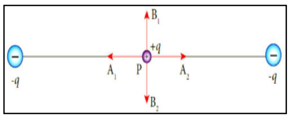
HSC – Second Year (12) – PHYSICS
MINIMUM LEARNING MATERIAL – 2024
MADURAI DISTRICT

Part – I - One Mark Questions and Answers (Book back)

UNIT ~ 1 – ELECTROSTATICS

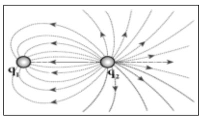
1. Two identical point charges of magnitude $-q$ are fixed as shown in the figure below. A third charge $+q$ is placed midway between the two charges at the point P. Suppose this charge $+q$ is displaced a small distance from the point P in the directions indicated by the arrows, in which direction(s)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

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

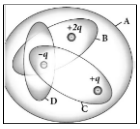
3. What is the ratio of the charges $\left|\frac{q_1}{q_2}\right|$ for the following electric field line pattern?



(a) $\frac{1}{15}$ **(b)** $\frac{25}{11}$ **(c)** 5 **(d)** $\frac{11}{25}$

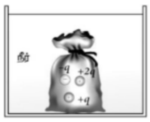
4. An electric dipole is placed at an alignment angle of 30^o with an electric field of 2×10^5 NC^{-1}. It experiences a torque equal to 8 N m. The charge on the dipole if the dipole length is 1 cm is
(a) *4 mC* **(b)** *8 mC* **(c)** *5 mC* **(d)** *7 mC*

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)** $D > C > B > A$

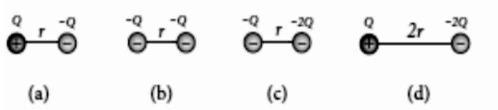
6. The total electric flux for the following closed surface which is kept inside water



(a) $\frac{80\,q}{\epsilon_0}$ **(b)** $\frac{q}{40\epsilon_0}$ **(c)** $\frac{q}{80\epsilon_0}$ **(d)** $\frac{q}{160\epsilon_0}$

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

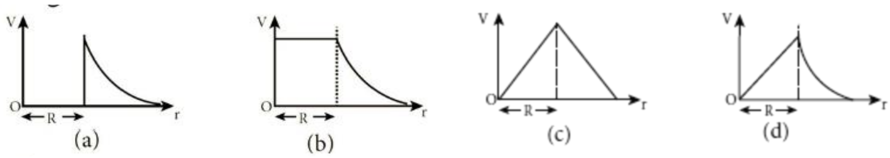
8. Rank the electrostatic potential energies for the given system of charges in increasing order.



(a) $1 = 4 < 2 < 3$ **(b)** $2 = 4 < 3 < 1$
(c) $2 = 3 < 1 < 4$ **(d)** $3 < 1 < 2 < 4$

9. An electric field $\vec{E} = 10x\,\hat{i}$ exists in a certain region of space. Then the potential difference $V = V_o - V_A$, where V_o is the potential at the origin and V_A is the potential at x = 2 m is:
(a) *10 V* **(b)** *–20 V* **(c)** *+20 V* **(d)** *–10 V*

10. A thin conducting spherical shell of radius R has a charge Q which is uniformly distributed on its surface. The correct plot for electrostatic potential due to this spherical shell is



11. Two points A and B are maintained at a potential of 7 V and -4V respectively. The work done in moving 50 electrons from A to B is

    (a) $8.8 \times 10^{-17} C$ ***(b)*** $-8.8 \times 10^{-17} C$ ***(c)*** $4.40 \times 10^{-17} C$ ***(d)*** $5.80 \times 10^{-17} C$

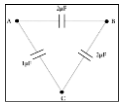
12. If voltage applied on a capacitor is increased from *V* to 2*V*, choose the correct conclusion.

    (a) *Q remains the same, C is doubled* ***(b)*** *Q is doubled, C doubled*
    (c) *C remains same, Q doubled* ***(d)*** *Both Q and C remain same*

13. A Parallel plate capacitor stores a charge Q at a voltage V. Suppose the area of the parallel plate capacitor and the distance between the plates are each doubled then which is the quantity that will change?

    (a) *capacitance* ***(b)*** *charge* ***(c)*** *voltage* ***(d)*** *energy density*

14. Three capacitors are connected in triangle as shown in the figure. The equivalent capacitance between the points A and C is



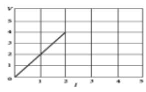
    (a) *1μF* ***(b)*** *2 μF* ***(c)*** *3 μF* ***(d)*** *14 μF*

15. Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} C and 5×10^{-2} C respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is

    (a) *3 x 10^{-2} C* ***(b)*** *4 x 10^{-2} C* ***(c)*** *1 x 10^{-2} C* ***(d)*** *2 x 10^{-2} C*

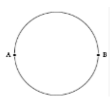
UNIT ~ 2. CURRENT ELECTRICITY

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



    (a) *2 Ω* ***(b)*** *4 Ω* ***(c)*** *8 Ω* ***(d)*** *1 Ω*

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) *π Ω* ***(b)*** $\frac{\pi}{2}$ *Ω* ***(c)*** *2π Ω* ***(d)*** $\frac{\pi}{4}$ *Ω*

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

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

4. A carbon resistor of (47 ± 4.7) k Ω to be marked with rings of different colours for its identification. The colour code sequence will be

    (a) *Yellow – Green – Violet – Gold* ***(b)*** *Yellow – Violet – Orange – Silver*
    (c) *Violet – Yellow – Orange – Silver* ***(d)*** *Green – Orange – Violet - Gold*

5. What is the value of resistance of the following resistor? (Brown, Black, Yellow)

    (a) *100 kΩ* ***(b)*** *10 kΩ*
    (c) *1 kΩ* ***(d)*** *1000 kΩ*

6. Two wires of A and B with circular cross section are made up of the same material with equal lengths. Suppose $R_A = 3 R_B$, then what is the ratio of radius of wire A to that of B?

    (a) *3* ***(b)*** $\sqrt{3}$ ***(c)*** $\frac{1}{\sqrt{3}}$ ***(d)*** $\frac{1}{3}$

7. A wire connected to a power supply of 230 V has power dissipation P_1. Suppose the wire is cut into two equal pieces and connected parallel to the same power supply. In this case power dissipation is P_2 . The ratio $\frac{P_2}{P_1}$ is

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

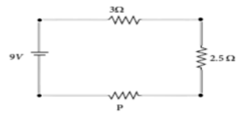
8. In India electricity is supplied for domestic use at 220 V. It is supplied at 110 V in USA. If the resistance of a 60W bulb for use in India is *R*, the resistance of a 60W bulb for use in USA will be

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

9. In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1k W are connected. The voltage of electric mains is 220 V. The maximum capacity of the main fuse of the building will be

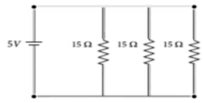
(a) *14A* **(b)** *8A* **(c)** *10A* **(d)** *12A*

10. There is a current of 1.0 A in the circuit shown below. What is the resistance of *P* ?



(a) *1.5 Ω* **(b)** *2.5 Ω*
(c) *3.5 Ω* **(d)** *4.5 Ω*

11. What is the current drawn out from the battery?



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

12. The temperature coefficient of resistance of a wire is 0.00125 per °C. At 20°C, its resistance is 1 Ω. The resistance of the wire will be 2 Ω at

(a) 800^0 *C* **(b)** 700^0 *C* **(c)** 850^0 *C* **(d)** 820^0 *C*

13. The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is

(a) *0.2 Ω* **(b)** *0.5 Ω* **(c)** *0.8 Ω* **(d)** *1.0 Ω*

14. 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*

15. In Joule's heating law, when R and t are constant, if the H is taken along the y axis and I^2 along the x axis, the graph is

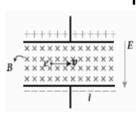
(a) *straight line* **(b)** *parabola* **(c)** *circle* **(d)** *ellipse*

UNIT ~ 3.MAGNETISM AND MAGNETIC EFFECTS OF ELECTRIC CURRENT

1. The magnetic field at the centre O of the following current loop is

(a) $\frac{\mu_0 I}{4r} \otimes$ **(b)** $\frac{\mu_0 I}{4r} \odot$ **(c)** $\frac{\mu_0 I}{2r} \otimes$ **(d)** $\frac{\mu_0 I}{2r} \odot$

2. An electron moves in a straight line inside a charged parallel plate capacitor of uniform charge density σ. The time taken by the electron to cross the parallel plate capacitor undeflected when the plates of the capacitor are kept under constant magnetic field of induction $\vec{B}$ is



(a) $\epsilon_0 \frac{elB}{\sigma}$ **(b)** $\epsilon_0 \frac{eB}{\sigma l}$ **(c)** $\epsilon_0 \frac{lB}{e\sigma}$ **(d)** $\epsilon_0 \frac{lB}{\sigma}$

3. A particle having mass *m* and charge *q* accelerated through a potential difference *V*. Find the force experienced when it is kept under perpendicular magnetic field $\vec{B}$

(a) $\sqrt{\frac{2q^3BV}{m}}$ **(b)** $\sqrt{\frac{q^3B^2V}{2m}}$ **(c)** $\sqrt{\frac{2q^3B^2V}{m}}$ **(d)** $\sqrt{\frac{2q^3BV}{m^3}}$

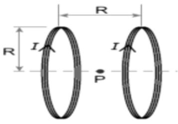
4. A circular coil of radius 5 cm and 50 turns carries a current of 3 ampere. The magnetic dipole moment of the coil is nearly

(a) *1.0 amp* m^2 **(b)** *1.2 amp* m^2 **(c)** *0.5 amp* m^2 **(d)** *0.8 amp* m^2

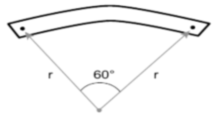
5. A thin insulated wire forms a plane spiral of *N* = 100 tight turns carrying a current *I* = 8 m A (milli ampere). The radii of inside and outside turns are *a* = 50 mm and *b* = 100 mm respectively. The magnetic induction at the centre of the spiral is

(a) *5 μT* **(b)** *7 μT* **(c)** *8 μT* **(d)** *10 μT*

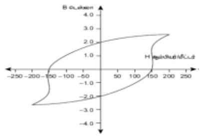
6. Three wires of equal lengths are bent in the form of loops. One of the loops is circle, another is a semi-circle and the third one is a square. They are placed in a uniform magnetic field and same electric current is passed through them. Which of the following loop configuration will experience greater torque ?
   (a) *Circle* ***(b)*** *Semi-circle* ***(c)*** *Square* ***(d)*** *All of them*
7. Two identical coils, each with *N* turns and radius *R* are placed coaxially at a distance *R* as shown in the figure. If *I* is the current passing through the loops in the same direction, then the magnetic field at a point P at a distance of $\frac{R}{2}$ from the centre of each coil is



   (a) $\frac{8N\mu o\ I}{\sqrt{5}R}$ **(b)** $\frac{8N\mu o\ I}{5^{3/2}\ R}$ **(c)** $\frac{8N\mu o\ I}{5R}$ **(d)** $\frac{4N\mu o\ I}{\sqrt{5}R}$
8. A wire of length l carrying a current *I* along the Y direction is kept in a magnetic field given by $\vec{B} = \frac{\beta}{\sqrt{3}}\left(\hat{\imath}+\hat{\jmath}+\hat{k}\right)T$.The magnitude of Lorentz force acting on the wire is
   (a) $\sqrt{\frac{2}{3}}\ \beta Il$ **(b)** $\sqrt{\frac{1}{3}}\ \beta Il$ **(c)** $\sqrt{2}\ \beta Il$ **(d)** $\sqrt{\frac{1}{2}}\ \beta Il$
9. A bar magnet of length *l* and magnetic moment p_m is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be



