rotating table. What will remain conserved?
(a) Angular velocity
(b) Angular momentum
(c) Linear momentum
(d) Kinetic energy

Ans: (b)

Solution: As net torque applied is zero. Hence, $\tau = \frac{dL}{dt}$
$\frac{dL}{dt} = 0$, L = constant.
L (angular momentum) remains conserved.

Chapter: System of Particles and Rotational Motion

[Topic: Torque, Couple and Angular Momentum]

Q78. A body is executing S.H.M. When the displacements from the mean position are 4cm and 5 cm, the corresponding velocities of the body are 10 cm per sec and 8 cm per sec. Then the time period of the body is

(a) 2π sec
(b) $\pi/2$ sec
(c) π sec
(d) $(3\pi/2)$sec

Ans: (c)

Solution: For S.H.M., Velocity,

$v = \omega\sqrt{a^2 - x^2}$ at displacement x.

$\Rightarrow 10 = \omega\sqrt{a^2 - 16}$ .....(1)

and $8 = \omega\sqrt{a^2 - 25}$ .....(2)

Dividing, $\frac{5^2}{4^2} = \frac{a^2-16}{a^2-25} = \frac{25}{16}$

or, $16a^2 - 256 = 25a^2 - 625 \Rightarrow 9a^2 = 369$

$a^2 = \frac{369}{9}$

Putting this value in equation (2) mentioned above,

$$10 = \omega\sqrt{\frac{369}{9} - 16} \Rightarrow 10 = \omega\sqrt{\frac{225}{9}}$$

or, $\omega = \frac{10\times3}{15} = 2$radian/sec.

Time period $= \frac{2\pi}{\omega} = \frac{2\pi}{2} = \pi$sec

Chapter: Oscillation
[Topic: Damped SHM, Forced Oscillations & Resonance]

Q79. Two identical long conducting wires AOB and COD are placed at right angle to each other, with one above other such that 'O' is their common point for the two. The wires carry I_1 and I_2 currents respectively. Point 'P' is lying at distance 'd' from 'O' along a direction perpendicular to the plane containing the wires. The magnetic field at the point 'P' will be :
[2014]

(a) $\frac{\mu_0}{2\pi d}\left(\frac{I_1}{I_2}\right)$
(b) $\frac{\mu_0}{2\pi d}(I_1 + I_2)$
(c) $\frac{\mu_0}{2\pi d}(I_1^2 - I_2^2)$
(d) $\frac{\mu_0}{2\pi d}(I_1^2 \times I_2^2)^{\frac{1}{2}}$

Ans: (d)

Solution: Net magnetic field, $B = \sqrt{B_1^2 + B_2^2}$

$= \sqrt{\left(\frac{\mu_0 I_1}{2\pi d}\right)^2 + \left(\frac{\mu_0 I_2}{2\pi d}\right)^2}$

$\left(B_1 = \frac{\mu_0 I_1}{2\pi d} \text{ and } B_2 = \frac{\mu_0 I_2}{2\pi d}\right)$

$= \frac{\mu_0}{2\pi d}\sqrt{I_1^2 + I_2^2}$

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q80. A certain metallic surface is illuminated with monochromatic light of wavelength λ. The stopping potential for photo-electric current for this light is $3V_0$. If the same surface is illuminated with light of wavelength 2λ, the stopping potential is V_0. The threshold wavelength for this surface for photo-electric effect is

(a) 4λ (b) $\frac{\lambda}{4}$
(c) $\frac{\lambda}{6}$ (d) 6λ

Ans: (a)

Solution: As we know,

$eV_s = \frac{hc}{\lambda} - \Psi$

$3eV_o = \frac{hc}{\lambda} - \Psi$ ... (1)

$eV_o = \frac{hc}{2\lambda} - \Psi$ ... (2)

$3eV_o = \frac{3hc}{2\lambda} - 3\Psi$ ... (3)

Multiplying eqn. (2) by (3) and subtracting it from eqn (1)

$\Psi = \frac{h}{4\lambda}$

So,threshold wavelength,

$\lambda_{th} = \frac{hc}{\Psi} = \frac{hc}{\frac{hc}{4\lambda}} = 4\lambda$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q81. Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be:

(a) $\frac{t_1t_2}{t_2-t_1}$ (b) $\frac{t_1t_2}{t_2+t_1}$
(c) $t_1 - t_2$ (d) $\frac{t_1+t_2}{2}$

Ans: (b)

Solution: Velocity of preeti w.r.t. elevator $v_1 = \frac{d}{t_1}$

Velocity of elevator w.r.t. ground $v_2 = \frac{d}{t_2}$ then velocity of preeti w.r.t. ground

$v = v_1 + v_2$

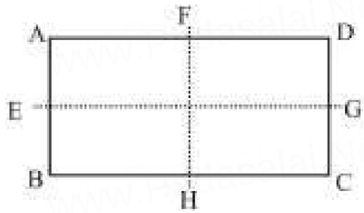
$\frac{d}{t} = \frac{d}{t_1} + \frac{d}{t_2}$

$\frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2}$

$\therefore t = \frac{t_1t_2}{(t_1+t_2)}$ (time taken by preeti to walk up on the moving escalator)

Chapter: Kinematics Motion in a Straight Line
[Topic: Distance, Displacement & Uniform motion]

Q82. In a rectangle ABCD (BC = 2 AB). The moment of inertia is minimum along axis through



(a) BC
(b) BD
(c) HF
(d) E G

Ans: (d)

Solution: The M.I. is minimum about EG because mass distribution is at minimum distance from EG.

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q83. Two sound waves having a phase difference of 60º have path difference of
(a) 2λ
(b) $\frac{\lambda}{2}$
(c) $\frac{\lambda}{3}$
(d) $\frac{\lambda}{6}$

Ans: (d)

Solution: Phase difference = $60° = \frac{\pi}{3}$

Path difference $= \frac{\lambda}{2\pi}$(phase diff)

$= \frac{\lambda}{2\pi} \times \frac{\pi}{3} = \frac{\lambda}{6}$

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q84. A current loop in a magnetic field
(a) can be in equilibrium in one orientation
(b) can be in equilibrium in two orientations, both the equilibrium states are unstable
(c) can be in equilibrium in two orientations, one stable while the other is unstable
(d) experiences a torque whether the field is uniform or non-uniform in all orientations

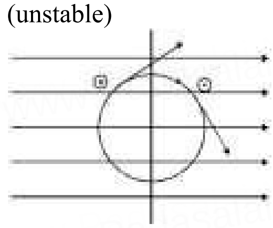
Ans: (c)

Solution: A current loop in a magnetic field is in equilibrium in two orientations one is stable and another unstable.

$\because \vec{\tau} = \vec{M} \times \vec{B} = MB\sin\theta$

If $\theta = 0° \Rightarrow \tau = 0$ (stable)

If $\theta = \pi \Rightarrow \tau = 0$ (unstable)



Do not experience a torque in some orientations
Hence option (c) is correct.

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q85. A photosensitive metallic surface has work function, $h\nu_0$. If photons of energy $2h\nu_0$ fall on this surface, the electrons come out with a maximum velocity of 4×10^6 m/s. When the photon energy is increased to $5h\nu_0$, then maximum velocity of photoelectrons will be [2005]

(a) 2×10^7 m/s
(b) 2×10^6 m/s
(c) 8×10^6 m/s
(d) 8×10^5 m/s

Ans: (c)

Solution: We know that

$h\nu - \phi = K_{max} = \frac{1}{2}mv_{max}^2$

According to question

$\frac{5h\nu_0 - h\nu_0}{2h\nu_0 - h\nu_0} = \frac{v_2^2}{v_1^2}$

$v_2 = 2v_1 = 2 \times 4 \times 10^6 = 8 \times 10^6$ m/s.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q86. The displacement of a particle varies with time (t) as: $s = at^2 - bt^3$. The acceleration of the particle at any given time (t) will be equal to
(a) $\frac{a}{b}$
(b) $\frac{a}{3b}$
(c) $\frac{3b}{a}$
(d) $\frac{2a}{3b}$

Ans: (b)

Solution: $s = at^2 - bt^3$

$v = \frac{ds}{dt} = 2at - 3bt^2$

$a = \frac{dv}{dt} = 2a - 6bt$

$2a - 6bt = 0 \Rightarrow t = \frac{a}{3b}$

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q87. A spherical planet has a mass M_p and diameter D_p. A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity, equal to :
(a) $\frac{4GM_P}{D_P^2}$
(b) $\frac{GM_P m}{D_P^2}$
(c) $\frac{GM_P}{D_P^2}$
(d) $\frac{4GM_P m}{D_P^2}$

Ans: (a)

Solution: Gravitational attraction force on particle B,

$F_g = \frac{GM_P m}{\left(\frac{D_P}{2}\right)^2}$

Acceleration of particle due to gravity

$a = \frac{F_g}{m} = \frac{4GM_P}{D_P^2}$

Chapter: Gravitation
[Topic: Newton's Universal Law of Gravitation]

Q88. If we study the vibration of a pipe open at both ends, then which of the following statements is not true ?
(a) Odd harmonics of the fundamental frequency will be generated
(b) All harmonics of the fundamental frequency will be generated
(c) Pressure change will be maximum at both ends
(d) Antinode will be at open end

Ans: (c)

Solution: Pressure change will be minimum at both ends. In fact, pressure variation is maximum at l /2 because the displacement node is pressure antinode.

Chapter: Waves
[Topic: Vibration of String & Organ Pipe]

Q89. To convert a galvanometer into an ammeter, one needs to connect a
(a) low resistance in parallel
(b) high resistance in parallel
(c) low resistance in series
(d) high resistance in series.

Ans: (a)

Solution: To convert a galvanometer into an ammeter, one needs to connect a low resistance in parallel so that maximum current passes through the shunt wire and ammeter remains protected.

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetism, Gauss's Law, Magnetic Moment & Properties of Magnet]

Q90. Energy levels *A*, *B*, *C* of a certain atom correspond to increasing values of energy i.e., $E_A < E_B < E_C$. If λ_1, λ_2, λ_3 are the wavelengths of radiation corresponding to the transitions *C* to *B*, *B* to *A* and *C* to *A* respectively, which of the following relation is correct?
(a) $\lambda_3 = \lambda_1 + \lambda_2$ (b) $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1+\lambda_2}$
(c) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (d) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Ans: (b)

Solution: $(E_2 - E_1) = h\nu = \frac{hc}{\lambda}$
$\therefore \frac{hc}{\lambda_1} = (E_C - E_B), \frac{hc}{\lambda_2} = (E_B - E_A)$
and $\frac{hc}{\lambda_3} = (E_C - E_A)$
Now,
$(E_C - E_A) = (B_C - B_B) + (E_B - E_A)$
or, $\frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$ or $\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$
$\therefore \frac{1}{\lambda_3} = \frac{\lambda_1+\lambda_2}{\lambda_1\lambda_2}$ or $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1+\lambda_2}$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q91. If vectors $\vec{A} = \cos\omega t\hat{i} + \sin\omega t\hat{j}$ and $\vec{B} = \cos\frac{\omega t}{2}\hat{i} + \sin\frac{\omega t}{2}\hat{j}$ are functions of time, then the value of t at which they are orthogonal to each other is :
(a) $t = \frac{\pi}{2\omega}$
(b) $t = \frac{\pi}{\omega}$
(c) t = 0 (d) $t = \frac{\pi}{4\omega}$

Ans: (b)

Solution: Two vectors are
$\vec{A} = \cos\omega t\hat{i} + \sin\omega t\hat{j}$
$\vec{B} = \cos\frac{\omega t}{2}\hat{i} + \sin\frac{\omega t}{2}\hat{j}$
For two vectors $\vec{A}$ and $\vec{B}$ to be orthogonal $\vec{A}.\vec{B} = 0$
$\vec{A}.\vec{B} = 0 = \cos\omega t.\cos\frac{\omega t}{2} + \sin\omega t.\sin\frac{\omega t}{2}$
$= \cos\left(\omega t - \frac{\omega t}{2}\right) = \cos\left(\frac{\omega t}{2}\right)$
So, $\frac{\omega t}{2} = \frac{\pi}{2} \therefore t = \frac{\pi}{\omega}$

Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q92. A remote - sensing satellite of earth revolves in a circular orbit at a height of 0.25×10^6 m above the surface of earth. If earth's radius is 6.38×10^6 m and g = 9.8 ms^{-2}, then the orbital speed of the satellite is:
(a) 8.56 km s^{-1} (b) 9.13 km s^{-1}
(c) 6.67 km s^{-1} (d) 7.76 km s^{-1}

Ans: (d)

Solution: Given: Height of the satellite from the earth's surface $h = 0.25 \times 10^6$m
Radius of the earth $R = 6.38 \times 10^6$m
Acceleration due to gravity g = 9.8 m/s^2
Orbital velocity, V_0 = ?
$V_0 = \sqrt{\frac{GM}{(R+h)}} = \sqrt{\frac{GM}{R^2}\cdot\frac{R^2}{(R+h)}}$
$= \sqrt{\frac{9.8\times6.38\times6.38}{6.63\times10^6}}$
$= 7.76$ km/s$\left[\frac{GM}{R^2} = g\right]$

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q93. A speeding motorcyclist sees trafic jam ahead of him. He slows down to 36 km/hour. He finds that traffic has eased and a car moving ahead of him at 18 km/hour is honking at a frequency of 1392 Hz. If the speeds of sound is 343 m/s, the frequency of the honk as heard by him will be :
(a) 1332 Hz (b) 1372 Hz
(c) 1412 Hz (d) 1464 Hz

Ans: (c)

Solution: According to Doppler's effect
Apparent frequency
$n' = n\left(\frac{v+v_0}{v+v_s}\right) = 1392\left(\frac{343+10}{343+5}\right)$.
= 1412Hz

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q94. For protecting a sensitive equipment from the external electric arc, it should be
(a) wrapped with insulation around it when a current is passing through it
(b) placed inside an iron can
(c) surrounded with fine copper sheet
(d) placed inside an aluminium can

Ans: (b)

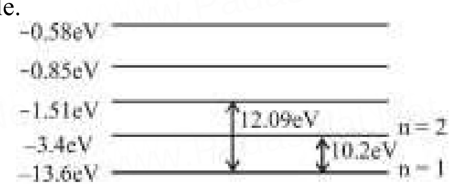
Solution: The iron can produces a magnetic screening for the equipment as lines of magnetic force can not enter iron enclosure.

Chapter: Magnetism and Matter
[Topic: Magnetic Equipments]

Q95. Out of the following which one is not a possible energy for a photon to be emitted by hydrogen atom according to Bohr's atomic model?
(a) 1.9 eV (b) 11.1 eV
(c) 13.6 eV (d) 0.65 eV

Ans: (b)

Solution: Obviously, difference of 11.1eV is not possible.



Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q96. A body of 3 kg moves in the XY plane under the action of a force given by $6t\hat{i} + 4t\hat{j}$. Assuming that the body is at rest at time t = 0, the velocity of the body at t = 3s is
(a) $6\hat{i} + 6\hat{j}$ (b) $18\hat{i} + 6\hat{j}$
(c) $18\hat{i} + 12\hat{j}$ (d) $12\hat{i} + 18\hat{j}$

Ans: (c)

Solution: $\vec{F} = 6t\hat{i} + 4t\hat{j}$
$F_x = 6t, F_y = 4t$
$a_x = \frac{6t}{3} = 2t, a_y = \frac{4t}{3}$
$v_x = 0 + 2t.t = 18$ for t = 3s
$v_y = 0 + \frac{4}{3}.t = 12$ for t = 3s
Velocity → $18\hat{i} + 12\hat{j}$

Chapter: Kinematics Motion in a Plane
[Topic: Motion in a Plane with Constant acceleration]

Q97. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied ?
[2013]
(a) Length = 100 cm, diameter = 1 mm
(b) Length = 200 cm, diameter = 2 mm
(c) Length = 300 cm, diameter = 3 mm
(d) Length = 50 cm, diameter = 0.5 mm

Ans: (d)

Solution: $F = \frac{YA}{L} \times l$ So, extension, $l \propto \frac{L}{A} \propto \frac{L}{D^2}$

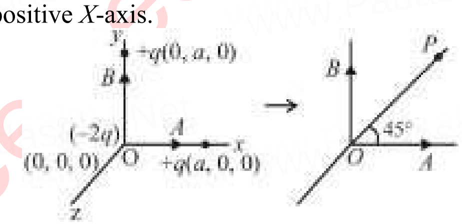
[∵ F and Y are constant]
$l_1 \propto \frac{100}{1^2} \propto 100$ and $l_2 \propto \frac{200}{2^2} \propto 50$
$l_3 \propto \frac{300}{3^2} \propto \frac{100}{3}$ and $l_4 \propto \frac{50}{\frac{1}{4}} \propto 200$
The ratio of $\frac{L}{D^2}$ is maximum for case (d) .
Hence, option (d) is correct.

Chapter: Mechanical Propertiesof Solids
[Topic: Hooke's Law & Young's Modulus of Elasticity]

Q98. Three point charges +*q*, –*q* and +*q* are placed at points (*x* = 0, *y* = *a*, *z* = 0), (*x* = 0, *y* = 0, *z* = 0) and (*x* = *a*, *y* = 0, *z* = 0) respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are
(a) $\sqrt{2}$qa along the line joini points (*x* = 0, *y* = 0, *z* = 0) and (*x* = *a*, *y* = *a*, *z* = 0)
(b) *qa* along the line joining points (*x* = 0, *y* = 0, *z* = 0) and (*x* = *a*, *y* = *a*, *z* = 0)
(c) $\sqrt{2}$qa along +ve *x* direction
(d) $\sqrt{2}$qa along +ve *y* direction

Ans: (a)

Solution: Three point charges +*q*, –2*q* and +*q* are placed at points *B* (*x* = 0, *y* = *a*, *z* = 0),
O (*x* = 0, *y* = 0, *z* = 0) and *A*(*x* = *a*, *y* = 0, *z* = 0)
The system consists of two dipole moment vectors due to (+*q* and –*q*) and again due to (+*q* and –*q*) charges having equal magnitudes qa units – one along $\overrightarrow{OA}$ and other along $\overrightarrow{OB}$. Hence, net dipole moment,
$p_{net} = \sqrt{(qa)^2 + (qa)^2} = \sqrt{2}qa$ along $\overrightarrow{OP}$ at an angle 45° with positive *X*-axis.



Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q99. A varying current in a coil changes from 10A to zero in 0.5 sec. If the average e.m.f induced in the coil is 220V, the self-inductance of the coil is
(a) 5 H (b) 6 H
(c) 11 H (d) 12 H

Ans: (c)

Solution: Initial current (I_1) = 10 A; Final current(I_2)= 0; Time (t) = 0.5 sec and induced e.m.f. (ε) = 220 V.
Induced e.m.f. (ε)
$= -L\frac{dI}{dt} = -L\frac{(I_2 - I_1)}{t} = -L\frac{(0-10)}{0.5} = 20L$
or, $L = \frac{220}{20} = 11H$
[where L = Self inductance of coil]

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q100. If radius of the $^{27}_{12}Al$ nucleus is taken to be R_{Al}, then the radius of $^{125}_{53}Te$ nucleus is nearly:
[2015]

(a) $\frac{5}{3}R_{Al}$
(b) $\frac{3}{5}R_{A1}$
(c) $\left(\frac{13}{53}\right)^{\frac{1}{3}}R_{A1}$
(d) $\left(\frac{53}{13}\right)^{\frac{1}{3}}R_{A1}$

Ans: (a)

Solution: As we know, $R = R_0 (A)^{1/3}$
where A = mass number
$R_{Al} = R_0 (27)^{1/3} = 3R_0$
$R_{Te} = R_0 (125)^{1/3} = 5R_0 = \frac{5}{3}R_{Al}$

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

PART 8. PHYSICS QUESTION BANK

Q1. Two particles of mass M and m are moving in a circle of radii R and r. If their time-periods are same, what will be the ratio of their linear velocities?

(a) MR : mr (b) M : m
(c) R : r (d) 1 : 1

Ans: (c)

Solution: Linear velocity v = rω

$v_1 = \omega r_1$, $v_2 = \omega r_2$

[ω is same in both cases because time period is same]

$\frac{v_1}{v_2} = \frac{r_1}{r_2} = \frac{R}{r}$

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q2. A centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers 140°. What is the fall in temperature as registered by the Centigrade thermometer?

(a) 80° (b) 60°
(c) 40° (d) 30°

Ans: (c)

Solution: Using $\frac{F-32}{180} = \frac{C}{100}$

$\Rightarrow \frac{140-32}{180} = \frac{C}{100}$

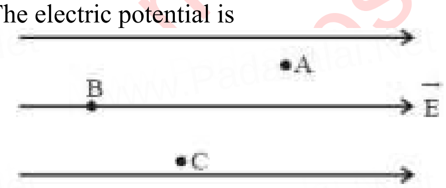
⇒ C = 60

Temperature of boiling water = 100°C

We get, fall in temperature = 100 – 60 = 40°C

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q3. A, B and C are three points in a uniform electric field. The electric potential is



(a) maximum at B
(b) maximum at C
(c) same at all the three points A, B and C
(d) maximum at A

Ans: (a)

Solution: Potential at B, V_B is maximum

$V_B > V_C > V_A$

As in the direction of electric field potential decreases.

Chapter: Electrostatic Potential and capacitance
[Topic: Electrostatic Potential & Equipotential Surfaces]

Q4. An ac voltage is applied to a resistance R and an inductor L in series. If R and the inductive reactance are both equal to 3Ω, the phase difference between the applied voltage and the current in the circuit is

(a) π/6 (b) π/4
(c) π/2 (d) zero

Ans: (b)

Solution: The phase difference φ is given by

$\tan\varphi = \frac{X_L}{R}$

$= \frac{3}{3} = 1 = \phi = \frac{\pi}{4}$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q5. The power obtained in a reactor using U^{235} disintegration is 1000 kW. The mass decay of U^{235} per hour is

(a) 10 microgram (b) 20 microgram
(c) 40 microgram (d) 1 microgram

Ans: (c)

Solution: $E = mc^2$

$m = \frac{E}{c^2}$

So, mass decay per second

$\frac{dm}{dt} = \frac{1}{c^2}\frac{dE}{dt} = \frac{1}{c^2}$ (Power in watt)

$= \frac{1}{(3\times10^8)^2} \times 1000 \times 10^3$

and mass decay per hour $= \frac{dm}{dt} \times 60 \times 60$

$= \frac{1}{(3\times10^8)^2} \times 10^6 \times 3600 = 4 \times 10^{-8}$ kg

= 40 microgram

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q6. A 600 kg rocket is set for a vertical firing. If the exhaust speed is 1000 ms^{-1}, the mass of the gas ejected per second to supply the thrust needed to overcome the weight of rocket is

(a) 117.6 kg s^{-1} (b) 58.6 kg s^{-1}
(c) 6 kg s^{-1} (d) 76.4 kg s^{-1}

Ans: (c)

Solution: Thrust $= \frac{udM}{dt} = mg = \frac{dM}{dt} = \frac{mg}{u}$

$= \frac{600\times10}{1000} = 6$ kg s^{-1}

Chapter: Dynamics Laws of Motion
[Topic: Ist, IInd & IIIrd Laws of Motion]

Q7. Radiation from which of the following sources, approximates black body radiation best?

(a) A tungsten lamp
(b) Sodium flame
(c) Hot lamp black
(d) A hole in a cavity, maintained at constant temperature

Ans: (d)

Solution: Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q8. Three capacitors each of capacitance C and of breakdown voltage V are joined in series. The capacitance and breakdown voltage of the combination will be

(a) 3C, $\frac{V}{3}$
(b) $\frac{C}{3}$, 3V
(c) 3C, 3V
(d) $\frac{C}{3}, \frac{V}{3}$

Ans: (b)

Solution: In series combination of capacitors
$V_{eff} = V + V + V = 3V$

$$\frac{1}{C_{eff}} = \frac{1}{c} + \frac{1}{c} + \frac{1}{c}$$

$= C_{eff} = \frac{C}{3}$

Thus, the capacitance and breakdown voltage of the combination will be $\frac{C}{3}$ and 3V.

Chapter: Electrostatic Potential and capacitance [Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q9. In an electromagnetic wave in free space the root mean square value of the electric field is $E_{rms} = 6$V/m. The peak value of the magnetic field is :-
(a) 2.83×10^{-8} T
(b) 0.70×10^{-8} T
(c) 4.23×10^{-8} T
(d) 1.41×10^{-8} T

Ans: (a)

Solution: Given, $E_{rms} = 6$ V/m

$$\frac{E_{rms}}{B_{rms}} = c$$

$\Rightarrow B_{rms} = \frac{E_{rms}}{c}$ ... (i)

$B_{rms} = \frac{B_0}{\sqrt{2}} = B_0 = \sqrt{2}B_{rms}$

$B_0 = \sqrt{2} \times \frac{E_{rms}}{c}$ From equation (i)

$= \frac{\sqrt{2}\times 6}{3\times 10^8} = 2.83 \times 10^{-8}$ T

Chapter - Electromagnetic Waves [Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q10. Solar energy is due to
(a) fusion reaction
(b) fission reaction
(c) combustion reaction
(d) chemical reaction

Ans: (a)

Solution: Fusion reaction.

Chapter: Nuclei [Topic: Mass-Energy & Nuclear Reactions]

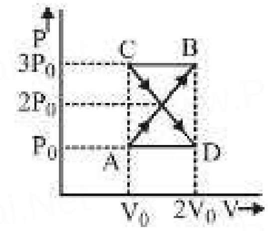
Q11. A 100 N force acts horizontally on a block of 10 kg placed on a horizontal rough surface of coefficient of friction μ = 0.5. If the acceleration due to gravity (g) is taken as 10 ms^{-2}, the acceleration of the block (in ms^{-2}) is
(a) 2.5
(b) 10
(c) 5
(d) 7.5

Ans: (c)

Solution: $a = \frac{F-\mu R}{m} = \frac{100-0.5\times(10\times10)}{10} = 5ms^{-2}$

Chapter: Dynamics Laws of Motion [Topic: Friction]

Q12. A thermodynamic system undergoes cyclic process ABCDA as shown in fig. The work done by the system in the cycle is :



(a) P_0V_0
(b) $2P_0V_0$
(c) $\frac{P_0V_0}{2}$
(d) Zero

Ans: (d)

Solution: Work done by the system in the cycle
= Area under P-V curve and V-axis

$= \frac{1}{2}(2P_0 - P_0)(2V_0 - V_0) + \left[-\left(\frac{1}{2}\right)(3P_0 - 2P_0)(2V_0 - V_0)\right]$

$= \frac{P_0V_0}{2} - \frac{P_0V_0}{2} = 0$

Chapter: Heat & Thermodynamics [Topic: Specific Heat Capacity & Thermodynamic Processes]

Q13. The resistance of a discharge tube is
(a) zero
(b) ohmic
(c) non-ohmic
(d) infinity

Ans: (c)

Solution: In discharge tube the current is due to flow of positive ions and electrons. Moreover, secondary emission of electrons is also possible. So V-I curve is non-linear; hence resistance is non-ohmic.

Chapter: Current Electricity [Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q14. Which of the following is positively charged?
(a) α-particle
(b) β-particle
(c) γ-rays
(d) X-rays

Ans: (a)

Solution: α rays contain Helium nuclei which contains 2 unit of positive charge.

Chapter - Electromagnetic Waves [Topic: Electromagnetic Spectrum]

Q15. A sample of radioactive element has a mass of 10gm at an instant *t*=0. The approximate mass of this element in the sample after two mean lives is
(a) 6.30 gm
(b) 1.35 gm
(c) 2.50 gm
(d) 3.70 gm

Ans: (b)

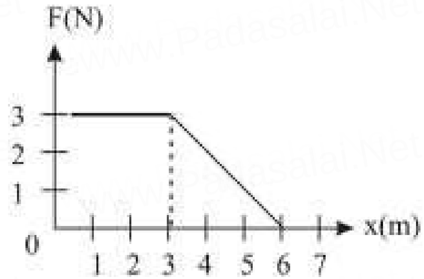
Solution: Using the relation for mean life.
Given : $t = 2\tau = 2\left(\frac{1}{\lambda}\right) \left(\because \tau = \frac{1}{\lambda}\right)$

Then from $M = M_0 e^{-\lambda t} = 10e^{\lambda \times \frac{2}{\lambda}}$

$= 10\left(\frac{1}{e}\right)^2 = 1.35g$

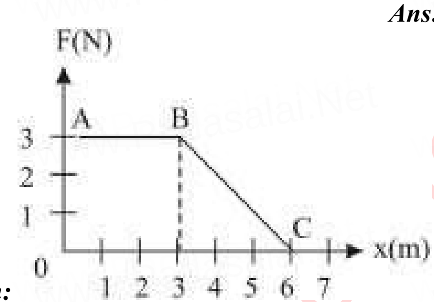
Chapter: Nuclei
[Topic: Radioactivity]

Q16. A force F acting on an object varies with distance x as shown here. The force is in N and x in m. The work done by the force in moving the object from x = 0 to x = 6 m is



(a) 18.0 J (b) 13.5 J
(c) 9.0 J (d) 4.5 J

Ans: (b)



Solution:
Work done = area under F-x graph
= area of trapezium OABC
$= \frac{1}{2}(3 + 6)(3) = 13.5$ J

Chapter: Work, Energy and Power
[Topic: Work]

Q17. When 1 kg of ice at 0°C melts to water at 0°C, the resulting change in its entropy, taking latent heat of ice to be 80 cal/°C, is
(a) 273 cal/K (b) 8 × 104 cal/K
(c) 80 cal/K (d) 293 cal/K

Ans: (d)

Solution: Change in entropy is given by
$dS = \frac{dQ}{T}$ or $\Delta S = \frac{\Delta Q}{T} = \frac{mL_f}{273}$
$\Delta S = \frac{1000\times 80}{273}$ =293cal/K.

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q18. The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is
[2013]
(a) 0.5 Ω (b) 0.8 Ω
(c) 1.0 Ω (d) 0.2 Ω

Ans: (a)

Solution: Given : emf ε = 2.1 V
I = 0.2 A, R = 10Ω
Internal resistance r = ?
From formula.
ε – Ir = V = IR
2.1 – 0.2r = 0.2 × 10
2.1 – 0.2 r = 2 or 0.2 r = 0.1
$= r = \frac{0.1}{0.2} = 0.5\ \Omega$
ALTERNATE : $i = \frac{\varepsilon}{r+R} \Rightarrow 0.2 = \frac{2.1}{r+10}$
$\Rightarrow 2.1 = 0.2r + 2 \Rightarrow r = \frac{1}{2} = 0.5\ \Omega$

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

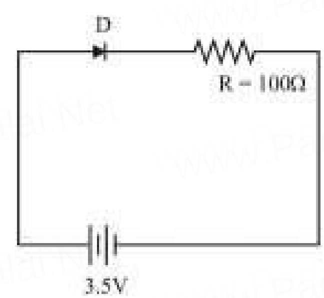
Q19. One face of a rectangular glass plate 6 cm thick is silvered. An object held 8 cm in front of the first face forms an image 12 cm behind the silvered face. The refractive index of the glass is
(a) 0.4 (b) 0.8
(c) 1.2 (d) 1.6

Ans: (c)

Solution: Thickness of glass plate (*t*) = 6 cm;
Distance of the object (*u*) = 8 cm.
And distance of the image (*v*) = 12 cm.
Let *x* = Apparent position of the silvered surface in cm.
Since the image is formed due to reflection at the silvered face and by the property of mirror image
Distance of object from the mirror = Distance of image from the mirror
or, $x + 8 = 12 + 6 - x \Rightarrow x = 5$ cm.
Therefore, refractive index of glass
$= \frac{\text{Real depth}}{\text{Apparent depth}} = \frac{6}{5} = 1.2$.

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q20. In the given figure, a diode D is connected to an external resistance R = 100 Ω and an e.m.f. of 3.5 V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:
[2015 RS]



(a) 40 mA (b) 20 mA
(c) 35 mA (d) 30 mA

Ans: (d)

Solution: Current $I = \frac{V}{R} = \frac{(3.5-0.5)}{100}$ A
[∵ Barrier potential $V_B = 0.5$V]
$= \frac{3}{100} = 30$mA

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q21. Two bodies of masses m and 4m are moving with equal kinetic energies. The ratio of their linear momenta will be

(a) 1 : 4 (b) 4 : 1
(c) 1 : 2 (d) 2 : 1

Ans: (c)

Solution: $\frac{K_1}{K_2} = \frac{p_1^2}{m_1} \times \frac{m_2}{p_2^2}$ $[\because p = mv \Rightarrow K = \frac{p^2}{2m}]$

Hence, $\frac{p_1}{p_2} = \sqrt{\frac{M_1}{M_2}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

Chapter: Work, Energy and Power [Topic: Power]

Q22. Relation between pressure (P) and energy (E) of a gas is

(a) $P = \frac{2}{3}E$
(b) $P = \frac{1}{3}E$
(c) $= \frac{1}{2}E$
(d) P = 3E

Ans: (a)

Solution: $P = \frac{1}{3}Nmc^2 = \frac{2}{3} \times \left(\frac{1}{2}Nm\right)c^2 = \frac{2}{3}KE$

Chapter: Kinetic Theory [Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q23. The charge flowing through a resistance R varies with time t as $Q = at - bt^2$, where a and b are positive constants. The total heat produced in R is:

(a) $\frac{a^3R}{6b}$
(b) $\frac{a^3R}{3b}$
(c) $\frac{a^3R}{2b}$
(d) $\frac{a^3R}{b}$

Ans: (a)

Solution: **Given:** Charge $Q = at - bt^2$

$\therefore$Current $i = \frac{\partial Q}{\partial t} = a - 2bt$

$\{\text{for } i = 0 \Rightarrow t = \frac{a}{2b}\}$

From joule's law of heating, heat produced

$dH = i^2Rdt$

$H = \int_0^{\frac{a}{2b}}(a - 2bt)^2Rdt$

H = $\frac{-}{-}$ —

Chapter: Current Electricity [Topic: Heating Effects of Current]

Q24. A lens is placed between a source of light and a wall. It forms images of area A_1 and A_2 on the wall for its two different positions. The area of the source of light is

(a) $\sqrt{A_1A_2}$
(b) $\frac{A_1+A_2}{2}$
(c) $\frac{A_1-A_2}{2}$
(d) $\frac{1}{A_1} + \frac{1}{A_2}$

Ans: (a)

Solution: Size of images = A_1 and A_2. From the displacement method, the area of the source of light = $\sqrt{A_1A_2}$.

Chapter - Ray Optics and Optical [Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q25. In a *p-n* junction photocell, the value of the photo-electromotive force produced by monochromatic light is proportional to

(a) the voltage applied at the *p-n* junction
(b) the barrier voltage at the *p-n* junction
(c) the intensity of the light falling on the cell
(d) the frequency of the light falling on the cell

Ans: (c)

Solution: Electromotive force depends upon intensity of light falling, it does not depend on frequency of barrier voltage.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q26. Two equal masses m_1 and m_2 moving along the same straight line with velocities + 3 m/s and – 5m/s respectively, collide elastically. Their velocities after the collision will be respectively.

(a) –3 m/s & +5 m/s (b) + 4 m/s for both
(c) –4 m/s & +4 m/s (d) –5m/s & +3 m/s

Ans: (d)

Solution: In elastic collision, the velocities get inter changed if the colliding objects have equal masses.

Chapter: Work, Energy and Power [Topic: Collisions]

Q27. Out of the following functions, representing motion of a particle, which represents SHM?

(A) $y = \sin\omega t - \cos\omega t$
(B) $y = \sin^3 \omega t$
(C) $y = 5\cos\left(\frac{3\pi}{4} - 3\omega t\right)$
(D) $y = 1 + \omega t + \omega^2t^2$

(a) Only (A)
(b) Only (D) does not represent SHM
(c) Only (A) and (C)
(d) Only (A) and (B)

Ans: (c)

Solution: Only functions given in (A) & (C) represent SHM.

Chapter: Oscillation [Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q28. A current of 2 A, passing through a conductor produces 80 J of heat in 10 seconds. The resistance of the conductor in ohm is

(a) 0.5 (b) 2
(c) 4 (d) 20

Ans: (b)

Solution: $H = I^2Rt$

or $R = \frac{H}{(I^2t)} = \frac{80}{(2^2\times10)} = 2\Omega$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q29. Colours appear on a thin soap film and on soap bubbles due to the phenomenon of
(a) refraction
(b) dispersion
(c) interference
(d) diffraction

Ans: (c)

Solution: We know that the colours for which the condition of constructive interference is satisfied are observed in a given region of the film. The path difference between the light waves reaching the eye changes when the position of the eye is changed. Therefore, colours appear on a thin soap film or soap bubbles due to the phenomenon of interference.

