SURA'S

PHYSICS

VOLUME - I & II

12th Standard

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- Public Examination March 2020 Question Paper with Answers are given.

SURA PUBLICATIONS
Chennai

Contents

VOLUME - I

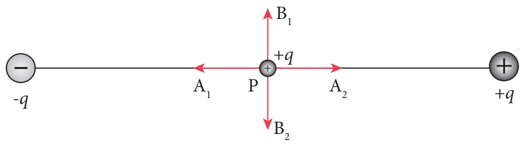
UNIT 1 ELECTROSTATICS

CHAPTER SNAPSHOT

Evaluation

I. Multiple choice questions :

1. **Two identical point charges of magnitude $-q$ are fixed as shown in the figure below. A third charge $+q$ is placed midway between the two charges at the point P. Suppose this charge $+q$ is displaced a small distance from the point P in the directions indicated by the arrows, in which direction(s) will $+q$ be stable with respect to the displacement?**



(a) A_1 and A_2 (b) B_1 and B_2
(c) both directions (d) No stable

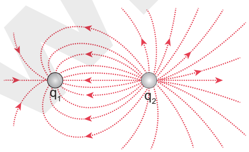
[*Ans.* (b) B_1 and B_2]

2. **Which charge configuration produces a uniform electric field?** *[HY-2019]*

(a) point Charge
(b) uniformly charged infinite line
(c) uniformly charged infinite plane
(d) uniformly charged spherical shell

[*Ans.* (c) uniformly charged infinite plane]

3. **What is the ratio of the charges $\left|\frac{q_1}{q_2}\right|$ for the following electric field line pattern?**



(a) $\frac{1}{5}$ (b) $\frac{25}{11}$
(c) 5 (d) $\frac{11}{25}$

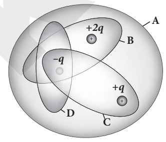
[*Ans.* (d) $\frac{11}{25}$]

4. **An electric dipole is placed at an alignment angle of 30° with an electric field of 2×10^5 N C^{-1}. It experiences a torque equal to 8 N m. The charge on the dipole if the dipole length is 1 cm is** *[QY-2019]*

(a) 4 mC (b) 8 mC
(c) 5 mC (d) 7 mC

[*Ans.* (b) 8 mC]

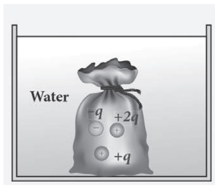
5. **Four Gaussian surfaces are given below with charges inside each Gaussian surface. Rank the electric flux through each Gaussian surface in increasing order.**



(a) D < C < B < A (b) A < B = C < D
(c) C < A = B < D (d) D > C > B > A

[*Ans.* (a) D < C < B <A]

6. **The total electric flux for the following closed surface which is kept inside water**



(a) $\frac{80q}{\varepsilon_o}$ (b) $\frac{q}{40\varepsilon_o}$
(c) $\frac{q}{80\varepsilon_o}$ (d) $\frac{q}{160\varepsilon_o}$

[*Ans.* (b) $\frac{q}{40\varepsilon_o}$]

7. **Two identical conducting balls having positive charges q_1 and q_2 are separated by a center to center distance r. If they are made to touch each other and then separated to the same distance, the force between them will be** *(NSEP 04-05)*

(a) less than before (b) same as before
(c) more than before (d) zero

[*Ans.* (c) more than before]

PTA Model Questions & Answers

Choose the Correct Answer 1 mark

1. An air-core capacitor is charged by a battery. After disconnecting it from the battery, a dielectric slab is fully inserted in between its plates. Now, which of the following quantities remains constant? *[PTA-1]*

(a) Energy (b) Voltage
(c) Electric field (d) Charge

[*Ans.* (d) Charge]

2. The unit of permittivity is: *[PTA-2]*

(a) $C^2 N^{-1} m^{-2}$ (b) $N m^2 C^{-2}$
(c) $H m^{-1}$ (d) $N C^{-2} m^{-2}$

[*Ans.* (a) $C^2 N^{-1} m^{-2}$]

3. A coil of area of cross-section 0.5 m^2 with 10 turns is in a plane which is parallel to a uniform electric field of 100 N/C. The flux through the plane is: *[PTA-2]*

(a) 100 V.m (b) 500 V.m
(c) 20 V.m (d) zero

[*Ans.* (b) 500 V.m]

4. Dimension and unit of Electric flux is ________ *[PTA-3]*

(a) $ML^2T^3A^{-2}$, Nm^2C^{-1}
(b) $ML^3T^{-3}A^{-1}$, Nm^2C^{-1}
(c) $ML^2T^{-1}A^{-2}$, Nm^2C^{-1}
(d) $ML^{-4}T^{-3}A^{-2}$, Nm^2C^{-1}

[*Ans.* (b) $ML^3T^{-3}A^{-1}$, Nm^2C^{-1}]

5. At infinity, the electrostatic potential is *[PTA-4]*

(a) infinity (b) maximum
(c) minimum (d) zero

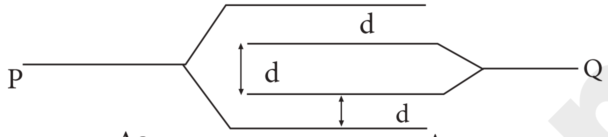
[*Ans.* (d) zero]

6. Five balls marked 1, 2, 3, 4 and 5 are suspended by separate threads. The pairs (1, 2) (2, 4) and (4, 1) show mutual attraction and the pairs (2,3) and (4, 5) show repulsion. The number of ball marked as 1 is *[PTA-5]*

(a) positive (b) negative
(c) neutral (d) can't determine

[*Ans.* (c) neutral]

7. The resultant capacitance of four plates, each is having an area A, arranged as shown above, will be (plate separation is d) *[PTA-5]*



(a) $\frac{A\varepsilon_0}{d}$ (b) $\frac{A\varepsilon_0}{2d}$
(c) $\frac{2A\varepsilon_0}{d}$ (d) $\frac{3A\varepsilon_0}{d}$

[*Ans.* (c) $\frac{2A\varepsilon_0}{d}$]

Hint: $C = C_1 + C_2 = 2C$

$\therefore C = \frac{2\varepsilon_0 A}{d}$

8. An electric dipole is placed at an angle 30° with an electric field intensity of 2×10^5 N C^{-1}. It experiences a torque equal to 4 N m. The charge on the dipole if the dipole length is 2 cm is *[PTA-6]*

(a) 8 mC (b) 2 mC
(c) 5 mC (d) 7 μC

[*Ans.* (2 mC)]

Very Short Answer Questions 2 marks

1. The electric field outside a conductor is perpendicular to its surface. Justify. *[PTA-1]*

Ans. (i) The electric field outside the conductor is perpendicular to the surface of the conductor and has a magnitude of $\frac{\sigma}{\varepsilon_0}$ where σ is the surface charge density at that point.

(ii) If the electric field has components parallel to the surface of the conductor, then free electrons on the surface of the conductor would experience acceleration.

(iii) This means that the conductor is not in equilibrium. Therefore at electrostatic equilibrium, the electric field must be perpendicular to the surface of the conductor.

2. State the law of conservation of electric charges. *[PTA-2]*

Ans. The total electric charge in the universe is constant and charge can neither be created nor be destroyed. In any physical process, the net change in charge will always be zero.

Given r < radius of the sphere.

Ans. (a) $I \propto \frac{1}{r^2}$

(b) $V \propto \frac{1}{r}$

(c) V does not depend on r.

30. What are the factors on which the capacity of a parallel plate capacitor with dielectric depend?

Ans. (i) Area of the plates

(ii) Separation between the plates.

(iii) Dielectric constant of the dielectric between the plates. The capacitance of a capacitor depend upon geometrical dimension and the nature of the dielectric between the plates.

31. A parallel plate capacitor is charged by a battery. After some time, the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates. How will be (i) the capacitance of the capacitor (ii) potential difference between the plates & (iii) the energy stored in the capacitor gets affected?

Ans. Q_0 - charge, V_0 - potential difference, C_0 - capacitance,

U_0 - energy stored, before the dielectric slab is inserted.

(i) The Capacitance of the capacitor without the dielectric is $C_0 = \frac{Q_0}{V_0}$

When the battery is disconnected and the dielectric is inserted, the capacitance increases from C_0 to C.

$\therefore C = \varepsilon_r C_0$, where ε_r is the dielectric constant.

(ii) The electrostatic potential difference is reduced and the charge Q_0 will remain constant, after the battery is disconnected.

$\therefore$ The new potential difference is, $V = \frac{V_0}{\varepsilon_r}$.

(iii) The energy stored in the capacitor before the insertion of the dielectric is,

$$U_0 = \frac{1}{2}\frac{Q_0^2}{C_0}$$

After the dielectric is inserted, the charge Q_0 remains constant but the capacitance is increased. As a result, the stored energy is decreased.

$$U = \frac{1}{2}\frac{Q_0^2}{C} = \frac{1}{2}\frac{Q_0^2}{\varepsilon_r C_0} = \frac{U_0}{\varepsilon_r}$$

Short Answer Questions — 3 marks

1. How do we determine the electric field due to a continuous charge distribution? Explain.

Ans. Electric filed due to continuous charge distribution : consider the charged object of irregular shape. It is divided into large number of charge elements.

$\Delta q_1 \rightarrow 1^{st}$ charge element; r_{1p} - distance of the point P from Ist charge

$\Delta q_2 \rightarrow$ Second charge element; r_{2p} - distance of the point P from 2st charge

$\Delta q_n \rightarrow n^{th}$ charge element; r_{np} - distance of the point P from nth charge

Then. electric filed at point P due to all charge elements is given by

$$\vec{E} \approx \frac{1}{4\pi\varepsilon_0}\left(\frac{\Delta q_1}{r_{1P}^2}\hat{r}_{1P} + \frac{\Delta q_2}{r_{2P}^2}\hat{r}_{2P} + \ldots\ldots + \frac{\Delta q_n}{r_{nP}^2}\hat{r}_{nP}\right) \quad (1)$$

$$\approx \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{\Delta q_i}{r_{iP}^2}\hat{r}_{iP}$$

For continuous distribution of charge,

Lt $\Delta q \rightarrow 0 (= dq)$

$$\therefore \vec{E} = \frac{1}{4\pi\varepsilon_0}\cdot\int\frac{dq}{r^2}\hat{r}$$

$r \rightarrow$ distance of point P from infinitesimal charge dq.

$\hat{r}$ Unit vector from dq to point P.

(i) For linear charge distribution :

Linear density $\lambda = \frac{Q}{L}$ C m^{-1}.

i.e. charge per unit length. where Q is uniformly distributed charge along the wire of length L. For infinitesimal length $dq = \lambda\, dl$.

(ii) Surface charge distribution :

$\sigma = \frac{Q}{A}$ C m^{-2}.

$\sigma \rightarrow$ surface charge density (charge per unit area)

Q $\rightarrow$ uniformly distributed charge on surface of area A.

For infinitesimal area, $dq = \sigma dA$.

(iii) Volume charge distribution :

$\rho = \frac{Q}{V}$ C m^{-3}.

$\rho \rightarrow$ Volume charge density (charge per unit volume)

Q $\rightarrow$ uniformly distribution of charge in a volume V.

UNIT 2 CURRENT ELECTRICITY

CHAPTER SNAPSHOT

(21) Metals – Positive temperature coefficient of resistance.
Insulators, Semiconductors – Negative temperature coefficient of resistance.

(22) Internal resistance r of a cell, $r = \left(\frac{\xi - V}{V}\right) R$

(23) Condition for bridge balance in a Wheatstone's bridge $\frac{P}{Q} = \frac{R}{S}$

(24) In Metre bridge : Unknown resistance $P = Q\frac{l_1}{l_2}$

(25) Specific resistance $\rho = \frac{P\pi r^2}{L}$; Where 'P' is the unknown resistance
Potential difference across the wire = I r l

(26) Potentiometer : $\varepsilon \,\alpha\, l \Rightarrow \xi = Irl$

(27) Unknown emf $\xi_2 = \xi_1 \frac{l_2}{l_1}$

(28) Electric power, $P = VI = I^2R = \frac{V^2}{R}$

(29) Heating effect : Joule's law

$H = VIt$; $H = I^2Rt$; $H = \frac{V^2}{R}t$

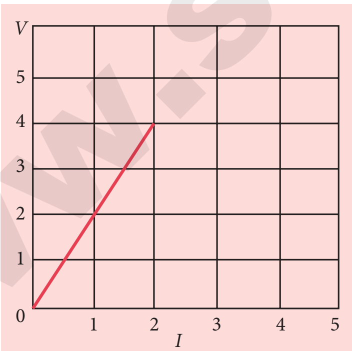
(30) Seebeck effect
Thermoelectric series of metals is Bi, Ni, Pd, Pt, Cu, Mn, Hg, Pb, Sn, Au, Ag, Zn, Cd, Fe, Sb

(31) Unit of emf = Volts.

EVALUATION

I. MULTIPLE CHOICE QUESTIONS :

1. The following graph shows current versus voltage values of some unknown conductor. What is the resistance of this conductor?