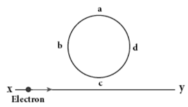
   (a) p_m **(b)** $\frac{3}{\pi}p_m$ **(c)** $\frac{2}{\pi}\ p_m$ **(d)** $\frac{1}{2}\ p_m$
10. A non-conducting charged ring carrying a charge of *q*, mass *m* and radius *r* is rotated about its axis with constant angular speed ω. Find the ratio of its magnetic moment with angular momentum is
   (a) $\frac{q}{m}$ **(b)** $\frac{2q}{m}$ **(c)** $\frac{q}{2m}$ **(d)** $\frac{q}{4m}$
11. The BH curve for a ferromagnetic material is shown in the figure. The material is placed inside a long solenoid which contains 1000 turns/cm. The current that should be passed in the solenoid to demagnetize the ferromagnet completely is



   (a) 1.00 mA **(b)** 1.25 mA
   (c) 1.50 mA **(d)** 1.75 mA
12. Two short bar magnets have magnetic moments 1.20 Am^2 and 1.00 Am^2 respectively. They are kept on a horizontal table parallel to each other with their north poles pointing towards south. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the resultant horizontal magnetic induction at the mid-point O of the line joining their centers is (Horizontal components of Earth's magnetic induction is 3.6 × 10^{-5} Wb m^{-2})
   (a) 3.60 x 10^{-5} Wb m^{-2} **(b)** 3.50 x 10^{-5} Wb m^{-2}
   (c) 2.56 x 10^{-5} Wb m^{-2} **(d)** 2.20 x 10^{-5} Wb m^{-2}
13. 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°
14. A flat dielectric disc of radius *R* carries an excess charge on its surface. The surface charge density is σ. The disc rotates about an axis perpendicular to its plane passing through the centre with angular velocity ω. Find the magnitude of the torque on the disc if it is placed in a uniform magnetic field whose strength is *B* which is directed perpendicular to the axis of rotation
   (a) $\frac{1}{4}\sigma\omega\pi BR$ **(b)** $\frac{1}{4}\sigma\omega\pi BR^2$ **(c)** $\frac{1}{4}\sigma\omega\pi BR^3$ **(d)** $\frac{1}{4}\sigma\omega\pi BR^4$
15. The potential energy of magnetic dipole whose dipole moment is $\overrightarrow{p_m} = (-0.5\ \hat{\imath} + 0.4\ \hat{\jmath})\ Am^2$ kept in uniform magnetic field $\vec{B} = 0.2\ \hat{\imath}\ T$
   (a) –0.1 J **(b)** –0.8 J **(c)** 0.1 J **(d)** 0.8 J

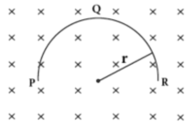
UNIT ~ 4.ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT

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?



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

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

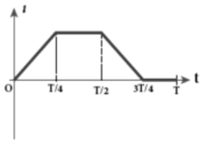


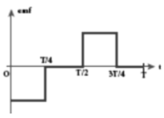
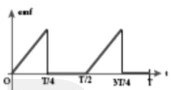
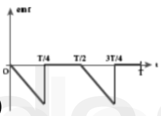
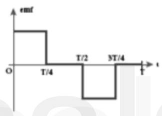
(a) Zero
(b) $\frac{Bv\pi r^2}{2}$ and P is at higher potential
(c) πrBv and R is at higher potential
(d) $2rBv$ and R is at higher potential

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
(a) -190 V **(b)** -10 V **(c)** 10 V **(d)** 190 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
(a) 0.2 H **(b)** 0.4 H **(c)** 0.8 H **(d)** 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



(a)  **(b)**  **(c)**  **(d)** 

6. A circular coil with a cross-sectional area of 4 cm^2 has 10 turns. It is placed at the centre 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) $7.54\ \mu H$ **(b)** $8.54\ \mu H$ **(c)** $9.54\ \mu H$ **(d)** $10.54\ \mu H$

7. In a transformer, the number of turns in the primary and the secondary are 410 and 1230 respectively. If the current in primary is 6A, then that in the secondary coil is
(a) 2 *A* **(b)** 18 *A* **(c)** 12 *A* **(d)** 1 *A*

8. A step-down transformer reduces the supply voltage from 220 V to 11 V and increase the current from 6 A to 100 A. Then its efficiency is
(a) 1.2 **(b)** 0.83 **(c)** 0.12 **(d)** 0.9

9. In an electrical circuit, *R, L, C* and AC voltage source are all connected in series. When *L* is removed from the circuit, the phase difference between the voltage and current in the circuit is $\frac{\pi}{3}$. Instead, if C is removed from the circuit, the phase difference is again $\frac{\pi}{3}$. The power factor of the circuit is
(a) $\frac{1}{2}$ **(b)** $\frac{1}{\sqrt{2}}$ **(c)** 1 **(d)** $\frac{\sqrt{3}}{2}$

10. In a series RL circuit, the resistance and inductive reactance are the same. Then the phase difference between the voltage and current in the circuit is
(a) $\frac{\pi}{4}$ **(b)** $\frac{\pi}{2}$ **(c)** $\frac{\pi}{6}$ **(d)** *zero*

11. In a series resonant *RLC* circuit, the voltage across 100 Ω resistor is 40 V. The resonant frequency ω is 250 rad/s. If the value of C is 4 μF, then the voltage across L is
(a) 600 V **(b)** 4000 V **(c)** 400 V **(d)** 1 V

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

  (a) 0.76 W **(b)** 0.89 W **(c)** 0.46 W **(d)** 0.67 W

13. The instantaneous values of alternating current and voltage in a circuit are $i = \frac{1}{\sqrt{2}}\sin(100\,\pi t)\ A$ and $v = \frac{1}{\sqrt{2}}\sin\left(100\pi t + \frac{\pi}{3}\right)\ V$.The average power in watts consumed in the circuit is

  (a) $\frac{1}{4}$ **(b)** $\frac{\sqrt{3}}{4}$ **(c)** $\frac{1}{2}$ **(d)** $\frac{1}{8}$

14. In an oscillating LC circuit, the maximum charge on the capacitor is Q. The charge on the capacitor when the energy is stored equally between the electric and magnetic fields is

  (a) $\frac{Q}{2}$ **(b)** $\frac{Q}{\sqrt{3}}$ **(c)** $\frac{Q}{\sqrt{2}}$ **(d)** Q

15. $\frac{20}{\pi^2} H$ inductor is connected to a capacitor of capacitance C. The value of C in order to impart maximum power at 50 Hz is

  (a) $50\ \mu F$ **(b)** $0.5\ \mu F$ **(c)** $500\ \mu F$ **(d)** $5\ \mu F$

UNIT ~ 5. ELECTROMAGNETIC WAVES

1. The dimension of $\frac{1}{\mu_0 \epsilon_0}$ is

  (a) $[LT^{-1}]$ ***(b)*** $[L^2T^{-2}]$ ***(c)*** $[L^{-1}T]$ ***(d)*** $[L^{-2}T^2]$

2. If the amplitude of the magnetic field is $3 \times 10^{-6}\ T$, then amplitude of the electric field for a electromagnetic waves is

  (a) *100 V m⁻¹* ***(b)*** *300 V m⁻¹* ***(c)*** *600 V m⁻¹* ***(d)*** *900 V m⁻¹*

3. Which of the following electromagnetic radiation is used for viewing objects through fog?

  (a) *microwave* ***(b)*** *gamma rays* ***(c)*** *X- rays* ***(d)*** *infrared rays*

4. Which of the following are false for electromagnetic waves?

  (a) *transverse* ***(b)*** *mechanical waves*
  (c) *longitudinal* ***(d)*** *produced by accelerating charges*

5. Consider an oscillator which has a charged particle and oscillates about its mean position with a frequency of *300 MHz*. The wavelength of electromagnetic waves produced by this oscillator is

  (a) *1 m* ***(b)*** *10 m* ***(c)*** *100 m* ***(d)*** *1000 m*

6. The electric and the magnetic field, associated with an electromagnetic wave, propagating along X axis can be represented by

  (a) $E = Eo\,\hat{j}$ *and* $B = Bo\,\hat{k}$ ***(b)*** $E = Eo\,\hat{k}$ *and* $B = Bo\,\hat{j}$
  (c) $E = Eo\,\hat{i}$ *and* $B = Bo\,\hat{j}$ ***(d)*** $E = Eo\,\hat{j}$ *and* $B = Bo\,\hat{i}$

7. In an electromagnetic wave in free space the *rms* value of the electric field is 3 V m^{-1}. The peak value of the magnetic field is

  (a) $1.414 \times 10^{-8}\ T$ ***(b)*** $1.0 \times 10^{-8}\ T$ ***(c)*** $2.828 \times 10^{-8}\ T$ ***(d)*** $2.0 \times 10^{-8}\ T$

8. An e.m. wave is propagating in a medium with a velocity $\vec{v} = v\,\hat{\imath}$. The instantaneous oscillating electric field of this e.m. wave is along +*y*-axis, then the direction of oscillating magnetic field of the e.m. wave will be along:

  (a) *-y direction* ***(b)*** *–x direction* ***(c)****+z direction* ***(d)*** *-z direction*

9. If the magnetic monopole exists, then which of the Maxwell's equation to be modified?

  (a) $\oint_S \vec{E}.d\vec{A} = \frac{Q_{enclosed}}{\epsilon_0}$ ***(b)*** $\oint \vec{B}.d\vec{A} = 0$
  (c) $\oint \vec{B}.d\vec{l} = \mu_0 I_{enclosed} + \mu_0\epsilon_0 \frac{d}{dt}\int \vec{E}.d\vec{A}$ ***(d)*** $\oint \vec{E}.d\vec{l} = -\frac{d}{dt}\,\Phi_B$

10. Fraunhofer lines are an example of _______ spectrum.

  (a) *line emission* ***(b)*** *line absorption* ***(c)*** *band emission* ***(d)*** *band absorption*

11. Which of the following is an electromagnetic wave?

(a) α – rays *(b)* β – rays *(c)* γ – rays *(d)* all of them

12. Which one of them is used to produce a propagating electromagnetic wave?
(a) an accelerating charge *(b)* a charge moving at constant velocity
(c) a stationary charge *(d)* an uncharged particle

13. Let $E = Eo \sin(10^6x - \omega t)$ be the electric field of plane electromagnetic wave, the value of ω is
(a) $0.3 \times 10^{-14}\ rad\ s^{-1}$ *(b)* $3 \times 10^{-14}\ rad\ s^{-1}$
(c) $0.3 \times 10^{14}\ rad\ s^{-1}$ *(d)* $3 \times 10^{14}\ rad\ s^{-1}$

14. Which of the following is NOT true for electromagnetic waves?
(a) it transport energy
(b) it transport momentum
(c) it transport angular momentum
(d) in vacuum, it travels with different speeds which depend on their frequency

15. The electric and magnetic fields of an electromagnetic wave are
(a) in phase and perpendicular to each other
(b) out of phase and not perpendicular to each other
(c) in phase and not perpendicular to each other
(d) out of phase and perpendicular to each other

UNIT ~ 6. RAY OPTICS

1) 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 with respect to medium

2) A rod of length *10 cm* lies along the principal axis of a concave mirror of focal length *10 cm* in such a way that its end closer to the pole is *20 cm* away from the mirror. The length of the image is,
(a) 2.5 cm *(b)* 5 cm *(c)* 10 cm *(d)* 15 cm

3) An object is placed in front of a convex mirror of focal length of *f* and the maximum and minimum distance of an object from the mirror such that the image formed is real and magnified.
(a) 2f and c *(b)* c and ∞ *(c)* f and O *(d)* None of these

4) For light incident from air on a slab of refractive index 2, the maximum possible angle of refraction is,
(a) 30° *(b)* 45° *(c)* 60° *(d)* 90°

5) 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)* $\frac{\lambda_a}{\lambda_w}$ *(d)* $\frac{V_a}{V_w}\ \frac{\lambda_a}{\lambda_w}$

6) Stars twinkle due to, *(a)* reflection *(b)* total internal reflection *(c)* refraction *(d)* polarization