Chapter - Wave Optics
[Topic: Wavefront, Interference of Light, Coherent & Incoherent Sources]

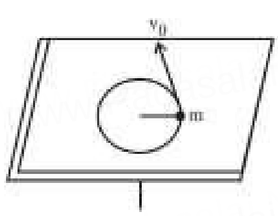
Q30. p-n junction is said to be forward biased, when [1988]
(a) the positive pole of the battery is joined to the *p*-semiconductor and negative pole to the *n*-semiconductor
(b) the positive pole of the battery is joined to the *n*-semiconductor and *p*-semiconductor joined to negative pole of the battery
(c) the positive pole of the battery is connected to *n*-semiconductor and *p*-semiconductor is connected to the positive pole of the battery
(d) a mechanical force is applied in the forward direction

Ans: (a)

Solution: For forward biasing of *p-n* junction, the positive terminal of external battery is to be connected to p-semiconductor and negative terminal of battery to the *n*-semiconductor.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q31. A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to string which passes through a smooth hole in the plane as shown.



The tension in the string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. The final value of the kinetic energy is

(a) $\frac{1}{4}mv_0^2$ (b) $2mv_0^2$
(c) $\frac{1}{2}mv_0^2$ (d) mv_0^2

Ans: (b)

Solution: Applying angular momentum conservation

$mV_0R_0 = (m)(V^1)\left(\frac{R_0}{2}\right)$

$\therefore v^1 = 2V_0$

Therefore, new KE $= \frac{1}{2}m(2V_0)^2 = 2mv_0^2$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q32. The angular velocity and the amplitude of a simple pendulum is ω and a respectively. At a displacement x from the mean position if its kinetic energy is T and potential energy is V, then the ratio of T to V is
(a) $\frac{(a^2-x^2\omega^2)}{x^2\omega^2}$
(b) $\frac{x^2\omega^2}{(a^2-x^2\omega^2)}$
(c) $\frac{(a^2-x^2)}{x^2}$
(d) $\frac{x^2}{(a^2-x^2)}$

Ans: (c)

Solution: P.E., $V = \frac{1}{2}m\omega^2x^2$

and K.E., $T = \frac{1}{2}m\omega^2(a^2 - x^2)$

$\frac{T}{V} = \frac{a^2 - x^2}{x^2}$

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q33. The magnetic force acting on a charged particle of charge – 2 μC in a magnetic field of 2T acting in y direction, when the particle velocity is $(2\hat{i} + 3\hat{j}) \times 10^6 ms^{-1}$,is [2009]
(a) 4 N in z direction (b) 8 N in y direction
(c) 8 N in z direction (d) 8 N in – z direction

Ans: (d)

Solution: The magnetic force acting on the charged paraticle is given by

$\vec{F} = q(\vec{v} \times \vec{B})$

$= (-2\times 10^{-6})[\{(2\hat{i} + 3\hat{j}) \times 10^6\} \times (2\hat{j})]$

$= -4(2\hat{k})$

$= -8\hat{k}$

$\therefore$ Force is of 8N along – z-axis.

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q34. The angular resolution of a 10 cm diameter telescope at a wavelength of 5000 Å is of the order of
(a) 10^6 rad (b) 10^{-2} rad
(c) 10^{-4} rad (d) 10^{-6} rad

Ans: (d)

Solution: $\delta\phi = 1.22\frac{\lambda}{D} = 1.22\frac{5000\times10^{-10}}{10\times10^{-2}} = 6.1 \times 10^{-6}$

$\therefore$ Order $= 10^{-6}$

Chapter - Wave Optics
[Topic: Diffraction, Polarization of Light & Resolving Power]

Q35. For amplification by a triode, the signal to be amplified is given to
(a) the cathode
(b) the grid
(c) the glass-envelope
(d) the anode

Ans: (b)

Solution: The amplifying action of a triode is based on the fact that a small change in grid voltage causes a large change in plate current. The AC input signal which is to be amplified is superimposed on the grid potential.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q36. Which one of the following groups have quantities that do not have the same dimensions?
(a) pressure, stress
(b) velocity, speed
(c) force, impulse
(d) work, energy

Ans: (c)

Solution: Force has dimension $[MLT^{-2}]$ while impulse has dimension $[MLT^{-1}]$, both have different dimensions.

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q37. A constant torque of 1000 N-m turns a wheel of moment of inertia 200 kg-m^2 about an axis through its centre. Its angular velocity after 3 seconds is
(a) 1 rad/s (b) 5 rad/s
(c) 10 rad/s (d) 15 rad/s

Ans: (d)

Solution: $\tau = 1000$ N - m, I = 200 kg-m^2
$\therefore I\alpha = 1000$
$\Rightarrow \alpha = \frac{1000}{200} = 5$ rad/sec^2
$\omega = \omega_0 + \alpha t = 0 + 3 \times 5 = 15$ rad/s

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q38. A simple pendulum is suspended from the roof of a trolley which moves in a horizontal direction with an acceleration a, then the time period is given by $T = 2\pi\sqrt{\left(\frac{l}{g}\right)}$, where g is equal to
(a) g
(b) g – a
(c) g + a
(d) $\sqrt{(g^2 + a^2)}$

Ans: (d)

Solution: The effective value of acceleration due to gravity is $\sqrt{(a^2 + g^2)}$

Chapter: Oscillation
[Topic: Damped SHM, Forced Oscillations & Resonance]

Q39. When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ towards west. The electric and magnetic fields in the room are respectively
(a) $\frac{ma_0}{e}$west, $\frac{2ma_0}{ev_0}$ down
(b) $\frac{ma_0}{e}$ east, $\frac{3ma_0}{ev_0}$ up
(c) $\frac{ma_0}{e}$east, $\frac{3ma_0}{ev_0}$ down
(d) $\frac{ma_0}{e}$ west, $\frac{2ma_0}{ev_0}$ up

Ans: (a)

Solution: When moves with an acceleration a_0 towards west, electric field
$E = \frac{F}{q} = \frac{ma_0}{e}$ (West)
When moves with an acceleration $3a_0$ towards east, magnetic field
$B = \frac{2ma_0}{ev_0}$ (downward)

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q40. Light of wavelength 500 nm is incident on a metal with work function 2.28 eV. The wavelength of the emitted electron is:
[2015 RS]
(a) $< 2.8 \times 10^{-9}$ *m*
(b) $\geq 2.8 \times 10^{-9}$ *m*
(c) $\leq 2.8 \times 10^{-12}$ *m*
(d) $< 2.8 \times 10^{-10}$ *m*

Ans: (b)

***Solution:* Given :** Work function φ of metal = 2.28 eV
Wavelength of light $\lambda = 500$ nm $= 500 \times 10^{-9}$m
$KE_{max} = \frac{hc}{\lambda} - \varphi$
$KE_{max} = \frac{6.6\times10^{-34}\times3\times10^{8}}{5\times10^{-7}\times1.6\times10^{-19}} - 2.28$
$KE_{max} = 2.48 - 2.28 = 0.2$ ev
$\lambda_{min} = \frac{h}{p} = \frac{h}{\sqrt{2m(KE)_{max}}}$
$= \frac{\frac{20}{3}\times10^{-34}}{\sqrt{2\times9\times10^{-31}\times0.2\times1.6\times10^{-19}}}$
$\lambda_{min} = \frac{25}{9} \times 10^{-9}$
$= 2.80 \times 10^{-9}$ nm $\therefore \lambda \geq 2.8 \times 10^{-9}$m

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q41. A particle covers half of its total distance with speed v_1 and the rest half distance with speed v_2. Its average speed during the complete journey is
(a) $\frac{v_1v_2}{v_1+v_2}$
(b) $\frac{2v_1v_2}{v_1+v_2}$
(c) $\frac{2v_1^2v_2^2}{v_1^2+v_2^2}$
(d) $\frac{v_1+v_2}{2}$

Ans: (b)

Solution: Let the total distance covered by the particle be 2s. Then

$v_{av} = \frac{2s}{\frac{s}{v_1}+\frac{s}{v_2}} = \frac{2v_1v_2}{v_1+v_2}$

Chapter: Kinematics Motion in a Straight Line
[Topic: Distance, Displacement & Uniform motion]

Q42. Moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an axis ⊥ to its plane and passing through a point on its rim will be

(a) 5 I (b) 3 I
(c) 6 I (d) 4 I

Ans: (c)

Solution: M.I of uniform circular disc about its diameter = I

According to theorem of perpendicular axes,

M.I. of disc about its axis $= \frac{1}{2}mr^2 = 2I$

Applying theorem of | | axes, $\left(I = \frac{1}{4}mr^2\right)$

M.I of disc about the given axis

$= 2I + mr^2 = 2I + 4I = 6I$

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q43. What is the effect of humidity on sound waves when humidity increases?

(a) speed of sound waves is more
(b) speed of sound waves is less
(c) speed of sound waves remains same
(d) speed of sound waves becomes zero

Ans: (a)

Solution: Velocity of sound $= \sqrt{\frac{\gamma RT}{M}}$

When water vapour are present in air, average molecular weight of air decreases and hence velocity increases.

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q44. A long straight wire carries a certain current and produces a magnetic field of $2 \times 10^{-4}\ \frac{weber}{m^2}$ at a perpendicular distance of 5 cm from the wire. An electron situated at 5 cm from the wire moves with a velocity 10^7 m/s towards the wire along perpendicular to it. The force experienced by the electron will be (charge on electron $=1.6 \times 10^{-19}$ C)

(a) Zero (b) 3.2 N
(c) 3.2×10^{-16} N (d) 1.6×10^{-16} N

Ans: (c)

Solution: Given:

Magnetic field $B = 2 \times 10^{-4}$ weber/m^2

Velocity of electron, $v = 10^7$ m/s

Lorentz force $F = qvB \sin\theta$

$= 1.6 \times 10^{-19} \times 10^7 \times 2 \times 10^{-4} (\because \theta = 90°)$

$= 3.2 \times 10^{-16}$ N

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q45. The work functions for metals A, B and C are respectively 1.92 eV, 2.0 eV and 5 eV. According to Einstein's equation, the metals which will emit photoelectrons for a radiation of wavelength 4100 Å is/are

(a) none
(b) A only
(c) A and B only
(d) all three metals

Ans: (c)

Solution: $E = \frac{hc}{\lambda}$

$\Rightarrow E = \frac{12375}{\lambda(\text{in A})}eV \Rightarrow E = \frac{12375}{4100}eV$

$\Rightarrow E \approx 3$ eV

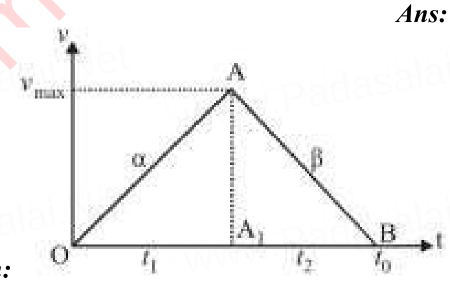
So, only metals having work function less than 3eV can emit photoelectrons for the incident radiation of wavelength 4100Å.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q46. A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β and comes to rest. If the total time elapsed is t, then the maximum velocity acquired by the car is

(a) $\left(\frac{\alpha^2+\beta^2}{\alpha\beta}\right)t$
(b) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$
(c) $\frac{(\alpha+\beta)t}{\alpha\beta}$
(d) $\frac{\alpha\beta t}{\alpha+\beta}$

Ans: (d)



Solution:

In Fig.

$AA_1 = v_{max.} = \alpha t_1 = \beta t_2$

But $t = t_1 + t_2 = \frac{v_{max}}{\alpha} + \frac{v_{max}}{\beta}$

$= v_{max}\left(\frac{1}{\alpha}+\frac{1}{\beta}\right) = v_{max}\left(\frac{\alpha+\beta}{\alpha\beta}\right)$

or, $v_{max} = t\left(\frac{\alpha\beta}{\alpha+\beta}\right)$

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q47. Two spheres of masses m and M are situated in air and the gravitational force between them is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force will now be

(a) $\frac{F}{9}$ (b) 3F
(c) F

(d) $\frac{F}{3}$

Ans: (c)

Solution: Gravitational force is independent of medium, Hence, this will remain same.

Chapter: Gravitation
[Topic: Newton's Universal Law of Gravitation]

Q48. The length of the wire between two ends of a sonometer is 100 cm. What should be the positions of two bridges below the wire so that the three segments of the wire have their fundamental frequencies in the ratio of 1 : 3 : 5?

(a) $\frac{1500}{23}$cm, $\frac{2000}{23}$cm
(b) $\frac{1500}{23}$cm, $\frac{500}{23}$cm
(c) $\frac{1500}{23}$cm, $\frac{300}{23}$cm
(d) $\frac{300}{23}$cm, $\frac{1500}{23}$cm

Ans: (a)

Solution: From formula, $f = \frac{1}{x}\sqrt{\frac{T}{m}}$

$\Rightarrow \frac{1}{f} \propto l$

$\therefore l_1 : l_2 : l_3 = \frac{1}{f_1} : \frac{1}{f_2} : \frac{1}{f_3}$

$= f_2f_3 : f_1f_3 : f_1f_2$ [Given: $f_1 : f_2 : f_3 = 1 : 3 : 5$]
$= 15 : 5 : 3$

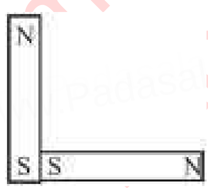
Therefore the positions of two bridges below the wire are $\frac{15\times100}{15+5+3}$cm and $\frac{15\times100+5\times100}{15+5+3}$cm

i.e., $\frac{1500}{23}$cm, $\frac{2000}{23}$cm

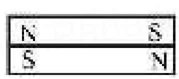
Chapter: Waves
[Topic: Vibration of String & Organ Pipe]

Q49. Following figures show the arrangement of bar magnets in different configurations. Each magnet has magnetic dipole moment $\vec{m}$. Which configuration has highest net magnetic dipole moment ?

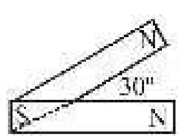
A.



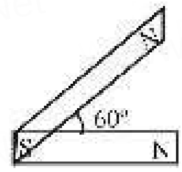
B.



C.



D.



(a) A
(b) B
(c) C
(d) D

Ans: (c)

Solution: Net magnetic dipole moment = 2 M$\cos\frac{\theta}{2}$

As value of $\cos\frac{\theta}{2}$ is maximum in case (c) hence net magnetic dipole moment is maximum for option (c) .

Chapter: Magnetism and Matter
[Topic: Magnetism, Gauss's Law, Magnetic Moment & Properties of Magnet]

Q50. A radio transmitter operates at a freqency 880 kHz and a power of 10 kW. The number of photons emitted per second is

(a) 1.72×10^{31} (b) 1.327×10^{25}
(c) 1.327×10^{37} (d) 1.327×10^{45}

Ans: (a)

Solution: No. of photons emitted per sec,

$n = \frac{\text{Power}}{\text{Energy of photon}}$

$= \frac{P}{h\nu} = \frac{10000}{6.6 \times 10^{-34} \times 880 \times 10^{3}}$

$= 1.72 \times 10^{31}$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

PART 9. PHYSICS QUESTION BANK

Q51. A particle is moving such that its position coordinate (x, y) are
(2m, 3m) at time t = 0
(6m, 7m) at time t = 2s and
(13m, 14m) at time t = 5s.
Average velocity vector $(\vec{V}_{av})$ from t = 0 to t = 5s is :
(a) $\frac{1}{5}(13\hat{i}+14\hat{j})$
(b) $\frac{7}{3}(\hat{i}+\hat{j})$
(c) $2(\hat{i}+\hat{j})$
(d) $\frac{11}{5}(\hat{i}+\hat{j})$

Ans: (d)

Solution: $\vec{V}_{av} = \frac{\Delta\vec{r}(\text{displacement})}{\Delta t(\text{time taken})}$
$= \frac{(13-2)\hat{i}+(14-3)\hat{j}}{5-0} = \frac{11}{5}(\hat{i}+\hat{j})$

Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q52. A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass = 5.98 × 10^{24} kg) have to be compressed to be a black hole?
(a) 10^{-9} m (b) 10^{-6} m
(c) 10^{-2} m (d) 100 m

Ans: (c)

Solution: From question,
Escape velocity
$= \sqrt{\frac{2GM}{R}} = c$ = speed of light
$\Rightarrow R = \frac{2GM}{c^2}$
$= \frac{2\times6.6\times10^{-11}\times5.98\times10^{24}}{(3\times10^8)^2}$ m
= 10^{-2} m

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q53. A train moving at a speed of 220 ms^{-1} towards a stationary object, emits a sound of frequency 1000 Hz. Some of the sound reaching the object gets reflected back to the train as echo. The frequency of the echo as detected by the driver of the train is :
(speed of sound in air is 330 ms^{-1})
(a) 3500 Hz (b) 4000 Hz
(c) 5000 Hz (d) 3000 Hz ***Solution:*** (c)
Frequency of the echo detected by the driver of the train is
(According to Doppler effect in sound)
$f' = \left(\frac{v+u}{v-u}\right)f$
where f = original frequency of source of sound
f ′ = Apparent frequency of source because of the relative motion between source and observer.
$f' = \left(\frac{330+220}{330-220}\right)1000 = 5000$ Hz

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q54. A bar magnet is oscillating in the earth's magnetic field with a period T. What happens to its period of motion, if its mass is quadrupled
(a) motion remains simple harmonic with new period = T/2
(b) motion remains simple harmonic with new period = 2 T
(c) motion remains simple harmonic with new period = 4T
(d) motion remains simple harmonic and the period stays nearly constant

Ans: (b)

Solution: The time period of a bar magnet in a magnetic field is given by.
$T = 2\pi\sqrt{\frac{I}{MB}}$;
Here, *I* = moment of inertia ∝ m , *M* = moment of magnet, *B* = magnetic field.
$T \propto \sqrt{I} \propto \sqrt{m}$; so, T becomes twice as mass becomes four times.

Chapter: Magnetism and Matter
[Topic: Magnetic Flux, Faraday's & Lenz's Law]

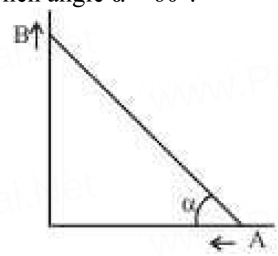
Q55. The energy of a hydrogen atom in the ground state is – 13.6 *eV*. The energy of a He^+ ion in the first excited state will be
(a) –13.6 *eV* (b) – 27.2 *eV*
(c) – 54.4 *eV* (d) – 6.8 *eV*

Ans: (a)

Solution: Energy of a H-like atom in it's n^{th} state is given by
$E_n = -Z^2 \times \frac{13.6}{n^2}$ eV
For, first excited state of He^+, n = 2, Z = 2
$\therefore E_{He^+} = -\frac{4}{2^2}\times 136 = -136$eV

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

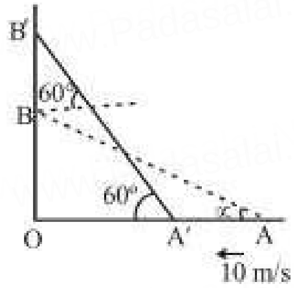
Q56. Two particles A and B are connected by a rigid rod AB. The rod slides along perpendicular rails as shown here. The velocity of A to the left is 10 m/s. What is the velocity of B when angle α = 60º?



(a) 5.8 m/s (b) 9.8 m/s
(c) 10 m/s (d) 17.3 m/s

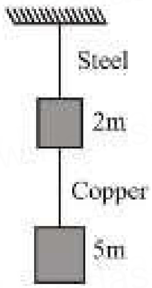
Ans: (d)

Solution: Let after 1 sec angle become 60°. When the end A moves by 10 m left, the end B moves upward by BB′=$10 \times \sqrt{3} = 10 \times 173$
= 17.3 m/s



Chapter: Kinematics Motion in a Plane
[Topic: Motion in a Plane with Constant acceleration]

Q57. If the ratio of diameters, lengths and Young's modulus of steel and copper wires shown in the figure are p, q and s respectively, then the corresponding ratio of increase in their lengths would be



(a) $\frac{7q}{(5sp)}$
(b) $\frac{5q}{(7sp^2)}$
(c) $\frac{7q}{(5sp^2)}$
(d) $\frac{2q}{(5sp)}$

Ans: (c)

Solution: From formula,
Increase in length$\Delta L = \frac{FL}{AY} = \frac{4FL}{\pi D^2 Y}$
$\frac{\Delta L_s}{\Delta L_c} = \frac{F_s}{F_c}\left(\frac{D_c}{D_s}\right)^2 \frac{Y_c}{Y_s}\frac{L_s}{L_c} = \frac{7}{5} \times \left(\frac{1}{p}\right)^2 \left(\frac{1}{s}\right) q$
$= \frac{7q}{(5sp^2)}$

Chapter: Mechanical Propertiesof Solids
[Topic: Hooke's Law & Young's Modulus of Elasticity]

Q58. The electric intensity due to a dipole of length 10 cm and having a charge of 500 μC, at a point on the axis at a distance 20 cm from one of the charges in air, is
(a) 6.25×10^7 N/C
(b) 9.28×10^7 N/C
(c) 13.1×10^{11} N/C
(d) 20.5×10^7 N/C

Ans: (a)

Solution: Given : Length of the dipole ($2l$) =10cm = 0.1m or l = 0.05 m
Charge on the dipole (q) = 500 μC = 500 $\times 10^{-6}$C and distance of the point on the axis from the mid-point of the dipole (r) = 20 + 5 = 25 cm = 0.25 m. We know that the electric field intensity due to dipole on the given point (E) = $\frac{1}{4\pi\varepsilon_0} \times \frac{2(q.2l)r}{(r^2-l^2)^2}$
$= 9 \times 10^9 \times \frac{2(500 \times 10^{-6} \times 0.1) \times 0.25}{[(0.25)^2 - (0.05)^2]^2}$
$= \frac{225\times10^3}{3.6\times10^{-3}} = 6.25 \times 10^7$ N/C

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q59. What is the self-inductance of a coil which produces 5V when the current changes from 3 ampere to 2 ampere in one millisecond?
(a) 5000 henry
(b) 5 milli-henry
(c) 50 henry
(d) 5 henry

Ans: (b)

Solution: $L = \frac{e}{\frac{di}{dt}} = \frac{edt}{di} = \frac{5\times10^{-3}}{(3-2)}H = 5mH$

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

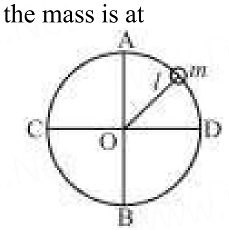
Q60. If the nuclear radius of ^{27}Al is 3.6 Fermi, the approximate nuclear radius of ^{64}Cu in Fermi is : [2012]
(a) 2.4
(b) 1.2
(c) 4.8
(d) 3.6

Ans: (c)

Solution: The radius of the nuclears is directly proportional to cube root of atomic number i.e. $R \propto A^{1/3}$
$\Rightarrow R = R_0 A^{1/3}$, where R_0 is a constant of proportionality
$\frac{R_2}{R_1} = \left(\frac{A_2}{A_1}\right)^{\frac{1}{3}} = \left(\frac{64}{27}\right)^{\frac{1}{3}} = \frac{4}{3}$
where R_1 = the radius of ^{27}Al, and A_1 = Atomic mass number of Al
R_2 = the radius of ^{64}Cu and A_2 = Atomic mass number of C4
$R_2 = 3.6 \times \frac{4}{3} = 4.8m$

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

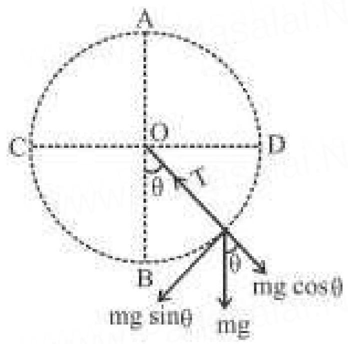
Q61. A small sphere is attached to a cord and rotates in a vertical circle about a point O. If the average speed of the sphere is increased, the cord is most likely to break at the orientation when the mass is at



(a) bottom point B
(b) the point C
(c) the point D
(d) top point A

Ans: (a)

Solution: In the case of a body describing a vertical circle,



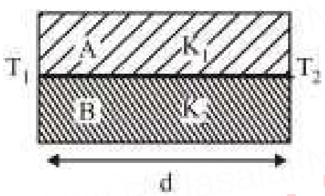
$T - mg\cos\theta = \frac{mv^2}{l}$; $T = mg\cos\theta + \frac{mv^2}{l}$

Tension is maximum when cos θ = +1 and velocity is maximum

Both conditions are satisfied at θ = 0º (i.e. at lowest point B)

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q62. Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be :
[2017]



(a) $\frac{3(K_1+K_2)}{2}$
(b) $K_1 + K_2$
(c) $2(K_1 + K_2)$
(d) $\frac{K_1+K_2}{2}$

Ans: (d)

Solution: Heat current $H = H_1 + H_2$

$= \frac{K_1A(T_1-T_2)}{d} + \frac{K_2A(T_1-T_2)}{d}$

$$\frac{K_{EQ}2A(T_1 - T_2)}{d} = \frac{A(T_1 - T_2)}{d}[K_1 + K_2]$$

Hence equivalent thermal conductivities for two rods of equal area is given by $K_{EQ} = \frac{k_1+k_2}{2}$

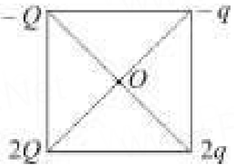
Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q63. Four point charges $-Q$, $-q$, $2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is :

(a) $Q = -q$
(b) $Q = -\frac{1}{q}$
(c) $Q = q$
(d) $Q = \frac{1}{q}$

Ans: (a)

Solution: Let the side length of square be '*a*' then potential at centre *O* is



$$v = \frac{k(-Q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{k(-q)}{\frac{a}{\sqrt{2}}} + \frac{k(2q)}{\frac{a}{\sqrt{2}}} + \frac{k(2Q)}{\frac{a}{\sqrt{2}}} = 0$$

(Given)

$= -Q - q + 2q + 2Q = 0 = Q + q = 0$

$Q = -q$

Chapter: Electrostatic Potential and capacitance
[Topic: Electrostatic Potential & Equipotential Surfaces]

Q64. A coil has resistance 30 ohm and inductive reactance 20 ohm at 50 Hz frequency. If an ac source, of 200 volt, 100 Hz, is connected across the coil, the current in the coil will be

(a) 4.0 A
(b) 8.0 A
(c) $\frac{20}{\sqrt{13}}$ A
(d) 2.0 A

Ans: (a)

Solution: If $\omega = 50 \times 2\pi$ then $\omega L = 20\Omega$

If $\omega' = 100 \times 2\pi$ then $\omega' L = 40\Omega$

Current flowing in the coil is

$$I = \frac{200}{Z} = \frac{200}{\sqrt{R^2 + (\omega' L)^2}} = \frac{200}{\sqrt{(30)^2 + (40)^2}}$$

I = 4A.

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q65. A nucleus of mass M emits a photon of frequency ν and the nucleus recoils. The recoil energy will be

(a) $Mc^2 - h\nu$
(b) $h^2\nu^2 / 2Mc^2$
(c) zero
(d) hν

Ans: (b)

Solution: Momentum

$Mu = \frac{E}{c} = \frac{h\nu}{c}$

Recoil energy

$\frac{1}{2}Mu^2 = \frac{1M^2u^2}{2M} = \frac{1}{2M}\left(\frac{h\nu}{c}\right)^2 = \frac{h^2\nu^2}{2Mc^2}$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q66. A particle of mass m is moving with a uniform velocity v_1. It is given an impulse such that its velocity becomes v_2. The impulse is equal to
[1990]

(a) $m[|v_2| - |v_1|]$
(b) $\frac{1}{2}m[v_2^2 - v_1^2]$
(c) $m[v_1 + v_2]$
(d) $m[v_2 - v_1]$

Ans: (d)

Solution: Impulse = final momentum – initial momentum
$= m(v_2 - v_1)$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q67. Two rods of thermal conductivities K_1 and K_2, cross-sections A_1 and A_2 and specific heats S_1 and S_2 are of equal lengths. The temperatures of two ends of each rod are T_1 and T_2. The rate of flow of heat at the steady state will be equal if

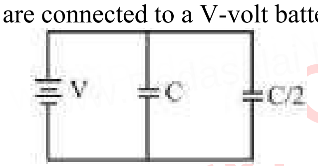
(a) $\frac{K_1}{A_1S_1} = \frac{K_2}{A_2S_2}$
(b) $K_1A_1 = K_2A_2$
(c) $K_1S_1 = K_2S_2$
(d) $A_1S_1 = A_2S_2$

Ans: (b)

Solution: Rate of heat flow for one rod
$= \frac{K_1A_1(T_1-T_2)}{d}$(d→Length)
Rate of heat flow for other rod
$= \frac{K_2A_2(T_1-T_2)}{d}$
In steady state, $\frac{K_1A_1(T_1-T_2)}{d}$
$= \frac{K_2A_2(T_1-T_2)}{d} \Rightarrow K_1A_1 = K_2A_2$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q68. Two condensers, one of capacity *C* and other of capacity C/2 are connected to a V-volt battery, as shown.



The work done in charging fully both the condensers is

(a) $\frac{1}{4}CV^2$ (b) $\frac{3}{4}CV^2$
(c) $\frac{1}{2}CV^2$ *(d)* $2CV^2$.

Ans: (b)

Solution: Work done = Change in energy
$= \frac{1}{2}\left(C + \frac{C}{2}\right)V^2 = \frac{1}{2}\left(\frac{3C}{2}\right)V^2 = \frac{3CV^2}{4}$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q69. Out of the following options which one can be used to produce a propagating electromagnetic wave ?

(a) A charge moving at constant velocity
(b) A stationary charge
(c) A chargeless particle
(d) An accelerating charge

Ans: (d)

Solution: To generate electromagnetic waves we need accelerating charge particle.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q70. The energy equivalent of one atomic mass unit is

(a) 1.6×10^{-19}J (b) 6.02×10^{23} J
(c) 931 MeV (d) 9.31 MeV

Ans: (c)

Solution: 1 a.m.u = 931 MeV

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q71. A block of mass 1 kg is placed on a truck which accelerates with acceleration $5 m/s^2$. The coefficient of static friction between the block and truck is 0.6. The frictional force acting on the block is

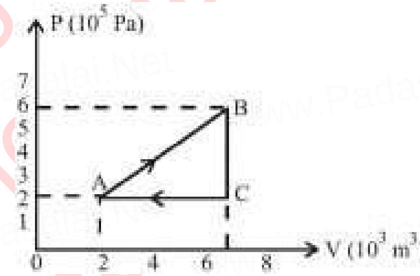
(a) 5 N (b) 6 N
(c) 5.88 N (d) 4.6 N

Ans: (a)

Solution: Maximum friction force = μmg
$= .6 \times 1 \times 9.8 = 5.88$ N
But here required friction force
$= ma = 1 \times 5 = 5$ N

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q72. A gas is taken through the cycle A→ B→ C→ A, as shown in figure. What is the net work done by the gas ?



(a) 1000 J (b) zero
(c) – 2000 J (d) 2000 J

Ans: (a)

Solution: W_{net} = Area of triangle ABC
$= \frac{1}{2} AC \times BC$
$= \frac{1}{2} \times 5 \times 10^{-3} \times 4 \times 10^5 = 1000$ J

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q73. There are three copper wires of length and cross sectional area (*L*, *A*), $\left(2L, \frac{1}{2}A\right)$, $\left(\frac{1}{2}L, 2A\right)$. In which case is the resistance minimum?

(a) It is the same in all three cases
(b) Wire of cross-sectional area 2*A*
(c) Wire of cross-sectional area *A*
(d) Wire of cross-sectional area $\frac{1}{2}A$

Ans: (b)

Solution: $R = \rho\frac{l}{A}$
$R_1 = \rho\frac{L}{A}$ ... (1)
$R_2 = \rho\frac{2L}{A} \times 2$ ... (2)
$R_3 = \rho\frac{L}{2.2A} = \frac{\rho L}{4A}$ ... (3)

$\Rightarrow R_3 < R_1 < R_2$

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q74. The frequencies of *X*-rays, γ-rays and ultraviolet rays are respectively a, b, and c. Then
(a) $a < b, b < c$
(b) $a < b, b > c$
(c) $a > b, b > c$
(d) $a > b, b < c$

Ans: (b)

Solution: γ rays has lowest wavelength and highest frequency among them while ultraviolet ray has highest wavelength and lowest frequency.
Order of frequency : $b > a > c$

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q75. A sample has 4×10^{16} radioactive nuclei of half life 10 days. The number of atoms decaying in 30 days is
(a) 3.9×10^{16} (b) 5×10^{15}
(c) 10^{16} (d) 3.5×10^{16}

Ans: (d)

Solution: $N = 4 \times 10^{16}\left(\frac{1}{2}\right)^{\frac{30}{10}} = \frac{1}{2} \times 10^{16}$

Atoms decayed $= 4 \times 10^{16} - \frac{1}{2} \times 10^{16}$
$= 3.5 \times 10^{16}$

Chapter: Nuclei
[Topic: Radioactivity]

Q76. A force of 250 N is required to lift a 75 kg mass through a pulley system. In order to lift the mass through 3 m, the rope has to be pulled through 12m. The efficiency of system is
(a) 50% (b) 75%
(c) 33% (d) 90%

Ans: (b)

Solution: Efficiency $= \frac{\text{output work}}{\text{input work}}$

i.e. Efficiency
= = 75%

Chapter: Work, Energy and Power
[Topic: Work]

Q77. An engine has an efficiency of 1/6. When the temperature of sink is reduced by 62°C, its efficiency is doubled. Temperature of the source is
(a) 37°C (b) 62°C
(c) 99°C (d) 124°C

Ans: (c)

Solution: Since efficiency of engine is $\eta = 1 - \frac{T_2}{T_1}$

According to problem,
$\frac{1}{6} = 1 - \frac{T_2}{T_1}$ .... (1)
When the temperature of the sink is reduced by 62°C, its efficiency is doubled
$2\left(\frac{1}{6}\right) = 1 - \frac{T_2 - 62}{T_1}$ .... (2)
Solving (1) and (2) $T_2 = 372$ K
$T_1 = 99$°C = Temperature of source.

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q78. A point source of light is placed 4 m below the surface of water of refractive index $\frac{5}{3}$. The minimum diameter of a disc, which should be placed over the source, on the surface of water to cut off all light coming out of water is
(a) ∞ (b) 6 m
(c) 4 m (d) 3 m

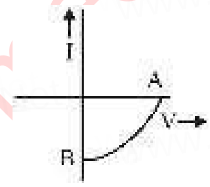
Ans: (b)

Solution: $\sin C = \frac{1}{\mu} = \frac{1}{\frac{5}{3}} = \frac{3}{5} \approx \tan C = \frac{3}{4}$

Now, $\tan C = \frac{r}{h}$; $r = h \tan C = 4 \times \frac{3}{4} = 3\text{m}$
Diameter of disc $= 2r = 6\ m$

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q79. The given graph represents V - I characteristic for a semiconductor device.



Which of the following statement is **correct** ?
[2014]
(a) It is V - I characteristic for solar cell where, point A represents open circuit voltage and point B short circuit current.
(b) It is a for a solar cell and point A and B represent open circuit voltage and current, respectively.
(c) It is for a photodiode and points A and B represent open circuit voltage and current, respectively.
(d) It is for a LED and points A and B represent open circuit voltage and short circuit current, respectively.