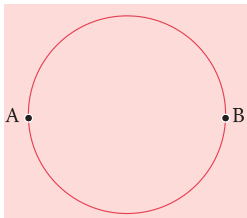


(a) 2 ohm (b) 4 ohm
(c) 8 ohm (d) 1 ohm

[*Ans.* (a) 2 ohm]

Hint: $R = \frac{V}{I}$

2. A wire of resistance 2 ohms per meter is bent to form a circle of radius 1m. The equivalent resistance between its two diametrically opposite points, A and B as shown in the figure is



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

[*Ans.* (a) $\pi\ \Omega$]

3. A toaster operating at 240 V has a resistance of 120 Ω. The power is

(a) 400 W (b) 2 W
(c) 480 W (d) 240 W

[*Ans.* (c) 480 W]

Hint: $P = V \times I$

Current Electricity

(1) × 3 $6I_1 + 3I_g = 9$ ...(3)

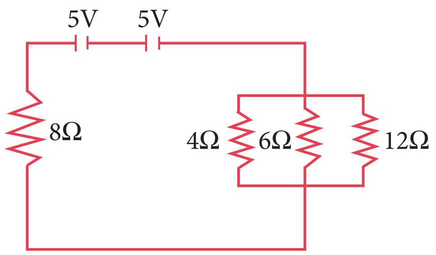
(2) × 2 $6I_1 - 8I_g = 8$ ...(4)

Solving (3) & (4)

$$+11 I_g = 1 ; I_g = \frac{1}{11} A$$

12. Two cells each of 5V are connected in series across a 8 Ω resistor and three parallel resistors of 4 Ω, 6 Ω and 12 Ω. Draw a circuit diagram for the above arrangement. Calculate (i) the current drawn from the cell (ii) current through each resistor. *[Govt. MQP-2019 ; PTA-4]*

Ans. Equivalent resistors of R′of 4, 6. 12 resistors connected in parallel is given by



$$\frac{1}{R'} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12}$$

Resistor of parallel combination R′ = 2 Ω

Total resistor i.e. 8 Ω is connected in series with R′.

$R_S = 8 + R'$

$R_S = 8 + 2 = 10\ \Omega$

$\therefore R_S = 10\ \Omega$

Net voltage (emf) V = 10 V [∵cells are connected in series total emf $\varepsilon + \varepsilon = 2\varepsilon$]

Current $I = \frac{V}{R}$ (from ohm's law)

$I = \frac{10}{10}$; I = 1 A

(i) So the current through each cell and 8Ω resistor is 1A.

Potential drop across the parallel combination of three resistors is $V' = I R' = 1 \times 2 = 2$ V

(ii) ∴Current through 4Ω resistor $I = \frac{2}{4} = 0.5$ A $[I = \frac{V}{R}]$

Current through 6Ω resistor, $I = \frac{2}{6} = 0.33$ A

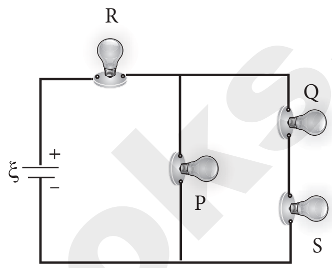
Current through 12 resistor, $I = \frac{2}{12} = \frac{1}{6} = 0.17$ A

13. Four bulbs P, Q, R, S are connected in a circuit of unknown arrangement. When each bulb is removed one at a time and replaced, the following behavior is observed.

	P	Q	R	S
P removed	*	on	on	on
Q removed	on	*	on	off
R removed	off	off	*	off
S removed	on	off	on	*

Draw the circuit diagram for these bulbs.

Ans.



14. In a potentiometer arrangement, a cell of emf 1.25 V gives a balance point at 35 cm length of the wire. If the cell is replaced by another cell and the balance point shifts to 63 cm, what is the emf of the second cell?

***Ans.* Given :** emf of cell 1 $\xi_1 = 1.25$ V

Balancing length $l_1 = 35$ cm

To find : Emf of cell 2 $\xi_2 = ?$

Balance length of cell 2 $l_2 = 63$ m.

Solution :

$$\frac{\xi_1}{\xi_2} = \frac{l_1}{l_2} ; \frac{1.25}{\xi_2} = \frac{35}{63}$$

$$\xi_2 = \frac{1.25}{35} \times 63$$

$$\xi_2 = 2.25 \text{ V.}$$

PTA Model Questions & Answers

Choose the Correct Answer 1 Mark

1. Resistance of resistor having colour code Yellow - Green - Red - Gold *[PTA-3]*

(a) (4700±5%) Ω (b) (4500±5%) Ω

(c) (4700±10%) Ω (d) (4500±10%)Ω

[*Ans.* (b) (4500±5%) Ω]

ADDITIONAL QUESTIONS AND ANSWERS

Choose the Correct Answer 1 MARK

1. The colour code on a carbon resistor is red - red - black. The resistance of the resistor is?

(a) 2.2 Ω (b) 22 Ω
(c) 220 2.2 Ω (d) 2.2 k Ω

[**Ans.** (b) 22 Ω]

2. The electrical resistivity of a thin copper wire and a thick copper wire are respectively P_1 Ω m and P_2 Ω m. Then

(a) $P_1 > P_2$ (b) $P_2 > P_1$
(c) $P_1 = P_2$ (d) $\frac{P_1}{P_2}$

[**Ans.** (c) $P_1 = P_2$]

Hint: Resistivity is not α structure of the material

3. When 'n' resistors of equal resistance (R) are connected in series and in parallel respectively, then the ratio of their effective resistance is

(a) $1 : n^2$ (b) $n^2 : 1$
(c) $n : 1$ (d) $1 : n$

[**Ans.** (b) $n^2 : 1$]

Hint:

$R_s = nR$

$R_p = \frac{R}{n}$ $\quad \frac{R_s}{R_p} = \frac{nR}{\frac{R}{n}} = \frac{n^2}{1}$

$\therefore R_s : R_p = n^2 : 1$

4. Which of the following has negative temperature coefficient of resistance?

(a) copper (b) tungsten
(c) carbon (d) silver

[**Ans.** (c) carbon]

5. The temperature co-efficient of resistance for alloys is

(a) low (b) very low
(c) high (d) very high

[**Ans.** (a) low]

6. Which of the following material has the highest specific resistance?

(a) rubber (b) silver
(c) germanium (d) glass

[**Ans.** (a) rubber]

7. Temperature co-efficient of resistance for metals is

(a) constant (b) positive
(c) zero (d) negative

[**Ans.** (b) positive]

8. An electron gun in a TV shoots out a beam of electrons. The beam current is 10μ A. The charge that strikes the screen in 1 minute is

(a) + 600 μC (b) – 600 μC
(c) + 10 μC (d) – 10 μC

[**Ans.** (b) – 600 μC]

Hint: $q = It$
$= 10 \times 10^{-6} \times 60 = -600\ \mu C$

9. If the specific resistance of a potentiometer wire is 10^{-7} Ωm and current flowing through it is 0.1 amp, cross - sectional area of wire is 10^{-6} m², then potential gradient will be

(a) 10^{-2} v/m (b) 10^{-4} v/m
(c) 10^{-6} v/m (d) 10^{-8} v/m

[**Ans.** (a) 10^{-2} v/m]

Hint:

Potential gradient $= \frac{V}{l} = \frac{IR}{l}$

We know that, $R = \frac{\rho l}{A}$

$\therefore \frac{R}{l} = \frac{\rho}{A}$

$\therefore \frac{V}{l} = I \times \frac{\rho}{A}$

$= \frac{0.1 \times 10^{-7}}{10^{-6}} = 10^{-2}$ V/m

10. A metallic block has no potential difference applied across it, then the mean velocity of free electrons is

(a) proportional to T
(b) proportional for $\sqrt{T}$
(c) finite but independent of temperature
(d) zero

[**Ans.** (d) zero]

11. In an electrical arrangement as shown the equivalent resistance between X and Y will be

(a) 158.75 Ω (b) 118.75 Ω
(c) 218 .75 Ω (d) 318.75 Ω

[**Ans.** (b) 118.75 Ω]

61. These are behaving like thermistor
(a) insulators and conductors
(b) semiconductors and conductors
(c) insulators and semiconductors
(d) conductors and alloys
[*Ans.* (c) insulators and semiconductors]

62. If the neutral temperature is 80°C and inversion temperature is 150°C, then the cold junction temperature is
(a) 230° (b) 70°C (c) 10°C (d) 5°C
[*Ans.* (c) 10°C]

63. Peltier effect is the converse of
(a) Joule effect
(b) Raman effect
(c) Thomson effect
(d) Seebeck effect [*Ans.* (d) Seebeck effect]

64. Which of the following principle is used in a thermopile?
(a) Thomson effect (b) Peltier effect
(c) Seebeck effect (d) Joules effect
[*Ans.* (c) Seebeck effect]

65. Unit of peltier coefficient is
(a) ohm (b) mho
(c) volt (d) ampere
[*Ans.* (c) volt]

66. Which one of the following has positive Thomson effect
(a) Zn (b) Bi (c) Ni (d) Hg
[*Ans.* (a) Zn]

67. Thomson effect for ______ is zero.
(a) Ag (b) Pt (c) Au (d) Pb
[*Ans.* (d)]

68. When an electric current is passed in a circuit consisting of two different metals, heat is evolved at one junction and absorbed at the other end. This is known as ______ .
(a) Seebeck effect (b) Peltier effect
(c) Joule's law (d) Thomson effect
[*Ans.* (b) Peltier effect]

69. The elements having positive Thomson effect are ______ .
(a) Sb, Hg, Zn (b) Ag, Hg, Cd
(c) Zn, Cd, Sb (d) Cd, Pt, Ag
[*Ans.* (c) Zn, Cd, Sb]

70. In a thermocouple, temperature of the cold junction is 20°C, the inversion temperature is 600°C, then neutral temperature is
(a) 310°C (b) 320°C
(c) 300°C (d) 315°C
[*Ans.* (a) 310°C]

71. To draw thermo electric diagrams Lead is used as one of the metals to form a thermo couple with other metal because ______ .
(a) It is a hard metal
(b) It has high nuclear density
(c) It does not allow X-rays
(d) It has zero Thomson effect
[*Ans.* (d) It has zero Thomson effect]

72. A thermo-couple is formed by Mn and Hg. The current flows ______ .
(a) from Mn to Hg at cold junction
(b) from Hg to Mn at cold junction
(c) from Hg to Mn at hot junction
(d) when Mn and Hg are at same temperature
[*Ans.* (b) from Hg to Mn at cold junction]

Match the following

1.

1.	Electric Heaters	a)	Tungsten
2.	Electric Fuses	b)	Molybdenum
3.	Electric furnace	c)	Lead
4.	Electrical Lamp	d)	Nichrome

	(1)	(2)	(3)	(4)
(a)	b	c	a	d
(b)	d	c	b	a
(c)	c	a	d	b
(d)	b	d	a	c

[*Ans.* (b) d c b a]

2.

1.	Current	a)	watt
2.	Resistance	b)	joule
3.	Power	c)	ohm
4.	Energy	d)	ampere

	(1)	(2)	(3)	(4)
(a)	d	c	a	b
(b)	b	c	a	d
(c)	c	d	a	b
(d)	b	d	a	c

[*Ans.* (a) d c a b]

UNIT 3 MAGNETISM AND MAGNETIC EFFECTS OF ELECTRIC CURRENT

CHAPTER SNAPSHOT

(b) If the conductor is placed perpendicular to the magnetic field, then the angle θ =90° Hence, the force experienced by the conductor is maximum, which is $F_{total} = BIl$.

IV. Numerical problems

1. A bar magnet having a magnetic moment $\vec{p}_m$ is cut into four pieces i.e., first cut in two pieces along the axis of the magnet and each piece is further cut into two pieces. Compute the magnetic moment of each piece.

Ans. When bar magnet cut into two pieces along axis the Magnetic strength is reduced to half and also magnetic moments reduce to half but length remains the same (2*l*).

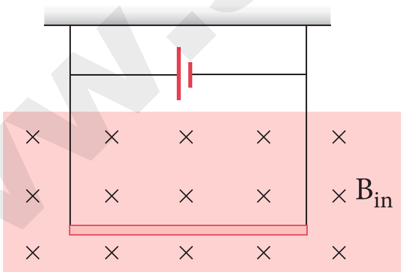
i.e magnetic moment = $\frac{M}{2}$

Again each piece is cut into two, so magnetic moment again becomes half

i.e $\frac{M/2}{2} = \frac{M}{4}$

∴ Magnetic moment of each piece $\vec{p}_{m_{new}} = \frac{1}{4}\vec{p}_m$

2. A conductor of linear mass density 0.2 g m^{-1} suspended by two flexible wire as shown in figure. Suppose the tension in the supporting wires is zero when it is kept inside the magnetic field of 1 T whose direction is into the page. Compute the current inside the conductor and also the direction of the current. Assume g = 10 ms^{-2}



Ans. Given that the conductor is horizontally supported from the suspension wires. It requires a vertically upward magnetic force (F = BI*l*) to support its own without making the support tension zero.

Upward magnetic force on the wire F = BI*l* ......(1)

Downward force to be supported (weight)

$F = (0.2 \times 10^{-3} \times l) \times 10$ ......(2)

Given data:

Linear density = $\frac{m}{l} = 0.2 \times 10^{-3}$ kg m^{-1}.

Magnetic field, B = 1 Tesla. $g = 10ms^{-2}$

Equating forces

$BIl = 0.2 \times 10^{-3} \times l \times 10$

$1 \times l \times I = 0.2 \times 10^{-3} \times l \times 10$

$I = 2 \times 10^{-3}$ A

I = 2mA

3. A circular coil with cross-sectional area 0.1 cm^2 is kept in a uniform magnetic field of strength 0.2 T. If the current passing in the coil is 3 A and plane of the loop is perpendicular to the direction of magnetic field. Calculate

(a) total torque on the coil

(b) total force on the coil

(c) average force on each electron in the coil due to the magnetic field. (The free electron density for the material of the wire is 10^{28} m^{-3}).

Ans. Area of circular coil A = 0.1 cm^2 = 0.1×10^{-4} m^2

Magnetic field of strength B = 0.2 T

Current passing in the coil I = 3 A

Total torque on the coil τ = NAB sin θ

θ is the angle between the normal drawn to the plane of the coil and direction of magnetic field.