7) When a biconvex lens of glass having refractive index *1.47* is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index,
(a) less than one *(b)* less than that of glass
(c) greater than that of glass *(d)* equal to that of glass

8) The radius of curvature of curved surface at a thin planoconvex lens is *10 cm* and the refractive index is *1.5*. If the plane surface is silvered, then the focal length will be,
(a) 5 cm *(b)* 10 cm *(c)* 15 cm *(d)* 20 cm

9) An air bubble in glass slab of refractive index *1.5* (near normal incidence) is *5 cm* deep when viewed from one surface and *3 cm* deep when viewed from the opposite face. The thickness of the slab is,
(a) 8 cm *(b)* 10 cm *(c)* 12 cm *(d)* 16 cm

10) A ray of light travelling in a transparent medium of refractive index *n* falls, on a surface separating the medium from air at an angle of incidents of *45o*. The ray can undergo total internal reflection for the following *n*,

(a) *n = 1.25* **(b)** *n = 1.33* **(c)** *n = 1.4* **(d)** *n = 1.5*

UNIT ~ 7. WAVE OPTICS

1. A plane glass is placed over a various coloured letters (violet, green, yellow, re**(d)** The letter which appears to be raised more is,

   (a) *red* **(b)** *yellow* **(c)** *green* **(d)** *violet*

2. Two point white dots are *1 mm* apart on a black paper. They are viewed by eye of pupil diameter *3 mm* approximately. The maximum distance at which these dots can be resolved by the eye is, [take wavelength of light, $\lambda = 500\ nm$]

   (a) *1 m* **(b)** *5 m* **(c)** *3 m* **(d)** *6 m*

3. In a Young's double-slit experiment, the slit separation is doubled. To maintain the same fringe spacing on the screen, the screen-to-slit distance D must be changed to,

   (a) $2D$ **(b)** $\frac{D}{2}$ **(c)** $\sqrt{2}\ D$ **(d)** $\frac{D}{\sqrt{2}}$

4. Two coherent monochromatic light beams of intensities *I* and *4I* are superposed. The maximum and minimum possible intensities in the resulting beam are

   (a) *5I and I* **(b)** *5I and 3I* **(c)** *9I and I* **(d)** *9I and 3I*

5. When light is incident on a soap film of thickness $5 \times 10{-}3\ cm$, the wavelength of light reflected maximum in the visible region is 5320 Å. Refractive index of the film will be,

   (a) *1.22* **(b)** *1.33* **(c)** *1.51* **(d)** *1.83*

6. First diffraction minimum due to a single slit of width $1.0 \times 10{-}5\ cm$ is at 30°. Then wavelength of light used is,

   (a) *400 Å* **(b)** *500 Å* **(c)** *600 Å* **(d)** *700 Å*

7. A ray of light strikes a glass plate at an angle 60°. If the reflected and refracted rays are perpendicular to each other, the refractive index of the glass is,

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

8. One of the of Young's double slits is covered with a glass plate as shown in figure. The position of central maximum will,

   (a) *get shifted downwards* **(b)** *get shifted upwards*
   (c) *will remain the same* **(d)** *data insufficient to conclude*

9. Light transmitted by Nicol prism is,

   (a) *partially polarised* **(b)** *unpolarised* **(c)** *plane polarised* **(d)** *elliptically polarized*

10. The transverse nature of light is shown in,

    (a) *interference* **(b)** *diffraction* **(c)** *scattering* **(d)** *polarization*

UNIT ~ 8. DUAL NATURE OF RADIATION AND MATTER

1. The wavelength λe of an electron and λp of a photon of same energy E are related by

   (a) $\lambda p \propto \lambda e$ **(b)** $\lambda p \propto \sqrt{\lambda e}$ **(c)** $\lambda p \propto \frac{1}{\sqrt{\lambda e}}$ **(d)** $\lambda p \propto \lambda_e^2$

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*

3. A particle of mass $3 \times 10^{-6}\ g$ has the same wavelength as an electron moving with a velocity $6 \times 10^{6}\ m\ s^{-1}$. The velocity of the particle is

   (a) $1.82 \times 10^{-18}\ m\ s^{-1}$ **(b)** $9 \times 10^{-2}\ m\ s^{-1}$ **(c)** $3 \times 10^{-31}\ m\ s^{-1}$ **(d)** $1.82 \times 10^{-15}\ m\ s^{-1}$

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

   (a) 4λ **(b)** 5λ **(c)** $\frac{5}{2}\lambda$ **(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 $h = 6.6 \times 10^{-34}\ J\ s$)

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

6. A photoelectric surface is illuminated successively by monochromatic light of wavelength λ and $\lambda/2$. 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

   (a) $\frac{hc}{\lambda}$ **(b)** $\frac{2hc}{\lambda}$ **(c)** $\frac{hc}{3\lambda}$ **(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) $\sqrt{\frac{h\nu_0}{m}}$ **(b)** $\sqrt{\frac{6h\nu_0}{m}}$ **(c)** $2\sqrt{\frac{h\nu_0}{m}}$ **(d)** $\sqrt{\frac{h\nu_0}{2m}}$

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*

9. A light source of wavelength 520 nm emits 1.04×10^{15} photons per second while the second source of 460 nm produces 1.38×10^{15} photons per second. Then the ratio of power of second source to that of first source is

   (a) *1.00* **(b)** *1.02* **(c)** *1.5* **(d)** *0.98*

10. The mean wavelength of light from sun is taken to be 550 nm and its mean power is $3.8 \times 10^{26} W$. The number of photons received by the human eye per second on the average from sunlight is the order of

    (a) 10^{45} **(b)** 10^{42} **(c)** 10^{54} **(d)** 10^{51}

11. The threshold wavelength for a metal surface whose photoelectric work function is 3.313 eV is

    (a) *4125 Å* **(b)** *3750 Å* **(c)** *6000 Å* **(d)** *2062.5 Å*

12. A light of wavelength 500 nm is incident on a sensitive plate of photoelectric work function 1.235 eV. The kinetic energy of the photo electrons emitted is be (Take $h = 6.6 \times 10{-34}\ J\ s$)

    (a) *0.58 eV* **(b)** *2.48 eV* **(c)** *1.24 eV* **(d)** *1.16 eV*

13. Photons of wavelength *λ* are incident on a metal. The most energetic electrons ejected from the metal are bent into a circular arc of radius *R* by a perpendicular magnetic field having magnitude *B*. The work function of the metal is

    (a) $\frac{hc}{\lambda} - m_e + \frac{e^2B^2R^2}{2m_e}$ **(b)** $\frac{hc}{\lambda} + 2m_e\left[\frac{eBR}{2m_e}\right]^2$

    (c) $\frac{hc}{\lambda} - m_ec^2 - \frac{e^2B^2R^2}{2m_e}$ **(d)** $\frac{hc}{\lambda} - 2m_e\left[\frac{eBR}{2m_e}\right]^2$

14. The work functions for metals A, B and C are *1.92 eV, 2.0 eV* and *5.0 eV* respectively. The metals which will emit photoelectrons for a radiation of wavelength 4100Å is/are

    (a) *A only* **(b)** *both A and B* **(c)** *all these metals* **(d)** *none*

15. Emission of electrons by the absorption of heat energy is called ____________ emission.

    (a) *photoelectric* **(b)** *field* **(c)** *thermionic* **(d)** *secondary*

UNIT ~ 9. ATOMIC AND NUCLEAR PHYSICS

1. Suppose an alpha particle accelerated by a potential of *V* volt is allowed to collide with a nucleus whose atomic number is *Z*, then the distance of closest approach of alpha particle to the nucleus is

(a) $14.4\frac{Z}{V}$ Å (b) $14.4\frac{V}{Z}$ Å (c) $1.44\frac{Z}{V}$ Å (d) $1.44\ \frac{V}{Z}$ Å

2. In a hydrogen atom, the electron revolving in the fourth orbit, has angular momentum equal to

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

3. Atomic number of H-like atom with ionization potential *122.4 V* for *n* = 1 is

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

4. The ratio between the first three orbits of hydrogen atom is

(a) 1:2:3 (b) 2:4:6 (c) 1:4:9 (d) 1:3:5

5. The charge of cathode rays is

(a) positive (b) negative (c) neutral (d) not defined

6. In J.J. Thomson e/m experiment, a beam of electron is replaced by that of muons (particle with same charge as that of electrons but mass 208 times that of electrons). No deflection condition is achieved only if

(a) B is increased by 208 times (b) B is decreased by 208 times
(c) B is increased by 14.4 times (d) B is decreased by 14.4 times

7. The ratio of the wavelengths for the transition from *n* =2 to *n* = 1 in Li^{++}, He^{+} and *H* is

(a) 1:2:3 (b) 1:4:9 (c) 3:2:1 (d) 4:9:36

8. The electric potential between a proton and an electron is given by $= Vo\ ln\left(\frac{r}{r_0}\right)$, where r_0 is a constant. Assume that Bohr atom model is applicable to potential, then variation of radius of n^{th} orbit r_n with the principal quantum number *n* is

(a) $r_n \propto \frac{1}{n}$ (b) $r_n \propto n$ (c) $r_n \propto \frac{1}{n^2}$ (d) $rn \propto n^2$

9. If the nuclear radius of ^{27}Al is *3.6* fermi, the approximate nuclear radius of ^{64}Cu is

(a) 2.4 (b) 1.2 (c) 4.8 (d) 3.6

10. The nucleus is approximately spherical in shape. Then the surface area of nucleus having mass number A varies as

(a) $A^{2/3}$ (b) $A^{4/3}$ (c) $A^{1/3}$ (d) $A^{5/3}$

11. The mass of a ^7_3Li nucleus is *0.042 u* less than the sum of the masses of all its nucleons. The binding energy per nucleon of ^7_3Li nucleus is nearly

(a) 46 MeV (b) 5.6 MeV (c) 3.9 MeV (d) 23 MeV

12. M_p denotes the mass of the proton and M_n denotes mass of a neutron. A given nucleus of binding energy *B*, contains *Z* protons and *N* neutrons. The mass *M(N,Z)* of the nucleus is given by(where *c* is the speed of light)

(a) $M\,(N, Z) = NMn + ZMp - Bc^2$ (b) $(N, Z) = NMn + ZMp + B\,c^2$
(c) $M\,(N, Z) = NMn + ZMp - B/c^2$ (d) $(N, Z) = NMn + ZMp + B/c^2$

13. A radioactive nucleus (initial mass number A and atomic number Z) emits 2α and 2 positrons. The ratio of number of neutrons to that of proton in the final nucleus will be

(a) $\frac{A-Z-4}{Z-2}$ (b) $\frac{A-Z-2}{Z-6}$ (c) $\frac{A-Z-4}{Z-6}$ (d) $\frac{A-Z-12}{Z-4}$

14. The half-life period of a radioactive element A is same as the mean life time of another radioactive element B. Initially both have the same number of atoms. Then

(a) A and B have the same decay rate initially (b) A and B decay at the same rate always
(c) B will decay at faster rate than A (d) A will decay at faster rate than B.

15. A system consists of N_0 nucleus at t = 0. The number of nuclei remaining after half of a half-life (that is, at time $t = \frac{1}{2}T_{\frac{1}{2}}$)

(a) $\frac{N_0}{2}$ (b) $\frac{N_0}{\sqrt{2}}$ (c) $\frac{N_0}{4}$ (d) $\frac{N_0}{8}$

UNIT ~ 10. ELECTRONICS AND COMMUNICATION

1. The barrier potential of a silicon diode is approximately,

   (a) *0.7 V* **(b)** *0.3V* **(c)** *2.0 V* **(d)** *2.2V*

2. Doping a semiconductor results in

   (a) *The decrease in mobile charge carriers* **(b)** *The change in chemical properties*
   (c) *The change in the crystal structure* **(d)** *The breaking of the covalent bond*

3. In an unbiased *p-n* junction, the majority charge carriers (that is, holes) in the *p*-region diffuse into *n*-region because of

   (a) *the potential difference across the p-n junction*
   (b) *the higher hole concentration in p-region than that in n-region*
   (c) *the attraction of free electrons of n-region*
   (d) *the higher concentration of electrons in the n-region than that in the p-region*

4. If a positive half –wave rectified voltage is fed to a load resistor, for which part of a cycle there will be current flow through the load?