Ans: (a)

Solution: The given graph represents V-I characteristics of solar cell.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q80. A body of mass 1 kg begins to move under the action of a time dependent force $\vec{F} = (2t\hat{i} + 3t^2\hat{j})$ N, where $\hat{i}$ and $\hat{j}$ are unit vectors alogn x and y axis. What power will be developed by the force at the time t?
(a) $(2t^2 + 3t^3)$W
(b) $(2t^2 + 4t^4)$W
(c) $(2t^3 + 3t^4)$ W
(d) $(2t^3 + 3t^5)$W

Ans: (d)

Solution: Given force $\vec{F} = 2t\hat{i} + 3t^2\hat{j}$
According to Newton's second law of motion,
$m\frac{d\vec{v}}{dt} = 2t\hat{i} + 3t^2\hat{j}$ (m = 1 kg)

$\Rightarrow \int_0^{\vec{v}} d\vec{v} = \int_0^t (2t\hat{i} + 3t^2\hat{j})d$

$\Rightarrow \vec{v} = t^2\hat{i} + t^3\hat{j}$

Power $P = \vec{F}.\vec{v}(2t\hat{i} + 3t^2\hat{j})(t^2\hat{i} + t^3\hat{j})$

$= (2t^3 + 3t^5)W$

Chapter: Work, Energy and Power
[Topic: Power]

Q81. Three containers of the same volume contain three different gases. The masses of the molecules are m_1, m_2 and m_3 and the number of molecules in their respective containers are N_1, N_2 and N_3. The gas pressure in the containers are P_1, P_2 and P_3 respectively. All the gases are now mixed and put in one of these containers. The pressure P of the mixture will be

(a) $P < (P_1 + P_2 + P_3)$ (b) $P = \frac{P_1+P_2+P_3}{3}$

(c) $P = P_1 + P_2 + P_3$ (d) $P > (P_1 + P_2 + P_3)$

Ans: (c)

Solution: According to Dalton's law of partial pressures, we have $P = P_1 + P_2 + P_3$

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q82. Two cities are 150 km apart. Electric power is sent from one city to another city through copper wires. The fall of potential per km is 8 volt and the average resistance per km is 0.5 Ω. The power loss in the wires is :

(a) 19.2 W (b) 19.2 kW

(c) 19.2 J (d) 12.2 kW

Ans: (b)

Solution: Total resistance R = (0.5 Ω/km) × (150 km)

= 75 Ω

Total voltage drop = (8 V/km) × (150 km)

= 1200 V

Power loss $= \frac{(\Delta V)^2}{R} = \frac{(1200)^2}{75}$ W

= 19200 W = 19.2 kW

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q83. Focal length of a convex lens will be maximum for

(a) blue light

(b) yellow light

(c) green light

(d) red light

Ans: (d)

Solution: For red light, focal length of lens is maximum because $f \propto \lambda$ and λ is maximum for red light.

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q84. If a full wave rectifier circuit is operating from 50Hz mains, the fundamental frequency in the ripple will be

(a) 100 Hz (b) 25 Hz

(c) 50 Hz (d) 70.7 Hz

Ans: (a)

Solution: In case of full wave rectifier,

Fundamental frequency = 2 × mains frequency

= 2 × 50 = 100Hz.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q85. A molecule of mass m of an ideal gas collides with the wall of a vessel with a velocity v and returns back with the same velocity. The change in linear momentum of molecule is

(a) 2 mv (b) 4 mv

(c) 8 mv (d) 10 mv

Ans: (a)

Solution: Chapter: Work, Energy and Power
[Topic: Collisions]

Q86. Two particles are oscillating along two close parallel straight lines side by side, with the same frequency and amplitudes. They pass each other, moving in opposite directions when their displacement is half of the amplitude. The mean positions of the two particles lie on a straight line perpendicular to the paths of the two particles. The phase difference is

(a) 0 (b) 2π/3

(c) π

(d) π/6

Ans: (b)

Solution: Equation of SHM is given by

$x = A \sin(\omega t + \delta)$

$(\omega t + \delta)$ is called phase.

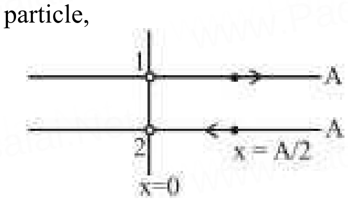
When $x = \frac{A}{2}$, then

$\sin(\omega t + \delta) = \frac{1}{2}$

$\approx \omega t + \delta = \frac{\pi}{6}$

or $\phi_1 = \frac{\pi}{6}$

For second particle,



$\phi_2 = \pi - \frac{\pi}{6} = \frac{5\pi}{6}$

$\phi = \phi_2 - \phi_1$

$= \frac{4\pi}{6} = \frac{2\pi}{3}$

Chapter: Oscillation
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q87. A potentiometer is an accurate and versatile device to make electrical measurements of E.M.F. because the method involves

(a) Potential gradients

(b) A condition of no current flow through the galvanometer

(c) A combination of cells, galvanometer and resistances

(d) Cells

Ans: (b)

Solution: Reading of potentiometer is accurate because during taking reading it does not draw any current from the circuit.

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q88. Interference was observed in interference chamber where air was present, now the chamber is evacuated, and if the same light is used, a careful observer will see
(a) no interference
(b) interference with brighter bands
(c) interference with dark bands
(d) interference fringe with larger width

Ans: (d)

Solution: In vaccum, λ increases very slightly compared to that in air. As $\beta \propto \lambda$, therefore, width of interference fringe increases slightly.

Chapter - Wave Optics
[Topic: Wavefront, Interference of Light, Coherent & Incoherent Sources]

Q89. At absolute zero, Si acts as
(a) non-metal
(b) metal
(c) insulator
(d) none of these

Ans: (c)

Solution: Semiconductors are insulators at room temperature.

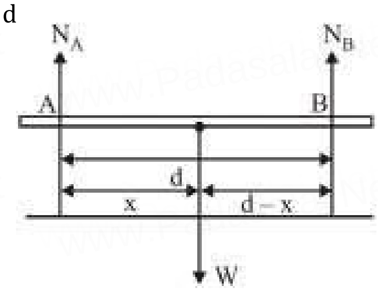
Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q90. A rod of weight W is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mass of the rod is at distance x from A. The normal reaction on A is
(a) $\frac{Wd}{x}$
(b) $\frac{W(d-x)}{x}$
(c) $\frac{W(d-x)}{d}$
(d) $\frac{Wx}{d}$

Ans: (c)

Solution: By torque balancing about B
N_A (d) = W (d – x)

$$N_A = \frac{W(d-x)}{d}$$



Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q91. A particle executes linear simple harmonic motion with an amplitude of 3 cm. When the particle is at 2 cm from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is
(a) $\frac{\sqrt{5}}{2\pi}$
(b) $\frac{4\pi}{\sqrt{5}}$
(c) $\frac{2\pi}{\sqrt{3}}$
(d) $\frac{\sqrt{5}}{\pi}$

Ans: (b)

Solution: Given, Amplitude A = 3 cm
When particle is at x = 2 cm
According to question, magnitude of velocity = acceleration

$\omega\sqrt{A^2 - x^2} = x\omega^2$

$\sqrt{(3)^2 - (2)^2} = 2\left(\frac{2\pi}{T}\right)$

$\sqrt{5} = \frac{4\pi}{T} \Rightarrow T = \frac{4\pi}{\sqrt{5}}$

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q92. Under the influence of a uniform magnetic field, a charged particle moves with constant speed v in a circle of radius R. The time period of rotation of the particle:
(a) depends on R and not on v
(b) is independent of both v and R
(c) depends on both v and R
(d) depends on v and not on R

Ans: (b)

Solution: The time period of the charged particle is given by $T = \frac{2\pi m}{qB}$
Thus, time period is independent of both v and R.

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q93. A paper, with two marks having separation d, is held normal to the line of sight of an observer at a distance of 50m. The diameter of the eye-lens of the observer is 2 mm. Which of the following is the least value of d, so that the marks can be seen as separate ? The mean wavelength of visible light may be taken as 5000 Å.
(a) 1.25 m (b) 12.5 cm
(c) 1.25 cm (d) 2.5 mm

Ans: (b)

Solution: Angular limit of resolution of eye, $\theta = \frac{\lambda}{d}$, where, d is diameter of eye lens.
Also, if *y* is the minimum separation between two objects at distance *D* from eye then

$\theta = \frac{y}{D}$

$\Rightarrow \frac{y}{D} = \frac{\lambda}{d} \Rightarrow y = \frac{\lambda D}{d}$ ... (1)

Here, wavelength $\lambda = 5000A = 5 \times 10^{-7}$m

D = 50 m

Diameter of eye lens = 2 mm = 2×10^{-3}m

From eq. (1) , minimum separation is

$$y = \frac{5 \times 10^{-7} \times 50}{2 \times 10^{-3}} = 12.5 \times 10^{-3}\text{m} = 12.5\text{cm}$$

Chapter - Wave Optics
[Topic: Diffraction, Polarization of Light & Resolving Power]

Q94. To use a transistor as an amplifier

(a) the emitter base junction is forward biased and the base collector junction is reverse biased

(b) no bias voltage is required

(c) both junctions are forward biased

(d) both junctions are reverse biased.

Ans: (a)

Solution: To use a transistor as an amplifier the emitter base junction is forward biased while the collector base junction is reverse biased.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q95. The dimensional formula for magnetic flux is

(a) $[ML^2T^{-2}A^{-1}]$

(b) $[ML^3T^{-2}A^{-2}]$

(c) $[M^0L^{-2}T^2A^{-2}]$

(d) $[ML^2T^{-1}A^2]$

Ans: (a)

Solution: Dimension of magnetic flux

= Dimension of voltage × Dimension of time

= $[ML^2T^{-3}A^{-1}]$ [T] = $[ML^2T^{-2}A^{-1}]$

$\because$Voltage= $\frac{\text{work}}{\text{charge}}$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q96. A weightless ladder 20 ft long rests against a frictionless wall at an angle of 60º from the horizontal. A 150 pound man is 4 ft from the top of the ladder. A horizontal force is needed to keep it from slipping. Choose the correct magnitude of the force from the following

(a) 175 lb (b) 100 lb

(c) 120 lb (d) 69.2 lb

Ans: (d)

Solution: AB is the ladder, let F be the horizontal force and W is the weigth of man. Let N_1 and N_2 be normal reactions of ground and wall, respectively. Then for vertical equilibrium

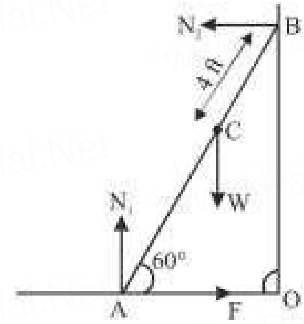
W = N_1.....(1)

For horizontal equilibrium, N_2 = F .....(2)

Taking moments about A,

N_2(AB sin60°) – W(AC cos 60°) = 0 ......(3)

Using (2) and AB = 20 ft, BC = 4 ft, we get



$$F\left(20 \times \frac{\sqrt{3}}{2}\right) - W\left(16 \times \frac{1}{2}\right) = 0$$

$= F = \frac{8W \times 2}{20\sqrt{3}} = \frac{4W}{5\sqrt{3}} = \frac{150 \times 4}{5\sqrt{3}}$ pound

$= 40\sqrt{3} = 40 \times 1.73 = 69.2$ pound

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q97. A mass m is suspended from a two coupled springs, connected in series. The force constant for springs are k_1 and k_2. The time period of the suspended mass will be

(a) $T = 2\pi\sqrt{\frac{m}{k_1 - k_2}}$

(b) $T = 2\pi\sqrt{\frac{mk_1k_2}{k_1 + k_2}}$

(c) $T = 2\pi\sqrt{\frac{m}{k_1 + k_2}}$

(d) $T = 2\pi\sqrt{\frac{m(k_1 + k_2)}{k_1k_2}}$

Ans: (d)

Solution: The effective spring constant of two springs in series; $K = \frac{k_1k_2}{k_1 + k_2}$.

Time period,

$$T = 2\pi\sqrt{\frac{m}{K}} = 2\pi\sqrt{\frac{m(k_1 + k_2)}{k_1k_2}}$$

Chapter: Oscillation
[Topic: Damped SHM, Forced Oscillations & Resonance]

Q98. Two similar coils of radius *R* are lying concentrically with their planes at right angles to each other. The currents flowing in them are *I* and 2 *I*, respectively. The resultant magnetic field induction at the centre will be:

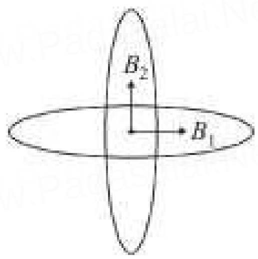
(a) $\frac{\sqrt{5}\mu_0 I}{2R}$

(b) $\frac{3\mu_0 I}{2R}$

(c) $\frac{\mu_0 I}{2R}$

(d) $\frac{\mu_0 I}{R}$

Ans: (a)



Solution:

The magnetic field, due the coil, carrying current *I* Ampere

$$B_1 = \frac{\mu_0 I}{2R}$$

The magnetic field due to the coil, carrying current 2*I* Ampere

$$B_2 = \frac{\mu_0 (2I)}{2R}$$

The resultant *B*

$$B_{net} = \sqrt{B_1^2 + B_2^2 + 2B_1B_2\cos\theta}\ \theta = 90°$$

$$B_{net} = \sqrt{B_1^2 + B_2^2} = \frac{\mu_0(2I)}{2R}\sqrt{1+4} = \frac{\sqrt{5}\mu_0 I}{2R}$$

Chapter: Moving Charges and Magnetic Field [Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q99. A photoelectric surface is illuminated successively by monochromatic light of wavelength λ and $\frac{\lambda}{2}$. If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times that in the first case, the work function of the surface of the material is :
(h = Planck's constant, c = speed of light)
[2015 RS]

(a) $\frac{hc}{\lambda}$
(b) $\frac{2hc}{\lambda}$
(c) $\frac{hc}{3\lambda}$
(d) $\frac{hc}{2\lambda}$

Ans: (d)

Solution: Photoelectric equations

$Ek_{1max} = \frac{hc}{\lambda} - \phi$ ... (*i*)

and $Ek_{2max} = \frac{hc}{\frac{\lambda}{2}} - \phi$

$EK_{2max} = \frac{2hc}{\lambda} - \phi$ ... (*ii*)

From question, $Ek_{2max} = 3Ek_{1max}$

Multiplying equation (i) by 3

$3Ek_{1max} = 3\left(\frac{hc}{\lambda} - \phi\right)$ ... (*iii*)

From equation (*ii*) and (*iii*)

$$\frac{3hc}{\lambda} - 3\phi = \frac{2hc}{\lambda} - \phi$$

∴ φ (work function) = $\frac{hc}{2\lambda}$

Chapter - Dual Nature of Radiation and Matter [Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q100. A car moves from X to Y with a uniform speed v_u and returns to Y with a uniform speed v_d. The average speed for this round trip is

(a) $\sqrt{v_u v_d}$
(b) $\frac{v_d v_u}{v_d + v_u}$
(c) $\frac{v_u + v_d}{2}$
(d) $\frac{2v_d v_u}{v_d + v_u}$

Ans: (d)

Solution: Average speed

$$= \frac{\text{total distance travelled}}{\text{total time taken}}$$

Let s be the distance from X to Y.

∴ Average speed $= \frac{s+s}{t_1+t_2} = \frac{2s}{\frac{s}{v_u}+\frac{s}{v_d}}$

$$= \frac{2v_u v_d}{v_d + v_u}$$

Chapter: Kinematics Motion in a Straight Line [Topic: Distance, Displacement & Uniform motion]

PART 10. PHYSICS QUESTION BANK

Q1. The moment of inertia of a body about a given axis is 1.2 kg m^2. Initially, the body is at rest. In order to produce a rotational kinetic energy of 1500 joule, an angular acceleration of 25 radian/sec^2 must be applied about that axis for a duration of

(a) 4 seconds (b) 2 seconds
(c) 8 seconds (d) 10 seconds

Ans: (b)

Solution: I = 1.2 kg m^2, E_r = 1500 J,
α = 25 rad/sec^2, ω_1 = 0, t = ?

As $E_r = \frac{1}{2}I\omega^2, \omega = \sqrt{\frac{2E_r}{I}}$

$= \sqrt{\frac{2\times1500}{12}} = 50\text{rad/sec}$

From $\omega_2 = \omega_1 + \alpha t$
50 = 0 + 25 t, t = 2 seconds

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q2. The equation of a sound wave is given as: y = 0.0015 sin (62.4 x + 316 t). The wavelength of this wave is

(a) 0.4 unit (b) 0.3 unit
(c) 0.2 unit (d) 0.1 unit

Ans: (d)

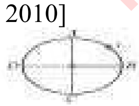
Solution: y = 0.0015 sin (62.4x + 316t)
On comparing with y = A sin (ωt + kx)
ω = 316, k = 62.4

$\Rightarrow k = \frac{2\pi}{\lambda} = 62.4 = \lambda = 0.1\text{unit}$

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q3. A circular coil *ABCD* carrying a current *i* is placed in a uniform magnetic field. If the magnetic force on the segment *AB* is $\vec{F}$, the force on the remaining segment *BCDA* is

[NEET Kar. 2013, 2010]



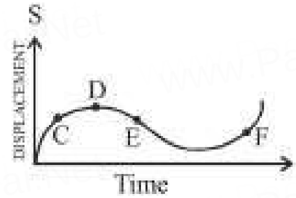
(a) $\vec{F}$
(b) $-\vec{F}$
(c) $3\vec{F}$
(d) $-3\vec{F}$

Ans: (b)

Solution: Here, $\vec{F}_{AB} + \vec{F}_{BCDA} = \vec{0}$
$= \vec{F}_{BCDA} = -\vec{F}_{AB} = -\vec{F}$
$(\vec{F}_{AB} = \vec{F})$

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q4. The displacement time graph of a moving particle is shown below



The instantaneous velocity of the particle is negative at the point

(a) D
(b) F
(c) C
(d) E

Ans: (d)

Solution: At E, the slope of the curve is negative.

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q5. What will be the formula of the mass in terms of g, R and G (R = radius of earth)

(a) $g^2\frac{R}{G}$
(b) $G\frac{R^2}{g}$
(c) $G\frac{R}{g}$
(d) $g\frac{R^2}{G}$

Ans: (d)

Solution: We know that $mg = \frac{GMm}{R^2}$

$\therefore g = \frac{GM}{R^2} \Rightarrow M = \frac{gR^2}{G}$

Chapter: Gravitation
[Topic: Acceleration due to Gravity]

Q6. Each of the two strings of length 51.6 cm and 49.1 cm are tensioned separately by 20 N force. Mass per unit length of both the strings is same and equal to 1 g/m. When both the strings vibrate simultaneously the number of beats is

(a) 7 (b) 8
(c) 3 (d) 5

Ans: (a)

Solution: The frequency of vibration of a string is given by, $f = \frac{1}{2l}\sqrt{\frac{T}{m}}$ where m is mass per unit length.

$f_1 = \frac{1}{2l_1}\sqrt{\frac{T}{m}}, f_2 = \frac{1}{2l_2}\sqrt{\frac{T}{m}},$

$f_2 - f_1 = \frac{1}{2}\sqrt{\frac{T}{m}}\frac{(l_1 - l_2)}{l_1 l_2}$

$\sqrt{\frac{T}{m}} = \sqrt{\frac{20}{10^{-3}}} = \sqrt{2}\times10^2 = 1.414\times100$
= 141.4

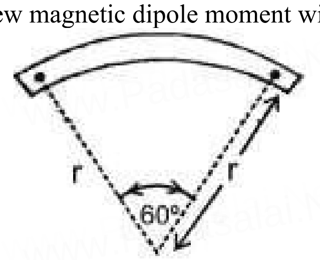
$\frac{l_1 - l_2}{l_1 l_2} = \frac{(51.6-49.1)\times10^2}{51.6\times49.1}$

$$= \frac{2.5 \times 10^2}{50 \times 50} = \frac{1}{10}$$

$\therefore f_2 - f_1 = \frac{1}{2} \times 141.4 \times \frac{1}{10} = 7\text{beats}$

Chapter: Waves
[Topic: Vibration of String & Organ Pipe]

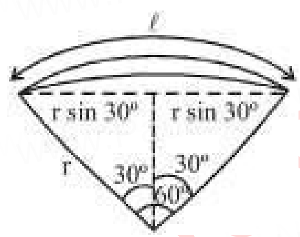
Q7. A bar magnet of length 'l ' and magnetic dipole moment 'M' is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be



(a) $\frac{3}{\pi}M$
(b) $\frac{2}{\pi}M$
(c) $\frac{M}{2}$
(d) M

Ans: (a)

Solution: Magnetic dipole moment
M = m × l M' = m × r
From figure



$l = \frac{\pi r}{3}$ or $r = \frac{3l}{\pi}$

so, $M' = m \times r = \frac{m \times 3\ell}{\pi} = \frac{3}{\pi}M$

Chapter: Magnetism and Matter
[Topic: Magnetism, Gauss's Law, Magnetic Moment & Properties of Magnet]

Q8. The momentum of a photon of an electromagnetic radiation is 3.3×10^{-29} kgms^{-1}. What is the frequency of the associated waves ?
[$h = 6.6 \times 10^{-34}$ Js; $c = 3 \times 10^8$ ms^{-1})
(a) 1.5×10^{13} Hz
(b) 7.5×10^{12} Hz
(c) 6.0×10^3 Hz
(d) 3.0×10^3 Hz

Ans: (a)

Solution: As $\lambda = \frac{h}{p}$ and $\lambda = \frac{c}{v}$; so

$$v = \frac{c}{\lambda} = \frac{cP}{h} = 3 \times 10^8 \times \frac{3.3 \times 10^{-29}}{6.6 \times 10^{-34}}$$

$= 1.5 \times 10^{13}$ Hz

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q9. Vectors $\vec{A}, \vec{B}$ and $\vec{C}$ are such that $\vec{A}.\vec{B} = 0$ and $\vec{A}.\vec{C} = 0$. Then the vector parallel to $\vec{A}$ is
[NEET Kar. 2013]
(a) $\vec{B}$ and $\vec{C}$
(b) $\vec{A} \times \vec{B}$
(c) $\vec{B} + \vec{C}$
(d) $\vec{B} \times \vec{C}$

Ans: (d)

Solution: Vector triple product

$\vec{A} \times (\vec{B} \times \vec{C}) = \vec{B}(\vec{A}.\vec{C}) - (\vec{A}.\vec{B}) = 0$

$\Rightarrow \vec{A} \parallel (\vec{B} \times \vec{C})$

$[\vec{A}.\vec{B} = 0 \text{and} \vec{A}.\vec{C} = 0]$ 1.(a)

$(\vec{A} + \vec{B})^2 = (\vec{C})^2$

$\Rightarrow A^2 + B^2 + 2\vec{A}.\vec{B} = C^2$

$\Rightarrow 3^2 + 4^2 + 2\vec{A}.\vec{B} = 5^2$

$= 2\vec{A}.\vec{B} = 0$

or $\Rightarrow \vec{A}.\vec{B} = 0$

$\vec{A} \perp \vec{B}$

Here $A^2 + B^2 = C^2$. Hence, $\vec{A} \perp \vec{B}$

Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q10. The radius of a planet is twice the radius of earth. Both have almost equal average mass-densities. If V_P and V_E are escape velocities of the planet and the earth, respectively, then
[NEET Kar. 2013]
(a) $V_E = 1.5V_P$
(b) $V_P = 1.5V_E$
(c) $V_P = 2V_E$
(d) $V_E = 3V_P$

Ans: (c)

Solution: Escape velocity, $V_e = R\sqrt{\frac{8}{3}\pi G P}$

$\Rightarrow V_e \propto R \Rightarrow \frac{V_P}{V_E} = \frac{R_P}{R_E} = 2$

$\Rightarrow V_P = 2V_E$.

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q11. The driver of a car travelling with speed 30 m/sec towards a hill sounds a horn of frequency 600 Hz. If the velocity of sound in air is 330 m/s, the frequency of reflected sound as heard by driver is
(a) 555.5 Hz
(b) 720 Hz
(c) 500 Hz
(d) 550 Hz

Ans: (b)

Solution:

f ′ is the apparent frequency received by an observer at the hill. f ″ is the frequency of the reflected sound as heard by driver.

$$f' = \frac{v}{v - 30} f,$$

$$f' = \frac{v + 30}{v} f' = \frac{v + 30}{v - 30} f = \frac{360}{300} \times 600$$

= 720 Hz

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q12. A long solenoid of diameter 0.1 m has 2×10^4 turns per meter. At the centre of the solenoid, a coil of 100 turns and radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0A from 4 A in 0.05 s. If the resistance of the coil is $10\pi^2\Omega$. the total charge flowing through the coil during this time is :-

(a) 16 μC (b) 32 μC
(c) 16 π μC (d) 32 π μC

Ans: (b)

Solution: Given, no. of turns N = 100
radius, r = 0.01 m
resistance, $R = 10\pi^2\Omega$, $n = 2 \times 10^4$
As we know,

$$\varepsilon = -N\frac{d\phi}{dt}$$

$$\frac{\varepsilon}{R} = -\frac{N}{R}\frac{d\phi}{dt}$$

$$\Delta I = -\frac{N}{R}\frac{d\phi}{dt}$$

$$\frac{\Delta q}{\Delta t} = -\frac{N}{R}\frac{\Delta\phi}{\Delta t}$$

$$\Delta q = -\left[\frac{N}{R}\left(\frac{\Delta\phi}{\Delta t}\right)\right]\Delta t$$

'–' ve sign shows that induced emf opposes the change of flux.

$$\Delta q = \left[\mu_0 nN\pi r^2\left(\frac{\Delta i}{\Delta t}\right)\right]\frac{1}{R}\Delta t = \frac{\mu_0 nN\pi r^2\Delta i}{R}$$

$$\Delta q = \frac{4\pi \times 10^{-7} \times 100 \times 4 \times \pi \times (0.01)^2 \times 2 \times 10^4}{10\pi^2}$$

$\Delta q = 32\mu C$

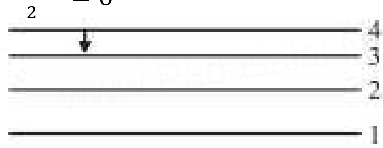
Chapter: Electromagnetic
[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q13. The ionization energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The atoms are excited to higher energy levels to emit radiations of 6 wavelengths. Maximum wavelength of emitted radiation corresponds to the transition between

(a) n = 3 to n = 1 states
(b) n = 2 to n = 1 states
(c) n = 4 to n = 3 states
(d) n = 3 to n = 2 states

Ans: (c)

Solution: $\frac{n(n-1)}{2} = 6$



$n^2 - n - 12 = 0$
$(n - 4)(n + 3) = 0$ or $n = 4$

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q14. The position vector of a particle is $\vec{r} = (a\cos\omega t)\hat{i} + (a\sin\omega t)\hat{j}$. The velocity of the particle is

(a) directed towards the origin
(b) directed away from the origin
(c) parallel to the position vector
(d) perpendicular to the position vector

Ans: (d)

Solution: $\vec{r} = (a\cos\omega t)\hat{i} + (a\sin\omega t)\hat{j}$

$\vec{v} = \frac{d(\vec{r})}{dt} = \frac{d}{dt}\{(a\cos\omega t)\hat{i} + (a\sin\omega t)\hat{j}\}$
$= (-a\omega\sin\omega t)\hat{i} + (a\omega\cos\omega t)\hat{j}$
$= \omega[(-a\sin\omega t)\hat{i} + (a\cos\omega t)\hat{j}]$

Slope of position vector$= \frac{a\sin\omega t}{a\cos\omega t} = \tan\omega t$ & slope of velocity vector

$$= \frac{-a\cos\omega t}{a\sin\omega t} = \frac{-1}{\tan\omega t}$$

∴ velocity is perpendicular to the displacement.

Chapter: Kinematics Motion in a Plane
[Topic: Motion in a Plane with Constant acceleration]

Q15. Two wires A and B are of the same material. Their lengths are in the ratio 1 : 2 and the diameter are in the ratio 2 : 1. If they are pulled by the same force, then increase in length will be in the ratio

(a) 2 : 1 (b) 1 : 4
(c) 1 : 8 (d) 8 : 1

Ans: (c)

Solution: We know that Young's modulus

$$Y = \frac{F}{\pi r^2} \times \frac{L}{l}$$

Since Y, F are same for both the wires, we have,

$$\frac{1}{r_1^2}\frac{L_1}{l_1} = \frac{1}{r_2^2}\frac{L_2}{l_2}$$

or, $\frac{l_1}{l_2} = \frac{r_2^2 \times L_1}{r_1^2 \times L_2} = \frac{\left(\frac{D_2}{2}\right)^2 \times L_1}{\left(\frac{D_1}{2}\right)^2 \times L_2}$

or, $\frac{\ell_1}{\ell_2} == \frac{D_1^2 \times L_2}{D_2^2 \times L_1} = \frac{D_2^2}{(2D_2)^2} \times \frac{L_2}{2L_2} = \frac{1}{8}$

So, $\ell_1 : \ell_2 = 1 : 8$

Chapter: Mechanical Propertiesof Solids
[Topic: Bulk and Rigidity Modulus & Work Done in Stretching a Wire]

Q16. If a dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$, then torque acting on it is given by

(a) $\vec{\tau} = \vec{p}.\vec{E}$
(b) $\vec{\tau} = \vec{p} \times \vec{E}$
(c) $\vec{\tau} = \vec{p} + \vec{E}$
(d) $\vec{\tau} = \vec{p} - \vec{E}$

Ans: (b)

Solution: Given : Dipole moment of the dipole $= \vec{p}$ and uniform electric field $= \vec{E}$. We know that dipole moment (p) = q.a (where q is the charge and a is dipole length). And when a dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$, then Torque (τ) = Either force ×

Perpendicular distance between the two forces = $qaE\sin\theta$
or $\tau = pE\sin\theta$ or $\vec{\tau} = \vec{p}\times\vec{E}$ (vector form)

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q17. If N is the number of turns in a coil, the value of self inductance varies as

(a) N^0 (b) N
(c) N^2 (d) N^{-2}

Ans: (c)

Solution: $L = \frac{N\phi}{i}; \phi = BA; B = \frac{\mu_0 Ni}{2R}$

$\Rightarrow L = \frac{N}{i}\left(\frac{\mu_0 Ni}{2R}\right)A = \frac{\mu_0 N^2}{2R}A \Rightarrow L \propto N^2$

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q18. Two nuclei have their mass numbers in the ratio of 1 : 3. The ratio of their nuclear densities would be

(a) 1 : 3 (b) 3 : 1
(c) $(3)^{1/3}$: 1 (d) 1 : 1

Ans: (d)

Solution: Requird ratio of nuclear densities = $\frac{\rho_1}{\rho_2}$

$= \frac{\left(\frac{M_1}{V_1}\right)}{\left(\frac{M_2}{V_2}\right)} = \frac{M_1}{M_2}\times\frac{V_2}{V_1} = \frac{1}{3}\times\frac{\frac{4}{3}\pi R_2^3}{\frac{4}{3}\pi R_1^3}$

$= \frac{1}{3}\times\left(\frac{R_2}{R_1}\right)^3 = \frac{1}{3}\times\left(\frac{R_0 M_2^{\frac{1}{3}}}{R_0 M_1^{\frac{1}{3}}}\right)^3$ $[\because R = R_0 M^{1/3}]$

$= \frac{1}{3}\times\left(\frac{M_2}{M_1}\right) = \frac{1}{3}\times\left(\frac{3}{1}\right) = 1:1$

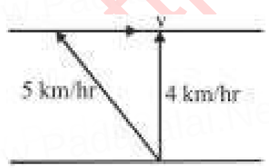
Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

Q19. A boat which has a speed of 5 km/hr in still water crosses a river of width 1 km along the shortest possible path in 15 minutes. The velocity of the river water in km/hr is
[2000, 1998]

(a) 3 (b) 4
(c) $\sqrt{21}$ (d) 1

Ans: (a)

Solution:



Speed along the shortest path
$\frac{1}{\frac{15}{60}} = 4$ km/hr

Speed of water $v = \sqrt{5^2 - 4^2} = 3$ km/hr

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q20. A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be :

(a) 450 (b) 1000
(c) 1800 (d) 225

Ans: (c)

Solution: Given r_1 = 12 cm , r_2 = 6 cm
T_1 = 500 K and T_2 = 2 × 500 = 1000 K
P_1 = 450 watt
Rate of power loss $P \propto r^2T^4$

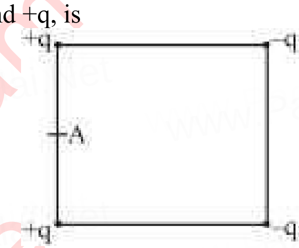
$\frac{P_1}{P_2} = \frac{r_1^2T_1^4}{r_2^2T_2^4}$

$P_2 = P_1\frac{r_2^2T_2^4}{r_1^2T_1^4}$

Solving we get, P_2 = 1800 watt

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

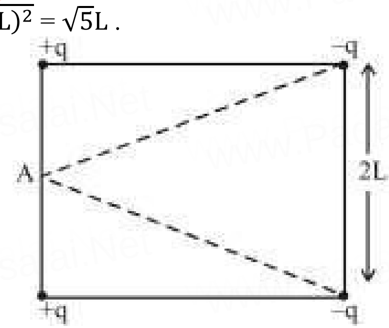
Q21. Four electric charges +q, +q, –q and – q are placed at the corners of a square of side 2L (see figure). The electric potential at point A, midway between the two charges +q and +q, is



(a) $\frac{1}{4\pi\epsilon_0}\frac{2q}{L}\left(1+\sqrt{5}\right)$
(b) $\frac{1}{4\pi\epsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$
(c) $\frac{1}{4\pi\epsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$
(d) zero

Ans: (c)

Solution: Distance of point A from the two +qcharges = L.
Distance of point A from the two –qcharges = $\sqrt{L^2+(2L)^2} = \sqrt{5}L$.



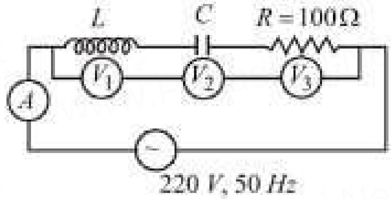
$V_A = \left(\frac{Kq}{L}\times 2\right) - \left(\frac{Kq}{\sqrt{5}L}\times 2\right)$

$= \frac{2Kq}{L}\left[1-\frac{1}{\sqrt{5}}\right]$

$= \frac{1}{4\pi\epsilon_0}.\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

Chapter: Electrostatic Potential and capacitance
[Topic: Electrostatic Potential & Equipotential Surfaces]

Q22. In the given circuit the reading of voltmeter V_1 and V_2 are 300 volts each. The reading of the voltmeter V_3 and ammeter A are respectively



(a) 150 V, 2.2 A (b) 220 V, 2.2 A
(c) 220 V, 2.0 A (d) 100 V, 2.0 A

Ans: (b)

Solution: As $V_L = V_C = 300\ V$, resonance will take place

$\therefore V_R = 220\ V$

Current, $I = \frac{220}{100} = 2.2\text{A}$

$\therefore$ reading of $V_3 = 220\ V$

and reading of $A = 2.2\ A$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q23. Fusion reaction takes place at high temperature because

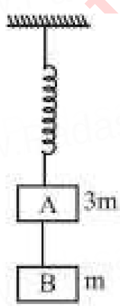
(a) nuclei break up at high temperature
(b) atoms get ionised at high temperature
(c) kinetic energy is high enough to overcome the coulomb repulsion between nuclei
(d) molecules break up at high temperature

Ans: (c)

Solution: When the coulomb repulsion between the nuclei is overcome then nuclear fusion reaction takes place. This is possible when temperature is too high.

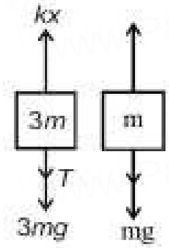
Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q24. Two blocks A and B of masses 3m and m respectively are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in figure. The magnitudes of acceleration of A and B immediately after the string is cut, are respectively :-



(a) $\frac{g}{3}$, g
(b) g, g
(c) $\frac{g}{3}, \frac{g}{3}$
(d) g, $\frac{g}{3}$

Ans: (a)



Solution:

Before cutting the string

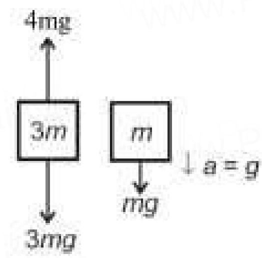
kx = T + 3 mg...(i)

T = mg...(ii)

$\Rightarrow$ kx = 4mg

After cutting the string T = 0

$$a_A = \frac{4mg - 3mg}{3m}$$



$a_A = \frac{g}{3} \uparrow$

and $a_B = \frac{mg}{m} = g \downarrow$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q25. A black body has maximum wavelength λ_m at temperature 2000 K. Its corresponding wavelength at temperature 3000 K will be

(a) $\frac{3}{2}\lambda_m$
(b) $\frac{2}{3}\lambda_m$
(c) $\frac{4}{9}\lambda_m$
(d) $\frac{9}{4}\lambda_m$

Ans: (b)

Solution: According to Wein's displacement law,

$\lambda_m T = 2.88 \times 10^{-3}$

When T = 2000 K,

$\lambda_m (2000) = 2.88 \times 10^{-3}$....(1)

When T = 3000 K,

$\lambda'_m (3000) = 2.88 \times 10^{-3}$....(2)

Dividing (1) by (2) ,

$$\frac{2\,\lambda_m}{3\,\lambda_m} = 1 \Rightarrow \frac{\lambda_m}{\lambda_m} = \frac{3}{2} = \lambda'_m = \frac{2}{3}\lambda_m$$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q26. A parallel plate air capacitor is charged to a potential difference of V volts. After disconnecting the charging battery the distance between the plates of the capacitor is increased using an insulating handle. As a result the potential difference between the plates

(a) does not change

(b) becomes zero
(c) increases
(d) decreases

Ans: (c)

Solution: If we increase the distance between the plates its capacity decreases resulting in higher potential as we know $Q = CV$. Since Q is constant (battery has been disconnected), on decreasing C, V will increase.