θ = 0

τ = NAB sin θ = 0

(a) τ = 0

(b) Total force on the coil F = BI*l* sin θ

(or) F = B*qv* sin θ

But θ = 0 here

∴ **F = 0**

(c) Electron density for the material of the wire = 10^{28} m^{-3}. $\sigma = \frac{q}{A}$

Average force on electron= Fm = ev_d

$$V_d = \frac{I}{neA}$$

$$F_m = e\left(\frac{I}{neA}\right)\times B = \frac{IB}{nA} = \frac{3\times0.2}{10^{28}\times0.1\times10^{-4}} = \frac{3\times0.2}{10^{28}\times10^{-5}}$$

$$= \frac{0.6}{10^{23}} = 0.6\times10^{-23}\text{ N}$$

Reason : Magnetic field due to a long current carrying solenoid is m

$$B = \frac{\mu NI}{L} = \mu nI \text{ (where, } n = \frac{N}{L}\text{)}$$

[Ans. (b) Assertion and Reason are true but Reason is the false explanation of the Assertion.]

Choose the correct or Incorrect statements

1. **(I)** **Closed line integral means integral over a closed curve (or line), (symbol is $\oint$ (or) $\oint_C$**

(II) **Right hand thumb Rule is used to determine the direction of magnetic moment**

Which one is correct statement?

(a) I only (b) II only
(c) both are correct
(d) none of these **[Ans. (c) both are correct]**

2. **(I)** **The ability of the materials to retain the magnetism in them even magnetising field vanishes is called remanence or retentivity**

(II) **Hysterisis means 'lagging beyond' which one is incorrect statement?**

(a) I only (b) II only
(c) both are correct (d) none of these
[Ans. (b) II only]

Very Short Answer Questions 2 marks

1. **What is Declination?**

Ans. The angle between magnetic meridian at a point and geographical meridian is called the declination or magnetic declination (D).

2. **What is meant by dip?**

Ans. The angle subtended by the Earth's total magnetic field $\vec{B}$ with the horizontal direction in the magnetic meridian is called dip or magnetic inclination (I) at that point.

3. **Define magnetic flux density.**

Ans. The magnetic flux density can be defined as the number of magnetic field lines crossing unit area kept normal to the direction of line of force. Its unit is Wb m^{-2} or tesla.

4. **Define remanence or retentivity?**

Ans. It is defined as the ability of the materials to retain the magnetism in them even if magnetising field vanishes.

5. **What do you mean by coercivity?**

Ans. The magnitude of the reverse magnetising field for which the residual magnetism of the material vanishes is called its coercivity.

6. **State Right hand thumb rule.**

Ans. Hold current carrying wire in right hand
Thumb - direction of current
Fingers - direction magnetic field.

7. **Define tesla.**

Ans. The strength of the magnetic field is one tesla if unit charge moving in it with unit velocity experiences unit force.

$$1T = \frac{1Ns}{Cm} = 1\frac{N}{Am} = 1NA^{-1}m^{-1}$$

8. **Write the limitations of cyclotron?**

Ans. (i) The speed of the ion is limited
(ii) Electron cannot be accelerated
(iii) Uncharged particles cannot be accelerated.

9. **When is a galvanometer said to be sensitive?**

Ans. The galvanometer is said to be sensitive if it shows large scale deflection even though a small current is passed through it or a small voltage is applied across it.

10. **Define Current sensitivity?**

Ans. It is defined as the deflection produced per unit current flowing through it.

$$I_s = \frac{\theta}{I} = \frac{NAB}{K} \Rightarrow I_s = \frac{1}{G}$$

11. **What are the causes for earth's magnetic field according to Gover?**

Ans. Gover suggested that the Earth's magnetic field is due to hot rays coming out from the Sun. These rays will heat up the air near equatorial region. Once air becomes hotter, it rises above and will move towards northern and southern hemispheres and get electrified. This may be responsible to magnetize the ferromagnetic materials near the Earth's surface.

12. **What is Geomagnetism?**

Ans. The branch of physics which deals with the Earth's magnetic field is called Geomagnetism or Terrestrial magnetism.

Unit 3

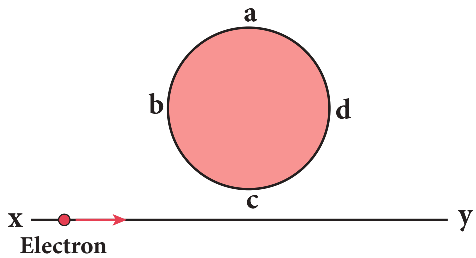
UNIT 4 ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT

CHAPTER SNAPSHOT

Evaluation

I. Multiple Choice Questions

1. **An electron moves on a straight line path XY as shown in the figure. The coil *abcd* is adjacent to the path of the electron. What will be the direction of current, if any, induced in the coil?** *(NEET – 2015)*

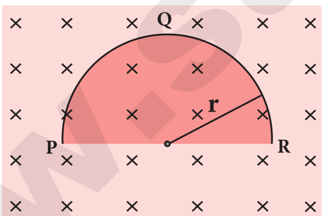


(a) The current will reverse its direction as the electron goes past the coil
(b) No current will be induced
(c) abcd (d) adcb

[*Ans.* (a) The current will reverse its direction as the electron goes past the coil]

Hint: Direction of current is opposite to the electron flowing direction.

2. **A thin semi-circular conducting ring (PQR) of radius r is falling with its plane vertical in a horizontal magnetic field B, as shown in the figure.**



The potential difference developed across the ring when its speed *v*, is *(NEET 2014)*

(a) Zero
(b) $\frac{Bv\pi r^2}{2}$ and P is at higher potential
(c) πrBv and R is at higher potential
(d) $2rBv$ and R is at higher potential

[*Ans.* (d) $2rBv$ and R is at higher potential]

3. **The flux linked with a coil at any instant t is given by $\Phi_B = 10t^2 - 50t + 250$. The induced emf at $t = 3$s is** *[HY-2019]*

(a) –190 V (b) – 10 V
(c) 10 V (d) 190 V

[*Ans.* (b) – 10 V]

Hint: $e = -\frac{d}{dt}(\phi_B) = \frac{-d}{dt}(10t^2 - 50t + 250) = (20t + 50)$
when $t = 3$s; e = –60 + 50 = –10 V

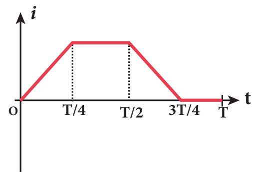
4. **When the current changes from +2A to –2A in 0.05 s, an emf of 8 V is induced in a coil. The co-efficient of self-induction of the coil is** *[Govt. MQP-2019]*

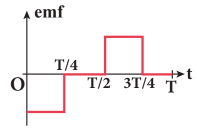
(a) 0.2 H (b) 0.4 H
(c) 0.8 H (d) 0.1 H

[*Ans.* (d) 0.1 H]

Hint: $L = \frac{-e}{dI/dt} = \frac{-8}{4/0.05} = 0.1$ H

5. **The current *i* flowing in a coil varies with time as shown in the figure. The variation of induced emf with time would be** *(NEET – 2011)*



(a)


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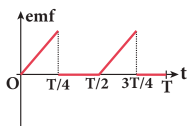
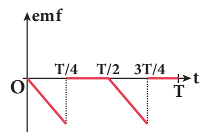
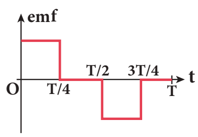
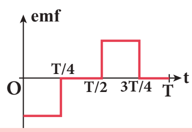


(c)


(d)


[*Ans.* (a) 

]

Hint: $e = \frac{LdI}{dt}$

IV. Numerical problems :

1. A square coil of side 30 cm with 500 turns is kept in a uniform magnetic field of 0.4 T. The plane of the coil is inclined at an angle of 30° to the field. Calculate the magnetic flux through the coil.

Ans. **Given :** Side of a square coil = 30 cm = 30×10^{-2} m

Area of a square coil A = side × side

$= 30 \times 30 \times 10^{-4} m^2$

Magnetic field B = 0.4 T

The plane inclined to the field = 30°

$\therefore \theta = 60°$ (90 – 30) i.e. θ = angle between normal surface

No. of turns N = 500

Formula :

$\phi = NAB \cos\theta$

$\phi = 500 \times 9 \times 10^{-2} \times 0.4 \times \cos 60°$

$= 500 \times 9 \times 10^{-2} \times 0.4 \times \frac{1}{2}$

$\phi = 9$ Wb

2. A straight metal wire crosses a magnetic field of flux 4 m Wb in a time 0.4 s. Find the magnitude of the emf induced in the wire.

Ans. **Given :** A metal wire crosses a magnetic field of flus

$\phi = 4$ mWb (or) 4×10^{-3} Wb

Time $dt = 0.4$ s

To find :

The magnetic of induced emf ε = ?

Formula :

$\varepsilon = \frac{d\phi}{dt} = \frac{4\times10^{-3}}{0.4} = 10^{-2}$ (or) 10 mV.

ε = 10 mV.

3. The magnetic flux passing through a coil perpendicular to its plane is a function of time and is given by $\Phi_B = (2t^3 + 4t^2 + 8t + 8)$ Wb. If the resistance of the coil is 5 Ω, determine the induced current through the coil at a time $t = 3$ second.

Ans. **Given :** The magnetic flux

$\Phi_B = (2t^3 + 4t^2 + 8t + 8)$ Wb.

Resistance of the coil R = 5Ω

To find :

Induced current through the coil i = ?

For a time $t = 3\ s$

Formula :

Induced emf $\varepsilon = \frac{d\Phi_B}{dt}$

Solution :

$\varepsilon = \frac{d}{dt}(2t^3 + 4t^2 + 8t + 8)$

$\varepsilon = 6t^2 + 8t + 8$

When t = 3s

$\varepsilon = 6 \times (3)^2 + (8 \times 3) + 8$

$= 54 + 24 + 8$

$\varepsilon = 86$ V

Induced current through the coil $i = \frac{\varepsilon}{R}$

$i = \frac{86}{5}$

$i = 17.2$ A

4. A closely wound coil of radius 0.02 m is placed perpendicular to the magnetic field. When the magnetic field is changed from 8000 T to 2000 T in 6 s, an emf of 44 V is induced. Calculate the number of turns in the coil.

Ans. **Given :** Radius of the closely wound coil, 'r' = 0.02 m

$\therefore$ Area of the coil, $A = \pi r^2 = \frac{22}{7} \times 0.02 \times 0.02\ m^2$

Change in magnetic field $dB = 8000 - 2000 = 6000$ T

Change in magnetic in time dt = 6s

To find :

No. of turns of the coil N = ?

$\varepsilon = \frac{d}{dt}(NAB.\cos\theta)$ [$\theta = 0\ \because$ coil is perpendicular to magnetic field]

Formula :

$\varepsilon = NA.\frac{dB}{dt}$

$44 = N.\frac{22}{7} \times 0.02 \times 0.02 \times \frac{6000}{6}$

$N = \frac{44\times7}{4\times10^{-4}\times10^{3}\times 22}$

$= \frac{11\times7\times10}{22} = 35$

N = 35 turns.

Total energy, $U = U_E + U_B = \frac{q^2}{2C} + \frac{1}{2}Li^2$

(ii) Let us consider 3 different stages of LC oscillations and calculate the total energy of the system.

Case (i) When the charge in the capacitor, $q = Q_m$ and the current through the inductor, $i = 0$, the total energy is given by

$$U = \frac{Q_m^2}{2C} + 0 = \frac{Q_m^2}{2C}$$

The total energy is wholly electrical.

Case (ii) When charge = 0 ; current = I_m , the total energy is

$$U = 0 + \frac{1}{2}LI_m^2 = \frac{1}{2}LI_m^2$$

$$= \frac{L}{2} \times \left(\frac{Q_m^2}{LC}\right) \text{ since } I_m = Q_m\omega = \frac{Q_m}{\sqrt{LC}}$$

$$= \frac{Q_m^2}{2C}$$

The total energy is wholly magnetic.

Case (iii) When charge = q; current = i, the total energy is

$$U = \frac{q^2}{2C} + \frac{1}{2}Li^2$$

Since $q = Q_m \cos \omega t$,

$$i = -\frac{dq}{dt} = Q_m \omega \sin \omega t$$

The negative sign in current indicates that the charge in the capacitor decreases with time.

$$U = \frac{Q_m^2 \cos^2 \omega t}{2C} + \frac{L\omega^2 Q_m^2 \sin^2 \omega t}{2}$$

$$= \frac{Q_m^2 \cos^2 \omega t}{2C} + \frac{LQ_m^2 \sin^2 \omega t}{2LC} \text{ since } \omega^2 = \frac{1}{LC}$$

$$= \frac{Q_m^2}{2C}(\cos^2 \omega t + \sin^2 \omega t)$$

$$U = \frac{Q_m^2}{2C}$$

From above three cases, it is clear that the total energy of the system remains constant.