   (a) $0^0–90^0$ **(b)** $90^0–180^0$ **(c)** $0^0–180^0$ **(d)** $0^0–360^0$

5. The zener diode is primarily used as

   (a) *Rectifier* **(b)** *Amplifier* **(c)** *Oscillator* **(d)** *Voltage regulator*

6. The principle based on which a solar cell operates is

   (a) *Diffusion* **(b)** *Recombination* **(c)** *Photovoltaic action* **(d)** *Carrier flow*

7. The light emitted in an LED is due to

   (a) *Recombination of charge carriers* **(b)** *Reflection of light due to lens action*
   (c) *Amplification of light falling at the junction* **(d)** *Large current capacity.*

8. The barrier potential of a *p-n* junction depends on

   i) type of semiconductor material
   ii) amount of doping
   iii) temperature. Which one of the following is correct?

   (a) *(i) and (ii) only* **(b)** *(ii) only* **(c)** *(ii) and (iii) only* **(d)** *(i) (ii) and (iii)*

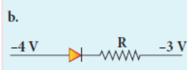
9. To obtain sustained oscillation in an oscillator,

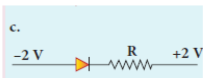
   (a) *Feedback should be positive* **(b)** *Feedback factor must be unity*
   (c) *Phase shift must be 0 or 2π* **(d)** *All the above*

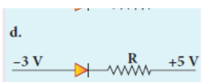
10. If the input to the NOT gate is A = 1011, its output is

    (a) *0100* **(b)** *1000* **(c)** *1100* **(d)** *0011*

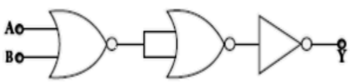
11. Which one of the following represents forward bias diode?





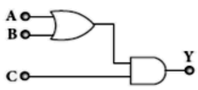


12. The given electrical network is equivalent to



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

13. The output of the following circuit is 1 when the input ABC is



    (a) *101* **(b)** *100* **(c)** *110* **(d)** *010*

14. The variation of frequency of carrier wave with respect to the amplitude of the modulating signal is called

    (a) *Amplitude modulation* **(b)** *Frequency modulation*
    (c) *Phase modulation* **(d)** *Pulse width modulation*

15. The frequency range of 3 MHz to 30 MHz is used for
(a) Ground wave propagation *(b) Space wave propagation*
(c) Sky wave propagation *(d) Satellite communication*

UNIT ~ 11. RECENT DEVELOPMENTS IN PHYSICS

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*
2. Which one of the following is the natural nanomaterial?
(a) Peacock feather *(b) Peacock beak* *(c) Grain of sand* *(d) Skin of the Whale*
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*
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*
5. "Sky wax" is an application of nano product in the field of
(a) Medicine *(b) Textile* *(c) Sports* *(d) Automotive industry*
6. The materials used in Robotics are
(a) Aluminium and silver *(b) Silver and gold*
(c) Copper and gold *(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*
8. The technology used for stopping the brain from processing pain is
(a) Precision medicine *(b) Wireless brain sensor* *(c) Virtual reality* *(d) Radiology*
9. The particle which gives mass to protons and neutrons are
(a) Higgs particle *(b) Einstein particle* *(c) Nanoparticle* *(d) Bulk particle*
10. The gravitational waves were theoretically proposed by
(a) Conrad Rontgen *(b) Marie Curie* *(c) Albert Einstein* *(d) Edward Purcell*

One Mark Answers (Book back)

ANSWERS : Unit – 1

1	(b) B_1 and B_2	6	(b) $\frac{q}{40\epsilon_0}$	11	(a) 8.8×10^{-17}C
2	(c) uniformly charged infinite plane	7	(c) more than before	12	(c) C remains same Q doubled
3	(d) $\frac{11}{25}$	8	(a) 1 = 4 < 2 < 3	13	(d) charge density
4	(b) 8 mC	9	(c) +20 V	14	(b) 2 μF
5	(a) D < C < B < A	10	(b)	15	(a) 3×10^{-2} C

ANSWERS : Unit – 2

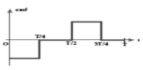
1	(a) 2 Ω	6	(c) $\frac{1}{\sqrt{3}}$	11	(c) 3.5 Ω
2	(a) π Ω	7	(d) 4	12	(d) 820^0 C

3	(c) 480 W	**8**	(c) $\frac{R}{4}$	**13**	(b) 0.5 Ω
4	(b) Yellow – Violet – Orange – Silver	**9**	(d) $12A$	**14**	**(d)** copper decreases and germanium increases
5	(a) 100 kΩ	**10**	(c) 3.5 Ω	**15**	**(a)** straight line

ANSWERS : Unit – 3

1	(a) $\frac{\mu_0 I}{4r} \otimes$	**6**	(a) Circle	**11**	(c) 1.50 mA
2	d) $\epsilon_0 \frac{lB}{\sigma}$	**7**	(b) $\frac{8N\mu_0 I}{5^{3/2} R}$	**12**	(c) 2.56 x 10^{-5} Wb m^{-2}
3	(c) $\sqrt{\frac{2q^3B^2V}{m}}$	**8**	a) $\sqrt{\frac{2}{3}}\,\beta Il$	**13**	(b) 45°
4	(b) 1.2 amp m^2	**9**	(b) $\frac{3}{\pi} p_m$	**14**	(d) $\frac{1}{4}\sigma\omega\pi BR^4$
5	(b) 7 µT	**10**	c) $\frac{q}{2m}$	**15**	(c) 0.1 J

ANSWERS : Unit – 4

1	(a) The current will reverse its direction as the electron goes past the coil	**6**	(a) 7.54 μH	**11**	(c) 400 V
2	(d) $2rBv$ and R is at higher potential	**7**	(a) $2\ A$	**12**	(c) 0.46 W
3	(b) -10 V	**8**	(b) 0.83	**13**	(d) $\frac{1}{8}$
4	(d) 0.1 H	**9**	(c) 1	**14**	(c) $\frac{Q}{\sqrt{2}}$
5	(a) 	**10**	(a) $\frac{\pi}{4}$	**15**	(d) 5 μF

ANSWERS : Unit – 5

1	(b) $[L^2T^{-2}]$	**6**	(b) $E = Eo\ \hat{k}$ and $B = Bo\ \hat{j}$	**11**	(c) γ – rays
2	(d) 900 V m^{-1}	**7**	(a) $1.414 \times 10^{-8}\ T$	**12**	(a) an accelerating charge
3	(d) infrared rays	**8**	(c) +z direction	**13**	(d) $3 \times 10^{14}\ rad\ s^{-1}$
4	(c) longitudinal	**9**	(b) $\oint \vec{B}.d\vec{A} = 0$	**14**	(d) in vacuum, it travels with different speeds which depend on their frequency
5	(a) 1 m	**10**	(b) line absorption	**15**	(a) in phase and perpendicular to each other

ANSWERS : Unit – 6

1	(b) its wavelength	6	(c) refraction
2	(b) 5 cm	7	(d) equal to that of glass
3	(d) None of these	8	(b) 10 cm

4 (a) 30^o
5 (b) $\frac{V_a}{V_w}$
9 (c) 12 cm
10 (d) n = 1.5

ANSWERS : Unit – 7

1 (d) violet
2 (b) 5 m
3 (a) 2D
4 (c) 9 I and I
5 (b) 1.33
6 (b) 500 Å
7 (a) $\sqrt{3}$
8 (b) get shifted upwards
9 (c) plane polarised
10 (d) polarization

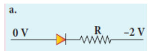
ANSWERS : Unit – 8

1 (d) $\lambda p \propto \lambda_e^2$
2 (c) decrease by 4 times
3 (d) $1.82 \times 10^{-15}\, m\, s^{-1}$
4 (d) 3λ
5 (b) $\geq 2.75 \times 10^{-9}$ m
6 (d) $\frac{hc}{2\lambda}$
7 (b) $\sqrt{\frac{6h\nu_0}{m}}$
8 (b) 1 : 3
9 (c) 1.5
10 (a) 10^{45}
11 (b) 3750 A^0
12 (c) 1.24 eV
13 (d) $\frac{hc}{\lambda} - 2m_e\left[\frac{eBR}{2m_e}\right]^2$
14 (b) both A and B
15 (c) thermionic

ANSWERS : Unit – 9

1 (b) $14.4\frac{V}{Z}$ Å
2 (d) $\frac{2h}{\pi}$
3 (c) 3
4 (c) 1:4:9
5 (b) negative
6 (c) B is increased by 14.4 times
7 (d) 4:9:36
8 (b) $r_n \propto n$
9 (c) 4.8
10 a) $A^{2/3}$
11 (b) 5.6 MeV
12 (c) $M(N, Z) = NMn + ZMp - B/c^2$
13 (b) $\frac{A-Z-2}{Z-6}$
14 (c) B will decay at faster rate than A
15 (b) $\frac{N_0}{\sqrt{2}}$

ANSWERS : Unit – 10

1 (a) 0.7 V
2 (c) The change in the crystal structure
3 (d) the higher concentration of electrons in the n-region than that in the p-region
4 (c) 0^0–180^0
5 (d) Voltage regulator
6 (c) Photovoltaic action
7 (a) Recombination of charge carriers
8 (d) (i) (ii) and (iii)
9 (d) All the above
10 (a) 0100
11 (a) 

12 (c) NOR gate
13 (a) 101
14 (b) Frequency modulation
15 (c) Sky wave propagation

ANSWERS : Unit – 11

1 (b) Nanomaterial
2 (a) Peacock feather
3 (c) Parrot fish
6 (d) Steel and aluminum
7 (a) Shape memory alloys
8 (c) Virtual reality

4	(b) Bottom up approach	**9**	(a) Higgs particle
5	(c) Sports	**10**	(c) Albert Einstein

Part – II, III and IV (2,3 and 5 Mark Question & Answer)

UNIT - 1 . ELECTROSTATICS

2- MARK - QUESTIONS AND ANSWERS :

1) State coulomb"s law in electrostatics.

The electrostatic force is directly proportional to the product of the magnitude of the two point charges and is inversely proportional to the square of the distance between them. $F \alpha \frac{q_1 q_2}{r^2}$

2) State Gauss law in electrostatics.

The total electric flux through a closed surface $\phi_E = \frac{Q}{\epsilon_0}$.

Here Q is the net charge enclosed by the surface .

3) Define electric field. Give its unit.

The electric field at a point is defined as the force experienced by a unit charge placed at that point. Its unit is NC^{-1} (or) $V m^{-1}$.

4) Define Electrostatic potential energy . Give its unit.

Electrostatic potential energy for system of charges is equal to the work done to arrange the charges in the given configuration.

Its unit is ***joule* (J).**

5) What is an Equipotential Surface?

An equipotential surface is a surface on which all the points are at the same electric potential.

6) What is an electrostatic induction?

The phenomenon of charging without actual contact of charged body is called electrostatic induction.

7) What is corona discharge (or) action at points ?

Leakage of electric charges from the sharp edge of the charged conductor is called corona dischargeor action at points.

8) Why is it safer to be inside a car than standing under a tree during lightning?

The metal body of the car provides electrostatic shielding, since the electric field inside is zero.

During lightning the electric discharge passes through the body of the car.

9) Define capacitance of a capacitor. Give its unit.

The capacitance C of a capacitor is defined as the ratio of the magnitude of charge on either of theconductor plates to the potential difference existing between them . (i.e) $C=Q/V$

Its unit is ***farad* (F)** or **C V^{-1}.**

10) Write a note on electrostatic shielding .