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

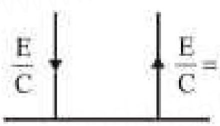
Q27. A radiation of energy 'E' falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (C = Velocity of light)

(a) $\frac{2E}{C}$
(b) $\frac{2E}{C^2}$
(c) $\frac{E}{C^2}$
(d) $\frac{E}{C}$

Ans: (a)

Solution: Momentum of light falling on reflecting surface $p = \frac{E}{C}$

As surface is perfectly reflecting so momentum reflect $p^1 = -\frac{E}{C}$



So, momentum transferred

$= P - P^1 = \frac{E}{C} - \left(-\frac{E}{C}\right) = \frac{2E}{C}$

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q28. An electron with (rest mass m_0) moves with a speed of 0.8 c. Its mass when it moves with this speed is

(a) m_0 (b) $\frac{m_0}{6}$
(c) $\frac{5m_0}{3}$ (d) $\frac{3m_0}{5}$

Ans: (c)

Solution: $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{m_0}{\sqrt{\frac{c^2-(0.8c)^2}{c^2}}} = \frac{5m_0}{3}$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q29. A person slides freely down a frictionless inclined plane while his bag falls down vertically from the same height. The final speeds of the man (V_M) and the bag (V_B) should be such that

(a) $V_M < V_B$
(b) $V_M = V_B$
(c) they depend on the masses
(d) $V_M > V_B$

Ans: (b)

Solution: As there is only gravitational field which works.

We know it is conservative field and depends only on the end points. So, $V_M = V_B$

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q30. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of $\frac{C_p}{C_v}$ for the gas is

[2013]

(a) 2 (b) $\frac{5}{3}$
(c) $\frac{3}{9}$ (d) $\frac{4}{3}$

Ans: (c)

Solution: According to question $P \propto T^3$

But as we know for an adiabatic process the pressure $P \propto T^{\frac{\gamma}{\gamma-1}}$.

So, $\frac{\gamma}{\gamma-1} = 3 \Rightarrow \gamma = \frac{3}{2}$ or, $\frac{C_p}{C_v} = \frac{3}{2}$

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q31. If the resistance of a conductor is 5 Ω at 50ºC and 7Ω at 100ºC, then the mean temperature coefficient of resistance (of the material) is

[1996]

(a) 0.001/ºC (b) 0.004/ºC
(c) 0.006/ºC (d) 0.008/ºC

Ans: (a)

Solution: As we know that resistance varies with temperature as

$R = R_0\,[1 + \alpha t]$

Ist Case : $5 = R_0\,[1 + \alpha(50)]$ .... (I)

IInd Case : $7 = R_0\,[1 + \alpha(100)]$ ..... (II)

Divide (I) by (II), $\frac{5}{7} = \frac{1+50\alpha}{1+100\alpha}$

$5 + 500\alpha = 7 + 350\alpha$

$150\,\alpha = 2 \Rightarrow \alpha = \frac{2}{150} = 0.001$ /°C

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q32. Which one of the following electromagnetic radiations has the smallest wavelength?

(a) ultraviolet waves
(b) X-rays
(c) γ-rays
(d) microwaves

Ans: (c)

Solution: RaysWavelength[Range in m]X-*rays*1×10^{-11} to 3×10^{-8}γ-rays6×10^{-14} to 1×10^{-11}Microwaves10^{-3} to 0.3Radiowaves10 to 10^4

Wavelength of U.V. Rays ranges from

6×10^{-8} to 4×10^{-7}.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q33. A deuteron strikes $_8O^{16}$ nucleus with subseq-uent emission of an alpha particle. Identify the nucleus so produced
(a) $_3Li^7$
(b) $_5B^{10}$
(c) $_7N^{13}$
(d) $_7N^{14}$

Ans: (d)

Solution: $_8O^{16} + {}_1H^2 \rightarrow {}_2He^4 + {}_7N^{14}$

Chapter: Nuclei
[Topic: Radioactivity]

Q34. A force acts on a 30 gm particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where x is in metres and t is in seconds. The work done during the first 4 seconds is
(a) 576 mJ (b) 450 mJ
(c) 490 mJ (d) 530 mJ

Ans: (a)

Solution: $x = 3t - 4t^2 + t^3$
$\frac{dx}{dt} = 3 - 8t + 3t^2$
Acceleration $= \frac{d^2x}{dt^2} = -8 + 6t$
Acceleration after 4 sec
$= -8 + 6 \times 4 = 16\ ms^{-2}$
Displacement in 4 sec
$= 3 \times 4 - 4 \times 4^2 + 4^3 = 12$ m
∴ Work = Force × displacement
= Mass × acc. × disp.
$= 3 \times 10^{-3} \times 16 \times 12 = 576$ mJ

Chapter: Work, Energy and Power
[Topic: Work]

Q35. A Carnot engine whose sink is at 300 K has an efficiency of 40%. By how much should the temperature of source be increased so as to increase, its efficiency by 50% of original efficiency ?
(a) 325 K (b) 250 K
(c) 380 K (d) 275 K

Ans: (b)

Solution: We know that efficiency of Carnot Engine
$= \frac{T_1 - T_2}{T_1}$
where, T_1 is temp. of source & T_2 is temp. of sink
$\therefore 0.40 = \frac{T_1 - 300}{T_1} \Rightarrow T_1 - 300 = 0.40T_1$
$06T_1 = 300 = T_1 = \frac{300}{.6} = \frac{3000}{6} = 500K$
Now efficiency to be increased by 50%
$\therefore 0.60 = \frac{T_1 - 300}{T_1} \Rightarrow T_1 - 300 = 0.6T_1$
$0.4T_1 = 300 = T_1 = \frac{300}{.4} = \frac{300 \times 10}{4} = 750$
Increase in temp = 750 – 500 = 250 K

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q36. A current of 2A flows through a 2Ω resistor when connected across a battery. The same battery supplies a current of 0.5 A when connected across a 9Ω resistor. The internal resistance of the battery is
(a) 0.5 Ω (b) 1/3 Ω
(c) 1/4 Ω (d) 1 Ω

Ans: (b)

Solution: Let the internal resistance of the battery be r. Then the current flowing through the circuit is given by
$i = \frac{E}{R+r}$
In first case,
$2 = \frac{E}{2+r}$ ... (1)
In second case,
$0.5 = \frac{E}{9+r}$ ... (2)
From (1) & (2) ,
$4 + 2r = 4.5 + 0.5\ r$
$\Rightarrow 1.5\ r = 0.5 \Rightarrow r = \frac{1}{3}\ \Omega$.

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q37. Time taken by sunlight to pass through a window of thickness 4 mm whose refractive index is $\frac{3}{2}$ is
(a) 2×10^{-4}sec (b) 2×10^{8}sec
(c) 2×10^{-11}sec (d) 2×10^{11}sec

Ans: (c)

Solution: $v_g = \frac{c}{\mu} = \frac{3\times10^8}{\frac{3}{2}} = 2 \times 10^8$ m/s
$t = \frac{x}{v_g} = \frac{4\times10^{-3}}{2\times10^8} = 2 \times 10^{-11}$ s

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q38. The barrier potential of a p-n junction depends on:
(A) type of semi conductor material
(B) amount of doping
(C) temperature
Which one of the following is correct ?
(a) (A) and (B) only
(b) (B) only
(c) (B) and (C) only
(d) (A) , (B) and (C)

Ans: (d)

Solution: The barrier potential of a p-n junction depends on amount of doping, type of semiconductor material and temperature.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q39. A particle of mass m is driven by a machine that delivers a constant power of k watts. If the particle starts from rest the force on the particle at time t is
(a) $\sqrt{mkt^{\frac{1}{2}}}$
(b) $\sqrt{2mkt^{\frac{1}{2}}}$

(c) $\frac{1}{2}\sqrt{mkt^{\frac{1}{2}}}$

(d) $\sqrt{\frac{mk}{2}}t^{\frac{1}{2}}$

Ans: (d)

Solution: As we know power $P = \frac{dw}{dt}$

$\Rightarrow w = Pt = \frac{1}{2}mV^2$

So, $v = \sqrt{\frac{2Pt}{m}}$

Hence, acceleration $a = \frac{dV}{dt} = \sqrt{\frac{2P}{m}} \cdot \frac{1}{2\sqrt{t}}$

Therefore, force on the particle at time 't'

$= ma = \sqrt{\frac{2Km^2}{m}}\frac{1}{2\sqrt{t}} = \sqrt{\frac{Km}{2t}} = \sqrt{\frac{mK}{2}}t^{-\frac{1}{2}}$

Chapter: Work, Energy and Power
[Topic: Power]

Q40. N molecules each of mass m of a gas A and 2N molecules each of mass 2m of gas B are contained in the same vessel which is maintained at temperature T. The mean square velocity of molecules of B type is v^2 and the mean square rectangular component of the velocity of A type is denoted by ω^2. Then ω^2/v^2

(a) 2 (b) 1
(c) 1/3 (d) 2/3

Ans: (d)

Solution: Mean kinetic energy of the two types of molecules should be equal. The mean square velocity of A type molecules $= \omega^2 + \omega^2 + \omega^2 = 3\omega^2$

Therefore, $\frac{1}{2}m(3\omega^2) = \frac{1}{2}(2m)v^2$

This gives $\frac{\omega^2}{v^2} = \frac{2}{3}$

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q41. Ten identical cells connected in series are needed to heat a wire of length one meter and radius '*r*' by 10ºC in time '*t*'. How many cells will be required to heat the wire of length two meter of the same radius by the same temperature in time '*t*'?

(a) 10 (b) 20
(c) 30 (d) 40

Ans: (b)

Solution: Resistance is directly proportionl to length of the wire. As length is doubled so mass is doubled and resistance is doubled.

We have

$\frac{(10E)^2}{R}t = mS\Delta T$, Now $\frac{(nE)^2 t}{2R} = (2m)S\Delta T$

$\Rightarrow \frac{n^2B^2t}{2R} = 2\frac{10^2E^2t}{R}$

$\Rightarrow n = 20$

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q42. Focal length of a convex lens of refractive index 1.5 is 2 cm. Focal length of the lens when immersed in a liquid of refractive index of 1.25 will be

(a) 10 cm (b) 2.5 cm
(c) 5 cm (d) 7.5 cm

Ans: (c)

Solution: $\frac{f_a}{f_l} = \frac{\left(\frac{\mu_g}{\mu_l}-1\right)}{(\mu_g-1)} = \frac{\left(\frac{1.5}{1.25}-1\right)}{1.5-1} = \frac{\frac{1}{5}}{\frac{1}{2}} = \frac{2}{5}$

$f_l = \frac{5}{2}f_a = \frac{5}{2}\times 2 = 5cm$

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q43. Barrier potential of a *p-n* junction diode does not depend on

(a) doping density
(b) diode design
(c) temperature
(d) forward bias

Ans: (b)

Solution: Barrier potential does not depend on diode design while barrier potential depends upon temperature, doping density, and forward biasing.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q44. A metal ball of mass 2 kg moving with a velocity of 36 km/h has a head on collision with a stationary ball of mass 3 kg. If after the collision, the two balls move together, the loss in kinetic energy due to collision is

(a) 140 J (b) 100 J
(c) 60 J (d) 40 J

Ans: (c)

Solution: Applying conservation of momentum,

$m_1v_1 = (m_1 + m_2)v$

$v = \frac{m_1v_1}{(m_1+m_2)}$

Here, v_1 = 36 km/hr = 10 m/s

$m_1 = 2$ kg, $m_2 = 3$ kg

$v = \frac{10\times2}{5} = 4$m/s

K.E. (initial) $= \frac{1}{2}\times 2\times(10)^2 = 100J$

K.E. (Final) $= \frac{1}{2}\times(3+2)\times(4)^2 = 40J$

Loss in K.E. = 100 – 40 = 60 J

Chapter: Work, Energy and Power
[Topic: Collisions]

Q45. The displacement of aparticle along the x-axis is given by $x = a\sin^2\omega t$. The motion of the particle corresponds to:

(a) simple harmonic motion of frequency $\frac{\omega}{\pi}$
(b) simple harmonic motion of frequency $\frac{3\omega}{2\pi}$
(c) non simple harmonic motion
(d) simple harmonic motion of frequency $\frac{\omega}{2\pi}$

Ans: (a)

Solution: $x = a\sin^2\omega t = \frac{a}{2}(1 - \cos 2\omega t)$

$\frac{dx}{dt} = \frac{a}{2}2\omega\sin 2\omega t$

$= \frac{d^2x}{dt^2} = \frac{4\omega^2 a}{2}\cdot\cos 2\omega t$

This represents an S. H. M. of frequency = $\frac{\omega}{\pi}$

Chapter: Oscillation
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q46. A potentiometer wire is 100 cm long and a constant potential difference is maintained across it. Two cells are connected in series first to support one another and then in opposite direction. The balance points are obtained at 50 cm and 10 cm from the positive end of the wire in the two cases. The ratio of emf's is :

(a) 5 : 1 (b) 5 : 4
(c) 3 : 4 (d) 3 : 2

Ans: (d)

Solution: When two cells are connected in series i.e., $E_1 + E_2$ the balance point is at 50 cm. And when two cells are connected in opposite direction i.e., $E_1 - E_2$ the balance point is at 10 cm. According to principle of potential

$$\frac{E_1 + E_2}{E_1 - E_2} = \frac{50}{10}$$

$$\Rightarrow \frac{2E_1}{2E_2} = \frac{50+10}{50-10} \Rightarrow \frac{E_1}{E_2} = \frac{3}{2}$$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q47. Ratio of intensities of two waves are given by 4 : 1. Then the ratio of the amplitudes of the two waves is

(a) 2 : 1 (b) 1 : 2
(c) 4 : 1 (d) 1 : 4

Ans: (a)

Solution: $\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \frac{4}{1} \therefore \frac{a_1}{a_2} = \frac{2}{1}$

Chapter - Wave Optics
[Topic: Wavefront, Interference of Light, Coherent & Incoherent Sources]

Q48. In a common emitter transistor amplifier the audio signal voltage across the collector is 3V. The resistance of collector is 3 kΩ. If current gain is 100 and the base resistance is 2 kΩ, the voltage and power gain of the amplifier is

(a) 15 and 200 (b) 150 and 15000
(c) 20 and 2000 (d) 200 and 1000

Ans: (b)

Solution: Given, current gain β = 100, R_c = 3kΩ, R_b = 2kΩ

Voltage gain (A_v) = $\beta \frac{R_c}{R_b} = 100\left(\frac{3}{2}\right) = 150$

Power gain = A_v β = 150 (100) = 15000

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q49. An automobile moves on a road with a speed of 54 km h^{-1}. The radius of its wheels is 0.45 m and the moment of inertia of the wheel about its axis of rotation is 3 kg m^2. If the vehicle is brought to rest in 15s, the magnitude of average torque transmitted by its brakes to the wheel is :
[2015 RS]

(a) 8.58 kg m^2 s^{-2} (b) 10.86 kg m^2 s^{-2}
(c) 2.86 kg m^2 s^{-2} (d) 6.66 kg m^2 s^{-2}

Ans: (d)

Solution: Given : Speed V = 54 kmh^{-1} = 15 ms^{-1}
Moment of inertia, I = 3 kgm^2
Time t = 15s

$\omega i = \frac{V}{r} = \frac{15}{0.45} = \frac{100}{3}$ $\omega f = 0$

$\omega_f = \omega_i + \alpha t$

$0 = \frac{100}{3} + (-\alpha)(15) \Rightarrow \alpha = \frac{100}{45}$

Average torque transmitted by brakes to the wheel

$\tau = (I)(\alpha) = 3 \times \frac{100}{45} = 6.66\ kgm^2s^{-2}$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q50. A spring of force constant k is cut into lengths of ratio 1 : 2 : 3. They are connected in series and the new force constant is k'. Then they are connected in parallel and force constant is k″ . Then k' : k″ is

(a) 1 : 9 (b) 1 : 11
(c) 1 : 14 (d) 1 : 6

Ans: (b)

Solution: Let l be the complete length of the spring.

Length when cut in ratio, 1 : 2 : 3 are $\frac{\ell}{6}, \frac{\ell}{3}$ and $\frac{\ell}{2}$

Spring constant (k) ∝ $\frac{1}{length(\ell)}$

Spring constant for given segments

$k_1 = 6k$, $k_2 = 3k$ and $k_3 = 2k$

When they are connected in series

$$\frac{1}{k'} = \frac{1}{6k} + \frac{1}{3k} + \frac{1}{2k}$$

$\Rightarrow \frac{1}{k'} = \frac{6}{6k}$

∴ Force constant k' = k

And when they are connected in parallel

k" = 6k + 3k + 2k

⇒ k" = 11k

Then the ratios

$\frac{k'}{k''} = \frac{1}{11}$ i.e., k' : k" = 1 : 11

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

PART 11. PHYSICS QUESTION BANK

Q51. A particle of mass m, charge Q and kinetic energy T enters a transverse uniform magnetic field of induction $\vec{B}$. After 3 seconds, the kinetic energy of the particle will be:

(a) 3T (b) 2T
(c) T (d) 4T

Ans: (c)

Solution: When a charged particle enters a transverse magnetic field it traverse a circular path. Its kinetic energy remains constant.

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q52. In a Fresnel biprism experiment, the two positions of lens give separation between the slits as 16 cm and 9 cm respectively. What is the actual distance of separation?

(a) 12.5 cm (b) 12 cm
(c) 13 cm (d) 14 cm

Ans: (b)

Solution: Separation between slits are (r_1=) 16 cmand (r_2=) 9 cm.
Actual distance of separation
$= \sqrt{r_1 r_2} = \sqrt{16 \times 9} = 12\text{cm}$

Chapter - Wave Optics
[Topic: Diffraction, Polarization of Light & Resolving Power]

Q53. In a common base amplifier the phase difference between the input signal voltage and the output voltage is

(a) 0 (b) $\frac{\pi}{4}$
(c) $\frac{\pi}{2}$
(d) π

Ans: (a)

Solution: The phase difference between output voltage and input signal voltage in common base transistor or circuit is zero.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q54. 22The force F on a sphere of radius a moving in a medium with velocity v is given by F = 6πηav. The dimensions of η are

(a) $[ML^{-3}]$
(b) $[ML^{-2}]$
(c) $[ML^{-1}]$
(d) $[ML^{-1}T^{-1}]$

Ans: (d)

Solution: F= 6πη av

$$\eta = \frac{F}{6\pi av} = \frac{[MLT^{-2}]}{[L][LT^{-1}]} = [ML^{-1}T^{-1}]$$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q55. A couple produces
(a) no motion
(b) purely linear motion
(c) purely rotational motion
(d) linear and rotational

Ans: (c)

Solution: A couple is formed of two equal and opposite forces at some separation; so net force is zero. Hence, a couple does not produce translatory motion; but it causes change in rotational motion.

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q56. The damping force on an oscillator is directly proportional to the velocity. The unit of the constant of proportionality is:

(a) $kgms^{-1}$ (b) $kgms^{-2}$
(c) kgs^{-1} (d) kgs

Ans: (c)

Solution: $F \propto v \Rightarrow F = kv$

$k = \frac{F}{v} \Rightarrow [k] = \frac{[kgms^{-2}]}{[ms^{-1}]} = kgs^{-1}$

Chapter: Oscillation
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q57. Charge q is uniformly spread on a thin ring of radius R. The ring rotates about its axis with a uniform frequency f Hz. The magnitude of magnetic induction at the centre of the ring is

(a) $\frac{\mu_0 qf}{2R}$
(b) $\frac{\mu_0 q}{2fR}$
(c) $\frac{\mu_0 q}{2\pi fR}$
(d) $\frac{\mu_0 qf}{2\pi R}$

Ans: (a)

Solution: When the ring rotates about its axis with a uniform frequency f Hz, the current flowing in the ring is

$1 = \frac{q}{T} = qf$

Magnetic field at the centre of the ring is

$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 qf}{2R}$

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q58. When the energy of the incident radiation is incredased by 20%, the kinetic energy of the photoelectrons emitted from a metal surface increased from 0.5 eV to 0.8 eV. The work function of the metal is :

(a) 0.65 eV (b) 1.0 eV
(c) 1.3 eV (d) 1.5 eV

Ans: (b)

Solution: According to Einstein's photoelectric equation,
$h\nu = \varphi_0 + K_{max}$
We have

$h\nu = \varphi_0 + 0.5$... (i)
and $1.2h\nu = \varphi_0 + 0.8$... (ii)
Therefore, from above two equations $\varphi_0 = 1.0$ eV.

Chapter - Dual Nature of Radiation and Matter [Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q59. If a car at rest accelerates uniformly to a speed of 144 km/h in 20 s, it covers a distance of
(a) 2880 m (b) 1440 m
(c) 400 m (d) 20 m

Ans: (c)

Solution: Initial velocity of car (u) = 0
Final velocity of car (v) = 144 km/hr = 40 m/s
Time taken = 20 s
We know that, v = u + at
$40 = a \times 20 \Rightarrow a = 2$ m/s^2
Also, $v^2 - u^2 = 2as$
$\Rightarrow s = \frac{v^2-u^2}{2a}$
$= s = \frac{(40)^2-(0)^2}{2\times2} = \frac{1600}{4} = 400$ m.

Chapter: Kinematics Motion in a Straight Line [Topic: Distance, Displacement & Uniform motion]

Q60. A fly wheel rotating about a fixed axis has a kinetic energy of 360 joule when its angular speed is 30 radian/sec. The moment of inertia of the wheel about the axis of rotation is
(a) 0.6 kg/m^2 (b) 0.15 kg m^2
(c) 0.8 kg m^2 (d) 0.75 kg m^2

Ans: (c)

Solution: $E_r = \frac{1}{2}I\omega^2$
$I = \frac{2E_r}{\omega^2} = \frac{2\times360}{30\times30} = 0.8 kgm^2$

Chapter: System of Particles and Rotational Motion [Topic: Moment of Inertia, Rotational K.E. and Power]

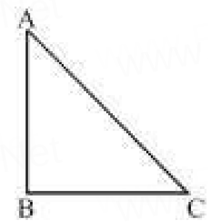
Q61. From a wave equation: $y = 0.5\sin\frac{(2.\pi)}{3.2}(64t - x)$, the frequency of the wave is
(a) 5 Hz (b) 15 Hz
(c) 20 Hz (d) 25 Hz

Ans: (c)

Solution: $y = 0.5\sin\frac{2\pi}{3.2}(64t - x)$. Standard equation of the wave is : $y = a\sin\frac{2\pi}{\lambda}(vt - x)$.
Comparing the given equation with the standard equation, we get v = 64 and λ = 3.2. Therefore, frequency $= \frac{64}{3.2} = 20Hz$.

Chapter: Waves [Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q62. A current carrying loop in the form of a right angle isosceles triangle ABC is placed in a uniform magnetic field acting along AB. If the magnetic force on the arm BC is F, what is the force on the arm AC?



(a) $-\sqrt{F}$
(b) $-\vec{F}$
(c) $\vec{F}$
(d) $\sqrt{2}\vec{F}$

Ans: (b)

Solution: Let a current i be flowing in the loop ABC in the direction shown in the figure. If the length of each of the sides AB and BC be x then
$|\vec{F}| = i \times B$
where B is the magnitude of the magnetic force.
The direction of $\vec{F}$ will be in the direction perpendicular to the plane of the paper and going into it.
By Pythagorus theorem,
$AC = \sqrt{x^2 + x^2} = \sqrt{2}x$
∴ Magnitude of force on AC
$= i\sqrt{2}x B \sin 45°$
$= i\sqrt{2}xB \times \frac{1}{\sqrt{2}}$
$= ixB = |\vec{F}|$
The direction of the force on AC is perpendicular to the plane of the paper and going out of it. Hence, force on $AC = -\vec{F}$

Chapter: Moving Charges and Magnetic Field [Topic: Force & Torque on a Current Carrying Conductor]

Q63. A photoelectric cell is illuminated by a point source of light 1m away. When the source is shifted to 2m then
(a) number of electrons emitted is a quarter of the initial number
(b) each emitted electron carries one quarter of the initial energy
(c) number of electrons emitted is half the initial number
(d) each emitted electron carries half the initial energy

Ans: (a)

Solution: Power ∝ No. of electrons emitted (N)
$P \propto \frac{1}{r^2} = N \propto \frac{1}{r^2}$

Chapter - Dual Nature of Radiation and Matter [Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q64. A particle moves along a straight line such that its displacement at any time t is given by $s = (t^3 - 6t^2 + 3t + 4)$ metres The velocity when the acceleration is zero is
(a) 3 ms^{-1} (b) – 12 ms^{-1}
(c) 42 ms^{-2} (d) – 9 ms^{-1}

Ans: (d)

Solution: Velocity, $v = \frac{ds}{dt} = 3t^2 - 12t + 3$

Acceleration, $a = \frac{dv}{dt} = 6t - 12$; For a = 0, we have, 0 = 6 t – 12 or t = 2s. Hence, at t = 2 s the velocity will be $v = 3 \times 2^2 - 12 \times 2 + 3 = -9ms^{-1}$

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q65. The acceleration due to gravity at a height 1 km above the earth is the same as at a depth d below the surface of earth. Then

(a) d = 1 km

(b) $d = \frac{3}{2}$km

(c) d = 2 km

(d) $d = \frac{1}{2}$km

Ans: (c)

Solution: Above earth surfaceBelow earth surface$g_h = g\left(1 - \frac{2h}{R_e}\right)$ $g_d = g\left(1 - \frac{d}{R_e}\right)$

According to question, $g_h = g_d$

$$\left(1 - \frac{2h}{R_e}\right) = g\left(1 - \frac{d}{R_e}\right)$$

Clearly,
d = 2h = 2 km

Chapter: Gravitation
[Topic: Acceleration due to Gravity]

Q66. A string of 7 m length has a mass of 0.035 kg. If tension in the string is 60.5 N, then speed of a wave on the string is

(a) 77 m/s (b) 102 m/s
(c) 110 m/s (d) 165 m/s

Ans: (c)

Solution: Given : Length (l) = 7 m
Mass (M) = 0.035 kg and tension (T) = 60.5 N.
Therefore, mass of string per unit length (m) = $\frac{0.035}{7}$ =0.005kg/m
speed of wave
$= \sqrt{\frac{T}{m}} = \sqrt{\frac{60.5}{0.005}}$ =110m/s

Chapter: Waves
[Topic: Vibration of String & Organ Pipe]

Q67. A bar magnet of magnetic moment *M* is placed at right angles to a magnetic induction *B*. If a force *F* is experienced by each pole of the magnet, the length of the magnet will be
[NEET Kar. 2013]

(a) F/MB
(b) MB/F
(c) BF/M
(d) MF/B

Ans: (b)

Solution: $FL = MB$ (= Torque) ⇒ $L = \frac{MB}{F}$

Chapter: Magnetism and Matter
[Topic: Magnetism, Gauss's Law, Magnetic Moment & Properties of Magnet]

Q68. Ultraviolet radiations of 6.2 eV falls on an aluminium surface. K.E. of fastest electron emitted is (work function = 4.2 eV)

(a) 3.2×10^{-21} J (b) 3.2×10^{-19} J
(c) 7×10^{-25} J (d) 9×10^{-32} J

Ans: (b)

Solution: K.E. of fastest electron
$= E - W_0 = 6.2 - 4.2 = 2.0$ eV
$= 2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$ J

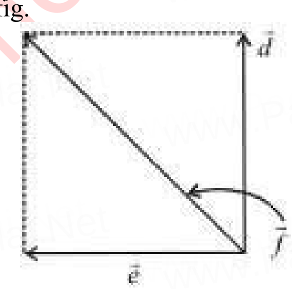
Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q69. Six vectors, $\vec{a}$ through $\vec{f}$ have the magnitudes and directions indicated in the figure. Which of the following statements is true?

(a) $\vec{b} + \vec{c} = \vec{f}$
(b) $\vec{d} + \vec{c} = \vec{f}$
(c) $\vec{d} + \vec{e} = \vec{f}$
(d) $\vec{b} + \vec{e} = \vec{f}$

Ans: (c)

Solution: Using the law of vector addition, $(\vec{d} + \vec{e})$ is as shown in the fig.



$\vec{d} + \vec{e} = \vec{f}$

Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q70. A particle of mass 'm' is kept at rest at a height 3R from the surface of earth, where 'R' is radius of earth and 'M' is mass of earth. The minimum speed with which it should be projected, so that it does not return back, is (g is acceleration due to gravity on the surface of earth)
[NEET Kar. 2013]

(a) $\left(\frac{GM}{R}\right)^{\frac{1}{2}}$

(b) $\left(\frac{GM}{2R}\right)^{\frac{1}{2}}$

(c) $\left(\frac{gR}{4}\right)^{\frac{1}{2}}$

(d) $\left(\frac{2g}{4}\right)^2 1$

Ans: (b)

Solution: As we know, the minimum speed with which a body is projected so that it does not return back is called escape speed.

$$V_e = \sqrt{\frac{2GM}{r}} = \sqrt{\frac{2G}{R+h}} = \sqrt{\frac{2GM}{4R}}$$

$$= \left(\frac{GM}{2R}\right)^{\frac{1}{2}} (h = 3R)$$

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q71. A car is moving towards a high cliff. The car driver sounds a horn of frequency f. The reflected sound heard by the driver has frequency 2f. If v be the velocity of sound, then the velocity of the car, in the same velocity units, will be

(a) v /2 (b) v /√2
(c) v /3 (d) v /4

Ans: (c)

Solution: Let f ' be the frequency of sound heard by cliff.

$f = \frac{vf}{v-v_c}$ ....(1)

Now, for the reflected wave, cliff acts as a source,

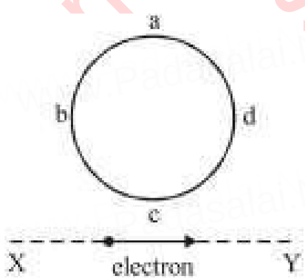
$2f = \frac{f'(v+v_c)}{v}$ ....(2)

$2f = \frac{(v+v_c)f}{v-v_c}$

$\Rightarrow 2v - 2v_c = v + v_c$ or $\frac{v}{3} = v_c$

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

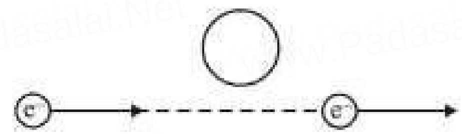
Q72. An electron moves on a straight line path XY as shown. The abcd is a coil adjacent to the path of electron. What will be the direction of current if any, induced in the coil?



(a) adcb
(b) The current will reverse its direction as the electron goes past the coil
(c) No current induced
(d) abcd

Ans: (b)

Solution: Current will be induced,
when e^- comes closer the induced current will be anticlockwise
when e^- comes farther induced current will be clockwise



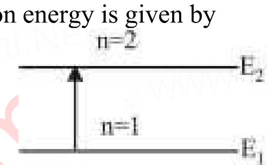
Chapter: Electromagnetic
[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q73. The ground state energy of hydrogen atom is 13.6eV. When its electron is in the first excited state, its excitation energy is

(a) 3.4 eV (b) 6.8 eV
(c) 10.2 eV (d) 0

Ans: (c)

Solution: When the electron is in first excited state (n = 2), the excitation energy is given by



$\Delta E = E_2 - E_1$

We have, $E_n = -\frac{13.6}{n^2}$ eV

$\therefore E_2 = -\frac{13.6}{2^2}$ eV $= -3.4$eV

Given $E_1 = -13.6$eV

$\therefore \Delta E = (-3.4) - (-13.6) = 10.2$ eV.

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q74. A bullet is fired from a gun with a speed of 1000 m/s in order to hit a target 100 m away. At what height above the target should the gun be aimed? (The resistance of air is negligible and g = 10 m/s^2)

(a) 5 cm (b) 10 cm
(c) 15 cm (d) 20 cm

Ans: (a)

Solution: Speed of the bullet (v) = 1000 m/s and horizontal distance of the target (s) = 100 m.

Time taken to cover the horizontal distance (t) $= \frac{100}{1000} = 0.1$sec .

During this time, the bullet will fall down vertically due to gravitational acceleration.

$\therefore$ height $(h) = ut + \frac{1}{2}gt^2$

$= (0 \times 01) + \frac{1}{2} \times 10(01)^2$ =0.05 m = 5cm

Chapter: Kinematics Motion in a Plane
[Topic: Projectile Motion]

Q75. The bulk modulus of a spherical object is 'B'. If it is subjected to uniform pressure 'p', the fractional decrease in radius is

(a) $\frac{B}{3p}$
(b) $\frac{3p}{B}$
(c) $\frac{p}{3B}$
(d) $\frac{p}{B}$

Ans: (c)

Solution: Bulk modulus is given by

$B = \frac{P}{\left(\frac{\Delta V}{V}\right)}$ or $\frac{\Delta V}{V} = \frac{P}{B}$

$3\frac{\Delta R}{R} = \frac{P}{B}$ (here, $\frac{\Delta R}{R}$ = fractional decreases in radius)

$\Rightarrow \frac{\Delta R}{R} = \frac{P}{3B}$

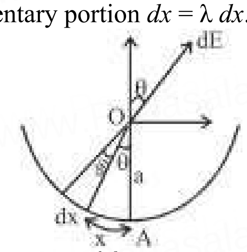
Chapter: Mechanical Propertiesof Solids
[Topic: Bulk and Rigidity Modulus & Work Done in Stretching a Wire]

Q76. A semi-circular arc of radius '*a*' is charged uniformly and the charge per unit length is λ. The electric field at the centre of this arc is

(a) $\frac{\lambda}{2\pi\varepsilon_0 a}$
(b) $\frac{\lambda}{2\pi\varepsilon_0 a^2}$
(c) $\frac{\lambda}{4\pi^2\varepsilon_0 a}$
(d) $\frac{\lambda^2}{2\pi\varepsilon_0 a}$

Ans: (a)

Solution: λ = linear charge density;
Charge on elementary portion *dx* = λ *dx*.



Electric field at o, $dE = \frac{\lambda dx}{4\pi\varepsilon_0 a^2}$

Horizontal electric field, i.e., perpendicular to *AO*, will be cancelled.
Hence, net electric field = addition of all electrical fields in direction of *AO*

$= \Sigma dE\cos\theta$

$\Rightarrow E = \int \frac{\lambda dx}{4\pi\varepsilon_0 a^2}\cos\theta$

Also, $d\theta = \frac{dx}{a}$ or $dx = a d\theta$

$E = \int_{-\pi}^{\frac{\pi}{2}} \frac{\cos\theta d\theta}{4\pi\varepsilon_0 a} = \frac{\lambda}{4\pi\varepsilon_0 a}[\sin\theta]_{-\frac{\pi}{2}}^{\frac{\pi}{2}}$

$= \frac{\lambda}{4\pi\varepsilon_{0}0}[1-(-1)] = \frac{\lambda}{2\pi\varepsilon_0 a}$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q77. A rectangular coil of 20 turns and area of cross-section 25 sq. cm has a resistance of 100Ω. If a magnetic field which is perpendicular to the plane of coil changes at a rate of 1000 tesla per second, the current in the coil is

(a) 1 A (b) 50 A
(c) 0.5 A (d) 5 A

Ans: (c)

Solution: $i = \frac{e}{R} = \frac{\frac{nAdB}{dt}}{R}$

$= \frac{20 \times (25 \times 10^{-4}) \times 1000}{100} = 0.5A$

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q78. If the nucleus ${}^{27}_{13}Al$ has nuclear radius of about 3.6 fm, then ${}^{125}_{32}Te$ would have its radius approximately as

(a) 9.6 fm (b) 12.0 fm
(c) 4.8 fm (d) 6.0 fm.

Ans: (d)

Solution: It has been known that a nucleus of mass number *A* has radius
$R = R_0 A^{1/3}$,
where $R_0 = 1.2 \times 10^{-15}$m
and *A* = mass number
In case of ${}^{27}_{13}Al$ let nuclear radius be R_1
and for ${}^{125}_{32}Te$ nuclear radius be R_2

For ${}^{27}_{13}Al$, $R_1 = R_0(27)^{\frac{1}{3}} = 3R_0$

For ${}^{125}_{32}Te$, $R_2 = R_0(125)^{\frac{1}{3}} = 5R_0$

$\frac{R_2}{R_1} = \frac{5R_0}{3R_0} = \frac{5}{3}R_1 = \frac{5}{3} \times 3.6 = 6fm$

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

Q79. A stone tied with a string, is rotated in a vertical circle. The minimum speed with which the string has to be rotated

(a) is independent of the mass of the stone
(b) is independent of the length of the string
(c) decreases with increasing mass of the stone
(d) decreases with increasing length of the string

Ans: (a)

Solution: Minimum speed with which the string is rotating in a vertical circle (v) = $\sqrt{gr}$
The minimum speed of stone is independent of mass of stone.