Government Exam Questions & Answers

Choose the Correct Answer 1 Mark

1. The equation for an alternating current is given by I = 77 sin 314 t find the frequency of current *[QY-2019]*

(a) 314 Hz (b) 50 Hz
(c) 77 Hz (d) zero

[Ans. (b) 50 Hz]

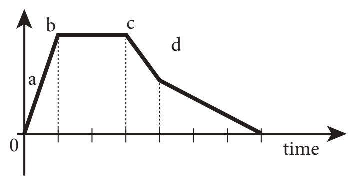
2. In a series RL circuit the resistance and inductive reactance are same. Then the phase difference between the voltage and current in the circuit is *[QY-2019]*

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{2}$ (c) $\frac{\pi}{6}$ (d) 0

[Ans. (a) $\frac{\pi}{4}$]

3. A graph between the magnitude of the magnetic flux linked with a closed loop and time is given above. From the graph select the regions of the graph, in the ascending order of the magnitude of induced emf produced as a result of change in magnetic flux. *[QY-2019]*

Magnetic flux



(a) a < b < c < d (b) d < c < b < a
(c) a < c < d < b (d) b < d < c < a

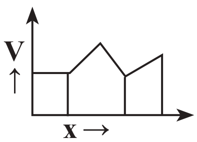
[Ans. (d) b < d < c < a]

4. In a transformer, the number of turns in the primary and the secondary coil are 300 and 1800 respectively. If the current in primary is 6 A, then that in the secondary coil is *[HY-2019]*

(a) 2A (b) 18A (c) 12A (d) 1A

[Ans. (d) 1A]

5. In the graph, potential (V) is plotted as a function of distance (X) from the center. In which part of the region the magnitude of X-component of electric field becomes zero? *[HY-2019]*



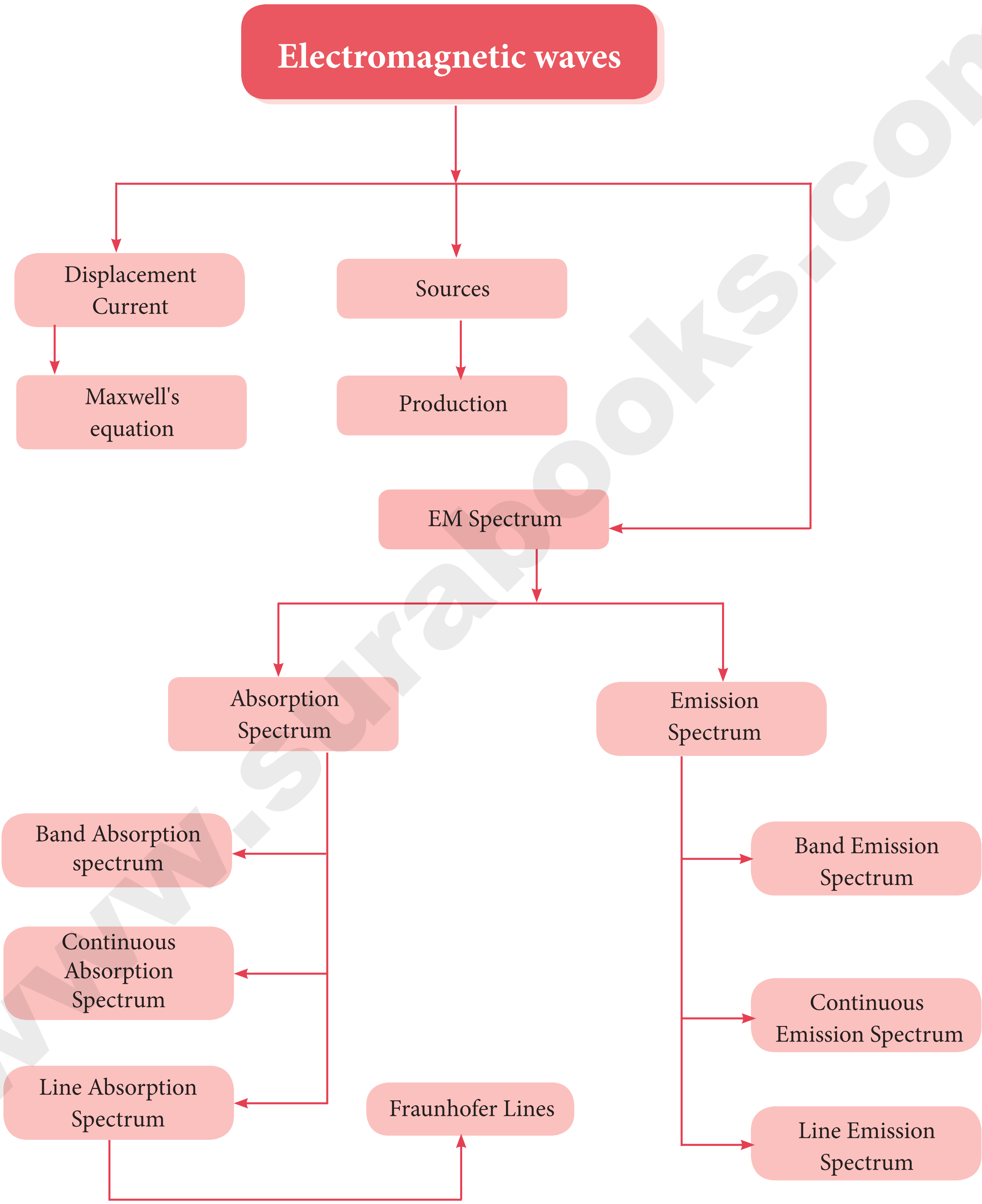
(a) 1 (b) 2 (c) 3 (d) 4

[Ans. (a) 1]

UNIT 5 ELECTROMAGNETIC WAVES

CHAPTER SNAPSHOT

CONCEPT MAP


Electromagnetic waves
Displacement Current
Maxwell's equation
Sources
Production
EM Spectrum
Absorption Spectrum
Emission Spectrum
Band Absorption spectrum
Continuous Absorption Spectrum
Line Absorption Spectrum
Fraunhofer Lines
Band Emission Spectrum
Continuous Emission Spectrum
Line Emission Spectrum

ADDITIONAL QUESTIONS AND ANSWERS

Choose the Correct Answer 1 MARK

1. Who produced the electromagnetic waves first?
(a) J.C.Bose (b) Marconi
(c) Maxwell (d) Hertz
[Ans. (d) Hertz]

2. Speed of electromagnetic wave is the same for all
(a) wavelength (b) media
(c) intensities (d) frequencies
[Ans. (c) intensities]

3. Electromagnetic waves are produced by
(a) static charge (b) moving charge
(c) an accelerating charge
(d) chargeless particles
[Ans. (c) an accelerating charge]

4. Which of the following electromagnetic waves has the highest frequency?
(a) radio waves (b) micro waves
(c) X- rays (d) γ-rays
[Ans. (d) γ-rays]

5. Which of the following E.M waves has the longest wavelength?
(a) Radio waves (b) IR
(c) X-rays (d) visible
[Ans. (a) Radio waves]

6. The EM waves do not transport
(a) energy (b) charge
(c) momentum (d) information
[Ans. (b) charge]

7. Which EM waves are used in medicine to destroy cancer cells?
(a) radio waves (b) IR
(c) γ rays (d) UV rays
[Ans. (c) γ rays]

8. Which of the following is a special aspect of EM wave?
(a) can be deflected by electric field
(b) can be deflected by magnetic filed
(c) can be deflected by both electric & magnetic filed
(d) none of these [Ans. (d) none of these]

9. The existence of E.M. waves was confirmed experimentally by
(a) Hertz (b) Maxwell
(c) Huygens (d) Planck
[Ans. (a) Hertz]

10. If the velocity of light in a medium is 2.25×10^8 ms^{-1} then the refractive index of the medium will be
(a) 1.5 (b) 0.5
(c) 1.33 (d) 1.73
[Ans. (c) 1.33]

11. A magnetic field is produced by
(a) a changing electric field
(b) a moving charge (c) both of them
(d) none of them [Ans. (c) both of them]

12. Accelerated charges would produce
(a) sound waves (b) γ - ways
(c) magnetic waves
(d) electromagnetic waves
[Ans. (d) electromagnetic waves]

13. Electromagnetic waves are discovered by
(a) Hertz (b) Maxwell
(c) Lenz (d) Huygens
[Ans. (b) Maxwell]

14. The wavelength range of ultra violet radiation is
(a) 6×10^{-10} to 4×10^{-7} m (b) 4×10^{-7} to 7×10^{-7} m
(c) 6×10^{-10} to 7×10^{-10} m (d) 7×10^{-7}to9×10^{-9} m
[Ans. (a) 6×10^{-10} to 4×10^{-7} m]

15. The phase difference between electric and magnetic field vectors in the electromagnetic waves is
(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{2}$
(c) π (d) zero
[Ans. (d) zero]

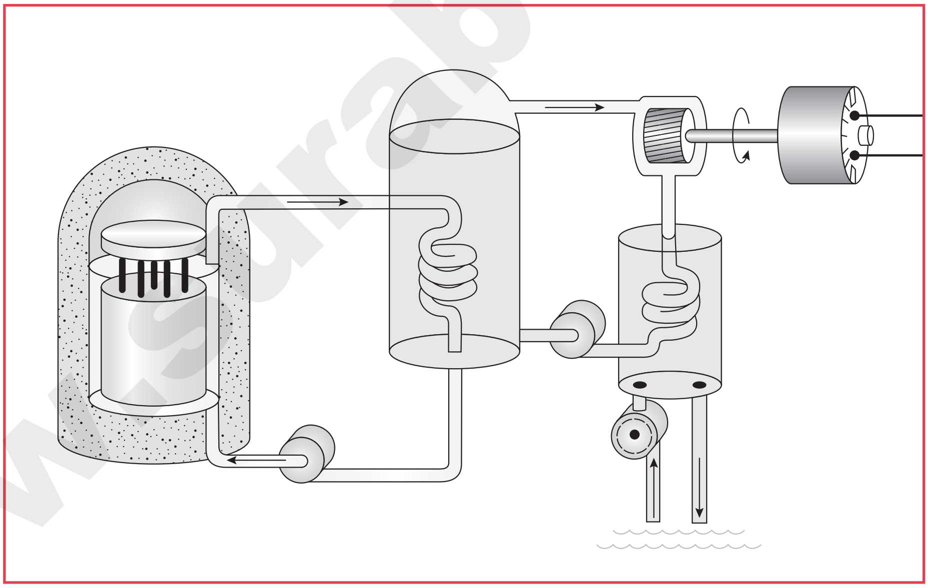
16. The phase and orientation of the magnetic vector associated with electromagnetic oscillations differ respectively from those of the corresponding electric vectors by
(a) zero, zero (b) $\frac{\pi}{2}, \frac{\pi}{2}$
(c) $0, \frac{\pi}{2}$ (d) $\frac{\pi}{2}, 0$
[Ans. (c) $0, \frac{\pi}{2}$]

17. An electromagnetic wave has 5 joules of electric energy. The magnetic energy is
(a) zero (b) 5 J
(c) 10 J (d) 2.5 J
[Ans. (b) 5 J]

PHYSICS

VOLUME - II

12th Standard



UNIT 6 OPTICS

CHAPTER SNAPSHOT

CHAPTER SNAPSHOT

Unit 6

MUST KNOW DEFINITIONS

Reflection of light	:	The bouncing back of light into the same medium when it encounters a reflecting surface is called **reflection of light**.
Angle of deviation	:	The angle between the incident and deviated light ray is called **angle of deviation of the light ray**.
Virtual image	:	Type of image which cannot be formed on the screen but can only be seen with the eyes is called **virtual image**.
Real image	:	Type of image which can be formed on a screen and can also be seen with the eyes is called **real image**.
Convex mirror	:	If the reflection takes place at the convex surface, it is called a **convex mirror**
Concave mirror	:	If the reflection takes place at the concave surface, it is called a **concave mirror**.
Center of curvature	:	The centre of the sphere of which the mirror is a part is called the **center of curvature** (C) **of the mirror**.
Radius of curvature	:	The radius of the sphere of which the spherical mirror is a part is called the **radius of curvature** (R) **of the mirror**.
Pole	:	The middle point on the spherical surface of the mirror (or) the geometrical center of the mirror is called **pole** (P) **of the mirror**.
Principal axis	:	The line joining the pole and the centre of curvature is called the **principal axis of the mirror**.
Focus or focal point	:	Light rays travelling parallel and close to the principal axis when incident on a spherical mirror, converge at a point for concave mirror or appear to diverge from a point for convex mirror on the principal axis. This point is called the **focus** or **focal point** (F) **of the mirror**.
Focal length	:	The distance between the pole and the focus is called the **focal length (f) of the mirror**.
Focal plane	:	The plane through the focus and perpendicular to the principal axis is called the **focal plane of the mirror**.
Paraxial rays	:	The rays travelling very close to the principal axis and make small angles with it are called **paraxial rays**.
Marginal rays	:	The rays travelling far away from the principal axis and fall on the mirror far away from the pole are called as **marginal rays**.
Refractive index	:	Refractive index of a transparent medium is defined as the ratio of speed of light in vacuum (or air) to the speed of light in that medium.
Optical path	:	Optical path of a medium is defined as the distance d' light travels in vacuum in the same time it travels a distance d in the medium.
Snell's law	:	The incident ray, refracted ray and normal to the refracting surface are all coplanar (ie. lie in the same plane).

cause : When an eye lens has too long focal length due to thinning of eye lens or shortening of the eyeball.

Remedy : By wearing concave lens.

79. What is presbyopia?

Ans. Farsightedness arising due to aging is called **presbyopia**.

Remedy : By wearing convex lens.

80. What is astigmatism?

Ans. (i) Astigmatism is the effect arising due to different curvatures along different planes in the eye lens.

(ii) Astigmatic person cannot see all the directions equally well.

(iii) This is more serious than myopia and hyperopia.

Remedy : Lenses with different curvatures in different planes to rectify this defect. Generally these lenses are called as cylindrical lenses.

LONG ANSWER QUESTIONS :

1. Derive the mirror equation and the equation for lateral magnification. *[PTA-5]*

Ans. The mirror equation establishes a relation among object distance u, image distance v and focal length f for a spherical mirror.

(i) An object AB is considered on the principal axis of a concave mirror beyond the center of curvature C.

(ii) Consider three paraxial rays from point B on the object.

(iii) The first paraxial ray BD travelling parallel to principal axis is incident on the concave mirror at D, close to the pole P.

(iv) After reflection, the ray passes through the focus F. The second paraxial ray BP incident at the pole P is reflected along PB′.

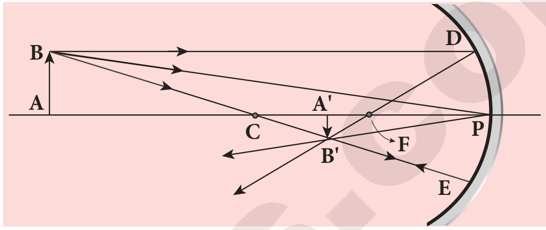
(v) The third paraxial ray BC passing through centre of curvature C, falls normally on the mirror at E is reflected back along the same path. The three reflected rays intersect at the point B′.