The electric field inside the charged spherical shell is zero.
A sensitive electrical instrument which is to be protected from external electrical disturbance is kept inside the cavity of a charged conductor . This is called electrostatic shielding. (e.g) Faraday cage .

11) Define "Electrostatic potential". Give its unit.

The electrostatic potential at a point is equal to the work done by an external force to bring a unit positive charge with constant velocity from infinity to that point in the region of the external electricfield.

Its unit is ***volt* (V).**

12) What is the general definition of electric dipole moment? Give its Unit.

The magnitude of the electric dipole moment is equal to the product of the magnitude of one of thecharges and the distance between them. (i.e) $|\vec{p}| = q\, 2a$.
Its unit is ***coulomb meter* (C m).**

13) What are non polar molecules ? Give examples.

A non polar molecule is one in which the centers of the positive and negative charges coincide.

It has no permanent dipole moment. **Examples :** O_2, H_2, CO_2.

14) What are polar molecules ? Give examples.

A polar molecule is one in which the centers of the positive and the negative charges are separatedeven in the absence of an electric field.

They have a permanent dipole moment. **Examples :** N_2O, H_2O, HCl, NH_3.

15) What is an electric dipole? Give few examples.

Two equal and opposite charges separated by a small distance constitute an electric dipole.

Examples : Water (H_2O), ammonia (NH_3), HCl and CO.

3 MARK – QUESTIONS AND ANSWERS :

1. List the properties of electric field lines.

i) They start from positive charge and end at negative charge.

ii) The electric field vector at a point in space is tangential to the electric field line at that point.

iii) The electric field lines are denser in a region where the electric field has larger magnitude and lessdense in region where the electric field is of smaller magnitude.

iv) No two electric field lines intersect each other.

v) The number of electric field line is directly proportional to the magnitude of the charge.

2. Give the applications of capacitors

Applications of capacitor:

i) Flash capacitors are used in digital camera .

ii) It is used in heart defibrillator to retrieve the normal heart function during cardiac arrest

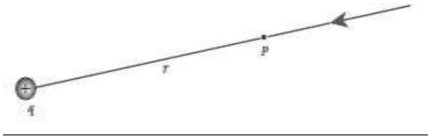
iii) Capacitors are used in the ignition system of automobile engines to eliminate sparking.

iv) Capacitors are used to reduce power fluctuations in power supplies and to increase the efficiency ofpower transmission.

3. Obtain an expression for electric potential at a point due to a point charge.

Consider a point charge +***q*** at origin. 'P' be a point at a distance 'r' from origin.

Electric potential at 'P' is $V = -\int_{\infty}^{r} \vec{E}.d\vec{r}$



By definition, the electric field at 'P' , $\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$

$$V = -\int_{\infty}^{r} \frac{1}{4\pi\ \epsilon_0}\frac{q}{r^2}\hat{r}\ d\vec{r}$$

Electric potential $\mathbf{V = \frac{q}{4\pi\epsilon_0 r}}$

4) Distinguish between Coulomb force and Gravitational force.

Sl.No	Coulomb force	Gravitational force
1	It acts between two charges.	It acts between two masses .
2	It can be attractive or repulsive .	It is always attractive .
3	It is always greater in magnitude .	It is always lesser in magnitude.
4	It depends on the nature of the medium .	It is independent of the medium.

5) Derive an expression for energy stored in capacitor .

- The work done to transfer charge from one plate to other plate is stored as electrostatic energy in thecapacitor. dW = V dQ $= \frac{Q}{C}dQ \left(\because V = \frac{Q}{C}\right)$
- The work done to transfer 'dQ' amount of charge
- The total work done to charge a capacitor, $W = \int_0^Q \frac{Q}{C}\ dQ = \frac{Q^2}{2C}$
- This work done is stored as electrostatic energy of the capacitor,

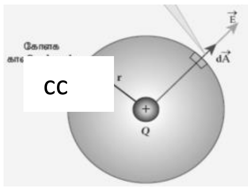
$U = \frac{Q^2}{2C}$ (or) $\mathbf{U = \frac{1}{2}CV^2}$.

6) Obtain Gauss"s law from Coulomb"s law.

Consider a point charge '+q'. C - is a point at a distance of 'r' from the charge.

$F = \frac{1}{4\pi\epsilon_0}\frac{q\,q_0}{r^2}\hat{r}$. (Coulomb Law)

$E = \frac{F}{q_0} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$ - - - - - (1)



$\Phi_E = \oint \vec{E}.d\vec{A} = \vec{E}\oint d\vec{A}$ - - - - - (2)

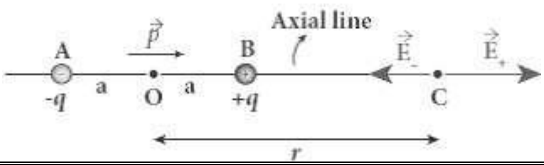
$\Phi_E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}\oint d\vec{A}$ - - - - - (3)

$\Phi_E = \frac{q}{\epsilon_0}$. (Gauss Law)

5 mark Questions

1. Calculate the electric field due to a dipole on its axial line.

- Electric field due to +q $\vec{E}_+ = \frac{1}{4\pi\epsilon_0}\frac{q}{(r-a)^2}\hat{p}$



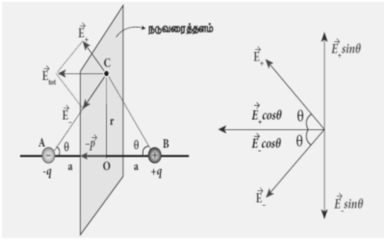
- Electric field due to -q , $\vec{E}_{-} = -\frac{1}{4\pi\epsilon_0}\frac{q}{(r+a)^2}\hat{p}$
- Total electric field due to dipole $\vec{E}_{tot} = \vec{E}_{+} + \vec{E}_{-}$
- Substuting and rearranging, simplifying the equations of $\vec{E}_{+}$ and $\vec{E}_{-}$
- $\vec{E}_{tot} = \frac{2\,\vec{p}}{4\pi\epsilon_0 r^3}$ (*the dirction of* $\vec{E}$ *is in the direction of* $\vec{p}$.)

2. Calculate the electric field due to a dipole on its equatorial line.

- The magnitude of electric field at C due +q is $|\vec{E}_{+}| = \frac{1}{4\pi\epsilon_0}\frac{q}{(r^2+a^2)}$ ----------- (1)
- The magnitude of electric field at C due -q is $|\vec{E}_{-}| = \frac{1}{4\pi\epsilon_0}\frac{q}{(r^2+a^2)}$ ----------- (2)

$$\vec{E}_{tot} = -2\,|\vec{E}_{+}|\cos\theta\,\hat{p} \quad \text{----------- (3)}$$

$$\cos\theta = \frac{a}{(r^2+a^2)^{1/2}} \quad \text{----------------------- (4)}$$



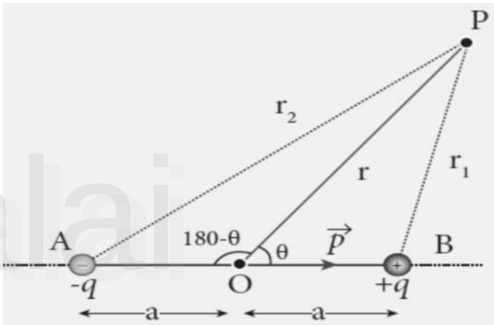
- substitute Eqn (1),(4) in (3) rearranging and simplifying
- $\vec{E}_{tot} = -\frac{\vec{p}}{4\pi\epsilon_0 r^3}$ ($\vec{p} = 2qa\,\hat{p}$) r >> a
- The direction of $\vec{E}_{tot}$ is opposite to the direction of $\vec{p}$

3. Derive an expression for electrostatic potential due to electric dipole.

- Electric potential at P due to +q is $V_1 = \frac{1}{4\pi\epsilon_0}\frac{q}{r_1}$
- Electric potential at P due to -q is $V_2 = \frac{-1}{4\pi\epsilon_0}\frac{q}{r_2}$
- Electric potential at P due to dipole

$$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r_1} - \frac{1}{4\pi\epsilon_0}\frac{q}{r_2}$$

$$V = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

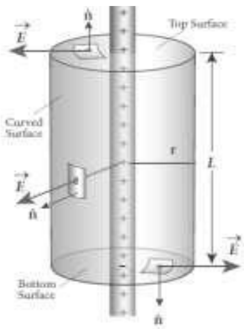


- By applying cosine law for triangles and using binomial theorem, and simplifying the equation, we get
- $V = \frac{P\cos\theta}{4\pi\epsilon_0 r^2}$ (P = 2 q a)

4. Obtain an expression for electric field due to an infinitely long charged wire.

- Consider linear charge density λ(*i.e*) $\lambda = \frac{Q}{L}$
- Hence total charge **Q**= λL - -- - - - - - - - - - - - - - - - - - *(1)*
- Gaussian surface :A cylinder of length 'L' and radius 'r'.
- The electric flux for the curved surface is

$$\Phi_E = \int E\,dA\cos\theta = E\,(2\pi rL) \quad [\because \theta = 0]$$



- Then the total electric flux $\Phi_E = E(2\pi rL)$- - - - - *(2)*
- According to Gauss Law $\Phi_E = \frac{Q}{\epsilon_0}$- - - - - - - - - - (3)
- Substitute the Equation(1),(2) in (3) $E(2\pi r L) = \frac{\lambda L}{\epsilon_0}$

$$E = \frac{\lambda}{2\pi\epsilon_0 r} \quad \text{or} \quad \vec{E} = \frac{1}{2\pi\epsilon_0}\frac{\lambda}{r}$$

5. Obtain an expression for electric field due to an charged infinite plane sheet.

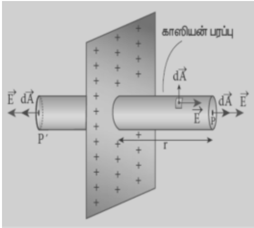
Consider an infinite plane sheet of uniform surface charge density 'σ' (*i. e*) $\sigma = \frac{Q}{A}_{enclosed}$

So, total charge enclosed by the plane sheet $Q_{encl} = \sigma A$- - - - - **(1)**

Electric field : Let 'E' be the electric field at 'P' which is at a distance 'r' from the sheet.

Gaussian surface : a cylindrical of length '2r' and area of cross section 'A'

The electric flux through the curved surface, $\phi_1 = \int E\, dA \cos\theta = 0$ [$\because \theta = 90$]



The electric flux through end surface P and P' $\phi_2 = 2EA$ ($\theta = 0^0$)

Total electric flux $\phi_E = 0 + 2EA = 2\,EA$. - - - - - (2)

According to Gauss Law $\phi_E = \frac{Q}{\epsilon_0}$ - - - - - - - - - - (3)

Substitute the Equation(1),(2) in (3) $2EA = \frac{\sigma A}{\epsilon_0}$ or $E = \frac{\sigma}{2\epsilon_0}$

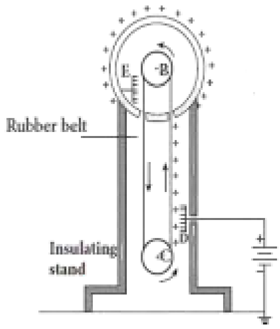
6. Explain in detail the construction and working of Van de Graff generator.

Principle : Electrostatic induction and Action at points

Construction :

- 'A' is a hollow spherical conductor fixed on the insulating stand.
  - 'B'and 'C' are pulleys and they are connected by a belt made up of silk .
  - 'D'and 'E' are metallic comb shaped conductors fixed near the pulleys.
  - The comb 'D' is maintained at a positive potential of $10^4 V$ by a powersupply.
  - The upper comb 'E' is connected to the inner side of the hollow metal sphere.

Working of comb D:



- Due to the high electric field near comb 'D', air gets ionized.
- The positive charges are pushed towards the belt and negative charges are attracted towards thecomb 'D' .
- The positive charges stick to the belt and reach comb 'E'.