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q80. A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3. Wien's constant, b = 2.88 × 10^6 nmK. Which of the following is correct ?

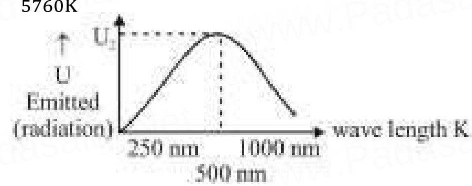
(a) $U_1 = 0$ (b) $U_3 = 0$
(c) $U_1 > U_2$ (d) $U_2 > U_1$

Ans: (d)

Solution: According to wein's displacement law, maximum amount of emitted radiation corresponding to

$\lambda_m = \frac{b}{T}$

$\lambda_m = \frac{288 \times 10^6 nmK}{5760K} = 500$ nm



From the graph $U_1 < U_2 > U_3$

Chapter: Thermal Properties

[Topic: Calorimetry & Heat Transfer]

Q81. Three concentric spherical shells have radii a, b and c (a < b < c) and have surface charge densities σ, – σ and σ respectively. If V_A, V_B and V_C denotes the potentials of the three shells, then for c = a + b, we have

(a) $V_C = V_B \neq V_A$
(b) $V_C \neq V_B \neq V_A$
(c) $V_C = V_B = V_A$
(d) $V_C = V_A \neq V_B$

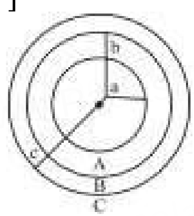
Ans: (d)

Solution: c = a + b.

$v_A = \frac{\sigma a}{\varepsilon_0} - \frac{\sigma b}{\varepsilon_0} + \frac{\sigma c}{\varepsilon_0} = \frac{\sigma}{\varepsilon_0}[c-(b-a)]$

$v_B = \frac{-\sigma b}{\varepsilon_0} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{\sigma \times 4\pi a^2}{b} + \frac{\sigma c}{\varepsilon_0}$

$= \frac{\sigma}{\varepsilon_0}\left[c - \frac{(b^2-a^2)}{b}\right]$



$v_c = \frac{\sigma c}{\varepsilon_0} - \frac{1}{4\pi\varepsilon_0} \cdot \frac{\sigma \times \pi b^2}{c} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{\sigma \times 4\pi a^2}{c}$

$= \frac{\sigma}{\varepsilon_0}\left[c - \frac{(b^2-a^2)}{c}\right]$

$= \frac{o}{\varepsilon_0}[c-(b-a)]$

$V_C = V_A \neq V_B$

Chapter: Electrostatic Potential and capacitance
[Topic: Electrostatic Potential & Equipotential Surfaces]

Q82. A condenser of capacity C is charged to a potential difference of V_1. The plates of the condenser are then connected to an ideal inductor of inductance L. The current through the inductor when the potential difference across the condenser reduces to V_2 is

(a) $\left(\frac{C(V_1^2-V_2^2)}{L}\right)^{\frac{1}{2}}$
(b) $\left(\frac{C(V_1-V_2)^2}{L}\right)^{\frac{1}{2}}$
(c) $\frac{C(V_1^2-y_2^2)}{L}$
(d) $\frac{C(V_1-V_2)}{L}$

Ans: (a)

Solution: $q = CV_1 \cos wt$

$\Rightarrow i = \frac{dq}{dt} = -\omega C v_1 \sin\omega t$

Also, $\omega^2 = \frac{1}{LC}$ and $V = V_1 \cos\omega t$

At $t = t_1$, $V = V_2$ and $i = -\omega CV_1 \sin\omega t_1$

$\therefore \cos\omega t_1 = \frac{V_2}{V_1}$ (–ve sign gives direction)

Hence, $i = V_1\sqrt{\frac{c}{L}}\left(1-\frac{V_2^2}{V_1^2}\right)^{\frac{1}{2}}$

$= \left(\frac{C(V_1^2-V_2^2)}{L}\right)^{\frac{1}{2}}$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q83. The mass of a $^7_3$Li nucleus is 0.042 u less than the sum of the masses of all its nucleons. The binding energy per nucleon of $^7_3$Li nucleus is nearly

(a) 46 MeV
(b) 5.6 MeV
(c) 3.9 MeV
(d) 23 MeV

Ans: (b)

Solution: B.E. = 0.042 × 931= 42 MeV

Number of nucleons in $^7_3$Li is 7.

∴ B.E./ nucleon = $\frac{42}{7}$ = 6 MeV = 5.6 MeV

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q84. One end of string of length l is connected to a particle of mass 'm' and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed 'v' the net force on the particle (directed towards centre) will be (T represents the tension in the string) :-

(a) $T + \frac{mv^2}{l}$
(b) $T - \frac{mv^2}{l}$
(c) Zero
(d) T

Ans: (d)

Solution: Net force on particle in uniform circular motion is centripetal force $\left(\frac{mv^2}{l}\right)$ which is provided by tension in string so the net force will be equal to tension i.e., T.

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q85. A cylindrical rod having temperature T_1 and T_2 at its end. The rate of flow of heat is Q_1 cal/sec. If all the linear dimensions are doubled keeping temperature constant, then the rate of flow of heat Q_2 will be

(a) $4Q_1$
(b) $2Q_1$
(c) $Q_1/4$
(d) $Q_1/2$

Ans: (b)

Solution: $Q = \frac{KA(\theta_1-\theta_2)t}{l}$

Rate of heat flow

$H = \frac{Q}{t} = \frac{KA(\theta_1-\theta_2)}{l}$ ie., $H \propto \frac{A}{l}$

Dimensions of area A = $[L^2]$, dimensions of distance l = [L]

$H \propto L = \frac{H_2}{H_1} = \frac{L_2}{L_1} = 2 \Rightarrow H_2 = 2H_1$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q86. Light with an energy flux of 25×10^4 Wm^{-2} falls on a perfectly reflecting surface at normal incidence. If the surface area is 15 cm^2, the average force exerted on the surface is :

(a) 1.25×10^{-6} N (b) 2.50×10^{-6} N
(c) 1.20×10^{-6} N (d) 3.0×10^{-6} N

Ans: (b)

Solution: Average force $F_{av} = \frac{\Delta p}{\Delta t} = \frac{2IA}{c}$

($\because$ Power = F.V)

$= \frac{2 \times 25 \times 10^4 \times 15 \times 10^{-4}}{3 \times 10^8}$

$= 2.50 \times 10^{-6}$ N

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q87. If the nuclear force between two protons, two neutrons and between proton and neutron is denoted by F_{pp}, F_{nn} and F_{pn} respectively, then [1991]

(a) $F_{pp} \approx F_{nn} \approx F_{pn}$
(b) $F_{pp} \neq F_{nn}$ and $F_{pp} = F_{nn}$
(c) $F_{pp} = F_{nn} = F_{pn}$
(d) $F_{pp} \neq F_{nn} \neq F_{pn}$

Ans: (d)

Solution: Nuclear force is not the same between any two nucleons.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q88. A block has been placed on an inclined plane with the slope angle θ, block slides down the plane at constant speed. The coefficient of kinetic friction is equal to

(a) sin θ
(b) cos θ
(c) g
(d) tan θ

Ans: (d)

Solution: When the block slides down the plane with a constant speed, then the inclination of the plane is equal to angle of repose (θ) .
Coeff. of friction = tan of the angle of repose = tan θ.

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q89. Which of the following relations does not give the equation of an adiabatic process, where terms have their usual meaning?

(a) $P^{\gamma}T^{1-\gamma}$ = constant
(b) $P^{1-\gamma}$ T^{γ} = constant
(c) PV^{γ} = constant
(d) $TV^{\gamma-1}$ = constant

Ans: (a)

Solution: Adiabatic equations of state are
PV^{γ} = constant
$TV^{\gamma-1}$ = constant
$P^{1-\gamma}T^{\gamma}$ = constant.

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q90. If a negligibly small current is passed through a wire of length 15 m and of resistance 5Ω having uniform cross-section of 6×10^{-7} m^2 , then coefficient of resistivity of material, is

(a) 1×10^{-7} Ω-m (b) 2×10^{-7} Ω-m
(c) 3×10^{-7} Ω-m (d) 4×10^{-7}Ω-m

Ans: (b)

Solution: Given : Length of wire (l) = 15m
Area (A) = 6×10^{-7} m^2
Resistance (R) = 5Ω.
We know that resistance of the wire material

$R = \rho \frac{l}{A}$

$\Rightarrow 5 = \rho \times \frac{15}{6 \times 10^{-7}} = 2.5 \times 10^7 \rho$

$\Rightarrow \rho = \frac{5}{2.5 \times 10^7} = 2 \times 10^{-7} \Omega - m$

[where ρ = coefficient of resistivity]

Chapter: Current Electricity
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q91. The structure of solids is investigated by using

(a) cosmic rays
(b) X-rays
(c) γ-rays
(d) infra-red radiations

Ans: (b)

Solution: X-rays are used for the investigation of structure of solids.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q92. The decay constant (λ) and the half-life (T) of a radioactive isotope are related as

(a) $\lambda = \frac{\log_e 2}{T}$
(b) $\lambda = \frac{1}{\log_e 2.T}$
(c) $\lambda = \frac{T}{\log_e 2}$
(d) $\lambda = \frac{2}{T}$

Ans: (a)

Solution: $t = \frac{1}{\lambda}\log\frac{a}{a-x}$ when $t = T$, $x = \frac{a}{2}$

$T = \frac{1}{\lambda}\log\frac{a}{a - \frac{a}{2}} = \frac{1}{\lambda}\log_e 2$

$= \lambda = \frac{1}{T}\log_e 2$

Chapter: Nuclei
[Topic: Radioactivity]

Q93. A position dependent force, F = $(7 - 2x + 3x^2)$ N acts on a small body of mass 2 kg and displaces it from x = 0 to x = 5 m. Work done in joule is

(a) 35 (b) 70
(c) 135 (d) 270

ANS: (C)

Solution: $W = \int_0^5 F dx = \int_0^5 (7 - 2x + 3x^2)\,dx$
$= [7x - x^2 + x^3]_0^5 = 135J$

Chapter: Work, Energy and Power
[Topic: Work]

Q94. Which of the following processes is reversible?
(a) Transfer of heat by conduction
(b) Transfer of heat by radiation
(c) Isothermal compression
(d) Electrical heating of a nichrome wire

Ans: (c)

Solution: For a process to be reversible, it must be quasi-static. For quasi static process, all changes take place infinitely slowly. Isothermal process occur very slowly so it is quasi-static and hence it is reversible.

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q95. The rate of increase of thermo–e.m.f. with temperature at the neutral temperature of a thermocouple
(a) is positive
(b) is zero
(c) depends upon the choice of the two materials of the thermocouple
(d) is negative

Ans: (b)

Solution: We have,
$e = at + bt^2$
$= \frac{de}{dt} = a + 2bt$
At neutral temperature,
$t = -\frac{a}{2b}$
$\frac{de}{dt} = 0$

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q96. A beam of monochromatic light is refracted from vacuum into a medium of refractive index 1.5, the wavelength of refracted light will be
(a) dependent on intensity of refracted light
(b) same
(c) smaller
(d) larger

Ans: (c)

Solution: From $\mu = \frac{c}{v} = \frac{n\lambda_v}{n\lambda_m}, \lambda_m = \frac{\lambda_v}{\mu}$
Here, c = velocity of light in medium and v = velocity of light in vacuum;
μ = refractive index of the medium.
Hence, wavelength in medium $(\lambda_m) < \lambda_a$
($\because \mu > 1$, given)
So, the required wavelength decreases.
ALTERNATIVELY,
$c = v\lambda$. On refraction, the frequency, v do not change. When light is refracted from vacuum to a medium, the velocity, c decreases. Therefore, λ also decreases.

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q97. In a n-type semiconductor, which of the following statement is true?
(a) Electrons are minority carriers and pentavalent atoms are dopants.
(b) Holes are minority carriers and pentavalent atoms are dopants.
(c) Holes are majority carriers and trivalent atoms are dopants.
(d) Electrons are majority carriers and trivalent atoms are dopants.

Ans: (b)

Solution: In a n-type semiconductor holes are minority carriers and pentavalent atoms are dopants.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q98. The heart of man pumps 5 litres of blood through the arteries per minute at a pressure of 150 mm of mercury. If the density of mercury be 13.6×10^3 kg/m^3 and g = 10m/s^2 then the power of heart in watt is :
(a) 2.35 (b) 3.0
(c) 1.50 (d) 1.70

Ans: (d)

Solution: Power $\vec{F}.\vec{V} = PA\vec{V} = \rho ghAV$
$\left[P = \frac{F}{A} \text{and} P = \rho gh\right]$
$= 13.6 \times 10^3 \times 10 \times 150 \times 10^{-3} \times 0.5 \times 10^{-3}/60$
$= \frac{102}{60} = 1.70$ watt

Chapter: Work, Energy and Power
[Topic: Power]

Q99. Two containers A and B are partly filled with water and closed. The volume of A is twice that of B and it contains half the amount of water in B. If both are at the same temperature, the water vapour in the containers will have pressure in the ratio of
(a) 1 : 2 (b) 1 : 1
(c) 2 : 1 (d) 4 : 1

Ans: (b)

Solution: Vapour pressure does not depend on the amount of substance. It depends on the temperature alone.

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q100. If voltage across a bulb rated 220 Volt-100 Watt drops by 2.5% of its rated value, the percentage of the rated value by which the power would decrease is :
(a) 20% (b) 2.5%
(c) 5% (d) 10%

Ans: (c)

Solution: Resistance of bulb is constant
$P = \frac{V^2}{R} \Rightarrow \frac{\Delta p}{p} = \frac{2\Delta V}{y} + \frac{\Delta R}{R}$

$\frac{\Delta p}{p} = 2 \times 2.5 + 0 = 5\%$

Chapter: Current Electricity
[Topic: Heating Effects of Current]

PART 12. PHYSICS QUESTION BANK

Q1. A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be

(a) 6° (b) 8°
(c) 10° (d) 4°

Ans: (a)

Solution: For dispersion without deviation

$(\mu-1)A_1+(\mu'-1)A_2=0$

$|(\mu-1)A_1|=|(\mu'-1)A_2|$

$(1.42-1)\times 10° = (1.7-1)A_2$

$4.2 = 0.7A_2$

$A_2 = 6°$

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q2. Reverse bias applied to a junction diode

(a) increases the minority carrier current
(b) lowers the potential barrier
(c) raises the potential barrier
(d) increases the majority carrier current

Ans: (c)

Solution: In reverse biasing, the conduction across the *p-n* junction does not take place due to majority carriers but takes place due to minority carriers if the voltage of external battery is large. The size of the depletion region increases thereby increasing the potential barrier.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q3. A body of mass m moving with velocity 3 km/h collides with a body of mass 2 m at rest. Now the coalesced mass starts to move with a velocity

(a) 1 km/h (b) 2 km/h
(c) 3 km/h (d) 4 km/h

Ans: (a)

Solution: Applying law of conservation of momentum,

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

or, $m_1u_1 = (m_1 + m_2)v$ ($\because u_2 = 0$)

$\Rightarrow m\frac{(3\times1000)}{3600} = 3m(v)$

$\Rightarrow v = \frac{1000}{3600}$ m/s = 1km/hr

Chapter: Work, Energy and Power
[Topic: Collisions]

Q4. Which one of the following equations of motion represents simple harmonic motion?

(a) Acceleration = – k(x + a)
(b) Acceleration = k(x + a)
(c) Acceleration = kx
(d) Acceleration = $-k_0x + k_1x^2$

where k, k_0, k_1 and a are all postive.

Ans: (a)

Solution: a = – kX, X = x + a.

In simple harmonic motion acceleration is directly proportional to the displacement from the mean position. Also the acceleration is in the opposite direction of displacement.

Chapter: Oscillation
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q5. A potentiometer wire has length 4 m and resistance 8Ω. The resistance that must be connected in series with the wire and an accumulator of e.m.f. 2V, so as to get a potential gradient 1 mV per cm on the wire is

(a) 40 Ω (b) 44 Ω
(c) 48 Ω (d) 32 Ω

Ans: (d)

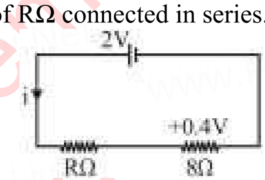
Solution: Total potential difference across potentiometer wire

$= 10^{-3} \times 400$ volt = 0.4 volt

potential gradient = $\frac{1mv}{cm}$

$= 10^{-3}$ v/cm $= 10^{-1}\frac{v}{m}$

Let resistance of RΩ connected in series.



So, $\frac{2}{R+8} = \frac{10^{-1}\times4}{8} = \frac{1}{20}$

$\Rightarrow R + 8 = 40$ or, $R = 32\ \Omega$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q6. Interference is possible in

(a) light waves only
(b) sound waves only
(c) both light and sound waves
(d) neither light nor sound waves

Ans: (c)

Solution: Interference is a wave phenomenon shown by both the light waves and sound waves.

Chapter - Wave Optics
[Topic: Wavefront, Interference of Light, Coherent & Incoherent Sources]

Q7. A npn transistor is connected in common emitter configuration in a given amplifier. A load resistance of 800 Ω is connected in the collector circuit and the voltage drop across it is 0.8 V. If the current amplification factor is 0.96 and the input resistance of the circuit is 192Ω, the voltage gain and the power gain of the amplifier will respectively be :

(a) 4, 3.84 (b) 3.69, 3.84
(c) 4, 4 (d) 4, 3.69

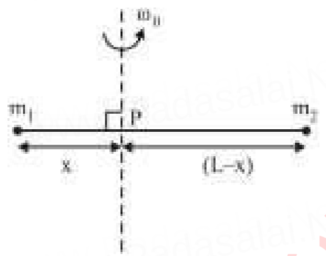
Ans: (a)

Solution: Given: amplification factor α = 0.96

load resistance, $R_L = 800\ \Omega$
input resistance, $R_i = 192\Omega$
So, $\beta = \frac{\alpha}{1-\alpha} = \frac{0.96}{0.04} = \beta = 24$
Voltage gain for common emitter configuration
$A_v = \beta \frac{R_L}{R_i} = 24 \times \frac{800}{192} = 100$
Power gain for common emitter configuration
$P_v = \beta A_v = 24 \times 100 = 2400$
Voltage gain for common base configuration
$A_v = \alpha, \frac{R_L}{R_P} = 0.96 \times \frac{800}{192} = 4$
Power gain for common base configuration
$P_v = A_v\alpha = 4 \times 0.96 = 3.84$

Chapter: Semiconductor Electronics Materials, Devices [Topic: Junction Transistor]

Q8. Point masses m_1 and m_2 are placed at the opposite ends of a rigid rod of length L, and negligible mass. The rod is to be set rotating about an axis perpendicular to it. The position of point P on this rod through which the axis should pass so that the work required to set the rod rotating with angular velocity ω_0 is minimum, is given by :



(a) $x = \frac{m_1}{m_2}L$
(b) $x = \frac{m_2}{m_1}L$
(c) $x = \frac{m_2 L}{m_1+m_2}$
(d) $x = \frac{m_1 L}{m_1+m_2}$

Ans: (c)

Solution: Work required to set the rod rotating with angular velocity ω_0
$K.E. = \frac{1}{2}I\omega^2$
Work is minimum when I is minimum.
I is minimum about the centre of mass
So, $(m_1)(x) = (m_2)(L - x)$
or, $m_1x = m_2L - m_2x$
$\therefore x = \frac{m_2 L}{m_1+m_2}$

Chapter: System of Particles and Rotational Motion [Topic: Torque, Couple and Angular Momentum]

Q9. A particle is executing SHM along a straight line. Its velocities at distances x_1 and x_2 from the mean position are V_1 and V_2, respectively. Its time period is

(a) $2\pi\sqrt{\frac{x_2^2-x_1^2}{V_1^2-V_2^2}}$ (b) $2\pi\sqrt{\frac{V_1^2+V_2^2}{x_1^2+x_2^2}}$
(c) $2\pi\sqrt{\frac{V_1^2-V_2^2}{x_1^2-x_2^2}}$ (d) $2\pi\sqrt{\frac{x_1^2-x_2^2}{V_1^2-V_2^2}}$

Ans: (a)

Solution: As we know, for particle undergoing SHM,
$V = \omega\sqrt{A^2 - X^2}$
$V_1^2 = \omega^2(A^2 - x_1^2)$
$V_2^2 = \omega^2(A^2 - x_2^2)$
Substracting we get,
$\frac{V_1^2}{\omega^2} + x_1^2 = \frac{V_2^2}{\omega^2} + x_2^2$
$\Rightarrow \frac{V_1^2-V_2^2}{\omega^2} = x_2^2 - x_1^2$
$\Rightarrow w = \sqrt{\frac{V_1^2-V_2^2}{x_2^2-x_1^2}}$
$\Rightarrow T = 2\pi\sqrt{\frac{x_2^2-x_1^2}{V_1^2-V_2^2}}$

Chapter: Oscillation [Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q10. A beam of electron passes undeflected through mutually perpendicular electric and magnetic fields. If the electric field is switched off, and the same magnetic field is maintained, the electrons move
(a) in a circular orbit
(b) along a parabolic path
(c) along a straight line
(d) in an elliptical orbit.

Ans: (a)

Solution: If the electric field is switched off, and the same magnetic field is maintained, the electrons move in a circular orbit and electron will travel a magnetic field ⊥ to its velocity.

Chapter: Moving Charges and Magnetic Field [Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q11. A parallel beam of monochromatic light of wavelength 5000Å is incident normally on a single narrow slit of width 0.001 mm. The light is focussed by a convex lens on a screen placed in focal plane. The first minimum will be formed for the angle of diffraction equal to
(a) 0° (b) 15°
(c) 30° (d) 50°

Ans: (c)

Solution: For first minimum, $a \sin\theta = n\lambda = 1\lambda$
$\sin\theta = \frac{\lambda}{a} = \frac{5000 \times 10^{-10}}{0.001 \times 10^{-3}} = 0.5$
$\theta = 30°$

Chapter - Wave Optics [Topic: Diffraction, Polarization of Light & Resolving Power]

Q12. Radiowaves of constant amplitude can be generated with
(a) FET
(b) filter
(c) rectifier
(d) oscillator

Ans: (d)

Solution: Radiowaves of constant amplitude can be produced by using oscillator with proper feedback.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Digital Electronics and Logic Gates]

Q13. An equation is given as : $\left(P + \frac{a}{V^2}\right) = b\frac{\theta}{V}$ where P = Pressure, V = Volume & θ = Absolute temperature. If a and b are constants, then dimensions of a will be

(a) $[ML^5T^{-2}]$
(b) $[M^{-1}L^5T^2]$
(c) $[ML^{-5}T^{-1}]$
(d) $[ML^5T^1]$

Ans: (a)

Solution: $\left(P + \frac{a}{V^2}\right) = b\frac{Q}{V}$

According to the principle of homogeinity quantity with same dimension can be added or subtracted.

Hence, Dimension of P = Dimension of $\frac{a}{V^2}$

$\Rightarrow$Dimension of $\frac{Force}{Area}$ = Dimension of $\frac{a}{V^2}$

$\Rightarrow\left[\frac{MLT^{-2}}{L^2}\right] = \frac{a}{[L^3]^2} \Rightarrow a = [M\,L^5\,T^{-2}]$

Chapter: Units and Measurement [Topic: Dimensions of Physical Quantities]

Q14. The angular momentum of a body with mass (m) , moment of inertia (I) and angular velocity (ω) rad/sec is equal to

(a) Iω
(b) $I\omega^2$
(c) $\frac{1}{\omega}$
(d) $\frac{1}{\omega^2}$

Ans: (a)

Solution: Let body contain m_1, m_2, m_3 ....m_n masses at distance r_1, r_2, r_3........ r_n from axis OA.

Angular momentum of body

$= m_1v_1r_1 + m_2v_2r_2.....+ m_nv_nr_n$

$= m_1(\omega r_1)r_1 + m_2(\omega r_2)r_2 \dots\dots + m_n(\omega r_n)r_n$

$= (m_1r_1^2)\omega + (m_2r_2^2)\omega \dots\dots. +(m_nr_n^2)\omega$

$= \left(\sum_{i=1}^{n} m_i\, r_i^2\right)\omega = I\omega$

Chapter: System of Particles and Rotational Motion [Topic: Torque, Couple and Angular Momentum]

Q15. In case of a forced vibration, the resonance wave becomes very sharp when the

(a) quality factor is small
(b) damping force is small
(c) restoring force is small
(d) applied periodic force is small

Ans: (b)

Solution: The resonance wave becomes very sharp when damping force is small.

Chapter: Oscillation [Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q16. A particle having a mass of 10^{-2} kg carries a charge of 5×10^{-8}C. The particle is given an initial horozontal velocity of 10^5 ms^{-1} in the presence of electric field $\vec{E}$ and magnetic field $\vec{B}$. To keep the particle moving in a horizontal direction, it is necessary that

(1) $\vec{B}$ should be perpendicular to the direction of velocity and $\vec{E}$ should be along the direction of velocity.

(2) Both $\vec{B}$ and $\vec{E}$ should be along the direction of velocity.

(3) Both $\vec{B}$ and $\vec{E}$ are mutually perpendicular and perpendicular to the direction of velocity.

(4) $\vec{B}$ should be along the direction of velocity and $\vec{E}$ should be perpendicular to the direction of velocity.

Which one of the following pairs of statements is possible?

(a) (2) and (4)
(b) (1) and (3)
(c) (3) and (4)
(d) (2) and (3)

Ans: (d)

Solution: Force due to electric field acts along the direction of the electric field but force due to the magnetic field acts along a direction perpendicular to both the velocity of the charged particle and the magnetic field. Hence both statements (2) and (3) are true. In statement (2) , magnetic force is zero, so, electric force will keep the particle continue to move in horizontal direction. In statement (3) , both electric and magnetic forces will be opposite to each other. If their magnitudes will be equal then the particle will continue horizontal motion.

Chapter: Moving Charges and Magnetic Field [Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q17. For photoelectric emission from certain metal the cut-off frequency is ν. If radiation of frequency 2ν impinges on the metal plate, the maximum possible velocity of the emitted electron will be (m is the electron mass)

(a) $\sqrt{\frac{h\nu}{m}}$
(b) $\sqrt{\frac{2h\nu}{m}}$
(c) $2\sqrt{\frac{h\nu}{m}}$
(d) $\sqrt{\frac{h\nu}{2m}}$

Ans: (b)

Solution: From photo-electric equation,

$h\nu' = h\nu + K_{max}$... (i)

$h.2\nu = h\nu + \frac{1}{2}mV^2_{max}$[$\therefore \nu' = 2\,\nu$]

$\Rightarrow h\nu = \frac{1}{2}mV^2 max \Rightarrow Vmax = \sqrt{\frac{2h\nu}{m}}$

Chapter - Dual Nature of Radiation and Matter [Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q18. A bus travelling the first one third distance at a speed of 10 km/h, the next one third at 20 km/h and the last one-third at 60 km/h. The average speed of the bus is
(a) 9 km/h (b) 16 km/h
(c) 18 km/h (d) 48 km/h

Ans: (c)

Solution: Average speed $= \frac{s}{\frac{\frac{s}{3}}{10}+\frac{\frac{s}{3}}{20}+\frac{\frac{s}{3}}{60}}$

$= \frac{s}{\frac{s}{18}}$=18km/h

Chapter: Kinematics Motion in a Straight Line
[Topic: Distance, Displacement & Uniform motion]

Q19. A ring of mass m and radius r rotates about an axis passing through its centre and perpendicular to its plane with angular velocity ω. Its kinetic energy is
(a) $\frac{1}{2}mr^2\omega^2$
(b) $mr\omega^2$
(c) $mr^2\omega^2$
(d) $\frac{1}{2}mr\omega^2$

Ans: (a)

Solution: Kinetic energy $= \frac{1}{2}I\omega^2$
and for ring $I = mr^2$
Hence, KE $= \frac{1}{2}mr^2\omega^2$

Chapter: System of Particles and Rotational Motion
[Topic: Rolling Motion]

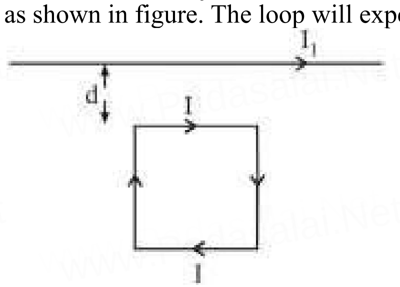
Q20. Two waves are approaching each other with a velocity of 20 m/s and frequency n. The distance between two consecutive nodes is
(a) $\frac{20}{n}$
(b) $\frac{10}{n}$
(c) $\frac{5}{n}$
(d) $\frac{n}{10}$

Ans: (b)

Solution: Distance between two successive nodes $= \frac{\lambda}{2} = \frac{v}{2n} = \frac{20}{2n} = \frac{10}{n}\left(\text{where } \lambda = \frac{v}{n}\right)$

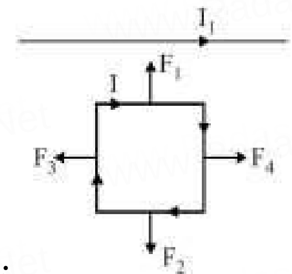
Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q21. A square loop, carrying a steady current I, is placed in a horizontal plane near a long straight conductor carrying a steady current I_1 at a distance d from the conductor as shown in figure. The loop will experience



(a) a net repulsive force away from the conductor
(b) a net torque acting upward perpendicular to the horizontal plane
(c) a net torque acting downward normal to the horizontal plane
(d) a net attractive force towards the conductor

Ans: (d)



Solution:
$F_1 > F_2$ as $F \propto \frac{1}{d}$, and F_3 and F_4 are equal and opposite. Hence, the net attraction force will be towards the conductor.

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q22. When ultraviolet radiation is incident on a surface, no photoelectrons are emitted. If a second beam causes photoelectrons to be ejected, it may consists of
(a) infra-red waves
(b) X-rays
(c) visible light rays
(d) radio waves

Ans: (b)

Solution: Energy of photon of *X*-rays is more than energy of photon of ultraviolet rays. Because frequency of *X* rays is more than ultraviolet rays.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q23. A body starts from rest, what is the ratio of the distance travelled by the body during the 4th and 3rd seconds ?
(a) $\frac{7}{5}$
(b) $\frac{5}{7}$
(c) $\frac{7}{3}$
(d) $\frac{3}{7}$

Ans: (a)

Solution: $\frac{D_4}{D_3} = \frac{0+\frac{a}{2}(2\times4-1)}{0+\frac{a}{2}(2\times3-1)} = \frac{7}{5}$

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q24. The height at which the weight of a body becomes 1/16th, its weight on the surface of earth (radius R), is :
(a) 5R (b) 15R
(c) 3R (d) 4R

Ans: (c)

Solution: Let at h height, the weight of a body becomes $\frac{1}{16}$th of its weight on the surface.

$W_h = 16\ W_s$....(i)

$\Rightarrow 16\ W_s = W_s$....(ii)

$W_h = mg = \frac{GM_m}{(R_e+h)^2}$

$g' = \frac{GM}{(R_e+h)^2}$

Similarly, $g = \frac{GM}{R_e^2}$

$\frac{g'}{g} = \frac{R_e^2}{(R_e+h)^2} \Rightarrow g' = g\left(1+\frac{h}{R}\right)^{-2}$

$\Rightarrow W_h = 16\ W_s$

$\Rightarrow g' = \frac{g}{16}$

$g' = 16g\left(1+\frac{h}{R}\right)^{-2}$

$\frac{1}{16} = \left(1+\frac{h}{R}\right)^{-2} \Rightarrow 4 = 1+\frac{h}{R}$

$h = 3R$

Chapter: Gravitation
[Topic: Acceleration due to Gravity]

Q25. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2, open at both ends vibrating in its third overtone are in resonance with a given tuning fork. The ratio of lengths of P_1 and P_2 respectively are given by

(a) 1 : 2 (b) 1 : 3
(c) 3 : 8 (d) 3 : 4

Ans: (c)

Solution: We know that the length of pipe closed at one end for first overtone $(l_1) = \frac{3\lambda}{4}$ and length of the open pipe for third overtone $(l_2) = \frac{4\lambda}{2} = 2\lambda$. Therefore, the ratio of lengths $\frac{l_1}{l_2} = \frac{\frac{3\lambda}{4}}{2\lambda} = \frac{3}{8}$ or $l_1 : l_2 = 3 : 8$.

Chapter: Waves
[Topic: Beats, Interference & Superposition of Waves]

Q26. A magnetic needle suspended parallel to a magnetic field requires $\sqrt{3}$ J of work to turn it through 60°. The torque needed to maintain the needle in this position will be :

(a) $2\sqrt{3}$J(b) 3J
(c) $\sqrt{3}$J
(d) $\frac{3}{2}$J

Ans: (b)

Solution: According to work energy theorem

$W = U_{final} - U_{initial} = MB(\cos 0 - \cos 60°)$

$W = \frac{MB}{2} = \sqrt{3}J$ ... (i)

$\tau = \vec{M}\times\vec{B} = MB\sin 60° = \left(\frac{MB\sqrt{3}}{2}\right)$ ... (ii)

From equation (i) and (ii)

$\tau = \frac{2\sqrt{3}\times\sqrt{3}}{2} = 3J$

Chapter: Magnetism and Matter
[Topic: Magnetism, Gauss's Law, Magnetic Moment & Properties of Magnet]

Q27. The energy of a photon of wavelength λ is [1988]

(a) hc λ
(b) $\frac{hc}{\lambda}$
(c) $\frac{\lambda}{hc}$
(d) $\frac{\lambda h}{c}$

Ans: (b)

Solution: Energy of a photon $E = h\nu = \frac{hc}{\lambda}$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q28. $\vec{A}$ and $\vec{B}$ are two vectors and θ is the angle between them, if $|\vec{A}\times\vec{B}| = \sqrt{3}(\vec{A}.\vec{B})$, the value of θ is

(a) 45° (b) 30°
(c) 90° (d) 60°

Ans: (d)

Solution: $|\vec{A}\times\vec{B}| = \sqrt{3}(\vec{A}.\vec{B})$

$\Rightarrow AB\sin 6 = \sqrt{3}AB\cos 9$

$= \tan\theta = \sqrt{3} \Rightarrow \theta = 60^o$

Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q29. A geostationary satellite is orbiting the earth at a height of 5R above that surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of 2R from the surface of the earth is :

(a) 5 (b) 10
(c) $6\sqrt{2}$
(d) $\frac{6}{\sqrt{2}}$

Ans: (c)

Solution: According to Kelpner's law of period$T^2 \propto R^3$

$\frac{T_1^2}{T_2^2} = \frac{R_1^3}{R_2^3} = \frac{(6R)^3}{(3R)^3} = 8$

$\frac{24\times 24}{T_2^2} = 8$

$T_2^2 = \frac{24\times24}{8} = 72 = 36\times 2$

$T_2 = 6\sqrt{2}$

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q30. An observer moves towards a stationary source of sound with a speed 1/5th of the speed of sound. The wavelength and frequency of the sound emitted are λ and f respectively. The apparent frequency and wavelength recorded by the observer are respectively.

(a) 0.8f, 0.8λ (b) 1.2f, 1.2λ
(c) 1.2f, λ
(d) f, 1.2λ

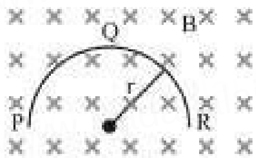
Ans: (c)

Solution: $f_{apparent} = \left(\frac{u+\frac{u}{5}}{u}\right)f = \frac{6}{5}f = 12f$

Wavelength remains constant (unchanged) in this case.

Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q31. A thin semicircular conducting ring (PQR) of radius 'r' is falling with its plane vertical in a horizontal magnetic field B, as shown in figure. The potential difference developed across the ring when its speed is v, is :



(a) Zero
(b) $Bv\pi r^2/2$ and P is at higher potnetial
(c) πrBv and R is at higher potnetial
(d) 2rBv and R is at higher potential

Ans: (d)

Solution: Rate of decreasing of area of semicircular ring $= \frac{dA}{dt} = (2r)V$

From Faraday's law of electromagnetic induction

$e = -\frac{d\theta}{dt} = -B\frac{dA}{dt} = -B(2rV)$

As induced current in ring produces magnetic field in upward direction hence R is at higher potential.

Chapter: Electromagnetic
[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q32. The total energy of electron in the ground state of hydrogen atom is – 13.6 eV. The kinetic energy of an electron in the first excited state is

(a) 6.8 eV
(b) 13.6 eV
(c) 1.7 eV
(d) 3.4 eV

Ans: (d)

Solution: Energy in the first excited state

$= \frac{-13.6}{n^2} = \frac{-13.6}{2^2} = -3.4eV$

But K.E. = –(Total energy) = +3.4 eV.