(vi) A perpendicular drawn as A′ B′ to the principal axis is the real, inverted image of the object AB.

(vii) As per law of reflection, the angle of incidence ∠BPA is equal to the angle of reflection ∠B′PA′.

(viii) The triangles ΔBPA and ΔB′PA′ are similar. Thus, from the rule of similar triangles,

$$\frac{A'B'}{AB} = \frac{PA'}{PA} \quad ...(1)$$



Mirror equation

(ix) The other set of similar triangles are, ΔDPF and ΔB′A′ F. (PD is almost a straight vertical line)

$$\frac{A'B'}{PD} = \frac{A'F}{PF}$$

As, the distances PD = AB the above equation becomes,

$$\frac{A'B'}{AB} = \frac{PA'}{PA} \quad ...(2)$$

From equations (1) and (2) we can write,

$$\frac{PA'}{PA} = \frac{A'F}{PF}$$

As, A′F = PA′ – PF , the above equation becomes,

$$\frac{PA'}{PA} = \frac{PA' - PF}{PF} \quad ...(3)$$

Apply the sign conventions for the various distances in the above equation.

$$PA = -u,\ PA' = -v,\ PF = -f$$

Negative sign is because they are measured to the left of the pole. Now, the equation (3) becomes,

$$\frac{-v}{-u} = \frac{-v-(-f)}{-f}$$

On further simplification,

$$\frac{1}{u} = \frac{1}{f} - \frac{1}{v}; \quad \frac{v}{u} = \frac{v}{f} - 1$$

Dividing either side with v,

$$\frac{1}{u} = \frac{1}{f} - \frac{1}{v}$$

$$\frac{1}{4u} - \frac{1}{u} = \frac{1}{20} \qquad \frac{1-4}{4u} = \frac{-3}{4u}$$

$$\frac{-3}{4u} = \frac{1}{20}$$

$$\Rightarrow \quad 4u = -60$$

$$\Rightarrow \quad u = \frac{-60}{4}$$

$$u = -15 \text{ cm}$$

2. A compound microscope has a magnification of 30. The focal length of eye piece is 5 cm. Assuming the final image to be at least distance of distinct vision, find the magnification produced by the objective.

Solution :

Given data :

Magnification of compound microscope $m = 30$

Focal length of eye piece f_e = 5 cm

Image distance D = 25 cm

To find :

Magnification of objective m_o = ?

Formula : Magnification $m = m_o m_e$

$$m = m_o\left(1+\frac{D}{f_e}\right)$$

$$30 = m_o\left(1+\frac{25}{5}\right)$$

$$\Rightarrow \quad m_o = 5$$

$$m_o = 5$$

3. An object is placed in front of a concave mirror of focal length 20 cm. The image formed is three times the size of the object. Calculate two possible distances of the object from the mirror.

Solution :

Given data :

The focal length of the concave lens f = 20 cm

Magnification m = 3

First case :

When the image is virtual, m = 3

$$\text{Magnification } m = \frac{-v}{u} = 3$$

$$\text{i.e } \frac{-v}{u} = 3$$

$$v = -3u$$

According to mirror formula :

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{-20} = \frac{1}{u} - \frac{1}{3u}$$

$$\frac{1}{-20} = \frac{3-1}{3u}$$

$$\frac{3u}{2} = -20 \qquad \therefore u = \frac{-40}{3}$$

$$u = \frac{-40}{3} \text{ cm}$$

$$\therefore v = -3 \times \left(\frac{40}{3}\right)$$

$$= -40 \text{ cm}$$

The distance of image from the mirror when the image is virtual is 39.9 cm.

Second case :

When the image is real, $m = -3$

$$\text{Magnification, } m = \frac{-v}{u}$$

$$\frac{-v}{u} = -3$$

$$v = 3u$$

According to mirror formula :

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{-20} = \frac{1}{u} + \frac{1}{3u}$$

$$\frac{1}{-20} = \frac{3+1}{3u}$$

$$\frac{3u}{4} = -20$$

$$3u = -80$$

$$u = \frac{-80}{3} \text{ cm}$$

Two possible distance of the object from the mirror are $\frac{-40}{3}$ and $\frac{-80}{3}$ cm .

4. A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm. What is the area of the surface of water through which light from the bulb can emerge out? Refractive index of water is 1.33. (Consider the bulb to be a point source.)

Solution :

Given data :

Actual depth of the bulb in water (d_1) = 80 cm

= 0.80 m

Refractive index of water (μ) = 1.33

Government Exam Questions & Answers

Choose the Correct Answer 1 MARK

1. For a myopic eye, the defect is cured by using a *[Govt. MQP-2019]*

(a) convex lens (b) concave lens
(c) cylindrical lens (d) plane glass

[**Ans.** (b) concave lens]

2. A ray of light gets refracted into the air medium from crown glass of refractive index 1.541. If angle of incidence is equal to the critical angle 40.5°, then the angle of refraction will be *[HY-2019]*

(a) equal to the critical angle
(b) lesser than the critical angle
(c) equal to 90°
(d) greater than critical angle

[**Ans.** (c) equal to 90°]

Very Short Answer Questions 2 MARKS

1. Two polaroids are kept with their transmission axes inclined at 30°. Unpolarised light of intensity I falls on the first polariod. Find out intensity of light emerging from the second period. *[HY-2019]*

Ans. **Solution :**

As the intensity of the unpolarised light falling on the first polaroid is I, the intensity of polarized light emerging will be, $I_0 = \left(\frac{I}{2}\right)$

Let I′ be the intensity of light emerging from the second polaroid. Malus' law, $I' = I_0 \cos^2\theta$

Substituting,

$$I' = \left(\frac{I}{2}\right)\cos^2(30°) = \left(\frac{I}{2}\right)\left(\frac{\sqrt{3}}{2}\right)^2 = I\frac{3}{8}$$

$$I' = \left(\frac{3}{8}\right)I$$

ADDITIONAL QUESTIONS AND ANSWERS

Choose the Correct Answer 1 MARK

1. A light bulb is placed between two mirrors (plane) inclined at an angle of 60°. Number of images formed are

(a) 2 (b) 4
(c) 5 (d) 6 [**Ans.** (c) 5]

2. Two plane mirror are inclined at an angle of 72°.The number of images of a point object placed between them will be

(a) 2 (b) 3
(c) 4 (d) 5 [**Ans.** (c) 4]

3. To get three images of a single object, one should have two plane mirror at an angle of

(a) 30° (b) 60°
(c) 90° (d) 120° [**Ans.**(c) 90°]

4. A man of length h requires a mirror of length at least equal to, to see his own complete image

(a) $\frac{h}{4}$ (b) $\frac{h}{3}$
(c) $\frac{h}{2}$ (d) h [**Ans.** (c) $\frac{h}{2}$]

5. Two plane mirrors are at 45° to each other. If an object is placed between them than the number of images will be

(a) 5 (b) 9
(c) 7 (d) 8 [**Ans.** (c) 7]

6. An object is at a distance of 0.5 in front of a plane mirror. Distance between the object and image is

(a) 0.5 m (b) 1 m
(c) 7 (d) 8 [**Ans.** (b) 1 m]

7. A man runs towards a mirror at a speed 15 m/s. The speed of the image relative to the man is

(a) 15 ms^{-1} (b) 30 ms^{-1}
(c) 35 ms^{-1} (d) 20 ms^{-1}

[**Ans.** (b) 30 ms^{-1}]

8. The light reflected by plane mirror may form a real images.

(a) If the rays incident on the mirror are diverging
(b) If the rays incident on the mirror are converging
(c) If the object is placed very close to mirror
(d) Under no circumstance

[**Ans.** (b) If the rays incident on the mirror are converging]

Unit 6

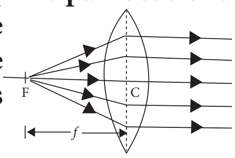
10. What is thin lens?

Ans. (i) A lens is formed by a transparent material bounded between two spherical surfaces or one plane and another spherical surface.

(ii) In a thin lens, the distance between the surfaces is very small. If there are two spherical surfaces, then there will be two centres of curvature C_1 and C_2 and correspondingly two radii of curvature R_1 and R_2.

(iii) A plane surface has its center of curvature C at infinity and its radius of curvature R is infinity (R = ∞).

11. An object is placed at the principal focus of a convex lens. Determine the position of the image making use of lens equation.



Solution : $u = -f$

From the lens equation,

$$\frac{1}{v} - \frac{1}{-f} = \frac{1}{f} \quad \text{or} \quad \frac{1}{v} = 0$$

$\therefore \quad v = \infty$

So, the image is formed at infinity.

12. Use the lens equation to deduce algebraically the following :
"An object placed within the focus of a convex lens produces a virtual and enlarged image"

Solution : $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ or $\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

convex lens : $f > 0$, $u < 0$ (object on the left)

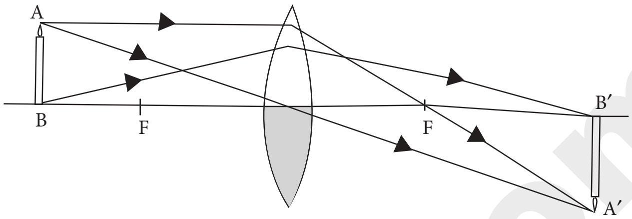
For $0 < |u| < f$

$\frac{1}{v} = \frac{1}{f} - \frac{1}{|u|} < 0$ i.e. $u < 0$ (image on left ; virtual)

Also for this case, $\frac{1}{|v|} < \frac{1}{|u|}$ i.e. $|u| < |v|$ (image enlarged)

13. The image of a candle is formed by a convex lens on a screen. The lower half of the lens is painted black to make it completely opaque. Draw the ray diagram to show the image formation. How will this image be different from the one obtained when the lens is not painted black?

Ans. The full size of the image will be obtained. But the intensity of image will be reduced. This is because the number of rays of light refracted through different parts of the lens will be reduced.

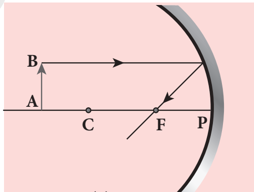


Long Answer Questions — 5 Marks

1. Draw and explain the image formation in spherical mirrors.

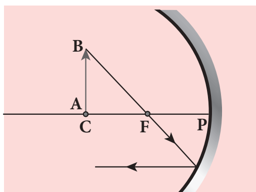
Ans. The image can be located by graphical construction. To locate the point of an image, a minimum of two rays must meet at that point.

(i) A ray parallel to the principal axis after reflection will pass through or appear to pass through the principal focus. (Figure(a))



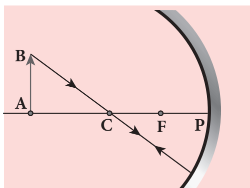
(a)

(ii) A ray passing through or appear to pass through the principal focus, after reflection will travel parallel to the principal axis. (Figure(b))



(b)

(iii) A ray passing through the centre of curvature retraces its path after reflection as it is a case of normal incidence. (Figure(c))



(c)

UNIT 7

DUAL NATURE OF RADIATION AND MATTER

CHAPTER SNAPSHOT

Evaluation

I. Multiple Choice Questions:

1. The wavelength λ_e of an electron and λ_p of a photon of same energy E are related by *(NEET 2013) [Govt. MQP-2019]*

(a) $\lambda_p \propto \lambda_e$ (b) $\lambda_p \propto \sqrt{\lambda_e}$
(c) $\lambda_p \propto \frac{1}{\sqrt{\lambda_e}}$ (d) $\lambda_p \propto \lambda_e^2$

[**Ans.** (d) $\lambda_p \propto \lambda_e^2$]

Hint: $\frac{\lambda_e}{\lambda_p} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc} = \frac{1}{C}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

2. In an electron microscope, the electrons are accelerated by a voltage of 14 kV. If the voltage is changed to 224 kV, then the de Broglie wavelength associated with the electrons would

(a) increase by 2 times
(b) decrease by 2 times
(c) decrease by 4 times
(d) increase by 4 times

[**Ans.** (c) decrease by 4 times]

Hint: $\lambda = \frac{h}{\sqrt{2mqV}}$

3. A particle of mass 3×10^{-6} g has the same wavelength as an electron moving with a velocity 6×10^6 ms^{-1}. The velocity of the particle is

(a) 1.82×10^{-18} ms^{-1} (b) 9×10^{-2} ms^{-1}
(c) 3×10^{-31} ms^{-1} (d) 1.82×10^{-15} ms^{-1}

[**Ans.** (d) 1.82×10^{-15} ms^{-1}]

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

4. 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 *(NEET 2016)*

(a) 4λ (b) 5λ
(c) $\frac{5}{2}\lambda$ (d) 3λ

[**Ans.** (d) 3λ]

5. If a light of wavelength 330 nm is incident on a metal with work function 3.55 eV, the electrons are emitted. Then the wavelength of the emitted electron is (Take $h = 6.6 \times 10^{-34}$ Js)

(a) $< 2.75\times10^{-9}$m (b) $\geq 2.75\times10^{-9}$m
(c) $\leq 2.75\times10^{-12}$m (d) $< 2.5\times10^{-10}$m

[**Ans.** (b) $\geq 2.75\times10^{-9}$m]

6. 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 at the surface of material is *(NEET 2015) [PTA-2]*

(a) $\frac{hc}{\lambda}$ (b) $\frac{2hc}{\lambda}$
(c) $\frac{hc}{3\lambda}$ (d) $\frac{hc}{2\lambda}$

[**Ans.** (d) $\frac{hc}{2\lambda}$]

7. In photoelectric emission, a radiation whose frequency is 4 times threshold frequency of a certain metal is incident on the metal. Then the maximum possible velocity of the emitted electron will be

(a) $\sqrt{\frac{hv_0}{m}}$ (b) $\sqrt{\frac{6hv_0}{m}}$
(c) $2\sqrt{\frac{hv_0}{m}}$ (d) $\sqrt{\frac{hv_0}{2m}}$

[**Ans.** (b) $\sqrt{\frac{6hv_0}{m}}$]

8. Two radiations with photon energies 0.9 eV and 3.3 eV respectively are falling on a metallic surface successively. If the work function of the metal is 0.6 eV, then the ratio of maximum speeds of emitted electrons will be

(a) 1:4 (b) 1:3
(c) 1:1 (d) 1:9

[**Ans.** (b) 1:3]

Unit 7

IV. Numerical Problems:

1. How many photons per second emanate from a 50 mW laser of 640 nm?

Solution :

Given data:

Wavelength of the laser = 640 nm

λ = 640×10^{-9} m

Power of laser P = 50 mw = 50×10^{-3} w

To find :

No. of photons emitted per second N = ?