Working of comb E:

- Due to electrostatic induction ,the comb 'E' get negative charges and the sphere gets positivecharges
- Due to action at points at 'E' ,descending belt has no charge.

Charge leakage:

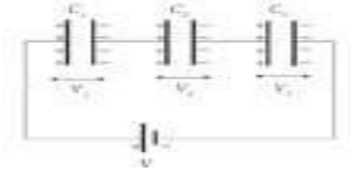
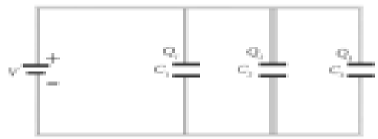
- Beyond the maximum potential difference of $10^7 V$ of the sphere, the charges start leaking to thesurroundings due to ionization of air.
- It is prevented by enclosing the machine in a gas filled steel chamber at very high pressure.

Application:

- The high voltage ($10^7 V$) produced in the Van de Graff generator is used to accelerate positive ions(protons and deuterons) for nuclear disintegrations.

7. Derive the expression for resultant capacitance, when capacitors are connected in series and in parallel.

Capacitors in series	Capacitors in parallel

Consider three capacitors of capacitance C_1, C_2 and C_3 connected in series .C_S - the equivalent capacitanceof capacitor in series connection .	Consider three capacitors of capacitance C_1, C_2 and C_3 connected in parallel .C_P - the equivalentcapacitance of capacitor in parallel connection
	
Each capacitor has same amount of charge (Q). But potential difference across each capacitor will bedifferent.	Each capacitor has same potential difference(V). But charges on each capacitor will be different .
$V = \frac{Q}{C_S}$; $V_1 = \frac{Q}{C_1}$, $V_2 = \frac{Q}{C_2}$, $V_3 = \frac{Q}{C_3}$ $\frac{Q}{C_S} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$ $\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$	$Q = C_P V$ and $Q_1 = C_1 V$, $Q_2 = C_2 V$, $Q_3 = C_3 V$ $C_P V = C_1 V + C_2 V + C_3 V$ $\mathbf{C_P = C_1 + C_2 + C_3}$

2. CURRENT ELECTRICITY

2 MARK -QUESTIONS AND ANSWERS:

1.Electric current is a scalar quantity why?

Even though current has particular direction and magnitude they will not obey vector laws. So current is a scalar quantity.

2. Distinguish between drift velocity and mobility.

N	Drift Velocity	bility
1	The average velocity acquired by the electrons inside the conductor when it is subjected to an electric field.	e magnitude of the drift velocity per unit electric field.
2	Its unit is	unit is

3. Define current density and give its unit.

The current density is defined as the current per unit area of cross section of the conductor.

4.Give the microscopic form of ohm's law.

Current density is directly proportional to the applied electric field.

5. Give the macroscopic form of ohm's law.

The macroscopic form of ohm's law is **V=IR**.

Here 'V' - Potential difference, '**I**' - Current and '**R**' - Resistance.

7.Define electrical resistivity and give its unit.

Electrical resistivity of a material is defined as the resistance offered to current flow by a conductor of unit length having unit area of cross section.

Its unit is Ω m (ohm meter).

8.Define temperature co-efficient of resistivity.

It is defined as the ratio of increase in resistivity per degree rise in temperature to its resistivity at T_o.

Its unit is per °C**.**

9.What is known as superconductivity?

The resistance of certain material becomes zero below certain temperature .

The materials which exhibit this property are called superconductors.

The property of conducting current with zero resistance is called superconductivity.

10. State Kirchhoff's first rule (current rule or junction rule).

It states that the algebraic sum of the currents at any junction of a circuit is zero.(i.e) Σ i = 0.

11.State Kirchhoff's second rule (voltage rule or loop rule).

It states that in a closed circuit the algebraic sum of the products of the current and resistance of each part of the circuit is equal to the total emf included in the circuit. (i.e) $\Sigma = \Sigma\ \varepsilon$.

12.State the principle of potentiometer.

The emf of the cell is directly proportional to the balancing length.

13.What is Seeback effect?

In a closed circuit consisting of two dissimilar metals, when the junctions are main ained at different temperatures an emf (potential difference) is developed. This phenomenon is called Seeback effect.

14.What is Thomson effect?

If two points in a conductor are at different temperatures the density of electrons at these points will differ and as a result the potential difference is created between these two points.

Hence heat is evolved or absorbed throughout the conductor . This is called Thomson effect.

15.What is Peltier effect?

When an electric current is passed through a circuit of thermocouple, heat is evolved at one junction and absorbed at the other junction. This is known as Peltier effect.

3 Marks

1.What are ohmic and non-ohmic materials?

Ohmic materials	Non-ohmic materials
	V-I graph is non-linear

V-I graph is a straight line	
obey Ohm's law	Doesn't obey Ohm's law
They have constant resistance	They do not have constant resistance

2.State the applications of seeback effect.

- Seeback effect is used in thermo electric generators . These generators are used in power plants to convert waste heat into electricity.
- It is used in automobiles as automotive thermoelectric generators for increasing fuel efficiency.
- It is used in thermocouples and thermopiles to measure the temperature difference between the two objects.

3. State Joule's heating law.

Heat librated by Joule's heating effect, **H= I^2R t**

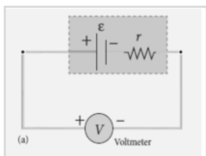
The heat developed in an electrical circuit due to the flow of current varies directly to

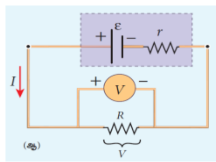
The square of the current (I^2)
The resistance of the circuit (R)
The time of flow (t)

4. **Differentiate Joule heating effect and peltier effect.**

Joule heating effect	**Peltier effect**
It is irreversible	It is reversible
Heat energy developed is directly proportional to the square of	Rate of heat energy developed is directly proportional to the current.
It *does not depend* on the direction of current.	depends on the direction of current.

5.Explain the determination of the internal resistance of a cell using voltmeter.

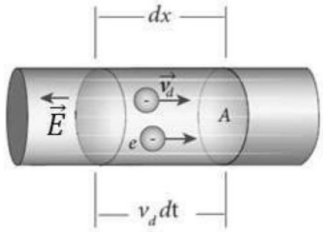




- V = ε .... (1)
- V = I R or **IR = V** - - - - (2)
- **V = ε - Ir** or **Ir = ε - V** - - - - - - (3)
- Eqn $\frac{(3)}{(2)} \rightarrow \frac{Ir}{IR} = \frac{\varepsilon - V}{V}$ Internal resistance $\boldsymbol{r = \left(\frac{\varepsilon - V}{V}\right) R}$.

5 marks

1.Describe the microscopic model of current and obtain general form of Ohm's law.



Area of cross section of the conductor = A

Number of electrons per unit volume = n

Applied electric field along leftwards = E

Drift velocity of the electrons = v_d

Charge of the electron = e

Then the total charge in this volume element is, $dQ = A\ v_d\ dt\ n\ e$

By definition, the current is given by $= \frac{dQ}{dt} = A\ v_d\ dt\ n\ e$, $\therefore$ $\boldsymbol{I = n\ e\ A\ v_d}$

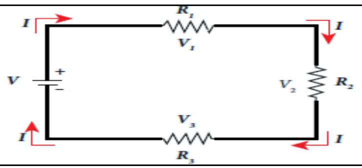
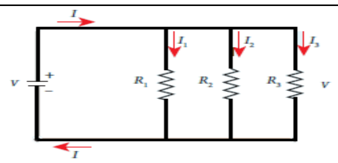
Current density(J): Current density (J) is defined as the current per unit area of cross section of the conductor. $J = \frac{I}{A}$ $\therefore$ $J = n\ e\ vd$ and $\vec{V_d} = -\frac{e\tau}{m}\vec{E}$

$\vec{J} = -n\ e\left(\frac{e\tau}{m}\vec{E}\right)$; $\therefore \vec{J} = -n\ \frac{e^2\tau}{m}\vec{E}$; $\vec{J} = -\sigma\vec{E}.$ *and* $\sigma = \frac{ne^2\tau}{m}$

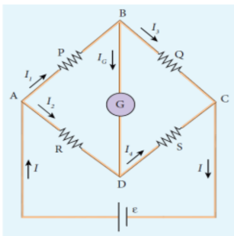
here $\sigma \rightarrow$ conductivity, But conventionally, we take the direction of current density as the direction of electric field (E). So the above equation becomes, $\vec{J} = \sigma\vec{E}.$

This is called microscopic form of Ohm‟s law.

2.Explain the equivalent resistance of a series and parallel resistor network.

S.no	Series circuit	Parallel circuit
1		
2	Let R_1, R_2,R_3 be the resistance three resistors connected in series	Let R_1, R_2, R_3 be resistance of three resistors connected in parallel
3	The current flowing through all the resistors are equal	The potential difference between all the resistors are equal
4	Potential difference varies	current varies
5	$V = V_1 + V_2 + V_3$	$I = I_1 + I_2 + I_3$
6	$V = IR_S$ $V_1 = IR_1$; $V_2 = IR_2$; $V_3 = IR_3$	$I = V/ R_P$ $I_1 = V / R_1$; $I_2 = V / R_2$; $I_3 = V / R_3$
7	$IR_S = IR_1 + IR_2 + IR_3$	$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$
8	$R_S = R_1 + R_2 + R_3$	$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

3. **Obtain the condition for bridge balance in wheatstone's bridge.**



The bridge consists of four resistances P,Q,R and S connected **as shown in figure.**

A galvanometer 'G' is connected between the points B nd D.

The battery is connected between the points A and C.

Applying Kirchhoff's current rule to junction B and D respectively.

$I_1 - I_G - I_3 = 0$ .... (1)

$I_2 + I_G - I_4 = 0$ ....(2)

Applying Kirchhoff's voltage rule to loop ABDA, and B C D B

$I_1P + I_GG - I_2R = 0$ ....(3)

$I_3Q - I_GG - I_4S = 0$ ....(4)

If $\boxed{I_G = 0}$; and substitute in Eqn (1),(2),(3)&(4)-

$I_1 = I_3$ - - - - **(5)** ; $I_2 = I_4$ - - - - **(6)** ; $I_1P = I_2R$ - - - **(7)** ; $I_3Q = I_4S$ - - - **(8)**

Eqn (7) ÷ (8) $\frac{I_1P}{I_3Q} = \frac{I_2R}{I_4S}$, Using Eqn (5), (6) we get $\boxed{\frac{P}{Q} = \frac{R}{S}}$

4. Explain the determination of the internal resistance of a cell using potentiometer.

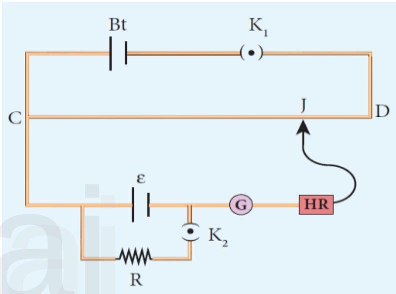
Primary circuit: Potentiometer is connected in series with battery (Bt) and key K_1.
Secondary circuit : The battery whose internal resistance is to be calculated is connected in parallel with resistance box(R) and Key(K_2).