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q33. A projectile is fired from the surface of the earth with a velocity of 5 ms^{-1} and angle θ with the horizontal. Another projectile fired from another planet with a velocity of 3 ms^{-1} at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) given g = 9.8 m/s^2 [2014]

(a) 3.5
(b) 5.9
(c) 16.3
(d) 110.8

Ans: (a)

Solution: Horizontal range $= \frac{u^2\sin 2\theta}{g}$ so g µ u^2

or $\frac{g_{planet}}{g_{earth}} = \frac{(u_{planet})^2}{(u_{earth})^2}$

Therefore $g_{planet} = \left(\frac{3}{5}\right)^2 (9.8m/s^2)$

$= 3.5\ m/s^2$

Chapter: Kinematics Motion in a Plane
[Topic: Projectile Motion]

Q34. When an elastic material with Young's modulus Y is subjected to stretching stress S, elastic energy stored per unit volume of the material is

(a) YS / 2
(b) $S^2Y / 2$
(c) $S^2 / 2Y$
(d) S / 2Y

Ans: (c)

Solution: Energy stored per unit volume

$= \frac{1}{2} \times$ stress × strain

$= \frac{1}{2} \times$stress ×(stress/Young's modulus)

$= \frac{1}{2} \times$(stress)^2/(Young's modulus)

$= \frac{S^2}{2Y}$

Chapter: Mechanical Propertiesof Solids
[Topic: Pressure, Density Pascal's Law & Archimedes' Principle]

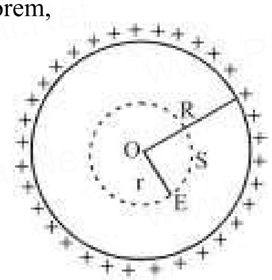
Q35. A hollow insulated conduction sphere is given a positive charge of 10 μC. What will be the electric field at the centre of the sphere if its radius is 2 metres?

(a) zero
(b) 5 μCm^{-2}
(c) 20 μCm^{-2}
(d) 8 μCm^{-2}

Ans: (a)

Solution: Charge resides on the outer surface of a conducting hollow sphere of radius R. We consider a spherical surface of radius *r* < R.

By Gauss's theorem,



$\int \vec{E}.\vec{ds} = \frac{1}{\varepsilon_0} \times$ charge enclosed

or, $E.4\pi r^2 = \frac{1}{\varepsilon_0} \times 0 \ = E = 0$

i.e. electric field inside a hollow sphere is zero.

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q36. The total charge induced in a conducting loop when it is moved in a magnetic field depend on

(a) the rate of change of magnetic flux
(b) initial magnetic flux only
(c) the total change in magnetic flux
(d) final magnetic flux only

Ans: (c)

Solution: $q = \int i\,dt = \frac{1}{R}\int e\,dt = \frac{1}{R}\int\left(\frac{-d\phi}{dt}\right)dt = \frac{1}{R}\int d$ (taking only magnitude of e)

Hence, total charge induced in the conducting loop depends upon the total change in magnetic flux.

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q37. The radius of germanium (Ge) nuclide is measured to be twice the radius of ${}^{9}_{4}Be$. The number of nucleons in Ge are

(a) 74 (b) 75
(c) 72 (d) 73

Ans: (c)

Solution: We use the formula,

$R = R_0 A^{1/3}$

This represents relation between atomic mass and radius of the nucleus.

For berillium, $R_1 = R_0 (9)^{1/3}$

For germanium, $R_2 = R_0 A^{1/3}$

$$\frac{R_1}{R_2} = \frac{(9)^{\frac{1}{3}}}{(A)^{\frac{1}{3}}} = \frac{1}{2} = \frac{(9)^{\frac{1}{3}}}{(A)^{\frac{1}{3}}}$$

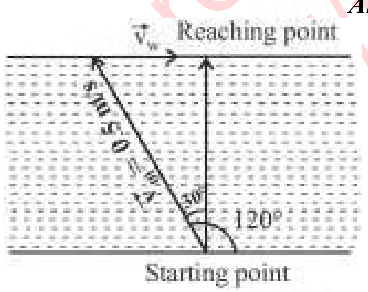
$\Rightarrow \frac{1}{8} = \frac{9}{A} \Rightarrow A = 8 \times 9 = 72$.

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

Q38. A person swims in a river aiming to reach exactly opposite point on the bank of a river. His speed of swimming is 0.5 m/s at an angle 120º with the direction of flow of water. The speed of water in stream is

(a) 1.0 m/s (b) 0.5 m/s
(c) 0.25 m/s (d) 0.43 m/s.

Ans: (c)



Solution:

Velocity of person $\vec{v}_m = 0.5$ m/s

$\sin 30° = \frac{v_w}{v_m} = v_w = v_m \sin 30°$

$$= v_w = \frac{v_m}{2} = \frac{0.5 \text{ mps}}{2} = 0.25 \text{ mps}$$

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q39. A piece of ice falls from a height h so that it melts completely. Only one-quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is :

[Latent heat of ice is 3.4×10^5 J/kg and g = 10 N/kg]

(a) 34 km (b) 544 km
(c) 136 km (d) 68 km

Ans: (c)

Solution: According to question only one-quarter of the heat produced by falling piece of ice is absorbed in the melting of ice.

i.e., $\frac{mgh}{4} = mL$

$\Rightarrow h = \frac{4L}{g} = \frac{4 \times 3.4 \times 10^5}{10} = 136\text{km}$.

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q40. The electric potential at a point (x, y, z) is given by $V = -x^2y - xz^3 + 4$. The electric field $\vec{E}$ at that point is

(a) $\vec{E} = \hat{i}2xy + \hat{j}(x^2 + y^2) + \hat{k}(3xz - y^2)$

(b) $\vec{E} = \hat{i}z^3 + \hat{j}xyz + \hat{k}z^2$

(c) $\vec{E} = \hat{i}(2xy - z^3) + \hat{j}xy^2 + \hat{k}3z^2x$

(d) $\vec{E} = \hat{i}(2xy + z^3) + \hat{j}x^2 + \hat{k}3xz^2$

Ans: (d)

Solution: The electric field at a point is equal to negative of potential gradient at that point.

$$\vec{E} = -\frac{\partial V}{\partial r} = \left[-\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}\right]$$

$= [(2xy + z^3)\,\hat{i} + \hat{j}\,x^2 + \hat{k}3xz^2]$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q41. Power dissipated in an LCR series circuit connected to an a.c source of emf ε is

(a) $\frac{\varepsilon^2\sqrt{R^2+\left(L\omega-\frac{1}{C\omega}\right)^2}}{R}$

(b) $\frac{\varepsilon^2\left[R^2+\left(L\omega-\frac{1}{C\omega}\right)^2\right]}{R}$

(c) $\frac{\omega^2 R}{\sqrt{R^2+\left(L_\omega-\frac{1}{C\omega}\right)^2}}$

(d) $\frac{\varepsilon^2 R}{\left[R^2+\left(L\omega-\frac{1}{C\omega}\right)^2\right]}$

Ans: (d)

Solution: Power dissipated in series LCR;

$P = I^2R = \frac{\varepsilon^2}{(Z)^2}R$

$= \frac{\varepsilon^2 R}{\left[R^2+\left(\omega L-\frac{1}{\omega C}\right)^2\right]}$

where $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

is called the impedance of the circuit.

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q42. The binding energy per nucleon in deuterium and helium nuclei are 1.1 *MeV* and 7.0 *MeV*, respectively. When two deuterium nuclei fuse to form a helium nucleus the energy released in the fusion is :

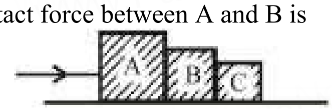
(a) 30.2 *MeV* (b) 23.6 *MeV*
(c) 2.2 *MeV* (d) 28.0 *MeV*

Ans: (b)

Solution: Binding energy of two ${}_1H^2$ nuclei
$= 2(1.1 \times 2) = 4.4\ MeV$
Binding energy of one ${}_2He^4$ nucelus
$= 4 \times 7.0 = 28\ MeV$
$\therefore$ Energy released $= 28 - 4.4 = 23.6\ MeV$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

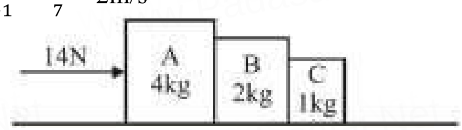
Q43. Three blocks A, B and C of masses 4 kg, 2 kg and 1 kg respectively, are in contact on a frictionless surface, as shown. If a force of 14 N is applied on the 4 kg block then the contact force between A and B is



(a) 6 N (b) 8 N
(c) 18 N (d) 2 N

Ans: (a)

Solution: Acceleration of system $a = \frac{F_{net}}{M_{totol}}$
$= \frac{14}{4+2+1} = \frac{14}{7} = 2 m/s^2$



The contact force between A and B
$= (m_B + m_C) \times a = (2 + 1) \times 2 = 6N$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q44. The presence of gravitational field is required for the heat transfer by
(a) conduction
(b) stirring of liquids
(c) natural convection
(d) radiation

Ans: (c)

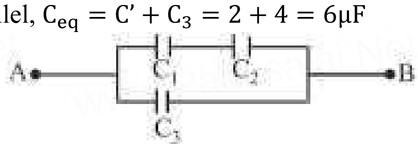
Solution: In convection, the temperature gradient exists in the vertical direction and not in the horizontal direction. So, up and down movement of particles takes place which depends on the weight and gravity.

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q45. Three capacitors each of capacity 4μF are to be connected in such a way that the effective capacitance is 6 μF. This can be done by
(a) connecting two in parallel and one in series
(b) connecting all of them in series
(c) connecting them in parallel
(d) connecting two in series and one in parallel

Ans: (d)

Solution: For series, $C' = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{4\times4}{4+4} = 2\mu F$
For parallel, $C_{eq} = C' + C_3 = 2 + 4 = 6\mu F$



Chapter: Electrostatic Potential and capacitance

[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q46. An electromagnetic wave of frequency ν = 3.0 MHz passes from vacuum into a dielectric medium with relative permittivity ε = 4.0. Then
[NEET Kar. 2013]
(a) wavelength is doubled and frequency is unchanged
(b) wavelength is doubled and frequency becomes half
(c) wavelength is halved and frequency remains unchanged
(d) wavelength and frequency both remain unchanged

Ans: (c)

Solution: Given: frequency f = 2MHz, relative permittivity $\in_r = 4$
From formula,
velocity $v = \frac{c}{\sqrt{\in_r}} = \frac{c}{2} = \lambda' = \frac{\lambda}{2}$
[Since frequency remains unchanged]

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q47. Which of the following statements is true for nuclear forces?
(a) they obey the inverse square law of distance
(b) they obey the inverse third power law of distance
(c) they are short range forces
(d) they are equal in strength to electromagnetic forces.

Ans: (c)

Solution: Nuclear forces are short range attractive forces which balance the repulsive forces between the protons inside the nucleus.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

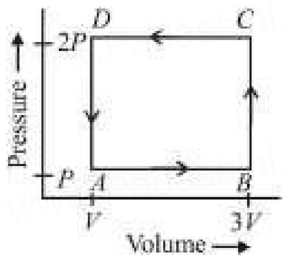
Q48. Consider a car moving along a straight horizontal road with a speed of 72 km/h. If the coefficient of static friction between the tyres and the road is 0.5, the shortest distance in which the car can be stopped is (taking g = 10 m/s^2)
(a) 30 m (b) 40 m
(c) 72 m (d) 20 m

Ans: (b)

Solution: Here u = 72 km/h = 20 m/s; v = 0;
$a = -\mu g = -0.5 \times 10 = -5\ m/s^2$
As $v^2 = u^2 + 2as$,
$$s = \frac{(v^2 - u^2)}{2a} = \frac{0 - (20)^2}{2 \times (-5)} = 40m$$

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q49. A thermodynamic system is taken through the cycle ABCD as shown in figure. Heat rejected by the gas during the cyclic process is :



(a) 2 PV (b) 4 PV

(c) $\frac{1}{2}$ PV

(d) P V

Ans: (a)

Solution: ∵ Internal energy is the state function.

∴In cyclie process; $\Delta U = 0$

According to 1st law of thermodynamics $\Delta Q = \Delta U + W$

So heat absorbed

$\Delta Q = W$ = Area under the curve

$= -(2V)(P) = -2PV$

So heat rejected = 2PV

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q50. If a wire of resistance R is melted and recasted to half of its length, then the new resistance of the wire will be

(a) R / 4 (b) R / 2

(c) R (d) 2R

Ans: (a)

Solution: Initial resistance (R_1) = R; Initial length is l_1 and final length (l_2) = 0.5 l. Volume of a wire = l . A. Since the volume of the wire remains the same after recasting, therefore $l_1 . A_1 = l_2 A_2$

or $\frac{\ell_1}{\ell_2} = \frac{A_2}{A_1}$ or $\frac{\ell}{0.5l} = \frac{A_2}{A_1}$ or $\frac{A_2}{A_1} = 2$.

We also know that resistance of a wire (R)

$R = \rho \times \frac{\ell}{A}$. ; $R \propto \frac{1}{A}$

$$\frac{R_1}{R_2} = \frac{\ell_1}{\ell_2} \times \frac{A_2}{A_1} = \frac{\ell}{0.5l} \times 2 = 4$$

or , $R_2 = \frac{R_1}{4} = \frac{R}{4}$.

[Alt : When wires are drawn from same volume but with different area of cross-section, then

$$R \propto \frac{1}{(\text{Area of cross} - \text{section})^2}$$

Chapter: Current Electricity
[Topic: Combination of Resistances]

PART 13. PHYSICS QUESTION BANK

Q51. Pick out the longest wavelength from the following types of radiation.
(a) blue light
(b) gamma rays
(c) X-rays
(d) red light

Ans: (d)

Solution: Wavelength of red light is longest.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q52. Atomic hydrogen has life period of
(a) one minute
(b) one day
(c) a fraction of a second
(d) one hour

Ans: (c)

Solution: Atomic hydrogen is unstable and it has life period of a fraction of a second.

Chapter: Nuclei
[Topic: Radioactivity]

Q53. A bullet of mass 10g leaves a rifle at an initial velocity of 1000 m/s and strikes the earth at the same level with a velocity of 500 m/s. The work done in joules overcoming the resistance of air will be
(a) 375 (b) 3750
(c) 5000 (d) 500

Ans: (b)

Solution: $W = \Delta E = \frac{1}{2}m(v_1^2 - v_2^2)$

Chapter: Work, Energy and Power
[Topic: Energy]

Q54. An ideal gas heat engine operates in Carnot cycle between 227°C and 127°C. It absorbs 6×10^4 cals of heat at higher temperature. Amount of heat converted to work is
(a) 4.8×10^4 cals (b) 6×10^4 cals
(c) 2.4×10^4 cals (d) 1.2×10^4cals

Ans: (d)

Solution: We know that efficiency of carnot engine =

$$1 - \frac{T_2}{T_1} = 1 - \frac{400}{500} = \frac{1}{5}$$

[$\because T_1 = (273 + 227)K = 500$ K
and $T_2 = (273 + 127)K = 400$ K]

Efficiency of Heat engine $= \frac{\text{Work output}}{\text{Heat input}}$

or, $\frac{1}{5} = \frac{\text{work output}}{6\times10^4}$

$\Rightarrow$ work output $= 1.2 \times 10^4$ cal

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q55. A thermocouple of negligible resistance produces an e.m.f. of 40 μV/°C in the linear range of temperature. A galvanometer of resistance 10 ohm whose sensitivity is 1μA/div, is employed with the termocouple. The smallest value of temperature difference that can be detected by the system will be
(a) 0.5°C (b) 1°C
(c) 0.1°C (d) 0.25°C

Ans: (d)

Solution: 1 division = 1μA

Current for 1°C $= \frac{40\mu V}{10} = 4\mu A$

$1\mu A = \frac{1}{4}$°C = 0.25°C.

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q56. Green light of wavelength 5460 Å is incident on an air-glass interface. If the refractive index of glass is 1.5, the wavelength of light in glass would be ($c = 3 \times 10^8$ ms^{-1})
(a) 3640 Å (b) 5460 Å
(c) 4861 Å
(d) none of the above

Ans: (a)

Solution: $\lambda_g = \frac{\lambda_a}{\mu} = \frac{5460}{15} = 3640A$

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q57. In an unbiased p-n junction, holes diffuse from the p-region to n-region because of
[NEET Kar. 2013]
(a) the potential difference across the p-n junction
(b) the attraction of free electrons of n-region
(c) the higher hole concentration in p-region than that in n-region
(d) the higher concentration of electrons in the n-region than that in the p-region

Ans: (c)

Solution: In p-region of p-n junction
holes concentration > electrons concentration and in n-region
electrons concentration > holes concentration.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q58. One coolie takes 1 minute to raise a suitcase through a height of 2 m but the second coolie takes 30 s to raise the same suitcase to the same height. The powers of two coolies are in the ratio of
(a) 1 : 2 (b) 1 : 3
(c) 2 : 1 (d) 3 : 1

Ans: (a)

Solution: $\because$ Power $P = \frac{w}{t}$

$\Rightarrow \frac{P_1}{P_2} = \frac{t_2}{t_1} = \frac{30s}{1\text{minute}} = \frac{30s}{60s} = \frac{1}{2}$

(t_1 = 1 minute; t_2 = 30 second given)

Chapter: Work, Energy and Power
[Topic: Power]

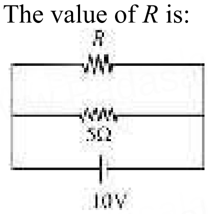
Q59. A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temperature T. Neglecting all vibrational modes, the total internal energy of the system is :-
(a) 15 RT (b) 9 RT
(c) 11 RT (d) 4 RT

Ans: (c)

Solution: Internal energy of the system is given by
$U = \frac{f}{2}nRT$
Degree of freedom
$F_{diatomic} = 5$
$f_{monoatomic} = 3$
and, number of moles
$n(O_2) = 2$
$n(Ar) = 4$
$U_{total} = \frac{5}{2}(2)RT + \frac{3}{2}(4)RT = 11RT$

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q60. The power dissipated in the circuit shown in the figure is 30 Watts. The value of *R* is:



(a) 20 Ω (b) 15 Ω
(c) 10 Ω (d) 30 Ω

Ans: (c)

Solution: The power dissipated in the circuit.
$P = \frac{V^2}{R_{eq}}$ ... (i)
$v = 10$ volt
$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{5} = \frac{5+R}{5R}$
$R_{eq} = \left(\frac{5R}{5+R}\right)$
$P = 30$ W
Substituting the values in equation (i)
$$30 = \frac{(10)^2}{\left(\frac{5R}{5+R}\right)}$$
$$\frac{15R}{5+R} = 10$$
$15R = 50 + 10R$
$5R = 50$
$R = 10\ \Omega$

Chapter: Current Electricity
[Topic: Heating Effects of Current]

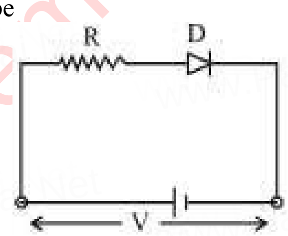
Q61. The angle of incidence for a ray of light at a refracting surface of a prism is 45° . The angle of prism is 60°. If the ray suffers minimum deviation through the prism, the angle of minimum deviation and refractive index of the material of the prism respectively, are :
(a) $45°, \frac{1}{\sqrt{2}}$
(b) $30°\sqrt{2}$
(c) $45°, \sqrt{2}$
(d) $30°, \frac{1}{\sqrt{2}}$

Ans: (b)

Solution: Given: Angle of incidence angle of prism,
$i = 45°$;
$A = 60°$;
Angle of minimum deviation,
$\delta_m = 2i - A = 30°$
Refractive index of material of prism.
$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$$
$$= \frac{\sin 45°}{\sin 30°} = \frac{1}{\sqrt{2}}\cdot\frac{2}{1} = \sqrt{2}$$

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q62. A d.c. battery of V volt is connected to a series combination of a resistor R and an ideal diode D as shown in the figure below. The potential difference across R will be



(a) 2V when diode is forward biased
(b) Zero when diode is forward biased
(c) V when diode is reverse biased
(d) V when diode is forward biased

Ans: (b)

Solution: In forward biasing, the diode conducts. For ideal junction diode, the forward resistance is zero; therefore, entire applied voltage occurs across external resistance R i.e., there occurs no potential drop, so potential across R is V in forward biased.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q63. A shell is fired from a cannon, it explodes in mid air, its total
(a) momentum increases
(b) momentum decreases
(c) K.E. increases
(d) K.E. decreases

Ans: (c)

Solution: When shell explodes in mid air its chemical energy is partly converted into mechanical energy, hence K.E. increases.

Chapter: Work, Energy and Power
[Topic: Collisions]

Q64. Two simple harmonic motions of angular frequency 100 and 1000 rad s^{-1} have the same displacement amplitude. The ratio of their maximum accelerations is:

(a) 1 : 10 (b) $1 : 10^2$
(c) $1 : 10^3$ (d) $1 : 10^4$

Ans: (b)

Solution: Maximum acceleration of a particle in the simple harmonic motion is directly proportional to the square of angular frequency i.e.

i.e. $a \propto \omega^2$

$\therefore \frac{a_1}{a_2} = \frac{\omega_1^2}{\omega_2^2} = \frac{(100)^2}{(1000)^2} = \frac{1}{100}$

$\Rightarrow a_1 : a_2 = 1 : 10^2$.

Chapter: Oscillation
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q65. A potentiometer wire of length L and a resistance r are connected in series with a battery of e.m.f. E_0 and a resistance r_1. An unknown e.m.f. E is balanced at a length l of the potentiometer wire. The e.m.f. E will be given by :

(a) $\frac{E_0 r}{(r+r_1)} \cdot \frac{l}{L}$
(b) $\frac{E_0 l}{L}$
(c) $\frac{LE_0 r}{(r+r_1)l}$
(d) $\frac{LE_0 r}{lr_1}$

Ans: (a)

Solution: EMF, $E = Kl$ where $K = \frac{V}{L}$ potential gradient

$K = \frac{V}{L} = \frac{iR}{L} = \left(\frac{E_0 r}{r+r_1}\right)\frac{l}{L}$

So, $E = Kl = \frac{E_0 r l}{(r+r_1)L}$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q66. Which one of the following phenomena is not explained by Huygens construction of wavefront?

(a) Refraction
(b) Reflection
(c) Diffraction
(d) Origin of spectra

Ans: (d)

Solution: Huygen's construction of wavefront does not apply to origin of spectra which is explained by quantum theory.

Chapter - Wave Optics
[Topic: Young's Double Slit Experiment]

Q67. The input signal given to a CE amplifier having a voltage gain of 150 is $V_i = 2\cos\left(15t + \frac{\pi}{3}\right)$. The corresponding output signal will be :

[2015 RS]

(a) $75\cos\left(15t + \frac{2\pi}{3}\right)$ (b) $2\cos\left(15t + \frac{5\pi}{6}\right)$
(c) $300\cos\left(15t + \frac{4\pi}{3}\right)$ (d) $300\cos\left(15t + \frac{\pi}{3}\right)$

Ans: (c)

***Solution:* Given :** Voltage gain $A_V = 150$

$V_i = 2\cos\left(15t + \frac{\pi}{3}\right)$; $V_0 = ?$

For CE transistor phase difference between input and output signal is $\pi = 180°$

Using formula, $A_V = \frac{V_0}{V_i}$

$\Rightarrow V_0 = A_V \times V_i$

$= 150 \times 2\cos\left(15t + \frac{\pi}{3}\right)$

or $V_0 = 300\cos\left(15t + \frac{\pi}{3} + \pi\right)$

$V_0 = 300\cos\left(15t + \frac{4}{3}\pi\right)$

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q68. A force $\vec{F} = \alpha \hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of α for which angular momentum about origin is conserved is :

(a) 2 (b) zero
(c) 1 (d) –1

Ans: (d)

Solution: From Newton's second law for rotational motion,

$\vec{\tau} = \frac{d\vec{L}}{dt}$, if $\vec{L}$ = constant then $\vec{\tau} = 0$

So, $\vec{\tau} = \vec{r} \times \vec{F} = 0$

$(2\hat{i} - 6\hat{j} - 12\hat{k}) \times (\alpha\hat{i} + 3\hat{j} + 6\hat{k}) = 0$

Solving we get $\alpha = -1$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q69. A particle is executing a simple harmonic motion. Its maximum acceleration is a and maximum velocity is b.

Then its time period of vibration will be :

(a) $\frac{\alpha}{\beta}$
(b) $\frac{\beta^2}{\alpha}$
(c) $\frac{2\pi\beta}{\alpha}$
(d) $\frac{\beta^2}{\alpha^2}$

Ans: (c)

Solution: As, we know, in SHM

Maximum acceleration of the particle, $\alpha = A\omega^2$

Maximum velocity, $\beta = A\omega$

$\Rightarrow \omega = \frac{\alpha}{\beta}$

$\Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi\beta}{\alpha}\left[\omega = \frac{2\pi}{T}\right]$

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q70. In a mass spectrometer used for measuring the masses of ions, the ions are initially accelerated by an electric potential V and then made to describe semicircular path of radius R using a magnetic field B. If

V and B are kept constant, the ratio $\left(\frac{\text{charge on the ion}}{\text{mass of the ion}}\right)$ will be proportional to

(a) $1/R^2$ (b) R^2
(c) R (d) 1/R

Ans: (a)

Solution: In mass spectrometer, when ions are accelerated through potential V

$\frac{1}{2}mv^2 = qV$ .... (i)

As the magnetic field curves the path of the ions in a semicircular orbit

$Bqv = \frac{mv^2}{R} \Rightarrow v = \frac{BR}{m}$ .... (ii)

Substituting (ii) in (i)

$\frac{1}{2}m\left[\frac{BqR}{m}\right]^2 = qV$

or $\frac{q}{m} = \frac{2V}{B^2R^2}$

Since *V* and *B* are constants,

$\frac{q}{m} \propto \frac{1}{R^2}$

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q71. Which of the following phenomenon is not common to sound and light waves ?

(a) Interference
(b) Diffraction
(c) Coherence
(d) Polarisation

Ans: (d)

Solution: Sound waves can not be polarised as they are longitudinal. Light waves can be polarised as they are transverse.

Chapter - Wave Optics
[Topic: Matter Waves, Cathode & Positive Rays]

Q72. The given electrical network is equivalent to : [2017, 2006, 2000]

(a) OR gate
(b) NOR gate
(c) NOT gate
(d) AND gate

Ans: (b)

Solution: $y_1 = \overline{A + B}$

$y_2 = \overline{y_1 + y_1} = \overline{y}_1 = A + B$

$y = \overline{y}_2 = \overline{A + B}$ i.e. NOR gate

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q73. Which of the following will have the dimensions of time

(a) LC
(b) $\frac{R}{L}$
(c) $\frac{L}{R}$
(d) $\frac{c}{L}$

Ans: (c)

Solution: $e = -L\frac{di}{dt}$ ....(1)

e = iR.........(2)

From (1) & (2) , $iR = -L\frac{di}{dt}$

∴Dimension of L.H.S. = Dimension of R.H.S.

$[A]\,R = L\,[AT^{-1}] = \frac{L}{R} = [T]$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q74. Angular momentum is

(a) vector (axial)
(b) vector (polar)
(c) scalar
(d) none of the above

Ans: (a)

Solution: Angular momentum $\vec{L}$ is defined as $\vec{L} = \vec{r} \times m(\vec{v})$

So, $\vec{L}$ is an axial vector.

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q75. Resonance is an example of

(a) tuning fork
(b) forced vibration
(c) free vibration
(d) damped vibration

Ans: (b)

Solution: We know that if frequency of an external forced oscillation is equal to the natural frequency of the body, then amplitude of the forced oscillation of the body becomes very large. This phenomenon is known as resonant vibration. Therefore, resonance is an example of forced vibration.

Chapter: Oscillation
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

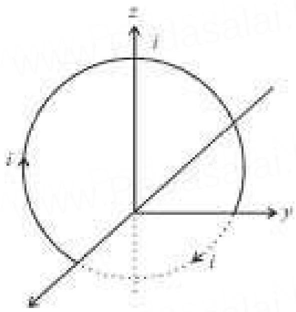
Q76. A current loop consists of two identical semicircular parts each of radius *R*, one lying in the *x-y* plane and the other in *x-z* plane. If the current in the loop is *i*., the resultant magnetic field due to the two semicircular parts at their common centre is

(a) $\frac{\mu_0 i}{\sqrt{2}R}$
(b) $\frac{\mu_0 i}{2\sqrt{2}R}$
(c) $\frac{\mu_0 i}{2R}$
(d) $\frac{\mu_0 i}{4R}$

Ans: (b)

Solution: Magnetic fields due to the two parts at their common centre are respectively,

$B_y = \frac{\mu_0 i}{4R}$ and $B_z = \frac{\mu_0 i}{4R}$



Resultant field = $\sqrt{B_y^2 + B_Z^2}$

$= \sqrt{\left(\frac{\mu_0 i}{4R}\right)^2 + \left(\frac{\mu_0 i}{4R}\right)^2} = \sqrt{2}.\frac{\mu_0 i}{4R} = \frac{\mu_0 i}{2\sqrt{2}R}$

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q77. A source of light is placed at a distance of 50 cm from a photocell and the stopping potential is found to be V_0. If the distance between the light source and photocell is made 25 cm, the new stopping potential will be

(a) $2V_0$ (b) $V_0/2$
(c) V_0 (d) $4V_0$

Ans: (c)

Solution: Since, stopping potential is independent of distance hence new stopping potential will remain unchanged i.e., new stopping potential = V_0.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q78. A car moves a distance of 200 m. It covers the first half of the distance at speed 40 km/h and the second half of distance at speed v. The average speed is 48 km/h. Find the value of v

(a) 56 km/h (b) 60 km/h
(c) 50 km/h (d) 48 km/h

Ans: (b)

Solution: $48 = \frac{200\times10^{-3}}{\left(\frac{100\times10^{-3}}{40}\right)+\left(\frac{100\times10^{-3}}{v}\right)}$

or $\frac{1}{40} + \frac{1}{v} = \frac{2}{48} = \frac{1}{24}$

or $\frac{1}{v} = \frac{1}{24} - \frac{1}{40} = \frac{2}{120} = \frac{1}{60}$

or v = 60 km/h

[Alt : $v_{av} = \frac{2v_1v_2}{v_1+v_2} \Rightarrow 48 = \frac{2\times40\times v}{40+v}$

= v = 60 km/h]

Chapter: Kinematics Motion in a Straight Line
[Topic: Distance, Displacement & Uniform motion]

Q79. A disk and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first ?

(a) Disk
(b) Sphere
(c) Both reach at the same time
(d) Depends on their masses

Ans: (b)

Solution: Time of descent $\propto \frac{K^2}{R^2}$

Order of value of $\frac{K^2}{R^2}$

for disc; $\frac{K^2}{R^2} = \frac{1}{2} = 0.5$

for sphere; $\frac{K^2}{R^2} = \frac{2}{5} = 0.4$

(sphere) < (disc)

∴Sphere reaches first

Chapter: System of Particles and Rotational Motion
[Topic: Rolling Motion]

Q80. The speed of a wave in a medium is 760 m/s. If 3600 waves are passing through a point in the medium in 2 min, then their wavelength is

(a) 13.8 m (b) 25.3 m
(c) 41.5 m (d) 57.2 m

Ans: (b)

Solution: Speed of the wave (v) = 760 m/s; Number of waves = 3600 and time taken (t) = 2 min = 120 sec.
Frequecny of waves

(n) = $\frac{3600}{120}$ =30/sec.

∴ wavelength of waves (λ)

$= \frac{v}{n} = \frac{760}{30} = 25.3$m .

[Alt : $\lambda = \frac{ct}{w}$, where c = velocity of wave
t = time in second
w = no. of waves]

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q81. A closely wound solenoid of 2000 turns and area of cross-section 1.5×10^{-4} m^2carries a current of 2.0 *A*. It suspended through its centre and perpendicular to its length, allowing it to turn in a horizontal plane in a uniform magnetic field 5×10^{-2} tesla making an angle of 30° with the axis of the solenoid. The torque on the solenoid will be:

(a) 3×10^{-2} N-m (b) 3×10^{-3} N-m
(c) 1.5×10^{-3} N-m (d) 1.5×10^{-2} N-m

Ans: (d)

Solution: Torque on the solenoid is given by
$\tau = MB \sin\theta$
where θ is the angle between the magnetic field and the axis of solenoid.
M = niA
∴ τ= niA B sin 30°

$= 2000 \times 2 \times 1.5 \times 10^{-4} \times 5 \times 10^{-2} \times \frac{1}{2}$

$= 1.5 \times 10^{-2}$N − m

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q82. Einstein work on the photoelectric effect provided support for the equation

(a) E = hν
(b) $E = mc^2$

(c) $E = -\frac{Rhc}{n^2}$
(d) $KE. = \frac{1}{2}mv^2$

Ans: (a)

Solution: Einstein work on photoelectric effect supports the equation $E = h\nu$.It is based on quantum theory of light.

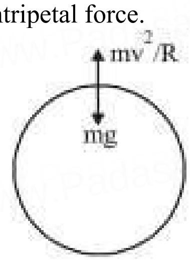
Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q83. A roller coaster is designed such that riders experience "weightlesness" as they go round the top of a hill whose radius of curvature is 20 m. The speed of the car at the top of the hill is between:

(a) 14 m/s and 15 m/s (b) 15 m/s and 16 m/s
(c) 16 m/s and 17 m/s (d) 13 m/s and 14 m/s

Ans: (a)

Solution: For the riders to experience weightlessness at the top of the hill, the weight of the rider must be balanced by the centripetal force.



i.e., $mg = \frac{mv^2}{R}$

$\Rightarrow v = \sqrt{gR} = \sqrt{10 \times 20} = 14.1 ms^{-1}$

Hence, the speed of the car should be between 14 ms^{-1} and 15 ms^{-1}.

Chapter: Gravitation
[Topic: Acceleration due to Gravity]

Q84. A cylindrical resonance tube open at both ends, has a fundamental frequency, f, in air. If half of the length is dipped vertically in water, the fundamental frequency of the air column will be

(a) 2f (b) 3f/2
(c) f (d) f/2

Ans: (c)

Solution: Fundamental frequency of open pipe, $f = \frac{v}{2l}$

When half of tube is filled with water, then the length of air column becomes half $\left[l' = \frac{1}{2}\right)$ and the pipe becomes closed.

So, new fundamental frequency

$f' = \frac{v}{4l} = \frac{v}{4\left(\frac{1}{2}\right)} = \frac{v}{2l}$

Clearly f ' = f.

Chapter: Waves
[Topic: Beats, Interference & Superposition of Waves]

Q85. A short bar magnet of magnetic moment 0.4J T^{-1} is placed in a uniform magnetic field of 0.16 T. The magnet is in stable equilibrium when the potential energy is

(a) –0.064 J (b) zero
(c) –0.082 J (d) 0.064 J

Ans: (a)

Solution: For stable equilibrium
U = –MB
= – (0.4) (0.16)
= – 0.064 J

Chapter: Magnetism and Matter
[Topic: Magnetism, Gauss's Law, Magnetic Moment & Properties of Magnet]

Q86. The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 5000 Å. Its work function is

(a) 4×10^{-19} J (b) 1 J
(c) 2×10^{-19}J (d) 3×10^{-19} J

Ans: (a)

Solution: $W_0 = \frac{hc}{\lambda_0}$

$\frac{6.63\times10^{-34}\times3\times10^{8}}{5000\times10^{-10}} = 4 \times 10^{-19}J$

Chapter - Dual Nature of Radiation and Matter
[Topic: Atomic Structure, Rutherford's Nuclear Model of Atom]

Q87. The vectors $\vec{A}$ and $\vec{B}$ are such that $|\vec{A}+\vec{B}||\vec{A}-\vec{B}|$

The angle between the two vectors is
[2006, 2001, 1996, 1991]

(a) 60° (b) 75°
(c) 45° (d) 90°

Ans: (d)

Solution: $|\vec{A}+\vec{B}|^2 = |\vec{A}-\vec{B}|^2$

$= |\vec{A}|^2 + |\vec{B}|^2 + 2\vec{A}.\vec{B} = A^2 + B^2 + 2ABcos6$

$= |\vec{A}-\vec{B}|^2 = |\vec{A}|^2 + |\vec{B}|^2 - 2\vec{A}.\vec{B}$

$= A^2 + B^2 - 2ABcosC$

So, $A^2 + B^2 + 2AB\cos\theta$

$= A^2 + B^2 - 2AB\cos\theta$

$4AB\cos\theta = 0 = \cos\theta = 0$

$\theta = 90°$

So, angle between A & B is 90°.

Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q88. If v_e is escape velocity and $v_0$is orbital velocity of a satellite for orbit close to the earth's surface, then these are related by :

(a) $v_0 = \sqrt{2}v_e$
(b) $v_0 = v_e$
(c) $v_e = \sqrt{2v_0}$
(d) $v_e = \sqrt{2}v_0$

Ans: (d)

Solution: $v_e = \sqrt{\frac{2GM}{R}} \Rightarrow v_0 = \sqrt{\frac{GM}{R}}$

$v_e = \sqrt{2}v_0$

Chapter: Gravitation
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q89. A whistle of frequency 385 Hz rotates in a horizontal circle of radius 50 cm at an angular speed of 20 radians s^{-1}. The lowest frequency heard by a listener a long distance away at rest with respect to the centre of the circle, given velocity of sound equal to 340 ms^{-1}, is

(a) 396 Hz (b) 363 Hz
(c) 374 Hz (d) 385 Hz

Ans: (c)

Solution: Velocity of source

$v_s = r\omega = 0.50 \times 20 = 10ms^{-1}$

$n' = \frac{v}{v+v_s} n = \frac{340 \times 385}{340+10} = 374Hz$

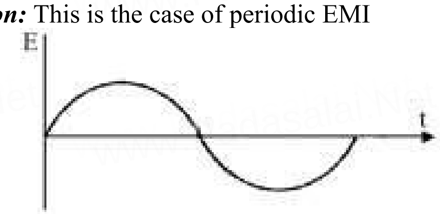
Chapter: Waves
[Topic: Musical Sound & Doppler's Effect]

Q90. A wire loop is rotated in a magnetic field. The frequency of change of direction of the induced e.m.f. is

(a) twice per revolution
(b) four times per revolution
(c) six times per revolution
(d) once per revolution

Ans: (a)

Solution: This is the case of periodic EMI



From graph, it is clear that direction is changing once in $\frac{1}{2}$ cycle.

Chapter: Electromagnetic
[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q91. Ionization potential of hydrogen atom is 13.6eV. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. According to Bohr's theory, the spectral lines emitted by hydrogen will be

(a) three
(b) Four
(c) One
(d) Two

Ans: (a)

Solution: Energy of ground state 13.6 eV

Energy of first excited state

$= -\frac{13.6}{4} = -3.4eV$

Energy of second excited state

$= -\frac{13.6}{9} - 1.5eV$

Difference between ground state and 2nd excited state = 13.6 – 1.5 = 12.1 eV

So, electron can be excited upto 3rd orbit

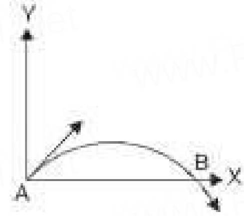
No. of possible transition

$1 \rightarrow 2, 1 \rightarrow 3, 2 \rightarrow 3$

So, three lines are possible.

Chapter: Atoms
[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q92. The velocity of a projectile at the initial point A is $(2\hat{i} + 3\hat{j})$ m/s. It's velocity (in m/s) at point B is



(a) $-2\hat{i} + 3\hat{j}$ (b) $2\hat{i} - 3\hat{j}$
(c) $2\hat{i} + 3\hat{j}$
(d) $-2\hat{i} - 3\hat{j}$

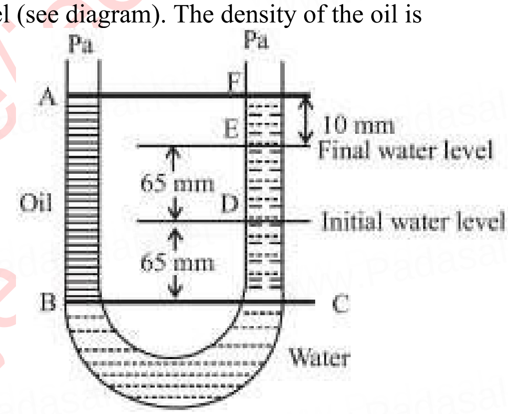
Ans: (b)

Solution: At point B the direction of velocity component of the projectile along Y - axis reverses.

Hence, $\vec{V}_B = 2\hat{i} - 3\hat{j}$

Chapter: Kinematics Motion in a Plane
[Topic: Projectile Motion]

Q93. A U tube with both ends open to the atmosphere, is partially filled with water. Oil, which is immiscible with water, is poured into one side until it stands at a distance of 10 mm above the water level on the other side. Meanwhile the water rises by 65 mm from its original level (see diagram). The density of the oil is



(a) 425 kg m^{-3} (b) 800 kg m^{-3}
(c) 928 kg m^{-3} (d) 650 kg m^{-3}

Ans: (c)

Solution: Here, $h_{oil} \times \rho_{oil} \times g = h_{water} \times \rho_{water} \times g$

$\rho_0 g \times 140 \times 10^{-3} = \rho_w g \times 130 \times 10^{-3}$

$\rho_{oil} = \frac{130}{140} \times 10^3 \approx 928 kg/m^3$

$[\because \rho_w = 1\ kgm^{-3}]$

Chapter: Mechanical Properties of Fluids
[Topic: Pressure, Density Pascal's Law & Archimedes' Principle]

Q94. A point *Q* lies on the perpendicular bisector of an electrical dipole of dipole moment *p*. If the distance of *Q* from the dipole is *r* (much larger than the size of the dipole), then the electric field at *Q* is proportional to

(a) p^{-1} and r^{-2} (b) p and r^{-2}
(c) p^2 and r^{-3} (d) p and r^{-3}

Ans: (d)

Solution: $E = \frac{p}{4\pi\varepsilon_0 r^3}$

Apparently, $E \propto p$ and $E \propto \frac{1}{r^3} \propto r^{-3}$.

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q95. A 100 millihenry coil carries a current of 1A. Energy stored in its magnetic field is

(a) 0.5 J (b) 1 A
(c) 0.05 J (d) 0.1 J

Ans: (c)

Solution: $E = \frac{1}{2}Li^2 = \frac{1}{2} \times (100 \times 10^{-3}) \times 1^2 = 0.05J$

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q96. The nuclei of which one of the following pairs of nuclei are isotones?

(a) ${}_{34}Se^{74}$, ${}_{31}Ga^{71}$ (b) ${}_{38}Sr^{84}$, ${}_{38}Sr^{86}$
(c) ${}_{42}Mo^{92}$, ${}_{40}Zr^{92}$ (d) ${}_{20}Ca^{40}$, ${}_{16}S^{32}$

Ans: (a)

Solution: Isotones means equal number of neutrons i.e., $(A–Z) = 74 – 34 = 71 – 31 = 40$.

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

Q97. A ball of mass 0.25 kg attached to the end of a string of length 1.96 m is moving in a horizontal circle. The string will break if the tension is more than 25 N. What is the maximum speed with which the ball can be moved?

(a) 14 m/s (b) 3 m/s
(c) 5 m/s (d) 3.92 m/s

Ans: (a)

Solution: $T = \frac{mv^2}{R}$

$v = \sqrt{\frac{TR}{m}} = \sqrt{\frac{25\times1.96}{0.25}} = \frac{5\times14}{5} = 14m/s$

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q98. On observing light from three different stars P, Q and R, it was found that intensity of violet colour is maximum in the spectrum of P, the intensity of green colour is maximum in the spectrum of R and the intensity of red colour is maximum in the spectrum of Q. If T_P, T_Q and T_R are the respective absolute temperature of P, Q and R, then it can be concluded from the above observations that

(a) $T_P > T_R > T_Q$
(b) $T_P < T_R < T_Q$
(c) $T_P < T_Q < T_R$
(d) $T_P > T_Q > T_R$

Ans: (a)

Solution: From Wein's displacement law

$\lambda_m \times T = \text{constant}$

P – max. intensity is at violet

$\Rightarrow \lambda_m$ is minimum $\Rightarrow$ temp maximum

R – max. intensity is at green

$\Rightarrow \lambda_m$ is moderate $\Rightarrow$ temp moderate

Q – max. intensity is at red $\Rightarrow \lambda_m$ is maximum

$\Rightarrow$ temp. minimum i.e., $T_p > T_R > T_Q$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q99. The electric potential at a point in free space due to a charge Q coulomb is $Q \times 10^{11}$ volts. The electric field at that point is

(a) $4\pi\varepsilon_0 Q\times10^{22}$ volt/m (b) $12\pi\varepsilon_0 Q\times10^{20}$ volt/m
(c) $4\pi\varepsilon_0 Q\times10^{20}$ volt/m (d) $12\pi\varepsilon_0 Q\times10^{22}$ volt/m

Ans: (a)

Solution: Given that, $V = Q \times 10^{11}$ volts

Electric potential at point is given by

$v = \frac{1}{4\pi\epsilon_0}.\frac{Q}{r}$ or, $Q \times 10^{11} = \frac{1}{4\pi\epsilon_0}.\frac{Q}{r}$

$r = \frac{1}{4\pi\epsilon_0}.10^{-11}m.$

As $|E| = \frac{|V|}{r} = \frac{Q\times10^{11}}{\frac{1}{4\pi\epsilon_0}.10^{-11}}$

$= = 4\pi\epsilon_0 Q \times 10^{22}$volt m

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q100. What is the value of inductance L for which the current is maximum in a series LCR circuit with $C = 10\ \mu F$ and $\omega = 1000s^{-1}$?

(a) 1 mH
(b) cannot be calculated unless R is known
(c) 10 mH (d) 100 mH

Ans: (d)

Solution: Condition for which the current is maximum in a series LCR circuit is,

$\omega = \frac{1}{\sqrt{LC}}$

$1000 = \frac{1}{\sqrt{L(10\times10^{-6})}}$

$\Rightarrow = L = 100$ mH

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

PART 14. PHYSICS QUESTION BANK

Q1. If M (A; Z), M_p and M_n denote the masses of the nucleus ${}^A_Z X$ proton and neutron respectively in units of u (1u = 931.5 MeV/c^2) and BE represents its bonding energy in MeV, then

(a) M (A, Z) = ZM_p + (A – Z) M_n –BE/c^2
(b) M (A, Z) = ZM_p+ (A–Z) M_n + BE
(c) M (A, Z) = ZM_p + (A – Z) M_n – BE
(d) M (A, Z) = ZM_p + (A – Z)M_n + BE/c^2

Ans: (a)

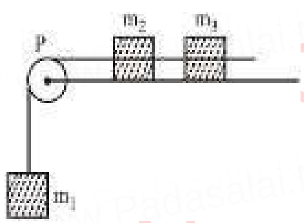
Solution: Mass defect = ZM_p + (A –Z)M_n–M(A,Z)

or, $\frac{B.E.}{c^2}$ = ZM_p + (A–Z) M_n–M(A,Z)

∴ M (A, Z) = ZM_p + (A–Z)M_n–$\frac{B.E.}{c^2}$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q2. A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is : (Assume $m_1 = m_2 = m_3 = m$) [2014]



(a) $\frac{g(1-g\mu)}{g}$
(b) $\frac{2g\mu}{3}$
(c) $\frac{g(1-2\mu)}{3}$
(d) $\frac{g(1-2\mu)}{2}$

Ans: (c)

Solution: Acceleration

$= \frac{\text{Net force in the direction of motion}}{\text{Total mass of system}}$

$= \frac{m_1 g-\mu(m_2+m_3)g}{m_1+m_2+m_3} = \frac{g}{3}(1-2\mu)$

(∵ $m_1 = m_2 = m_3$ = m given)

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q3. If 1 g of steam is mixed with 1 g of ice, then the resultant temperature of the mixture is

(a) 270ºC (b) 230ºC
(c) 100ºC (d) 50ºC

Ans: (c)

Solution: Heat required by ice at 0°C to reach a temperature of 100°C = mL + mcΔθ

= 1 × 80 + 1 × 1 × (100 – 0) = 180 cal

Heat available with 1 g steam to condense into 1 g of water at 100°C = 536 cal.

Obviously the whole steam will not be condensed and ice will attain a temperature of 100°C; so the temperature of mixture = 100°C.

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q4. A capacitor C_1 is charged to a potential difference *V*. The charging battery is then removed and the capacitor is connected to an uncharged capacitor C_2. The potential difference across the combination is

(a) $\frac{VC_1}{(C_1+C_2)}$
(b) $V\left(1+\frac{C_2}{C_1}\right)$
(c) $V\left(1+\frac{C_1}{C_2}\right)$
(d) $\frac{VC_2}{(C_1+C_2)}$

Ans: (a)

Solution: Charge $Q = C_1 V$

Total capacity of combination (parallel)

$C = C_1 + C_2$

$\text{P. D.} = \frac{Q}{C} = \frac{C_1 V}{C_1 + C_2}$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q5. The electric field associated with an e.m. wave in vacuum is given by $\vec{E} = \hat{i}\,40\cos(kz - 6\times10^8 t)$, where *E*, *z* and *t* are in volt/m, meter and seconds respectively. The value of wave vector *k* is :

(a) 2 m^{-1} (b) 0.5 m^{-1}
(c) 6 m^{-1} (d) 3 m^{-1}

Ans: (a)

Solution: On comparing the given equation to

$\vec{E} = a_0\hat{i}\cos(\omega t - kz)$

$\omega = 6 \times 10^8$

$k = \frac{2\pi}{r} = \frac{\omega}{c}$

$k = \frac{\omega}{c} = \frac{6\times10^8}{3\times10^8} = 2m^{-1}$

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q6. The average binding energy of a nucleon inside an atomic nucleus is about

(a) 8 MeV (b) 8 eV
(c) 8 J (d) 8 ergs

Ans: (a)

Solution: Average B.E./nucleon in nuclei is of the order of 8 MeV.

Chapter: Nuclei
[Topic: Radioactivity]

Q7. A heavy uniform chain lies on horizontal table top. If the coefficient of friction between the chain and the table surface is 0.25, then the maximum fraction of the length of the chain that can hang over one edge of the table is

(a) 20% (b) 25%
(c) 35% (d) 15%

Ans: (a)

Solution: The force of friction on the chain lying on the table should be equal to the weight of the hanging chain. Let

ρ = mass per unit length of the chain
μ = coefficient of friction
l = length of the total chain
x = length of hanging chain

Now, $\mu(l - x)\rho g = x\rho g$ or $\mu(l - x) = x$
or $\mu l = (\mu + 1)x$ or $x = \mu l/(\mu + 1)$

$$x = \frac{0.25l}{(025 + 1)} = \frac{0.25l}{125} = 0.2l$$

$$\frac{x}{l} = 0.2 = 20\%$$

Chapter: Dynamics Laws of Motion
[Topic: Friction]

Q8. The velocity of charge carriers of current (about 1 amp) in a metal under normal conditions is of the order of

(a) a fraction of mm/sec
(b) velocity of light
(c) several thousand metres/second
(d) a few hundred metres per second

Ans: (a)

Solution: Chapter: Current Electricity
[Topic: Combination of Resistances]

Q9. Which of the following, is the longest wave ?

(a) X-rays
(b) γ-rays
(c) microwaves
(d) radio waves

Ans: (d)

Solution: RaysWavelength[Range in m]X-rays1 × 10^{-11} to 3 × $10^{-8}$$\gamma$-rays6 × 10^{-14} to 1 × 10^{-11}Microwaves10^{-3} to 0.3Radio waves10 to 10^4

Chapter - Electromagnetic Waves
[Topic: Plane Mirror, Spherical Mirror & Reflection of Light]

Q10. Alpha-particles are

(a) protons
(b) positron
(c) neutrally charged
(d) ionized helium atoms

Ans: (d)

Solution: We know that alpha particles are the nucleus of ionized helium atoms which contain two protons and two neutrons. These are emitted by the nuclei of certain radioactive substances. Streams of alpha particles, called α-rays, produce intense ionisation in gases through which they pass and are easily absorbed by matter.

Chapter: Nuclei
[Topic: Radioactivity]

Q11. A particle of mass 10 g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal to 8 × 10^{-4} J by the end of the second revolution after the beginning of the motion ?

(a) 0.1 m/s^2 (b) 0.15 m/s^2
(c) 0.18 m/s^2 (d) 0.2 m/s^2

Ans: (a)

Solution: Given: Mass of particle, M = 10g = $\frac{10}{1000}$kg
radius of circle R = 6.4 cm
Kinetic energy E of particle = 8 × 10^{-4}J
acceleration a_t = ?

$\frac{1}{2}mv^2 = E \Rightarrow \frac{1}{2}\left(\frac{10}{1000}\right)v^2 = 8 \times 10^{-4}$

$\Rightarrow v^2 = 16 \times 10^{-2}$

$\Rightarrow v = 4 \times 10^{-1} = 0.4$ m/s

Now, using

$v^2 = u^2 + 2a_t s (s = 4\pi R)$

$(0.4)^2 = 0^2 + 2a_t\left(4 \times \frac{22}{7} \times \frac{6.4}{100}\right)$

$\Rightarrow a_t = (0.4)^2 \times \frac{7\times100}{8\times22\times6.4} = 0.1$ m/s^2

Chapter: Work, Energy and Power
[Topic: Energy]

Q12. A Carnot engine whose efficiency is 50% has an exhaust temperature of 500 K. If the efficiency is to be 60% with the same intake temperature, the exhaust temperature must be (in K)

(a) 800 (b) 200
(c) 400 (d) 600

Ans: (c)

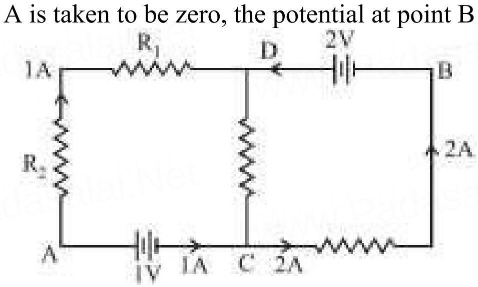
Solution: $\eta = 1 - \frac{T_2}{T_1}$ or $\frac{50}{100} = 1 - \frac{500}{T_1}$

$= T_1 = 1000K$

Also, $\frac{60}{100} = 1 - \frac{T_2}{1000} = T_2 = 400K$

Chapter: Heat & Thermodynamics
[Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q13. In the circuit shown in the figure, if potential at point A is taken to be zero, the potential at point B is



(a) –1V
(b) + 2V
(c) –2V
(d) + 1V

Ans: (d)

Solution: Current from D to C = 1A

$\therefore V_D - V_C = 2 \times 1 = 2V$

$V_A = 0 \therefore V_C = 1V, \therefore V_D - V_C = 2$

$\Rightarrow V_D - 1 = 2 \therefore V_D = 3V$

$\therefore V_D - V_B = 2 \therefore 3 - V_B = 2 \therefore V_B = 1V$

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

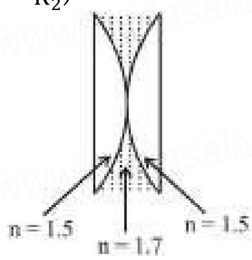
Q14. Two identical thin plano-convex glass lenses (refractive index 1.5) each having radius of curvature of 20 cm are placed with their convex surfaces in contact at the centre. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is

(a) –25 cm (b) –50 cm
(c) 50 cm (d) –20 cm

Ans: (b)

Solution: Using lens maker's formula,

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$



$$\frac{1}{f_1} = \left(\frac{1.5}{1} - 1\right)\left(\frac{1}{\infty} - \frac{1}{-20}\right)$$

$\Rightarrow f_1 = 40$cm

$$\frac{1}{f_2} = \left(\frac{1.7}{1} - 1\right)\left(\frac{1}{-20} - \frac{1}{+20}\right)$$

$= f_2 = -\frac{100}{7}$cm

and $\frac{1}{f_3} = \left(\frac{1.5}{1} - 1\right)\left(\frac{1}{\infty} - \frac{1}{-20}\right)$

$\Rightarrow f_3 = 40$ cm

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

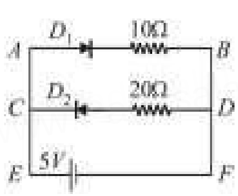
$$\frac{1}{f_{eq}} = \frac{1}{40} + \frac{1}{\frac{-100}{7}} + \frac{1}{40}$$

$\therefore f_{eq} = -50$ cm

Therefore, the focal length of the combination is – 50 cm.

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q15. Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is :



(a) 0.75 A (b) zero
(c) 0.25 A (d) 0.5 A

Ans: (d)

Solution: Here D_1 is in forward bias and D_2 is in reverse bias so, D_1 will conduct and D_2 will not conduct. Thus, no current will flow through *DC*.

$I = \frac{V}{R} = \frac{5}{10} = \frac{1}{2}$Amp.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q16. A car of mass m starts from rest and accelerates so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to :

(a) t^2P_0 (b) $t^{1/2}$
(c) $t^{-1/2}$ (d) $\frac{t}{\sqrt{m}}$

Ans: (b)

Solution: Constant power of car P_0 = F.V = ma.v

$$P_0 = m\frac{dv}{dt}v$$

$P_0 dt = mvdv$ Integrating

$$P_0 t = \frac{mv^2}{2}$$

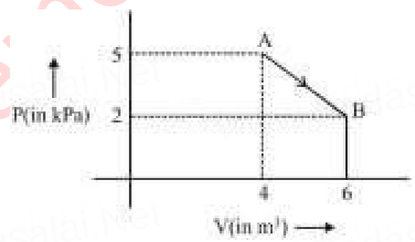
$$v = \sqrt{\frac{2P_0 t}{m}}$$

$\because P_0$, m and 2 are constant

$\therefore v \propto \sqrt{t}$

Chapter: Work, Energy and Power
[Topic: Power]

Q17. One mole of an ideal diatomic gas undergoes a transition from A to B along a path AB as shown in the figure.



The change in internal energy of the gas during the transition is:

(a) – 20 kJ (b) 20 J
(c) –12 kJ (d) 20 kJ

Ans: (a)

Solution: Change in internal energy from A → B

$\Delta U = \frac{f}{2} nR\Delta T = \frac{f}{2} nR\,(T_f - T_i)$

$= \frac{5}{2}\{P_fV_f - P_iV_i\}$

(As gas is diatomic ∴ f = 5)

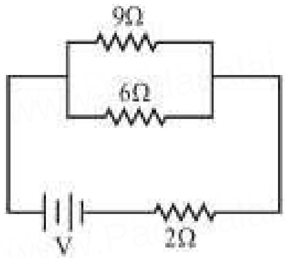
$= \frac{5}{2}\{2 \times 10^3 \times 6 - 5 \times 10^3 \times 4\}$

$= \frac{5}{2}\{12 - 20\} \times 10^3$ J $= 5 \times (-4) \times 10^3$ J

$\Delta U = -20$ KJ

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q18. If power dissipated in the 9-Ω resistor in the circuit shown is 36 watt, the potential difference across the 2-Ω resistor is



(a) 4 volt (b) 8 volt
(c) 10 volt (d) 2 volt

Ans: (c)

Solution: We have,

$P = \frac{V^2}{R}$

$= 36 = \frac{V^2}{9}$

$\Rightarrow V = 18V$

Current passing through the 9Ω resistor is

$i_1 = \frac{V}{R} = \frac{18}{9} = 2A$

The 9Ω and 6Ω resistors are in parallel, therefore

$i_1 = \frac{6}{9+6} \times i$

where i is the current delivered by the battery.

$\therefore i = \frac{2\times15}{6} = 5A$

Thus, potential difference across 2Ω resistor is

$V = iR$

$= 5 \times 2$

$= 10V$

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q19. The refracting angle of a prism is 'A', and refractive index of the material of the prism is cot(A/2). The angle of minimum deviation is : [2015]

(a) 180° – 2A (b) 90° – A
(c) 180° + 2A (d) 180° – 3A

Ans: (a)

Solution: As we know, the refractive index of the material of the prism

$$\mu = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$\cot A/2 = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\frac{\sin A}{2}} = \frac{\cos\left(\frac{A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

[$\because$ $\mu = \cot(A/2)$]

$\Rightarrow \sin\left(\frac{\delta_m+A}{2}\right) = \sin(90° + A/2)$

$\Rightarrow \delta_{min} = 180° - 2A$

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q20. In a *p-n* junction

(a) The potential of the *p* and *n*-sides becomes higher alternately
(b) The *p*-side is at higher electrical potential than the n side
(c) The *n*-side is at higher electrical potential than the *p*-side
(d) Both the *p* and *n*-sides are at the same potential

Ans: (b)

Solution: For conduction, *p-n* junction must be forward biased. For this *p*-side should be connected to higher potential and *n*-side to lower potential.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q21. Two identical balls A and B moving with velocities +0.5 m/s and –0.3 m/s respectively, collide head on elastically. The velocities of the balls A and B after collision, will be, respectively

(a) +0.5 m/s and +0.3 m/s (b) – 0.3 m/s and +0.5 m/s
(c) +0.3 m/s and 0.5 m/s (d) –0.5 m/s and +0.3 m/s

Ans: (b)

Solution: When the identical balls collide head-on, their velocities are exchanged.

Chapter: Work, Energy and Power
[Topic: Collisions]

Q22. The phase difference between the instantaneous velocity and acceleration of a particle executing simple harmonic motion is

(a) π (b) 0.707π
(c) zero (d) 0.5π

Ans: (d)

Solution: Let y = A sin ωt

$v_{inst} = \frac{dy}{dt} = A\omega\cos\omega t = A\omega\sin\left(\omega t + \frac{\pi}{2}\right)$

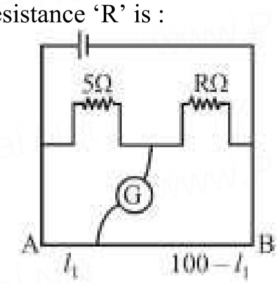
Acceleration$= -A\omega^2\sin\omega t$

$= A\omega^2\sin(\pi + \omega t)$

$\phi = \frac{\pi}{2} = 0.5\pi$

Chapter: Oscillation
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q23. The resistances in the two arms of the meter bridge are 5Ω and RΩ, respectively. When the resistance R is shunted with an equal resistance, the new balance point is at 1.6 l_1. The resistance 'R' is :



(a) 10Ω (b) 15Ω
(c) 20Ω (d) 25Ω

Ans: (b)

Solution: This is a balanced wheatstone bridge condition,

$\frac{5}{R} = \frac{l_1}{100-\ell_1}$ and $\frac{5}{\frac{R}{2}} = \frac{1.6\ell_1}{100-16\ell_1}$

$\Rightarrow R = 15\ \Omega$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q24. Young's double slit experment is first performed in air and then in a medium other than air. It is found that 8^{th} bright fringe in the medium lies where 5^{th} dark fringe lies in air. The refractive index of the medium is nearly

(a) 1.59 (b) 1.69
(c) 1.78 (d) 1.25

Ans: (c)

Solution: According to question

8^{th} bright fringe in medium = 5th dark fring in air

$Y_{8thbright} = 8\frac{\lambda D}{\mu d}$

$Y_{5thdark} = (2\times 5-1)\frac{\lambda D}{2d} = \frac{9}{2}\frac{\lambda D}{d}$

$\Rightarrow \frac{9}{2}\frac{\lambda D}{d} = 8\frac{\lambda D}{\mu d}$

or, refractive index $\mu = \frac{16}{9} = 1.78$

Chapter - Wave Optics
[Topic: Young's Double Slit Experiment]

Q25. In a common emitter (CE) amplifier having a voltage gain G, the transistor used has transconductance 0.03 mho and current gain 25. If the above transistor is replaced with another one with transconductance 0.02 mho and current gain 20, the voltage gain will be

(a) 1.5 G
(b) $\frac{1}{3}$ G
(c) $\frac{5}{4}$ G
(d) $\frac{2}{3}$ G

Ans: (d)

Solution: Voltage gain $A_v = \beta\frac{R_{out}}{R_{in}}$

$\Rightarrow G = 25\frac{R_{out}}{R_{in}}$ ... (i)

Transconductance $g_m = \frac{\beta}{R_{in}}$

$\Rightarrow R_{in} = \frac{\beta}{g_m} = \frac{25}{0.03}$

Putting this value of R_{in} in eqn. (i)

$G = 25\frac{R_{out}}{25}\times 0.03$... (ii)

$\therefore G' = 20\frac{R_{out}}{20}\times 0.02$... (iii)

From eqs. (ii) and (iii)

Voltage gain of new transistor $G' = \frac{2}{3}G$

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q26. A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular acceleration of 2 revolutions s^{-2} is:

(a) 25 N (b) 50 N
(c) 78.5 N (d) 157 N

Ans: (d)

Solution: Here α = 2 revolutions/s^2 = 4π rad/s^2 (given)

$I_{cylinder} = \frac{1}{2}MR^2 = \frac{1}{2}(50)(0.5)^2 = \frac{25}{4}$ Kg-m^2

As $\tau = I\alpha$ so $TR = I\alpha$

$\Rightarrow T = \frac{I\alpha}{R} = \frac{\left(\frac{25}{4}\right)(4\pi)}{(0.5)}N = 50\pi N = 157$ N

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q27. The period of oscillation of a mass M suspended from a spring of negligible mass is T. If along with it another mass M is also suspended, the period of oscillation will now be

(a) T
(b) $\frac{T}{\sqrt{2}}$
(c) 2T
(d) $\sqrt{2}$ T

Ans: (d)

Solution: $T = 2\pi\sqrt{\frac{m}{K}}$

$\therefore \frac{T_1}{T_2} = \sqrt{\frac{M_1}{M_2}}$

$\therefore T_2 = T_1\sqrt{\frac{M_2}{M_1}} = T_1\sqrt{\frac{2M}{M}}$

$T_2 = T_1\sqrt{2} = \sqrt{2}$ T (where T_1 =T)

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q28. A charged paritcle (charge *q*) is moving in a circle of radius R with uniform speed *v*. The associated magnetic moment μ is given by

(a) qvR^2 *(b)* $qvR^2/2$
(c) qvR *(d)* $qvR/2$

Ans: (d)

Solution: Magnetic moment, $m = IA$

$= \frac{qv}{2\pi R}(\pi R^2) = \frac{qvR}{2}$

$[\because I = \frac{q}{T}$ and $T = \frac{2\pi R}{v}]$

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q29. The de-Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature T (Kelvin) and mass m, is :-

(a) $\frac{h}{\sqrt{3mk}}$
(b) $\frac{2h}{\sqrt{3mkT}}$
(c) $\frac{2h}{\sqrt{mkT}}$
(d) $\frac{h}{\sqrt{mkT}}$

Ans: (a)

Solution: We know that,

de-Broglie wavelength $\lambda = \frac{h}{P} = \frac{h}{\sqrt{2m(KE)}}$

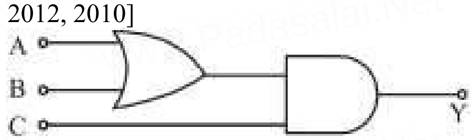
K.E. of thermal neutron $= \frac{3}{2}kT$

$= \frac{h}{\sqrt{2m\left(\frac{3}{2}kT\right)}}$

$\lambda = \frac{h}{\sqrt{3mkT}}$

Chapter - Dual Nature of Radiation and Matter
[Topic: Matter Waves, Cathode & Positive Rays]

Q30. To get output 1 for the following circuit, the correct choice for the input is
[2016, 2012, 2010]



(a) A = 0, B = 1, C = 0 (b) A = 1, B = 0, C = 0
(c) A = 1, B = 1, C = 0 (d) A = 1, B = 0, C = 1

Ans: (d)

Solution: The Boolen expression for the given combination is
output Y = (A + B) · C
Truth tableABCY = (A + B) · C0000100001000010111000111101111111
Hence, A = 1, B = 0, C = 1

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q31. Which of the following is a dimensional constant?
(a) Refractive index
(b) Poissons ratio
(c) Relative density
(d) Gravitational constant

Ans: (d)

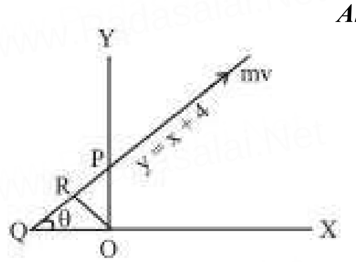
Solution: A quantity which has dimensions and a constant value is called dimensional constant. Therefore, gravitational constant (G) is a dimensional constant.

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q32. A particle of mass m = 5 is moving with a uniform speed $v = 3\sqrt{2}$ in the XOY plane along the line y = x + 4. The magnitude of the angular momentum of the particle about the origin is
[1991]
(a) 60 units (b) $40\sqrt{2}$ units
(c) zero (d) 7.5 units

Ans: (a)

Solution:



y = x + 4 line has been shown in the figure when x = 0, y = 4. So, OP = 4.
The slope of the line can be obtained by comparing with the equation of the straight line
y = mx + c
m = tan θ = 1
$\Rightarrow \theta = 45°$
$\angle OQP = \angle OPQ = 45°$
If we draw a line perpendicular to this line, length of the perpendicular = OR
In ΔOPR, $\frac{OR}{OP} = \sin 45°$
$= OR = OP\sin 45°$
$= 4 \times \frac{1}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}$
Angular momentum of particle going along this line = r × mv = $2\sqrt{2} \times 5 \times 3\sqrt{2} = 60$units

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q33. A particle, with restoring force proportional to displacement and resistve force proportional to velocity is subjected to a force F sin ω_0. If the amplitude of the particle is maximum for $\omega = \omega_1$ and the energy of the particle is maximum for$\omega = \omega_2$, then
(a) $\omega_1 = \omega_0$ and $\omega_2 \neq \omega_0$ (b) $\omega_1 = \omega_0$ and $\omega_2 = \omega_0$
(c) $\omega_1 \neq \omega_0$ and $\omega_2 = \omega_0$ (d) $\omega_1 \neq \omega_0$ and $\omega_2 \neq \omega_0$

Ans: (c)

Solution: At maximum energy of the particle, velocity resonance takes place, which occurs when frequency of external periodic force is equal to natural frequency of undamped vibrations, i.e. $\omega_2 = \omega_0$.
Further, amplitude resonance takes place at a frequency of external force which is less than the frequency of undamped natural vibrations, i.e. $\omega_1 \neq \omega_0$.

Chapter: Oscillation
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

Q34. Two circular coils 1 and 2 are made from the same wire but the radius of the 1st coil is twice that of the 2nd coil. What potential difference in volts should be applied across them so that the magnetic field at their centres is the same
(a) 4 (b) 6
(c) 2 (d) 3 ***Solution:*** (None) If R_1 & R_2 be the radius of the circular wires, $\frac{R_1}{R_2} = \frac{2}{1}$. If same potential is applied on them, current in Ist will be half that in the later. If *V* potential is applied on them, current in them $= \frac{V}{2R}$&$\frac{V}{R}$.
Now magnetic field at the centre of circular coil, $= \frac{\mu_0 I}{2r}$
For first wire, field $B_1 = \frac{\mu_0 V}{2R \times 2R}$
For second wire, field $B_2 = \frac{\mu_0 V}{2\left(\frac{R}{2}\right) \times R}$
Given $B_1 = B_2$
The given data do not provide any required result. There is a mistake in the framing of the question.

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q35. A 200 W sodium street lamp emits yellow light of wavelength 0.6 μm. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is
(a) 1.5×10^{20} (b) 6×10^{18}
(c) 62×10^{20} (d) 3×10^{19}

Ans: (a)

Solution: Give that, only 25% of 200W converter electrical energy into light of yellow colour

$$\left(\frac{hc}{\lambda}\right) \times N = 200 \times \frac{25}{100}$$

Where *N* is the No. of photons emitted per second, *h* = plank's constant, *c*, speed of light.

$$N = \frac{200 \times 25}{100} \times \frac{\lambda}{hc}$$

$$\frac{200\times25\times0.6\times10^{-6}}{100\times6.2\times10^{-34}\times3\times10^{8}} = 1.5 \times 10^{20}$$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q36. A car covers the first half of the distance between two places at 40 km/h and other half at 60 km/h. The average speed of the car is
(a) 40 km/h (b) 48 km/h
(c) 50 km/h (d) 60 km/h

Ans: (b)

Solution: Total distance = s;

Total time taken $= \frac{\frac{s}{2}}{40} + \frac{\frac{s}{2}}{60} = \frac{5s}{240} = \frac{s}{48}$

∴ Average speed= $\frac{\text{total distance}}{\text{total time}}$

$= \frac{s}{\frac{s}{48}}$ =48km/h

[Alt : $v_{av} = \frac{2v_1v_2}{v_1+v_2} = \frac{2\times40\times60}{40+60} = 48$ km/h]

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q37. The ratio of the accelerations for a solid sphere (mass 'm' and radius 'R') rolling down an incline of angle 'θ' without slipping and slipping down the incline without rolling is :
(a) 5 : 7 (b) 2 : 3
(c) 2 : 5 (d) 7 : 5

Ans: (a)

Solution: For solid sphere rolling without slipping on inclined plane, acceleration

$a_1 = \frac{g\sin\theta}{1+\frac{K^2}{R^2}}$

For solid sphere slipping on inclined plane without rolling, acceleration

$a_2 = g \sin \theta$

Therefore required ratio $= \frac{a_1}{a_2}$

$= \frac{1}{1+\frac{K^2}{R^2}} = \frac{1}{1+\frac{2}{5}} = \frac{5}{7}$

Chapter: System of Particles and Rotational Motion
[Topic: Rolling Motion]

Q38. A hospital uses an ultrasonic scanner to locate tumours in a tissue. The operating frequency of the scanner is 4.2 MHz. The speed of sound in a tissue is 1.7 km/s. The wavelength of sound in tissue is close to
(a) 4×10^{-4}m (b) 8×10^{-4}m
(c) 4×10^{-3}m (d) 8×10^{-3}m

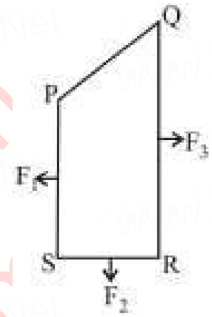
Ans: (a)

Solution: Frequency (n) = 4.2 MHz = 4.2×10^6 Hz and speed of sound (v) = 1.7 km/s = 1.7×10^3 m/s. Wave length of sound in tissue

$(\lambda) = \frac{v}{n} = \frac{1.7\times10^3}{4.2\times10^6} = 4 \times 10^{-4}$m .