The energy of a photon E $= h\nu = \frac{hc}{\lambda}$

c - velocity of light $= 3 \times 10^8 \text{ ms}^{-1}$

h - planck constant $= 6.626 \times 10^{-34}$ Js.

P = no. of photons emitted per second × energy of one photon.

$$P = NE$$

$$N = \frac{P}{E}$$

$$= \frac{50\times10^{-3}\times640\times10^{-9}}{6.626\times10^{-34}\times3\times10^{8}} = \frac{32000\times10^{-12}}{19.878\times10^{-26}}$$

$$N = 1609.8 \times 10^{14} \text{ s}^{-1}$$

No. of protons emitted per second = **1.61×10^{17} s^{-1}**

2. Calculate the maximum kinetic energy and maximum velocity of the photoelectrons emitted when the stopping potential is 81V for the photoelectric emission experiment.

Solution :

Given data:

Stopping potential $V_0 = 81$ V

To find :

Maximum Kinetic Energy = ?

Maximum velocity of photoelectrons emitted V_{max} = ?

(i) $eV_0 = \frac{1}{2} m\upsilon^2_{max}$ = Kinetic Energy$_{max}$

e - charge of the electron $= 1.6 \times 10^{-19}$ C

$$K.E._{max} = eV_0 = 1.6 \times 10^{-19} \times 81$$

$$= 129.6 \times 10^{-19} \text{ J}$$

Kinetic Energy$_{max}$ = **1.3×10^{-17} J**

(ii) Maximum velocity $v^2_{max} = \frac{2eV_0}{m}$

$$\therefore v_{max} = \sqrt{\frac{2eV_0}{m}}$$

m - mass of the e$^-$ $= 9.1 \times 10^{-31}$

$$v_{max} = \sqrt{\frac{2\times1.3\times10^{-17}}{9.1\times10^{-31}}} = \sqrt{0.2857\times10^{14}}$$

$$= \sqrt{28.57\times10^{12}}$$

$$v_{max} = \mathbf{5.3 \times 10^6 \text{ ms}^{-1}}$$

3. Calculate the energies of the photons associated with the following radiation: (i) violet light of 413 nm (ii) X-rays of 0.1 nm (iii) radio waves of 10 m.

Solution :

Given data :

(i) Wavelength of violet light λ_v = 413 nm $= 413 \times 10^{-9}$ m

(ii) Wavelength of X-rays λ_x = 0.1 nm $= 0.1 \times 10^{-9}$ m

(iii) Wavelength of radio waves λ_r = 10 m

Energy of the photons associated with the radiation E = ?

$$E = h\nu = \frac{hc}{\lambda}$$

c - Velocity of light - $3 \times 10^8 \text{ ms}^{-1}$

h - Planck constant - 6.626×10^{-34} Js

(i) $$E_r = \frac{hc}{\lambda_v} = \frac{6.626\times10^{-34}\times3\times10^{8}}{413\times10^{-9}}$$

$$= \frac{19.878\times10^{-26}}{413\times10^{-9}} = 0.0481 \times 10^{-17} \text{ J}$$

[To convert from J into ev]

$$= \frac{0.0481\times10^{-17}}{1.6\times10^{-19}} = 0.03 \times 10^2 = 3 \text{ eV.}$$

$$E_r = \mathbf{3 \text{ eV.}}$$

(ii) $$E_x = \frac{hc}{\lambda_x} = \frac{19.878\times10^{-26}}{10^{-10}}$$

$$= 19.878 \times 10^{-16} \text{ J}$$

$$= \frac{19.878\times10^{-16}}{1.6\times10^{-19}} \text{ eV} = 12.424 \times 10^3$$

$$E_x = \mathbf{12424 \text{ eV.}}$$

(iii) $$E_r = \frac{hc}{\lambda_r} = \frac{19.878\times10^{-26}}{10}$$

$$= \frac{19.878\times10^{-27}}{1.6\times10^{-19}} \text{ eV} = 12.424 \times 10^{-8}$$

$$E_r = \mathbf{1.24 \times 10^{-7} \text{ eV.}}$$

Government Exam Questions & Answers

Choose the Correct Answer 1 mark

1. In an electron microscope, the electrons are accelerated by a voltage of 25 kV. If the voltage is changed to 225 kV, then the de-Broglie wavelength associated with the electrons would *[HY-2019]*

(a) increased by 3 times
(b) decrease by 3 times
(c) decrease by 4 times
(d) increase by 4 times

[Ans. (b) decrease by 3 times]

Short Answer Questions 2 mark

1. Calculate the radius of $^{197}_{79}Au$ *[Govt. MQP-2019 ; PTA-3]*

Solution :

According to the $R = R_0 A^{\frac{1}{3}}$

$$R = 1.2 \times 10–15 \times (197)^{\frac{1}{3}} = 6.97 \times 10^{-15} \text{ m}$$

Or R = 6.97 F.

ADDITIONAL QUESTIONS AND ANSWERS

Choose the Correct Answer 1 mark

1. P and E denote the linear momentum and energy of a photon. If the wavelength is decreased.

(a) Both P and E increase
(b) P increases and E decreases
(c) P decreases and E increases
(d) both P & E decrease

[Ans. (a) Both P and E increase]

2. The work function of a metal is $h\nu_0$. Light of frequency ν falls on this metal. The photoelectric effect will take place only if

(a) $\nu > \nu_0$ (b) $\nu > 2\nu_0$
(c) $\nu < \nu_0$ (d) $\nu > \nu_0/2$

[Ans. (a) $\nu > \nu_0$]

3. When stopping potential is applied in an experiment on photoelectric effect, no photocurrent is observed. This means that.

(a) The emission of photoelectrons is stopped
(b) The photoelectrons are emitted but are reabsorbed by the emitter metal
(c) The photo electrons are accumulated near the collector plate
(d) The photoelectrons are dispersed from the sides of the apparatus.

[Ans. (b) The photoelectrons are emitted but are reabsorbed by the emitter metal]

4. If the frequency of light in a photoelectron experiment is doubled the stopping potential will

(a) be doubled (b) be halved
(c) become more than double
(d) become less than double.

[Ans. (c) become more than double]

5. Light of wavelength falls on a metal having work function $\frac{h_c}{\lambda_0}$. Photoelectric effect will place only if

(a) $\lambda \geq \lambda_0$ (b) $\lambda \geq 2\lambda_0$
(c) $\lambda \leq \lambda_0$ (d) $\lambda < \lambda_0/2$.

[Ans. (c) $\lambda \leq \lambda_0$]

6. When the intensity of a light source is increased

(a) the number of photons emitted by the source in unit time increases
(b) more energetic photons are emitted
(c) faster photons are emitted
(d) total energy of the photons emitted per unit time decreases.

[Ans. (a) the number of photons emitted by the source in unit time increases]

UNIT 8 ATOMIC AND NUCLEAR PHYSICS

CHAPTER SNAPSHOT

$\frac{dN}{dt} = 3.7 \times 10^{10}$ disintegrations/second

$\therefore N = 3.7 \times 10^{10} \times \frac{1600}{0.6931} \times 365 \times 24 \times 60 \times 60$

$= 3.7 \times 10^{10} \times 1.443 \times 1600 \times 365 \times 24 \times 60 \times 60$

$N = 2.694 \times 10^{21}$ atoms

According to Avogadro's principle

Mass of 6.023×10^{23} atoms give : 226 gm of radium

$\therefore$ Mass of 2.694×1021 atoms will give

$$= \frac{226}{6.023 \times 10^{23}} \times 2.694 \times 10^{21} = 1.011 \text{ gm.}$$

$\therefore$ The mass of radium with an activity of 1 cuire is almost 1 gram.

Unit 8

11. Characol pieces of tree is found from an archeological site. The carbon-14 content of this characol is only 17.5% that of equivalent sample of carbon from a living tree. What is the age of tree?

Solution :

Intral activity of the living tree = N_0

Activity of the charcoal N = 17.5 % of N_0.

$= 0.175\ N_0$.

Half life of carbon $T_{1/2} = 5730$ years

Disintegration constant of carbon =

$$\lambda = \frac{ln_2}{T_{1/2}} = \frac{0.6931}{T_{1/2}} = \frac{0.6931}{5730} = 1.2094 \times 10^{-4} \text{ years.}$$

Let the average of the tree = t

$$\frac{N}{N_0} = e^{-\lambda t}$$

$$t = \frac{1}{\lambda} ln\left[\frac{N_0}{N}\right]$$

$$= \left[\frac{1}{1.2094 \times 10^{-4}\ /\text{years}}\right] ln\left[\frac{N_0}{0.175\,N_0}\right]$$

$$= \frac{1}{1.2094 \times 10^{-4}} . ln\left[\frac{1}{0.175}\right] = 14.408 \text{ years}$$

$\therefore$ The age of the tree = **1.44×10^4** years.

PTA Model Questions & Answers

Choose the Correct Answer — 1 Mark

1. The ratio of kinetic energy to the total energy of an electron in a Bohr orbit of the hydrogen atom is: *[PTA-1]*

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

[Ans. (b) 1 : –1]

2. Two nuclei have mass numbers in the ratio 1 : 8. Find the ratio of their nuclear radii *[PTA-1]*

(a) 1 : 8 (b) 1 : 2
(c) 2 : 1 (d) 8 : 1

[Ans. (b) 1 : 2]

3. Hydrogen atom in ground state is excited by a monochromatic radiation of wavelength of λ = 975 Å. Number of spectral lines in the resulting spectrum emitted will be: *[PTA-2]*

(a) 10 (b) 6
(c) 3 (d) 2

[Ans. (b) 6]

4. The radius of the 5th orbit of hydrogen atom is 13.25 Å. Calculate the wavelength of the electron in the 5th orbit *[PTA-3]*

(a) λ = 16.64 Å (b) λ = 26.50 Å
(c) λ = 13.25 Å (d) λ = 13.64 Å

[Ans. (a) λ = 16.64 Å]

5. Half of an element is 25 years, then what percentage of sample will be left over after 125 years and its life time are? *[PTA-3]*

(a) 3.125% & 1250 (b) 3.125% & ∞
(c) 6.25% & 1250 (d) 6.25 % & ∞

[Ans. (a) 3.125% & 1250]

6. Relation between Half life and average life of radioactivity is *[PTA-4]*

(a) $T_{1/2} = 1/\tau$ (b) $T_{1/2} = 0.6931/\tau$
(c) $T_{1/2} = \tau/2$ (d) $T_{1/2} = 0.6931\tau$

[Ans. (d) $T_{1/2} = 0.6931\tau$]

7. If in nuclear fusion process, the masses of the fusing nuclei be m_1 and m_2 and the mass of the resultant is m_3, then *[PTA-5]*

(a) $m_3 = m_1 + m_2$ (b) $m_3 = (m_1 - m_2)$
(c) $m_3 < (m_1 + m_2)$ (d) $m_3 > (m_1 + m_2)$

[Ans. (c) $m_3 < (m_1 + m_2)$]

8. Which of the following transition will have highest emission wavelength *[PTA-6]*

(a) n = 2 to n = 1 (b) n = 4 to n = 1
(c) n = 6 to n = 2 (d) n = 5 to n = 2

[Ans. (d) n = 5 to n = 2]

UNIT 9 SEMICONDUCTOR ELECTRONICS

CHAPTER SNAPSHOT

$(I_C + I_B)\ 1k + 10k\ I_B + V_{BE} + (I_C + I_B)\ 1k = 12$

$$I_B = \frac{I_C}{\beta} \text{ but, } \beta = \frac{\alpha}{1-\alpha} = \frac{0.99}{1-0.99} = 99$$

$$I_B = \frac{I_C}{99}$$

$$I_C = 99\ I_B \qquad ...(1)$$

$$I_C + I_B + 10\ I_B + 0.7 + I_C + I_B = 12$$

$$2\ I_C + 12\ I_B + 0.7 = 12$$

$$2\ I_C + 12\ I_B = 11.3$$

substitute equation (1),

$$2 \times 99\ I_B + 12\ I_B = 11.3$$

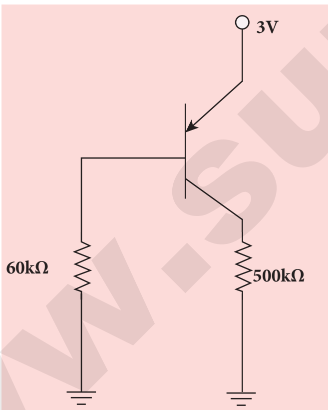
$$210\ I_B = 11.3$$

$$I_B = \frac{11.3}{210} = 0.0538$$

$$I_C = 99 \times 0.0538 = 5.32 \text{ mA}$$

$$\boxed{I_C = 5.32 \text{ mA}}$$

5. In the circuit shown in the figure, the BJT has a current gain (β) of 50. For an emitter – base voltage V_{EB} = 600 mV, calculate the emitter – collector voltage V_{EC} (in volts).