- When key K_1 open, Balancing length l_1

$\xi \propto l_1$ – – – – – – – – (1)

- When key K_2 closed, Balancing length l_2

$$\frac{\xi}{R+r} R \propto l_2 \quad - - - - - - - - (2)$$



Eqn (1) ÷ (2) $\boxed{r = R\left[\frac{l_1 - l_2}{l_2}\right]}$ – – – – – – –(3)

5 . ELECTROMAGNETIC WAVES

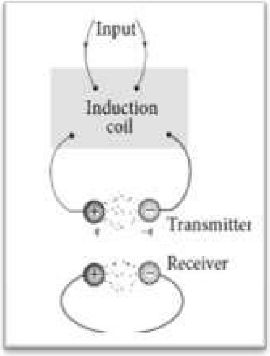
2 MARK - QUESTIONS AND ANSWERS:

1. **What is displacement current?**
   - The current present in the region in which the electric field and the electric flux are changing with time .
2. **What are electromagnetic waves?**
   - Electromagnetic waves are non-mechanical waves which move with speed equals to the speed of light in vacuum. It is a transverse wave.
3. **What are Fraunhofer lines?**
   - The dark lines in the solar spectrum are known as Fraunhofer lines.
4. **Why are electromagnetic waves non-mechanical?**
   - Electromagnetic waves do not require any medium for propagation.

3 - Mark Questions And Answers:

1. Discuss briefly the experiment conducted by Hertz to produce and detect electromagnetic spectrum.

- It consists of two metal electrodes which are made of small spherical metals as shown in figure.
- Transmitter electrodes are connected to induction coil with very large number of turns. This is used to produce very high electromotive force (emf).



- Transmitter electrodes are maintained at very high potential, air between the electrodes get ionized and spark is produced. The gap between electrodes of receiver also gets spark. This implies that the energy is transmitted from transmitter to the receiver in the form of waves, known as electromagnetic waves.

  If the receiver is rotated by 90^0, then no spark is observed by the receiver. This confirms that electromagnetic waves are transverse waves as predicted by Maxwell.

  Hertz detected radio waves and also computed the speed of radio waves which is equal to the speed of light.

2.Write short notes on [i) microwaves (ii) X-ray (iii) radio waves (iv) visible spectrum

Microwaves:

It is produced by special vacuum tubes (magnetron, gun diode)

It undergoes reflection and polarization.

X-ray:

It is produced when there is a sudden stopping of high speed electrons by high-atomic number target and also by electronic transitions among innermost orbits of atoms.

X-rays have more penetrating power than ultraviolet radiation.

Radio waves:

It is produced by accelerating charges in conducting wire.

- It undergoes reflection and diffraction.
- It is used in radio and television communication systems.

Visible light:

- It is produced by incandescent bodies and also it is radiated by excited atoms in gases.
- It obeys the laws of reflection and refraction.

- It undergoes interference, diffraction, polarization and photo-electric effect .

3. Give any two uses of (i) IR radiation, (ii) Microwaves and (iii) UV radiation

IR radiation

It is used to provide electrical energy to satellites .

It is used to produce dehydrated fruits.

Microwaves

It is used in microwave oven for cooking.

It is used in very long distance wireless communication through satellites

UV radiation

It is used in the study of molecular structure

It is used to destroy bacteria and sterilizing the surgical instruments.

4. Write down the properties of electromagnetic waves.

- Electromagnetic waves are produced by any accelerated charge.
- Electromagnetic waves do not require any medium for propagation. So electromagnetic wave is a non-mechanical wave.
- Electromagnetic waves travel with the speed of light in vacuum or free space.
- Electromagnetic waves are not deflected by electric field or magnetic field.
- Electromagnetic waves can exhibit interference, diffraction and polarization.
- Electromagnetic waves carry energy, linear momentum and angular momentum

5 - MARK QUESTIONS AND ANSWERS:

1.What is emission spectra? Explain their types.

When the spectrum of self luminous source is taken, we get emission spectrum. Each source has its own characteristic emission spectrum.

Types of emission spectrum:

Continuous emission spectra

Line emission spectrum

Band emission spectrum

Continuous emission spectra

- If the light from incandescent lamp is allowed to p ss through prism, it splits into seven colours. It consists of wavelengths containing all the visible colours ranging from violet to red.
- ***Examples:*** spectrum obtained from carbon arc and incandescent solids.

Line emission spectrum

- Light from hot gas is allowed to pass through prism, line spectrum is observed. The line spectra are sharp lines of definite wavelengths or frequencies.
- It arises due to excited atoms of elements.
- These lines are the characteristics of the element.

Examples: spectra of atomic hydrogen, helium.

Band emission spectrum

- Band spectrum consists of several number of very closely spaced spectral lines which overlapped together forming specific bands which are separated by dark spaces.
- This spectrum has a sharp edge at one end and fades out at the other end.
- ***Examples:*** spectra of ammonia gas in the discharge tube.

2.What is absorption spectra? Explain their types.

- When light is allowed to pass through a medium or an absorbing substance then the spectrum obtained is known as absorption spectrum.
- It is the characteristic of absorbing substance.

Types of absorption spectrum:

Continuous absorption spectrum.

Line absorption spectrum.

Band absorption spectrum.

Continuous absorption spectrum

- When we pass white light through a blue glass plate, it absorbs all the colours except blue and give continuous absorption spectrum.

Line absorption spectrum

When light from the incandescent lamp is passed through cold gas , the spectrum obtained through the dispersion due to prism is line absorption spectrum

Example: If the light from the carbon arc is made to pass through sodium vapour, **a** continuous spectrum of carbon arc with two dark lines in the yellow region are obtained.

Band absorption spectrum

When the white light is passed through the iodine vapour, dark bands on continuous bright background is obtained.

Example: when white light is passed through diluted solution of blood or chlorophyll, band absorption spectrum is obtained.

3. Write down Maxwell equations in integral form.

Maxwell First equation	$\oint_S \vec{E} \cdot d\vec{A} = \frac{Q_{closed}}{\varepsilon_0}$	It is nothing but Gauss's law. It relates the net electric flux to net electric charge enclosed in a surface
Maxwell Second equation	$\oint_S \vec{B}.dA = 0$	This law can be called as Gauss's law in magnetism
Maxwell Third equation	$\oint_l \vec{E}.d\vec{l} = -\frac{d\varphi_B}{dt}$	This is Faraday's laws of electromagnetic induction. This law relates electric field with the changing magnetic flux.
Maxwell Fourth equation	$\oint_l \vec{B}.\vec{dl} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d}{dt} \oint_S \vec{E} \cdot d\vec{A}$	It is called as Ampere - Maxwell's law. This law relates the magnetic field around any closed path to the conduction current and displacement current through that path.

These four equations are known as Maxwell's equations in electrodynamics. This equation ensures the existence of electromagnetic waves.

8. DUAL NATURE OF RADIATION AND MATTER

2 - MARK QUESTIONS AND ANSWERS:

1. Define stopping potential.

- The negative or retarding potential given to collecting electrode which is just sufficient to stop the most energetic photoelectrons emitted and make the photocurrent zero is called stopping potential or cut-off potential.

2. Define work function of a metal. Give its unit.

- The minimum energy needed for an electron to escape from the metal surface is called work function of that metal.
- Its unit is electron volt. (eV).

3. What is photoelectric effect?

- The ejection of electrons from a metal plate when illuminated by light or any other electromagnetic radiation of suitable wavelength is called Photoelectric effect.

4. Define surface barrier.

- The potential barrier which prevents free electrons from leaving the metallic surface

5. What is photo electric cell? Give its types.

- The device which converts light energy into electrical energy is called Photo electric cell.
- It works on the principle of photo electric effect.
- They are of three types
  - i) Photo emissive cell.
  - ii) Photo voltaic cell.
  - iii) Photo conductive cell.

6. What is De Broglie hypothesis?

- Due to the symmetry in nature, de Broglie suggested that if radiation like light can act as particles attimes, then material particles like electrons can also act as waves at times.
- According to de Broglie hypothesis, all material particles like electrons, protons, neutrons in motion areassociated with waves. These waves are called de Broglie waves or matter waves.

7. Define threshold frequency.

- For a given surface, the emission of photoelectrons takes place only if the frequency of incident light isgreater than a certain minimum frequency called threshold frequency.

---

3 - Marks

1. Derive the expression of De Broglie wavelength.

Let an electron of mass **m** accelerated through a potential difference of V volt.

The KE acquired by the electron is given by $\frac{1}{2} m v^2 = e V$

The Speed of the electron is $v = \sqrt{\frac{2e V}{m}}$

Hence the de Broglie wave length of the electron is $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}}$

Kinetic energy k = e V then $\lambda = \frac{h}{\sqrt{2mk}}$

Substituting the known valus $\lambda = \frac{12.27\ A^0}{\sqrt{V}}$

2. Write the characteristics of photons.

i) Each photon will have energy $E = h\nu$.

ii) The energy of a photon is determined by the frequency of the radiation.

iii) The photons travel with the speed of light.

iv) They are unaffected by electric and magnetic fields.

v) When a photon interacts with matter, the total energy and angular momentum are conserved.

2. Give the application of photo cells.

i) It is used as switches and sensors.

ii) Automatic lights that turn on when it gets dark use photocells.

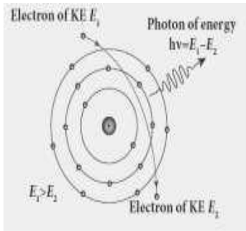
iii) Street lights that switch on and off according to whether it is night or day.

iv) They are used for reproduction of sound in motion pictures.

v) They are used as timers to measure the speeds of athletes during a race.

vi) They are used to measure the intensity of the given light in photography.

3. Write a note on continuous X-ray spectrum.



i) When a fast moving electron penetrates and approaches a targetnucleus, the electron either accelerates or decelerates.

ii) It results in a change of path of the electron.

iii) The radiation produced from such decelerating electron is called **Bremsstrahlung or braking radiation.**

iv) The energy of the photon emitted=The loss of kinetic energy of the electron. $h\nu_0 = \frac{hc}{\lambda_0} = eV$

Substitute the known values, Minimum wavelength $\lambda_0 = \frac{12400\ A^0}{V}$

v) This relation is known as **Duane-Hunt** formula.

4. Explain the applications of X-rays.

i) It is used to detect fractures, foreign bodies in Medical diagnosis.

ii) It is used to cure malignant tumours.

iii) It is used to check for flaws in welded joints, tennis balls.

iv) It is used for detection of contraband goods in custom
It is used to study the structure of the crystalline materials.

5 MARKS

1. State the Laws of Photoelectric effect.

a. For a given frequency of incident light, the number of photoelectrons emitted is directly proportional tothe intensity of incident light.

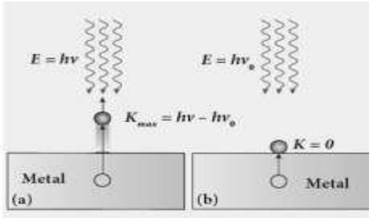
b. Maximum kinetic energy of the photo electrons is independent of intensity of the incident light.

c. Maximum kinetic energy of the photo electrons is directly proportional to the frequency of incidentlight.

d. For a given surface, the emission of photoelectrons takes place only if the frequency of incident light isgreater than a certain minimum frequency called threshold frequency.

e. There is no time lag between incidence of light and ejection of photoelectrons.

2. Obtain Einstein's photoelectric equation with necessary explanation.



- When a photon of energy $h\nu$ is incident on a metal surface, it is completely absorbed by a single electron is utilized in two ways.
  - i) Part of the photon energy is used for the ejection of the electrons from the metal surface and it is called ***work function*** (φ_0).
  - ii) Remaining energy as the kinetic energy $\frac{1}{2}mv^2$ of the ejected electron.
- From the law of conservation of energy,

$$h\nu = \phi_0 + \frac{1}{2}mv^2 \text{ - - - - (1)}$$

Here m—mass of the electron and v —velocity.

- At threshold frequency, the kinetic energy of ejected electrons will be zero.

$$h\nu_0 = \phi_0 \quad \text{- - - - } \mathbf{(2)}$$

- Substitute (2) in (1) $\qquad h\nu = h\nu_0 + \frac{1}{2}mv^2$ - - - - (3).

The equation (3) is known as Einstein's photoelectric equation.