Chapter: Waves
[Topic: Basic of Mechanical Waves, Progressive & Stationary Waves]

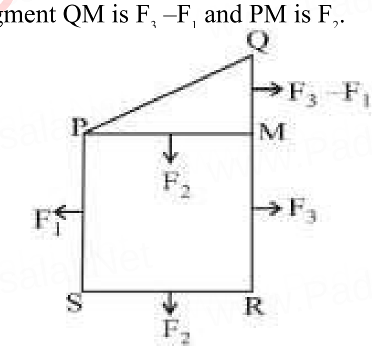
Q39.



A closed loop PQRS carrying a current is placed in a uniform magnetic field. If the magnetic forces on segments PS, SR, and RQ are F_1 , F_2 and F_3 respectively and are in the plane of the paper and along the directions shown, the force on the segment QP is
(a) $F_3 - F_1 - F_2$ (b) $\sqrt{(F_3 - F_1)^2 + F_2^2}$
(c) $\sqrt{(F_3 - F_1)^2 - F_2^2}$
(d) $F_3 - F_1 + F_2$

Ans: (b)

Solution: According to the figure the magnitude of force on the segment QM is $F_3 - F_1$ and PM is F_2.



Therefore, the magnitude of the force on segment PQ is $\sqrt{(F_3 - F_1)^2 + F_2^2}$

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q40. As the intensity of incident light increases
(a) photoelectric current increases
(b) K. E. of emitted photelectrons increases
(c) photoelectric current decreases
(d) K.E. of emitted photoelectrons decreases

Ans: (a)

Solution: K.E. of electrons emitted depends upon the frequency of incident rays rather than the intensity. While number of photo electrons emitted depends upon intensity of radiation.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q41. A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a distance with velocity 30 km/h and 40 km/h respectively. The velocity of the car midway between P and Q is
[1988]

(a) 33.3 km /h
(b) $20\sqrt{2}$ km/ h
(c) $25\sqrt{2}$ km/h
(d) 35 km/h

Ans: (c)

Solution: Let PQ = x , then

$a = \frac{40^2 - 30^2}{2x} = \frac{350}{x}$ [$\because v^2 = u^2 + 2as$]

Also, velocity at mid point is given by

$$v^2 - 30^2 = 2 \times \frac{350}{x} \times \frac{x}{2}$$

This gives $v = 25\sqrt{2}$kmph

Chapter: Kinematics Motion in a Straight Line
[Topic: Relative Velocity]

Q42. Imagine a new planet having the same density as that of earth but it is 3 times bigger than the earth in size. If the acceleration due to gravity on the surface of earth is g and that on the surface of the new planet is g’, then
[2005]

(a) g’ = g/9
(b) g’ = 27g
(c) g’=9g
(d) g’=3g

Ans: (d)

Solution: We know that

$g = \frac{GM}{R^2} = \frac{G\left(\frac{4}{3}\pi R^3\right)\rho}{R^2} = \frac{4}{3}\pi G R \rho$

$$\frac{g}{g'} = \frac{R'}{R} = \frac{3R}{R} = 3$$

$g' = 3g$

Chapter: Gravitation
[Topic: Acceleration due to Gravity]

Q43. A stretched string resonates with tuning fork frequency 512 Hz when length of the string is 0.5 m. The length of the string required to vibrate resonantly with a tuning fork of frequency 256 Hz would be

(a) 0.25 m
(b) 0.5 m
(c) 1 m
(d) 2 m

Ans: (d)

Solution: $f = \frac{1}{2l}\left[\frac{T}{\mu}\right]^{\frac{1}{2}}$. When f is halved, the length is doubled.

Chapter: Waves
[Topic: Beats, Interference & Superposition of Waves]

Q44. A bar magnet having a magnetic moment of 2×10^4 JT^{-1} is free to rotate in a horizontal plane. A horizontal magnetic field $B = 6 \times 10^{-4}$ T exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction 60° from the field is

(a) 12 J
(b) 6 J
(c) 2 J
(d) 0.6 J

Ans: (b)

Solution: Work done

$= MB (\cos\theta_1 - \cos\theta_2)$

$= MB (\cos 0° - \cos 60°)$

$= MB\left(1 - \frac{1}{2}\right) = \frac{2\times10^4\times6\times10^{-4}}{2} = 6$ J

Chapter: Magnetism and Matter
[Topic: Magnetism, Gauss's Law, Magnetic Moment & Properties of Magnet]

Q45. When an α-particle of mass 'm' moving with velocity 'v' bombards on a heavy nucleus of charge 'Ze', its distance of closest approach from the nucleus depends on m as :

(a) $\frac{1}{m}$
(b) $\frac{1}{\sqrt{m}}$
(c) $\frac{1}{m^2}$
(d) m

Ans: (a)

Solution: At closest distance of approach, the kinetic energy of the particle will convert completely into electrostatic potential energy.

Kinetic energy K.E. $= \frac{1}{2}mv^2$

Potential energy P.E. $= \frac{KQq}{r}$

$\frac{1}{2}mv^2 = \frac{KQq}{r} \Rightarrow r \propto \frac{1}{m}$

Chapter: Atoms
[Topic: Atomic Structure, Rutherford's Nuclear Model of Atom]

Q46. If a vector $2\vec{i} + 3\hat{j} + 8\hat{k}$ is perpendicular to the vector $4\hat{j} - 4\hat{i} + \alpha\hat{k}$, then the value of α is

(a) 1/2
(b) –1/2
(c) 1
(d) –1

Ans: (b)

Solution: For two vectors to be perpendicular to each other

$\vec{A}.\vec{B} = 0$

$(2\hat{i} + 3\hat{j} + 8\hat{k}) \cdot (4\hat{j} - 4\hat{i} + \alpha\hat{k}) = 0$

$-8 + 12 + 8\alpha = 0$

$$\alpha = -\frac{4}{8} = -\frac{1}{2}$$

Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q47. A planet moving along an elliptical orbit is closest to the sun at a distance r_1 and farthest away at a distance of r_2. If v_1 and v_2 are the linear velocities at these points respectively, then the ratio $\frac{v_1}{v_2}$ is

(a) $(r_1/r_2)^2$
(b) r_2/r_1

(c) $(r_2/r_1)^2$ (d) r_1/r_2

Ans: (b)

Solution: Angular momentum is conserved

$\therefore L_1 = L_2$

$\Rightarrow mr_1v_1 = mr_2v_2$

$\Rightarrow r_1v_1 = r_2v_2$

$= \frac{v_1}{v_2} = \frac{r_2}{r_1}$

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q48. A source and an observer move away from each other, with a velocity of 10m/s with respect to ground. If the observer finds the frequency of sound coming from the source as 1950 Hz, then original frequency of source is (velocity of sound in air = 340 m/s)

(a) 1950 Hz (b) 2068 Hz

(c) 2132 Hz (d) 2486 Hz

Ans: (b)

Solution: According to Doppler's effect

$n' = \left(\frac{v - v_0}{v - v_s}\right) n = \left(\frac{340 - 10}{340 + 10}\right) n = \frac{330}{350} \times 1950$

= 2068 Hz

Chapter: Waves

[Topic: Musical Sound & Doppler's Effect]

Q49. A current of 2.5 A flows through a coil of inductance 5 H. The magnetic flux linked with the coil is

(a) 2 Wb (b) 0.5 Wb

(c) 12.5 Wb

(d) Zero

Ans: (c)

Solution: Given: current I = 2.5 A

Inductance, L = 5H

Magnatic flux, φ = ?

We know, $\varphi = LI \Rightarrow 5 \times 2.5$ Wb = 12.5 Wb

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q50. The total energy of an electron in the first excited state of hydrogen atom is about –3.4 eV. Its kinetic energy in this state is

(a) 3.4 eV (b) 6.8 eV

(c) –3.4 eV (d) –6.8 eV

Ans: (a)

Solution: KE. $= \frac{Z^2}{n^2}(13.6\text{eV})$

Mechanical energy $= \frac{-Z^2}{n^2}(13.6\text{eV})$

∴ K.E. in 2nd orbital for hydrogen

= – Mechanical energy

$= \frac{(1)^2}{(2)^2}(13.6) = +3.4\text{eV}$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

PART 15. PHYSICS QUESTION BANK

Q51. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectiles is :

(a) $\theta = \tan^{-1}\left(\frac{1}{4}\right)$
(b) $\theta = \tan^{-1}(4)$
(c) $\theta = \tan^{-1}(2)$
(d) $\theta = 45°$

Ans: (b)

Solution: Horizontal range

$R = \frac{u^2 \sin 2\theta}{g}$ ....(1)

Maximum height

$H = \frac{u^2 \sin^2\theta}{2g}$ ....(2)

According to the problem

R = H

$$\frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g}$$

$\Rightarrow 2 \sin\theta \cos\theta = \frac{\sin^2\theta}{2}$

$2\cos\theta = \frac{\sin\theta}{2}$

$\Rightarrow \cot\theta = \frac{1}{4}$

$\Rightarrow \tan\theta = 4$

$\Rightarrow \theta = [\tan^{-1}(4)]$

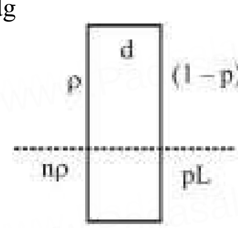
Chapter: Kinematics Motion in a Plane
[Topic: Projectile Motion]

Q52. Two non-mixing liquids of densities ρ and nρ (n > 1) are put in a container. The height of each liquid is h. A solid cylinder of length L and density d is put in this container. The cylinder floats with its axis vertical and length pL(p < 1) in the denser liquid. The density d is equal to :
[2016]

(a) {1 + (n + 1)p}ρ
(b) {2 + (n + 1)p}ρ
(c) {2 + (n – 1)p}ρ
(d) {1 + (n – 1)p}ρ

Ans: (d)

Solution: As we know,
Pressure P = Vdg



Here, L A d g = (pL) A (nρ)g + (1 – p)L A ρ g

⇒d = (1 – p)ρ + pn ρ = [1 + (n – 1)p]ρ

Chapter: Mechanical Properties of Fluids
[Topic: Pressure, Density Pascal's Law & Archimedes' Principle]

Q53. From a point charge, there is a fixed point A. At A, there is an electric field of 500 V/m and potential difference of 3000 V. Distance between point charge and A will be

(a) 6 m   (b) 12 m
(c) 16 m   (d) 24 m

Ans: (a)

Solution: Given : Electric field (E) = 500 V/m
and potential difference (V) = 3000 V.
We know that electric field

(E) = 500 = $\frac{V}{d}$ or $d = \frac{3000}{500} = 6\text{m}$

[where *d* = Distance between point chargeand A]

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Field, Electric Field Lines & Dipole]

Q54. If the number of turns per unit length of a coil of solenoid is doubled, the self-inductance of the solenoid will

(a) remain unchanged
(b) be halved
(c) be doubled
(d) become four times

Ans: (d)

Solution: Self inductance of a solenoid = $\frac{\mu n^2 A}{\ell}$

So, self induction ∝ n^2

So, inductance becomes 4 times when n is doubled.

Chapter: Electromagnetic
[Topic: Motional and Static EMI & Applications of EMI]

Q55. A nucleus represented by the symbol $^A_Z X$ has

(a) *A* protons and (*Z-A*) neutrons
(b) *Z* neutrons and (*A-Z*) protons
(c) *Z* protons and (*A-Z*) neutrons
(d) *Z* protons and *A* neutrons

Ans: (c)

Solution: $^A_Z X$ has *Z* protons and (*A* – *Z*) neutrons

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

Q56. A body is whirled in a horizontal circle of radius 20 cm. It has an angular velocity of 10 rad/s. What is its linear velocity at any point on circular path

(a) $\sqrt{2}$m/s   (b) 2 m/s
(c) 10 m/s   (d) 20 m/s

Ans: (b)

Solution: Radius of circular path = 20 cm = $\frac{2}{10}$ m

Angular speed of body = 10 rad/s

Linear velocity = radius × Angular speed

$= \frac{2}{10} \times 10 = 2\text{m/s}$

Chapter: Kinematics Motion in a Plane
[Topic: Relative Velocity in2D & Circular Motion]

Q57. The two ends of a metal rod are maintained at temperatures 100°C and 110°C. The rate of heat flow in the rod is found to be 4.0 J/s. If the ends are maintained at temperatures 200°C and 210°C, the rate of heat flow will be

(a) 16.8 J/s (b) 8.0 J/s
(c) 4.0 J/s (d) 44.0 J/s

Ans: (c)

Solution: As the temperature difference $\Delta T = 10°C$ as well as the thermal resistance is same for both the cases, so thermal current or rate of heat flow will also be same for both the cases.

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q58. A solid spherical conductor is given a charge. The electrostatic potential of the conductor is

(a) constant throughout the conductor
(b) largest at the centre
(c) largest on the surface
(d) largest somewhere between the centre and the surface

Ans: (a)

Solution: Electric potential is constant (equal to $\frac{kq}{R}$,where $k = \frac{1}{4\pi\epsilon_0}$) within or on the surface of conductor.

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q59. A coil of inductive reactance 31 Ω has a resistance of 8 Ω. It is placed in series with a condenser of capacitative reactance 25Ω. The combination is connected to an a.c. source of 110 volt. The power factor of the circuit is

(a) 0.64 (b) 0.80
(c) 0.33 (d) 0.56

Ans: (b)

Solution: Power factor, $\phi = \frac{R}{\sqrt{\left(\omega L - \frac{1}{\omega C}\right)^2 + R^2}}$

$$= \frac{8}{\sqrt{(31-25)^2 + 8^2}} = \frac{8}{\sqrt{6^2 + 8^2}}$$

$$= \frac{8}{10} = 0.8$$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q60. A nucleus ^A_ZX has mass represented by $M(A, Z)$. If M_p and M_n denote the mass of proton and neutron respectively and B.E. the binding energy in MeV, then

(a) B.E. = $[ZM_p + (A - Z)M_n - M(A, Z)]c^2$
(b) B.E. = $[ZM_p + ZM_n - M(A, Z)]c^2$
(c) B.E. = $M(A, Z) - ZM_p - (A - Z)M_n$
(d) B.E. = $[M(A, Z) - ZM_p - (A - Z)M_n]c^2$

Ans: (a)

Solution: The difference in mass of a nucleus and its constituents, ΔM, is called the mass defect and is given by

$$\Delta M = [ZM_p + (A - Z)M_n] - M$$

and binding energy = ΔMc^2

$$= [\{ZM_p + (A - Z)M_n\} - M]c^2$$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q61. A balloon with mass 'm' is descending down with an acceleration 'a' (where a < g). How much mass should be removed from it so that it starts moving up with an acceleration 'a'?

(a) $\frac{2ma}{g+a}$
(b) $\frac{2ma}{g-a}$
(c) $\frac{ma}{g+a}$
(d) $\frac{ma}{g-a}$

Ans: (a)

Solution: Let upthrust of air be F_a then

For downward motion of balloon

$F_a = mg - ma$

$mg - F_a = ma$

For upward motion

$F_a - (m - \Delta m)g = (m - \Delta m)a$

Therefore $\Delta m = \frac{2ma}{g+a}$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q62. The radiant energy from the sun, incident normally at the surface of earth is 20 k cal/m^2 min. What would have been the radiant energy, incident normally on the earth, if the sun had a temperature, twice of the present one?

(a) 160 k cal/m^2 min (b) 40 k cal/m^2 min
(c) 320k cal/m^2 min (d) 80 k cal/m^2 min

Ans: (c)

Solution: According to Stefan's law

$E \propto T^4$

$\frac{E_1}{E_2} = \frac{T_1^4}{T_2^4}$ or $\frac{20}{E_2} = \frac{T^4}{2^4T^4}$

$= E_2 = 320$ kcal/m^2. min.

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q63. In a parallel plate capacitor, the distance between the plates is d and potential difference across the plates is V. Energy stored per unit volume between the plates of capacitor is

(a) $\frac{Q^2}{2V^2}$
(b) $\frac{1}{2}\varepsilon_0\frac{V^2}{d^2}$
(c) $\frac{1}{2}\frac{V^2}{\varepsilon_0 d^2}$
(d) $\frac{1}{2}\varepsilon_0\frac{V^2}{d}$

Ans: (b)

Solution: Energy stored per unit volume

$$= \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\varepsilon_0\left(\frac{V}{d}\right)^2 = \frac{1}{2}\varepsilon_0\frac{V^2}{d^2}\left(E = \frac{y}{d}\right)$$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q64. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to :
(a) the speed of light in vacuum
(b) reciprocal of speed of light in vacuum
(c) the ratio of magnetic permeability to the electric susceptibility of vacuum
(d) unity

Ans: (b)

Solution: The average energy stored in the electric field $U_E = \frac{1}{2}\varepsilon_0 E^2$

The average energy stored in the magnetic field = $U_B = \frac{1}{2}\frac{B^2}{\mu_0}$,

According to conservation of energy $U_E = U_B$

$$\varepsilon_0\mu_0 = \frac{B^2}{E^2}$$

$$\frac{B}{E} = \sqrt{\varepsilon_0\mu_0} = \frac{1}{c}$$

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q65. Radioactive material 'A' has decay constant '8 λ' and material 'B' has decay constant 'λ'. Initially they have same number of nuclei. After what time, the ratio of number of nuclei of material 'B' to that 'A' will be $\frac{1}{e}$?
(a) $\frac{1}{7\lambda}$
(b) $\frac{1}{8\lambda}$
(c) $\frac{1}{9\lambda}$
(d) $\frac{1}{\lambda}$

Ans: (a)

Solution: Given, $\lambda_A = 8\lambda, \lambda_B = \lambda$

$N_B = \frac{N_A}{e}$

$\Rightarrow N_o e^{-\lambda_B t} = N_o \frac{e^{-\lambda_A t}}{e}$

$e^{-\lambda t} = e^{-8\lambda t}e^{-1}$

$e^{-\lambda t} = e^{-8\lambda t-1}$

Comparing both side powers

$-\lambda t = -8\lambda t - 1$

$-1 = 7\lambda t$

$t = -\frac{1}{7\lambda}$

The best possible answer is $t = \frac{1}{7\lambda}$

Chapter: Nuclei
[Topic: Radioactivity]

Q66. Starting from rest, a body slides down a 45° inclined plane in twice the time it takes to slide down the same distance in the absence of friction. The coefficient of friction between the body and the inclined plane is
(a) 0.80 (b) 0.75
(c) 0.25 (d) 0.33

Ans: (b)

Solution: In presence of friction a = (g sinθ – μg cos θ)

∴ Time taken to slide down the plane

$$t_1 = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2s}{g(\sin\theta - \mu\cos\theta)}}$$

In absence of friction $t_2 = \sqrt{\frac{2s}{g\sin\theta}}$

$t_1 = 2t_2 \therefore t_1^2 = 4t_2^2$

or $\frac{2s}{g(\sin\theta-\mu\cos\theta)} = \frac{2s\times4}{g\sin\theta}$

sin θ = 4 sinθ – 4μ cos θ

$$\mu = \frac{3}{4}\tan\theta = \frac{3}{4} = 0.75$$

Chapter: Dynamics Laws of Motion
[Topic: Circular Motion, Banking of Road]

Q67. During an isothermal expansion, a confined ideal gas does –150 J of work against its surroundings. This implies that
(a) 150 J heat has been removed from the gas
(b) 300 J of heat has been added to the gas
(c) no heat is transferred because the process is isothermal
(d) 150 J of heat has been added to the gas

Ans: (a)

Solution: or (d)

If a process is expansion then work done is positive so answer will be (a) .

But in question work done by gas is given –150J so that according to it answer will be (d) .

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q68. The masses of the three wires of copper are in the ratio of 1 : 3 : 5 and their lengths are in the ratio of 5 : 3 : 1. The ratio of their electrical resistance is
(a) 1 : 3 : 5 (b) 5 : 3 : 1
(c) 1 : 25 : 125 (d) 125 : 15 : 1

Ans: (d)

Solution: $R = \frac{\rho l}{\pi r^2}$. But $m = \pi r^2 ld$ $\pi r^2 = \frac{m}{ld}$

$R = \frac{\rho l^2 d}{m}, R_1 = \frac{\rho l_1^2 d}{m_1}, R_2 = \frac{\rho l_2^2 d}{m^2}$

$$R_3 = \frac{\rho l_3^2 d}{m_3}$$

$$R_1 : R_2 : R_3 = \frac{l_1^2}{m_1} : \frac{l_2^2}{m_2} : \frac{l_3^2}{m_3}$$

$$R_1 : R_2 : R_3 = \frac{25}{1} : \frac{9}{3} : \frac{1}{5} = 125 : 15 : 1$$

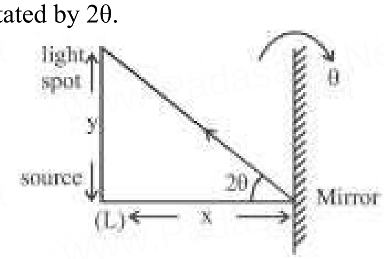
Chapter: Current Electricity
[Topic: Combination of Resistances]

Q69. A beam of light from a source L is incident normally on a plane mirror fixed at a certain distance x from the source. The beam is reflected back as a spot on a scale placed just above the source I. When the mirror is rotated through a small angle θ, the spot of the light is found to move through a distance y on the scale. The angle θ is given by

(a) $\frac{y}{x}$
(b) $\frac{x}{2y}$
(c) $\frac{x}{y}$
(d) $\frac{y}{2x}$

Ans: (d)

Solution: When mirror is rotated by angle θ reflected ray will be rotated by 2θ.



$\frac{y}{x} = 2\theta \Rightarrow \theta = \frac{y}{2x}$

Chapter - Ray Optics and Optical [Topic: Plane Mirror, Spherical Mirror & Reflection of Light]

Q70. After 1α and 2 β-emissions
(a) mass number reduces by 4
(b) mass number reduces by 5
(c) mass number reduces by 6
(d) mass number increases by 4

Ans: (a)

Solution: Emission of 1α particle led to decrease in atomic number by 2 while mass number by 4. On the other hand, emission of 2β particles increases atomic number by 2. Hence, overall emission of, 1α and 2β particles led to decrease in mass number by 4.

Chapter: Nuclei [Topic: Radioactivity]

Q71. A block of mass 10 kg, moving in x direction with a constant speed of 10 ms^{-1}, is subject to a retarding force F = 0.1 × J/m during its travel from x = 20 m to 30 m. Its final KE will be :
(a) 450 J (b) 275 J
(c) 250 J (d) 475 J

Ans: (d)

Solution: From, F = ma

$a = \frac{F}{m} = \frac{0.1x}{10} = 0.01x = V\frac{dV}{dx}$

So, $\int_{V_1}^{V_2} v\,dV = \int_{20}^{30} \frac{x}{100}dx$

$-\frac{\Delta V^2}{2} = \frac{\Delta x^2}{200} = \frac{30^2}{200} - \frac{20^2}{200}$

= 4.5 – 2 = 2.5

$\frac{1}{2}m(V_2^2 - V_1^2) = 10 \times 2.5J = -25J$

Final K.E.

$= \frac{1}{2}mv_2^2 = \frac{1}{2}mv_1^2 - 25 = \frac{1}{2} \times 10 \times 10 \times 10 - 25$

= 500 – 25 = 475 J

Chapter: Work, Energy and Power [Topic: Energy]

Q72. An ideal gas heat engine operates in a Carnot cycle between 227ºC and 127ºC. It absorbs 6 kcal at the higher temperature. The amount of heat (in kcal) converted into work is equal to
(a) 1.2 (b) 4.8
(c) 3.5 (d) 1.6

Ans: (a)

Solution: Efficiency $= \frac{T_1 - T_2}{T_1}$

$T_1 = 227 + 273 = 500$ K
$T_2 = 127 + 273 = 400$ K

$\eta = \frac{500 - 400}{500} = \frac{1}{5}$

Hence, output work

$= (\eta) \times \text{Heatinput} = \frac{1}{5} \times 6 = 1.2\text{kcal}$

Chapter: Heat & Thermodynamics [Topic: Carnot Engine, Refrigerator & Second Law of Thermodynamics]

Q73. In producing chlorine by electrolysis 100 *kW* power at 125 *V* is being consumed. How much chlorine per minute is liberated? (E.C.E. of chlorine is 0.367×10^{-6} kg / C)
(a) 1.76×10^{-3} *kg* (b) 9.67×10^{-3} *kg*
(c) 17.61×10^{-3} *kg* (d) 3.67×10^{-3} *kg*

Ans: (c)

Solution: $I = \frac{P}{V} = \frac{100 \times 10^3}{125}A = \frac{10^5}{60}A$

E.C.E. $= 0.367 \times 10^{-6}$ *kg C*$^{-1}$

Charge per minute = (I × 60) *C*

$= \frac{10^5 \times 60}{125}C = \frac{6 \times 10^6}{125}C$

∴ Mass liberated

$= \frac{6 \times 10^6}{125} \times 0.367 \times 10^{-6}$

$= \frac{6 \times 1000 \times 0.367 \times 10^{-3}}{125}$

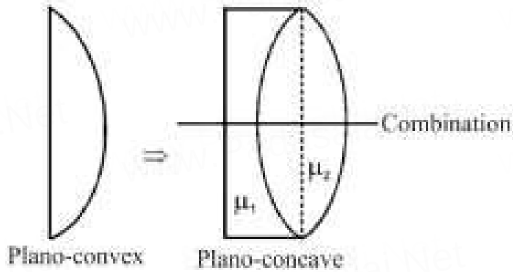
$= 17.616 \times 10^{-3}$ *kg*

Chapter: Current Electricity [Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q74. A plano convex lens fits exactly into a plano concave lens. Their plane surfaces are parallel to each other. If lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of the curved surface of the lenses, then the focal length of the combination is
(a) $\frac{R}{2(\mu_1 - \mu_2)}$
(b) $\frac{R}{(\mu_1 - \mu_2)}$
(c) $\frac{2R}{(\mu_2 - \mu_1)}$
(d) $\frac{R}{2(\mu_1 + \mu_2)}$

Ans: (b)

Solution:



$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$

$=(\mu_1-1)\left(\frac{1}{\infty}-\frac{1}{-R}\right)+(\mu_2-1)\left(\frac{1}{\infty}-\frac{1}{R}\right)$

$=\left(\frac{\mu_1-1}{R}\right)-\frac{(\mu_2-1)}{R}\Rightarrow\frac{1}{f}=\frac{\mu_1-\mu_2}{R}$

$\Rightarrow f=\frac{R}{\mu_1-\mu_2}$

Hence, focal length of the combination is $\frac{R}{\mu_1-\mu_2}$.

Chapter - Ray Optics and Optical [Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q75. C and Si both have same lattice structure, having 4 bonding electrons in each. However, C is insulator whereas Si is intrinsic semiconductor. This is because :

(a) In case of C the valence band is not completely filled at absolute zero temperature.

(b) In case of C the conduction band is partly filled even at absolute zero temperature.

(c) The four bonding electrons in the case of C lie in the second orbit, whereas in the case of Si they lie in the third.

(d) The four bonding electrons in the case of C lie in the third orbit, whereas for Si they lie in the fourth orbit.

Ans: (c)

Solution: Electronic configuration of ^6C

$^6C = 1s^2, 2s^2\,2p^2$

The electronic configuration of ^{14}Si

$^{14}Si = 1s^2, 2s^2\,2p^6, 3s^2\,3p^2$

As they are away from Nucleus, so effect of nucleus is low for Si even for Sn and Pb are almost mettalic.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q76. A body projected vertically from the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest

(a) at the highest position of the body

(b) at the instant just before the body hits the earth

(c) it remains constant all through

(d) at the instant just after the body is projected

Ans: (b)

Solution: Power exerted by a force is given by

P = F.v

When the body is just above the earth's surface, its velocity is greatest. At this instant, gravitational force is also maximum. Hence, the power exerted by the gravitational force is greatest at the instant just before the body hits the earth.

Chapter: Work, Energy and Power [Topic: Power]

Q77. The ratio of the specific heats $\frac{C_p}{C_v}=\gamma$ in terms of degrees of freedom (n) is given by

(a) $\left(1+\frac{n}{3}\right)$

(b) $\left(1+\frac{2}{n}\right)$

(c) $\left(1+\frac{n}{2}\right)$

(d) $\left(1+\frac{1}{n}\right)$

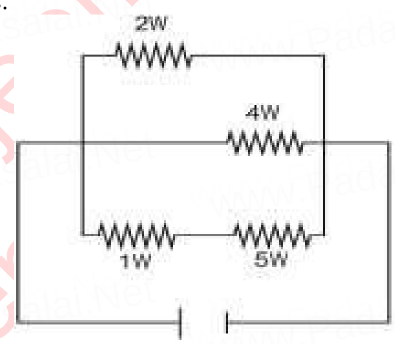
Ans: (b)

Solution: Let 'n' be the degree of freedom

$$\gamma=\frac{C_p}{C_v}=\frac{\left(\frac{n}{2}+1\right)R}{\left(\frac{n}{2}\right)R}=\left(1+\frac{2}{n}\right)$$

Chapter: Kinetic Theory [Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q78. A current of 3 amp flows through the 2Ω resistor shown in the circuit. The power dissipated in the 5-Ω resistor is:



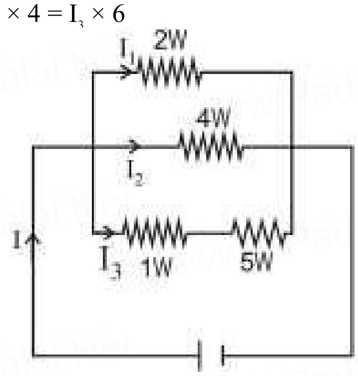
(a) 4 watt (b) 2 watt

(c) 1 watt (d) 5 watt

Ans: (d)

Solution: Clearly, 2Ω , 4Ω and (1 + 5) Ω resistors are in parallel. Hence, potential difference is same across each of them.

$\therefore I_1\times 2=I_2\times 4=I_3\times 6$



Given I_1 = 3A$\therefore I_1\times 2=I_3\times 6$

Given I_1 = 3A.

$\therefore I_1\times 2=I_3\times 6$ provides

$I_3 = \frac{I_1 \times 2}{6} = \frac{3 \times 2}{6} = 1A.$

Now, the potential across the 5Ω resistor is

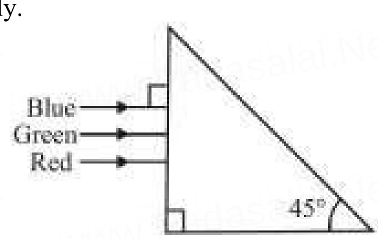
$V = I_3 \times 5 = 1 \times 5 = 5V.$

∴ the power dissipated in the 5Ω resistor

$P = \frac{V^2}{R} = \frac{5^2}{5} = 5$watt.

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q79. A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive index of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47, respectively.



The prism will:
(a) separate all the three colours from one another
(b) not separate the three colours at all
(c) separate the red colour part from the green and blue colours
(d) separate the blue colour part from the red and green colours

Ans: (c)

Solution: For total internal reflection, incident angle (i) > critical angle (i_c)
So, sin i > sin i_c
$\sin 45° > \frac{1}{\mu} \Rightarrow \mu > \sqrt{2} \Rightarrow 1.414$
Since refractive index μ of green and voilet are greater than 1.414 so they will total internal reflected. But red colour will be refracted.

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q80. The intrinsic semiconductor becomes an insulator at
(a) 0ºC (b) 0 K
(c) 300 K (d) –100ºC

Ans: (a)

Solution: At 0K, motion of free electrons stop. Hence conductivity becomes zero. Therefore, at 0K intrinsic semiconductor becomes insulator.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q81. A body of mass 5 kg explodes at rest into three fragments with masses in the ratio 1 : 1 : 3. The fragments with equal masses fly in mutually perpendicular directions with speeds of 21 m/s. The velocity of heaviest fragment in m/s will be
(a) $7\sqrt{2}$ (b) $5\sqrt{2}$
(c) $3\sqrt{2}$ (d) $\sqrt{2}$

Ans: (a)

Solution: Masses of the pieces are 1, 1, 3 kg. Hence
$(1 \times 21)^2 + (1 \times 21)^2 = (3 \times V)^2$
That is, $V = 7\sqrt{2}$ m/s

Chapter: Work, Energy and Power
[Topic: Collisions]

Q82. A particle executing simple harmonic motion of amplitude 5 cm has maximum speed of 31.4 cm/s. Its oscillation per second
(a) 4 (b) 3
(c) 2 (d) 1

Ans: (a)

Solution: When v is maximum, a is zero
$v = \omega\sqrt{A^2 - x^2}$;$a = \omega^2 x$
v_{max} at x = 0, but at x = 0, a = 0

Chapter: Oscillation
[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q83. A potentiometer circuit has been set up for finding the internal resistance of a given cell. The main battery used across the potentiometer wire, has an emf of 2.0 V and a negligible internal resistance. The potentiometer wire itself is 4m long, When the resistace R, connected across the given cell, has values of
(i) infinity (ii) 9.5Ω
The balancing lengths', on the potentiometer wire are found to be 3 m and 2.85 m, respectively. The value of internal resistance of the cell is
[2014]
(a) 0.25Ω (b) 0.95Ω
(c) 0.5Ω (d) 0.75Ω

Ans: (c)

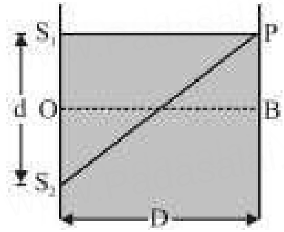
Solution: Internal resistance of the cell,
$r = \left(\frac{E-V}{V}\right)R = \left(\frac{\ell_1 - l_2}{p_2}\right)R$
$= \left(\frac{3-2.85}{2.85}\right) \times (9.5)\Omega = 0.5\Omega$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q84. The intensity at the maximum in a Young's double slit experiment is I_0. Distance between two slits is d = 5λ, where λ is the wavelength of light used in the experiment. What will be the intensity in front of one of the slits on the screen placed at a distance D = 10 d ?
(a) I_0 (b) $\frac{I_0}{4}$
(c) $\frac{3}{4}I_0$ (d) $\frac{I_0}{2}$

Ans: (d)

Solution: Let P is a point infront of one slit at which intensity is to be calculated. From figure,



Path difference = $S_2P - S_1P$

$= \sqrt{D^2 + d^2} - D = D\left(1 + \frac{1}{2}\frac{d^2}{D^2}\right) - D$

$= D\left[1 + \frac{d^2}{2D^2} 1\right] = \frac{d^2}{2D}$

$\Delta x = \frac{d^2}{2\times 10d} = \frac{d}{20} = \frac{5\lambda}{20} = \frac{\lambda}{4}$

Phase difference,

$\Delta\varphi = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2}$

So, resultant intensity at the desired point 'p' is

$I = I_0 \cos^2\frac{\phi}{2} = I_0 \cos^2\frac{\pi}{4} = \frac{I_0}{2}$

Chapter - Wave Optics
[Topic: Young's Double Slit Experiment]

Q85. One way in which the operation of a n-p-n transistor differs from that of a p-n-p

(a) the emitter junction is reversed biased in n-p-n

(b) the emitter junction injects minority carriers into the base region of the p-n-p

(c) the emitter injects holes into the base of the p-n-p and electrons into the base region of n-p-n

(d) the emitter injects holes into the base of n-p-n

Ans: (c)

Solution: In p-n-p transistor holes are injected into the base while electrons are injected into the base of n-p-n transistor. Emitter-base junction is forward biased.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]