Solution:

Given data :

Current gain (β) = 50

Emitter base voltage $V_{EB} = 600$ mV $= 600 \times 10^{-3}$V

$R_B = 60\ K\Omega = 60 \times 10^3 \Omega$

$R_E = 500\ K\Omega = 500 \times 10^3 \Omega$

$V_{EB} - V_E - V_B$

(or)

$$V_B = V_E - V_{EB}$$

$$V_B = 3 - 0.6 = 2.4 \text{ V}$$

$$I_B = \frac{V_B}{60K} = \frac{2.4}{60K} = 40\ \mu A$$

$$I_c = \beta . I_B = 50 \times 40\ \mu A = 2 \text{ mA}$$

$$V_c = R_E . I_C = 500\ I_C$$

$$= 500 \times 2 \text{ mA} = 1 \text{ V}$$

$V_C = 1$V

So,

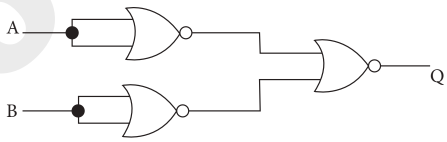
$$V_{EC} = V_E - V_C = 3 - 1 = 2\text{V}$$

$$\boxed{V_{EC} = 2\text{V}}$$

PTA Model Questions & Answers

Choose the Correct Answer — 1 Mark

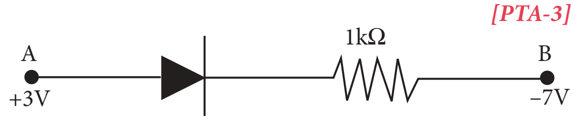
1. Which logic operation does the output Q of the above gate combination produce? *[PTA-1]*



(a) NOT (b) OR
(c) AND (d) EXOR

[*Ans.* (c) AND]

2. Consider an ideal junction diode. Find the value of current flowing through AB is *[PTA-3]*



(a) 10 mA (b) 20 mA
(c) 15 mA (d) 11 mA

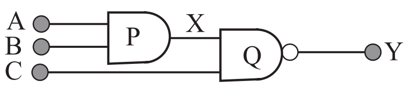
[*Ans.* (a) 10 mA]

3. Blue colour LED is made up of *[PTA-4]*

(a) SiC (b) AlGaP
(c) GaAsP (d) GalnN

[*Ans.* (d) GalnN]

4.



What is the output Y in the above circuit, when all the three inputs A, B, and C are 0? *[PTA-4]*

(a) 0 (b) 1 (c) 10 (d) 11

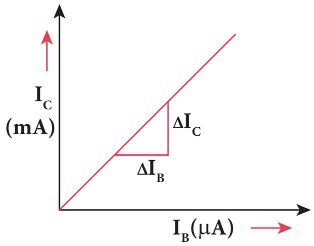
[*Ans.* (a) 0]

Forward current gain :

(i) The ratio of the change in collector current (ΔI_C) to the change in base current (ΔI_B) at constant collector-emitter voltage (V_{CE}) is called **forward current gain** (β).

$$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$

(ii) Its value is very high and it generally ranges from 50 to 200. It depends on the construction of the transistors and will be provided by the manufacturer.



Current transfer characteristics of a NPN transistor common emitter configuration

Unit 9

4. Write any two distinguishing features between Insulators, Metals and semiconductors and insulators based on the basis of energy band diagrams.

Ans. **Insulators :**

(i) The valence band and the conduction band are separated by a large energy gap.

(ii) The forbidden energy gap is approximately 6 eV in insulators.

(iii) The gap is very large that electrons from valence band cannot move into conduction band even on the application of strong external electric field or the increase in temperature.

Metals

(i) In metals, the valence band and conduction band overlap.

(ii) Hence, electrons can move freely into the conduction band which results in a large number of free electrons in the conduction band.

Semiconductors

(i) In semiconductors, there exists a narrow forbidden energy gap (E_g <3eV) between the valence band and the conduction band.

(ii) Free electrons are small in number, the conductivity of the semiconductors is not as high as that of the conductors.

Numerical Problems

1. For a BJT, the common - base current gain α = 0.98 and the collector base junction reverse bias saturation I_{Cu} = 0.6 μA. This BJT is connected in the common emitter mode and operated in the active region with a base drive current I_D = 20 μA. The collector current I_C for this mode of operating is

Solution :

$\alpha = 0.98$; $I_{Cu} = 0.6\ \mu A$

$$\alpha = \frac{\beta}{1+\beta}$$

(or)

$$0.98 = \frac{1}{\frac{1}{\beta}+1}$$

$\beta = 49$

$I_{CEO} = (1+\beta)I_{CBO} = (1+49) \times 0.6\ \mu A$

$I_{CEO} = 30\ \mu A$

$I_C = \beta I_B + I_{CEO}$

$= 49 \times 20\ \mu A + 30\ \mu A = 1010\ \mu A$

$\boxed{I_C = 1.01\ mA}$

2. For a BJT circuit shown, assume that the 'β' of the transistor is very large and V_{BE} = 0.7 V. The mode of operation.

Solution :

$V_{BE} = 0.7\ V$

Input junction is a forward biased.

Since,

$V_{BE} = 0.7\ V$

$V_{CE} = V_{BE} + V_{CB}$

$V_{CB} = V_{CE} - V_{BE}$

To determine V_{CB} we find I_C

$$I_C \cong I_C = \frac{2 - V_{BE}}{R_2} = \frac{2-0.7}{1k\Omega}$$

$I_C = 1.3\ mA$

$V_{CE} = V_{CC} - I_C(R_1 + R_2)$

$= 10 - 1.3\ mA\ (10K + 1K)$

$V_{CE} = -4.3\ V$

$V_{CE} = -4.3\ V - 0.7$

$V_{CB} = -5V$

☆ ☆ ☆

UNIT 10 COMMUNICATION SYSTEMS

CHAPTER SNAPSHOT

89. A continuously varying voltage is called ________ voltage.
(a) analog (b) digital
(c) simultaneous (d) scanned
[**Ans.** (a) analog]

90. If a signal can take any value within a given range it is ________ signal.
(a) analog (b) scanned
(c) simultaneous (d) digital
[**Ans.** (a) analog]

91. The greatest technical problem with an analog communication system is ________.
(a) noise (b) low speed
(c) low range (d) accessibility
[**Ans.** (a) noise]

92. A digital system is ________ in nature.
(a) analog (b) binary
(c) direct (d) continuous
[**Ans.** (b) binary]

93. The abbreviation of the term 'Modulator and Demodulator' is ________.
(a) model (b) modem
(c) alternator (d) decoder
[**Ans.** (b) modem]

94. Digital signals are converted into analog signals using ________.
(a) FAX (b) Modem
(c) Cable (d) Coaxial Cable
[**Ans.** (b) modem]

95. ________ is the most often used wire material.
(a) Copper (b) Aluminium
(c) Sulphur (d) iron
[**Ans.** (a) Copper]

96. A bundle of wires with a protective outer jacket is called ________.
(a) transmitter (b) cable
(c) coil (d) packet
[**Ans.** (b) cable]

97. ________ wire is used between telephones and the central office.
(a) Flat (b) Multiconnector
(c) Co-axial (d) Twisted pair
[**Ans.** (d) Twisted pair]

98. A multiconductor flat cable can have any number of wires in the range ________.
(a) 5 - 10 (b) 10 - 25
(c) 10 - 50 (d) 50 - 100
[**Ans.** (c) 10 - 50]

99. The principle used for transmission of light signals through optical fibre is
(a) refraction (b) diffraction
(c) polarisation
(d) total internal reflection
[**Ans.** (d) total internal reflection]

100. The minimum difference in frequencies between the uplink and downlink transmission is ________
(a) 200 kHz (b) 2 GHz
(c) 2 MHz (d) 20 MHz
[**Ans.** (b) 2 GHz]

101. The abbreviation of the term 'Modulator and Demodulator' is ________.
(a) model (b) modem
(c) alternator (d) decoder
[**Ans.** (b) modem]

102. Digital signals are converted into analog signals using ________.
(a) FAX (b) Modem
(c) Cable (d) Coaxial Cable
[**Ans.** (b) modem]

103. ________ is the most often used wire material.
(a) Copper (b) Aluminium
(c) Sulphur (d) iron
[**Ans.** (a) Copper]

104. A bundle of wires with a protective outer jacket is called ________.
(a) transmitter (b) cable
(c) coil (d) packet
[**Ans.** (b) cable]

105. ________ wire is used between telephones and the central office.
(a) Flat
(b) Multiconnector (c) Co-axial
(d) Twisted pair [**Ans.** (d) Twisted pair]

106. A multiconductor flat cable can have any number of wires in the range ________.
(a) 5 - 10 (b) 10 - 25
(c) 10 - 50 (d) 50 - 100
[**Ans.** (c) 10 - 50]

107. The principle used for transmission of light signals through optical fibre is
(a) refraction (b) diffraction
(c) polarisation
(d) total internal reflection
[**Ans.** (d) total internal reflection]

108. The minimum difference in frequencies between the uplink and downlink transmission is ________
(a) 200 kHz (b) 2 GHz
(c) 2 MHz (d) 20 MHz
[**Ans.** (b) 2 GHz]

EVALUATION

I. MULTIPLE CHOICE QUESTIONS:

1. **The particle size of ZnO material is 30 nm. Based on the dimension it is classified as**
   (a) Bulk material (b) Nanomaterial
   (c) Soft material
   (d) Magnetic material **[Ans. (b) Nanomaterial]**

2. **Which one of the following is the natural nanomaterial.** *[PTA-2, 4]*
   (a) Peacock feather (b) Peacock beak
   (c) Grain of sand (d) Skin of the Whale
   [Ans. (a) Peacock feather]

3. **The blue print for making ultra durable synthetic material is mimicked from**
   (a) Lotus leaf (b) Morpho butterfly
   (c) Parrot fish (d) Peacock feather
   [Ans. (c) Parrot fish]

4. **The method of making nanomaterial by assembling the atoms is called**
   (a) Top down approach
   (b) Bottom up approach
   (c) Cross down approach
   (d) Diagonal approach
   [Ans. (b) Bottom up approach]

5. **"Sky wax" is an application of nano product in the field of**
   (a) Medicine (b) Textile
   (c) Sports
   (d) Automotive industry **[Ans. (c) Sports]**

6. **The materials used in Robotics are** *[Govt. MQP-2019]*
   (a) Aluminium and silver
   (b) Silver and gold (c) Copper and gold
   (d) Steel and aluminum
   [Ans. (d) Steel and aluminum]

7. **The alloys used for muscle wires in Robots are**
   (a) Shape memory alloys
   (b) Gold copper alloys
   (c) Gold silver alloys
   (d) Two dimensional alloys
   [Ans. (a) Shape memory alloys]

8. **The technology used for stopping the brain from processing pain is**
   (a) Precision medicine
   (b) Wireless brain sensor
   (c) Virtual reality
   (d) Radiology **[Ans. (c) Virtual reality]**

9. **The particle which gives mass to protons and neutrons are** *[PTA-1]*
   (a) Higgs particle (b) Einstein particle
   (c) Nanoparticle (d) Bulk particle
   [Ans. (a) Higgs particle]

10. **The gravitational waves were theoretically proposed by**
    (a) Conrad Rontgen
    (b) Marie Curie
    (c) Albert Einstein
    (d) Edward Purcell **[Ans. (c) Albert Einstein]**

II. SHORT ANSWERS :

1. **Distinguish between Nanoscience and Nanotechnology.**

Ans.

Nanoscience	Nanotechnology
Nanoscience is the science of objects with typical sizes of 1- 100 nm. One nanometer = 10^{-9} meter.	Nanotechnology is a technology involving in the design, production, characterization, and application of nano structured materials.

2. **What is the difference between Nano materials and Bulk materials?**

Ans.

Nano materials	Bulk materials
If the particle of a solid is of size less than 100 nm, it is said to be a non solid or nano materials	When the particle size exceeds 100 nm, it is a bulk solid or bulk material.

3. **Give any two examples for "Nano" in nature.**

Ans. Single strand of DNA, Peacock feathers, Morpho butterfly, Parrot fish and Lotus leaf surface.