- If the electron does not lose energy by internal collisions, then it is emitted with maximum kinetic energy.
- $h\nu = h\nu_0 + \frac{1}{2}mv_{max}^2$ - - - - (4)

Unit – 9 – ATOMIC AND NUCLEAR PHYSICS

2 MARK QUESTIONS AND ANSWERS

1. **Define impact parameter.**

   The impact parameter (b) is defined as perpendicular distance between the centre of the gold nucleus and the direction of velocity vector of alpha particle when it is at a large distance.

2. **What is distance of closest approach?**

   The minimum distance between the centre of the nucleus and the alpha particle just before it gets reflected back through 180° is defined as the distance of closest approach (or) contact distance $\boldsymbol{r_0}$

3. Define ionization energy and ionization potential.

Ionization Energy

The minimum energy required to remove an electron from an atom in the ground state is known as binding energy or ionization energy.

Ionization energy of hydrogen atom is $Eionization = 13.6\ eV$

Ionization Potential

Ionization potential is defined as ionization energy per unit charge.

The ionization potential of hydrogen atom is $Vionization = 13.6\ V$

4. **What is isotope? Give an example.**

The atoms of the same element having same atomic number Z, but different mass number A are called isotopes.

The isotopes of any element have same electronic structure and same chemical properties.

5. What is isobars? Give an example.

The atoms of different elements having the same mass number A, but different atomic number Z are called isobars.

They have different physical and chemical properties

6. What is isotones? Give an example.

The atoms of different elements having same number of neutrons are called *isoton*es.

7. Define atomic mass unit.

One atomic mass unit (u) is defined as the 1/12th of the mass of the isotope of carbon . $\mathbf{1\ u = 1.66\ X\ 10{-}19\ kg}$

8. State the law of radioactive decay.

At any instant t, the number of decays per unit time, called rate of decay is proportional to the number of nuclei (N) at the same instant.

9. Define activity. Give its unit.

Activity or decay rate which is the number of nuclei decayed per second and it is denoted as R and $\mathbf{R = \ /dt}$

Its unit is becquerel (Bq) and curie (Ci)

10. Define one bequerel.

One Becquerel (Bq) is equal to one decay per second.

$$\mathbf{1\ Bq = 1\ decay/second}$$

11. Define one curie.

One curie was defined as number of decays per second in 1 g of radium,

$$1\ Ci = 3.7 \times 10^{10}\ decay/second$$

12. What is half life of nucleus. Give the expression.

The half life ($T_{1/2}$) is the time required for the number of atoms initially present to reduce to one half of the initial amount .

$$T_{\frac{1}{2}} = \frac{0.6931}{\lambda}$$

13. What is mean life of nucleus? Give the expression.

The mean life time (τ) of the nucleus is the ratio of sum or integration of life times of all nuclei to the total number nuclei present initially. $\tau = 1 / \lambda$

14. What is radio carbon dating?

Radioactive dating or carbon dating is the technique to estimate the age of ancient object by using radio carbon isotope (**14**)

15. **What is mass defect?**

The experimental mass of a nucleus is less than the total mass of its individual constituents.

The mass difference between total mass of the nucleons and the real mass of the nucleus is called mass defect (Δm)

$$\Delta m = (Zm_p + Nm_n) - M$$

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3 MARKS

1. **What are called cathode rays? Give the properties of cathode rays.**
   - When the pressure is about 0.01 mm of Hg, positive column disappears and a dark space formed between anode and cathode which is called Crooke's dark space.
   - At this time the walls of the tube appear with green colour and some invisible rays emanate from cathode called cathode rays, which are later found be a beam of electrons.

Properties of cathode rays:

- Cathode rays possess energy and momentum
- They travel in a straight line with high speed of the order of 107 m s-1.
- It can be deflected by both electric and magnetic fields.
- The direction of deflection indicates that they are negatively charged particles.
- When the cathode rays are allowed to fall on matter, they produce heat.
- They affect the photographic plates

- They produce fluorescence
- When the cathode rays fall on a material of high atomic weight, x-rays are produced.
- Cathode rays ionize the gas through which they pass.
- The speed of cathode rays is up to (1/10)th of the speed of light.

2. List the properties of neutrons.

- Mass of the neutron is little greater than the mass of the proton and had no charge.
- Neutrons are stable inside the nucleus. But free neutron has half life of
- 13 minutes. Then it decays with emission of proton, electron and anti neutrino.
- Neutrons are classified according to their kinetic energy as
  - slow neutrons (0 to 1000 eV)
  - fast neutrons (0.5 MeV to 10 MeV).
- The neutrons with average energy of about ***0.025 eV*** in thermal equilibrium are called thermal neutron

3. State the properties of neutrino.

- It has zero charge
- It has an antiparticle called anti-neutrino.
- Recent experiments showed that the neutrino has very tiny mass.
- It interacts very weakly with the matter. Therefore, it is very difficult to detect.

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5 marks

1. Explain JJ Thomson experiment to determine specific charge.

Principle: Deflection of electron in electric and magnetic field.

Construction:

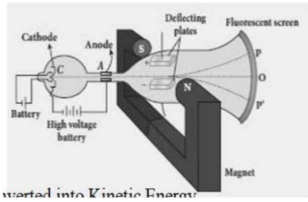
- A highly evacuated discharge tube is used.
- Cathode rays are produced and accelerated towards the anode.
- Cathode rays are made into a narrow beam by a pin hole in anode disc.
- Electric field is provided by the parallel plates and magnetic field is provided by the magnets.
- When cathode rays fall on the screen (at O), they produce fluorescence .

Velocity selector

For a fixed electric field between the plates, the magnetic field is adjusted such that the cathode rays strike at the original position 'O'.

$$Bev = eE$$

$$\boxed{v = \frac{E}{B}} \text{ - - - - - } (1)$$



Specific charge

Cathode rays are accelerated towards anode, Potential energy is converted into Kinetic Energy

By law of conservation of Energy , Potential energy = Kinetic energy

- $eV = \frac{1}{2} mv^2$

$$\frac{e}{m} = \frac{1}{2}\frac{v^2}{V} \qquad \boxed{\frac{e}{m} = \frac{E^2}{2VB^2} = 1.7 \times 10^{11}\ C\ Kg^{-1}}$$

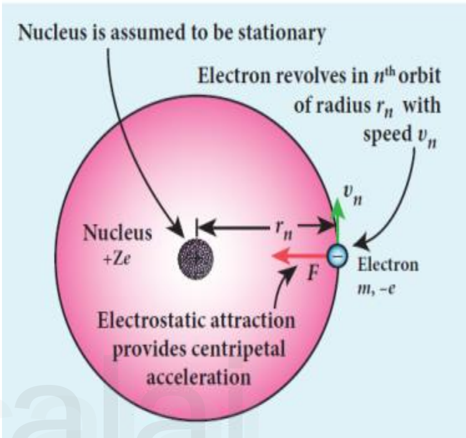
2. Obtain the expression for Radius of nth orbit of an electron.

Ze = charge of the nucleus

-e = charge of the electron

r_n = radius of the nth orbit

Z = atomic number of the atom



From Coulomb's Law,

$$\vec{F}_{coloumb} = -\frac{1}{4\pi\varepsilon_0}\frac{Z e^2}{r_n^2}\hat{r} \text{ ....}(1)$$

This gives the necessary centripetal foce

- $\vec{F}_{centripetal} = -\frac{mv_n^2}{r_n}\hat{r}$ . . . . (2)
- Equating and rearranging

$$\left|\vec{F}_{coloumb}\right| = \left|\vec{F}_{centripetal}\right|$$

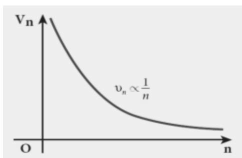
$$r_n = \frac{4\pi\epsilon_0 (mv_n r_n)^2}{Zme^2} \text{ . . . . (3)}$$

- From Bohr's assumption angular momentum, $mv_n r_n = \frac{nh}{2\pi}$
- $r_n = \frac{4\pi\epsilon_0}{Zme^2}\frac{n^2h^2}{4\pi^2}$. here $\boldsymbol{\varepsilon_0}, \boldsymbol{h}, \boldsymbol{e}, \boldsymbol{\pi}$ are constants,
- Therefore Radius $\boldsymbol{r_n = a_0 \frac{n^2}{Z}}$.
- where $\boldsymbol{a_0} = \frac{\epsilon_0 h^2}{\pi me^2}$ = 0.529 A^0. This is called BOHR'S RADIUS
- For Hydrogen atom z = 1, Therefore the radius of the nth orbit is

$$\boldsymbol{r_n = a_0 n^2} .$$

Variarion of Velocity :

- $mv_n r_n = m\, v_n a_0 n^2 = \frac{nh}{2\pi}$



$v_n \alpha \frac{1}{n}$.

- Note that the velocity of electron decreases as the principal quantum number (orbit number) increases .
- This implies that the velocity of electron in ground state is maximum when compared to that in excited states.

3. Explain the spectral series of an hydrogen atom.

- These series are named as Lyman series, Balmer series, Paschen series, Brackett series, Pfund series, etc. The wavelengths of these spectral lines perfectly agree with the wavelengths calculate using equation derived from Bohr atom model.

$$\frac{1}{\lambda} = R\left(\frac{1}{n^2} - \frac{1}{m^2}\right) = \bar{v}$$

- where $\bar{v}$ is known as wave number which is inverse of wavelength, R is known as Rydberg constant whose value is 1.09737×10^7 m^{-1} and m and n are positive integers such that $m > n$.

n	m	Name of the Series	Wave number $\nu = \left(\frac{1}{\lambda}\right)$	Region
1	2,3,4,5,6	Lyman	$R\left[\frac{1}{1} - \frac{1}{2^2}\right]$	Ultraviolet
2	3,4,5,6,7	Balmer	$R\left[\frac{1}{4} - \frac{1}{3^2}\right]$	visible
3	4,5,6,7,8	Balmer	$R\left[\frac{1}{9} - \frac{1}{4^2}\right]$	Infrared
4	5,6,7,8,9	Paschen	$R\left[\frac{1}{16} - \frac{1}{5^2}\right]$	Infrared
5	6,7,8,9	Brackett	$R\left[\frac{1}{25} - \frac{1}{6^2}\right]$	Infrared

4. Obtain the expression for number of atoms present at any instant and also derive the equation for half life period. (or) State and explain Radioactive law of disintegration.

Statement:

Rate of decay at any instant is directly proportional to the number of nuclei at the same instant.

$\frac{dN}{dt} \alpha N$ (or) $\frac{dN}{dt} = -\lambda N$. λ – decay constant

$$\frac{dN}{N} = -\lambda\, dt.$$

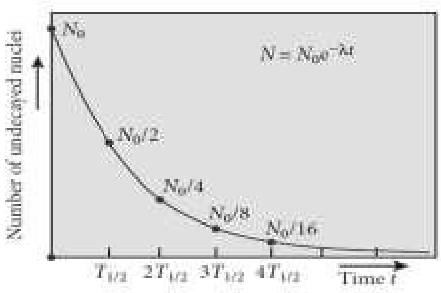
Integrating both sides $\int_{N_0}^{N} \frac{dN}{N} = -\int_0^t \lambda dt$; $\mathbf{ln}\left(\frac{\mathbf{N}}{\mathbf{N_0}}\right) = -\boldsymbol{\lambda t}$

Taking exponentials $\frac{\mathbf{N}}{\mathbf{N_0}} = \mathbf{e^{-\lambda t}}$ **(or)** $\boxed{N = N_0\, e^{-\lambda t}}$

<u>Half life</u>

The time required for the number of atoms to reduce one half of the initial amount.

$N = \frac{N_0}{2}$; $t = T_{\frac{1}{2}}$



$\frac{N_0}{2} = N_0\, e^{-\lambda T_{\frac{1}{2}}}$ ➔ $e^{\lambda T_{\frac{1}{2}}} = 2$

Taking log on both sides

$$\boxed{T_{\frac{1}{2}} = \frac{\ln 2}{\lambda} = \frac{0.6931}{\lambda}}$$

$$

$$

$$$$$$$$$$$$$$$$$$$$