NEET BASED QUESTIONS

1. The moment of inertia of a collapsing star changes to one-third of its initial value. The ratio of the new rotational kinetic energy to the initial rotational kinetic energy is____
(A) 3 : 1 (B) 1 : 3 (C) 9 : 1 (D) 1 : 9

2. A body of 10 kg is dropped from infinite height towards earth's surface. What will be its velocity just before touching the earth's surface. (Gravitational potential energy of the body at earth's surface is $6{\cdot}25 \times 10^8$ Joule).
(A) 22·4 km/sec (B) 11·2 km/sec
(C) 6·4 km/sec (D) Infinite

3. The vertical escape velocity of a body from earth's surface is 11·2 km/sec. If the body is projected at an angle of 45° from the vertical, its escape velocity will be ______.
(A) $11{\cdot}2 \times \sqrt{2}$ km/s (B) $\frac{11{\cdot}2}{\sqrt{2}}$ km/s
(C) $11{\cdot}2 \times 2$ km/s (D) 11·2 km/s

4. Which of the following equations represents a simple harmonic wave ?
(A) $y = a \sin \omega t$ (B) $y = a \sin \omega t \cos kt$
(C) $y = a \sin (\omega t - kx)$ (D) $y = a \cos kx$

5. The focal length of a convex lens is f. When it is divided in two parts by a plane parallel to the principal axis, focal length of each part will be ________
(A) f (B) $\frac{f}{2}$ (C) $2f$ (D) Zero

6. During negative β-decay ________.
(A) Atom electron is ejected
(B) Electron, already present in the nucleus is ejected
(C) Neutron of the nucleus decays ejecting the electron
(D) A part of binding energy is converted into an electron

7. The maximum intensity in the interference pattern of two equal and parallel slits is I. if one of the slits is closed, the intensity at the same point is I_0. Then ________.
(A) $I = I_0$ (B) $I = 2I_0$
(C) $I = 4I_0$
(D) There is no relation between I and I_0

8. X-rays coming out of an X-ray tube ________.
(A) Are monochromatic
(B) Have all wavelengths below a certain minimum wavelength
(C) Have all wavelengths above a certain minimum wavelength
(D) Have all wavelengths between a certain minimum and maximum wavelength

9. The current amplification of common base N–P–N transistor is 0·96. What will be the current gain if it is used as common emitter amplifier ?
(A) 16 (B) 24 (C) 20 (D) 32

10. Who discovered neutron and positron respectively ?
(A) Thomson and Rutherford
(B) Rutherford and Thomson
(C) Anderson and Chadwick
(D) Chadwick and Anderson

11. Amplification factor of a triode is 20 and its plate resistance is 20 kΩ. Its mutual conductance will be ________.
(A) 2×10^5 mho (B) 2×10^4 mho
(C) 500 mho (D) 2×10^{-3} mho

12. The co-ordinates of a moving particle at time t are given by $x = at^2$, $y = bt^2$ The speed of the particle is ________.
(A) $2(a + b)t$ (B) $(a^2 + b^2)^{1/2} \times t$
(C) $2(a^2 + b^2)^{1/2} \times t$ (D) $(a + b)t$

100. Two particles whose masses are 10 kg and 30 kg and their position vectors are $\hat{i}+\hat{j}+\hat{k}$ and $-\hat{i}-\hat{j}-\hat{k}$ respectively, would have the centre of mass at ________

(A) $-\frac{\hat{i}+\hat{j}+\hat{k}}{2}$ (B) $\frac{\hat{i}+\hat{j}+\hat{k}}{2}$

(C) $-\frac{\hat{i}+\hat{j}+\hat{k}}{4}$ (D) $\frac{\hat{i}+\hat{j}+\hat{k}}{4}$

Answers

1.	(A)	**2.**	(B)	**3.**	(D)	**4.**	(C)	**5.**	(A)
6.	(C)	**7.**	(C)	**8.**	(C)	**9.**	(B)	**10.**	(D)
11.	(D)	**12.**	(C)	**13.**	(A)	**14.**	(A)	**15.**	(C)
16.	(C)	**17.**	(B)	**18.**	(C)	**19.**	(A)	**20.**	(C)
21.	(B)	**22.**	(B)	**23.**	(C)	**24.**	(A)	**25.**	(B)
26.	(D)	**27.**	(B)	**28.**	(D)	**29.**	(D)	**30.**	(D)
31.	(D)	**32.**	(D)	**33.**	(C)	**34.**	(B)	**35.**	(B)
36.	(D)	**37.**	(A)	**38.**	(C)	**39.**	(B)	**40.**	(C)
41.	(D)	**42.**	(D)	**43.**	(B)	**44.**	(C)	**45.**	(D)
46.	(C)	**47.**	(B)	**48.**	(C)	**49.**	(B)	**50.**	(B
51.	(C)	**52.**	(A)	**53.**	(B)	**54.**	(D)	**55.**	(C)
56.	(C)	**57.**	(A)	**58.**	(B)	**59.**	(D)	**60.**	(D)
61.	(B)	**62.**	(A)	**63.**	(A)	**64.**	(D)	**65.**	(B)
66.	(B)	**67.**	(B)	**68.**	(C)	**69.**	(A)	**70.**	(C)
71.	(B)	**72.**	(D)	**73.**	(D)	**74.**	(B)	**75.**	(D)
76.	(B)	**77.**	(C)	**78.**	(C)	**79.**	(A)	**80.**	(C)
81.	(D)	**82.**	(D)	**83.**	(D)	**84.**	(C)	**85.**	(B)
86.	(D)	**87.**	(A)	**88.**	(C)	**89.**	(D)	**90.**	(B)
91.	(B)	**92.**	(D)	**93.**	(C)	**94.**	(D)	**95.**	(A)
96.	(A)	**97.**	(D)	**98.**	(A)	**99.**	(C)	**100.**	(A)

Explanatory Notes:

1. Rotational K.E., $E = \frac{1}{2}I\omega^2$ or, $2EI = (I\omega)^2$

Angular momentum $I\omega = \sqrt{2EI}$

In absence of any external torque, the net angular momentum of the system remains conserved. Thus,

$$\sqrt{2E_1I_1} = \sqrt{2E_2I_2}$$

$$\frac{E_2}{E_1} = \frac{I_1}{I_2} = \frac{3}{1}$$

2. The gravitational potential energy is obtained as kinetic energy

$$\therefore \frac{1}{2}mv^2 = 6{\cdot}25 \times 10^8$$

$$v = \sqrt{\frac{2\times 6{\cdot}25\times 10^8}{10}}$$

$$\Rightarrow v = 11{\cdot}2 \text{ km/sec}$$

3. The escape velocity does not depend on direction and angle of projection.

5. The radii of curvature of the two faces of the lens remain unchanged. Hence, focal length will also remain unchanged.

6. $_0n^1 \longrightarrow {}_1H^1 + {}_{-1}\beta^0$
(neutron) (proton) (electron)

7.
$$I_{max} = (a + a)^2 = 4a^2 = I$$

when one slit is closed, intensity at the same point is

$$I' = a^2 = I_0$$

$$\therefore I = 4I_0$$

8. X-ray spectrum is continuous with a cut-off at a minimum wavelength

$$\lambda_{min} = \frac{hc}{eV}$$

At a given V, X-rays of wavelength lower than λ_{min} are not emited.

9.
$$\beta = \frac{\alpha}{1-\alpha} = \frac{0{\cdot}96}{1-0{\cdot}96} = \frac{0{\cdot}96}{0{\cdot}04} = 24$$

11.
$$\mu = r_p \times g_m$$

$$\therefore g_m = \frac{\mu}{r_p} = \frac{20}{10\times 10^3} = 2 \times 10^{-3} \text{ mho}$$

12.
$$x = at^2, \; y = bt^2$$

$$v_x = \frac{dx}{dt} = 2at \; ; \; v_y = \frac{dy}{dt} = 2bt$$

$$\therefore v = \sqrt{v_x^2 + v_y^2} = \sqrt{(2at)^2 + (2bt)^2} = 2(a^2 + b^2)^{1/2} \times t$$

13. Pressure exerted by a gas

$$\rho = \frac{1}{3}\rho v^{-2} \; ; \; v \propto \sqrt{\frac{3\rho}{\rho}} \qquad [v] = [\rho^{1/2}, \rho^{-1/2}]$$

15. Horizontal Range= max. height reached

$$\frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g} \; ; \; 2\sin\theta\cos\theta = \frac{\sin^2\theta}{2}$$

$$4\cos\theta = \sin\theta$$

$$\tan\theta = 4 \Rightarrow \theta = \tan^{-1} 4$$

16.
$$F_e = \frac{1}{4\pi\varepsilon_0}\cdot\frac{e^2}{r^2} \text{ and } F_m = \frac{\mu_0}{4\pi}\cdot\left(\frac{e^2v^2}{r^2}\right)$$

$$\frac{F_m}{F_e} = \mu_0\varepsilon_0 v^2 = \frac{v^2}{c^2} \quad \text{Since } \mu_0\varepsilon_0 = \frac{1}{c^2}$$

17.
$$\alpha = \omega^2 y$$

$$\omega^2 = \frac{\alpha}{y} = \frac{12}{3} = 4$$

$$\therefore \omega = 2s^{-1}$$

$$T = \frac{2\pi}{\omega} = \frac{2\times 3{\cdot}14}{2} = 3{\cdot}14\, s$$

Physics

12th STD.

Sura's Model Question Paper

Physics

Time Allowed : 3 Hours Maximum Marks : 70

Instructions : (1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.

(2) Use Blue or Black ink to write and underline and pencil to draw diagrams.

Part - I

Note : (i) Answer all the questions: **(15 × 1 = 15)**

(ii) Choose the most suitable answer from the given four alternatives and write the option code and the corresponding answer.

1. Which charge configuration produces a uniform electric field?
   (a) point Charge
   (b) infinite uniform line charge
   (c) uniformly charged infinite plane
   (d) uniformly charged spherical shell

2. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of
   (a) each of them increases
   (b) each of them decreases
   (c) copper increases and germanium decreases
   (d) copper decreases and germanium increases

3. A circular coil of radius 5 cm and has 50 turns carries a current of 3 ampere. The magnetic dipole moment of the coil is
   (a) 1.0 amp - m^2 (b) 1.2 amp - m^2
   (c) 0.5 amp - m^2 (d) 0.8 amp - m^2

4. A long straight conductor carrying a current lies along the axis of a ring. The conductor will exert a force on the ring, if the ring
   (a) carries a current
   (b) has uniformly distributed charge
   (c) has non-uniformly distributed
   (d) none of the above

5. A circular coil with a cross-sectional area of 4 cm^2 has 10 turns. It is placed at the center of a long solenoid that has 15 turns/cm and a cross-sectional area of 10 cm^2. The axis of the coil coincides with the axis of the solenoid. What is their mutual inductance?
   (a) 7.54 μH (b) 8.54 μH
   (c) 9.54 μH (d) 10.54 μH

6. What is the value of resistance of the following resistor?

   (a) 100 k Ω (b) 10 k Ω
   (c) 1k Ω (d) 1000 k Ω

7. Which of the following are false for electromagnetic waves
   (a) transverse
   (b) mechanical waves
   (c) longitudina
   (d) produced by accelerating charges

8. The speed of light in an isotropic medium depends on,
   (a) its intensity
   (b) its wavelength
   (c) the nature of propagation
   (d) the motion of the source w.r. to medium

9. In an electron microscope, the electrons are accelerated by a voltage of 14 kV. If the voltage is changed to 224 kV, then the de Broglie wavelength associated with the electrons would
   (a) increase by 2 times
   (b) decrease by 2 times
   (c) decrease by 4 times
   (d) increase by 4 times

12th STD

COMMON HALF-YEARLY EXAMINATION - 2019

Reg. No.

Time Allowed : 3.00 Hours **Physics** **Maximum Marks : 70**

Instructions : **(1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.**
(2) Use Blue or Black ink to write and underline and pencil to draw diagrams.

Part - I

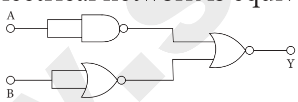
Note : **(i) Answer all the questions. (15 × 1 = 15)**
(ii) Choose the correct answer from the four alternatives and write the option code and the corresponding answer.

1. If the velocity and wavelength of light in air is V_a and λ_a and that in water is V_w and λ_w then the refractive index of water is
(a) $\frac{V_w}{V_a}$ (b) $\frac{V_a}{V_w}$ (c) $\frac{\lambda_w}{\lambda_a}$ (d) $\frac{V_a\lambda_a}{V_w\lambda_w}$

2. The flux linked with a coil at any instant t is given by $\phi_B = 10t^2 - 50t + 250$. The induced emf at t = 3 S is.
(a) –190 V (b) –10 V (c) 10 V (d) 190 V

3. If V_g, V_x, V_m are speeds of Gamma rays, X-rays and microwaves respectively in vacuum then
(a) $V_g < V_x < V_m$ (b) $V_g > V_x > V_m$
(c) $V_m > V_g > V_x$ (d) $V_g = V_x = V_m$

4. The given electrical network is equivalent to,



(a) AND gate (b) OR gate
(c) NOR gate (d) NOT gate

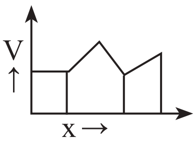
5. Which charge configuration produces a uniform electric field?
(a) point charge
(b) infinite uniform line charge
(c) uniformly charged infinite plane
(d) uniformly charged spherical shell

6. In an electron microscope, the electrons are accelerated by a voltage of 25 kV. If the voltage is changed to 225 kV, then the de-Broglie wavelength associated with the electrons would
(a) increased by 3 times
(b) decrease by 3 times
(c) decrease by 4 times
(d) increase by 4 times

7. In a transformer, the number of turns in the primary and the secondary coil are 300 and 1800 respectively. If the current in primary is 6 A, then that in the secondary coil is
(a) 2A (b) 18A (c) 12A (d) 1A

8. The magnitude of magnetic moment of an electron orbiting in a circular orbit of radius r with a speed V is equal to
(a) $\frac{eVr}{2}$ (b) eVr (c) $\frac{er}{2V}$ (d) $\frac{2V}{er}$

9. In the graph, potential (V) is plotted as a function of distance (X) from the center. In which part of the region the magnitude of X-component of electric field becomes zero?



(a) 1 (b) 2 (c) 3 (d) 4

10. A ray of light gets refracted into the air medium from crown glass of refractive index 1.541. If angle of incidence is equal to the critical angle 40.5°, then the angle of refraction will be
(a) equal to the critical angle
(b) lesser than the critical angle
(c) equal to 90°
(d) greater than critical angle

11. An electric bulb is rated 100 W, 230 V. The supply voltage drops to 115 V. What is the heat energy produced by the bulb in 20 min?
(a) 30 kJ (b) 40 kJ (c) 35 kJ (d) 45 kJ

12. The vertical component of Earth's magnetic field at a place is equal to the horizontal component. What is the value of angle of dip at this place?
(a) 30° (b) 45° (c) 60° (d) 90°

13. The radius of $^{27}_{13}Al$ nucleus is.
(a) 6.97 F (b) 3.6 F
(c) 2.4 F (d) 4.2 F

14. Calculate the height of the antenna required to transmit the modulated signal of frequency ν = 3 MHz is
(a) 25 m (b) 75 m
(c) 7.5 km (d) 2.5 km

15. The primary use of a zener diode is
(a) rectifier (b) amplifier
(c) oscillator (d) voltage regulator