Class -XII

Physics
WORKBOOK

Azadi Ka Amrit Mahotsav

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Class - XII

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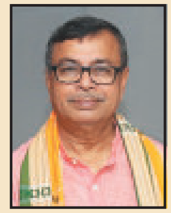
রতন লাল নাথ
মন্ত্রী
শিক্ষা দপ্তর
ত্রিপুরা সরকার

বার্তা



শিক্ষার প্রকৃত বিকাশের জন্য, শিক্ষাকে যুগোপযোগী করে তোলার জন্য প্রয়োজন শিক্ষাসংক্রান্ত নিরন্তর গবেষণা। প্রয়োজন শিক্ষা সংশ্লিষ্ট সকলকে সময়ের সঙ্গে সঙ্গে প্রশিক্ষিত করা এবং প্রয়োজনীয় শিখন সামগ্রী, পাঠ্যক্রম ও পাঠ্যপুস্তকের বিকাশ সাধন করা। এস সি ই আর টি ত্রিপুরা রাজ্যের শিক্ষার বিকাশে এসব কাজ সুনামের সঙ্গে করে আসছে। শিক্ষার্থীর মানসিক, বৌদ্ধিক ও সামাজিক বিকাশের জন্য এস সি ই আর টি পাঠ্যক্রমকে আরো বিজ্ঞানসম্মত, নান্দনিক এবং কার্যকর করবার কাজ করে চলেছে। করা হচ্ছে সুনির্দিষ্ট পরিকল্পনার অধীনে।

এই পরিকল্পনার আওতায় পাঠ্যক্রম ও পাঠ্যপুস্তকের পাশাপাশি শিশুদের শিখন সক্ষমতা বৃদ্ধির জন্য তৈরি করা হয়েছে ওয়ার্ক বুক বা অনুশীলন পুস্তক। প্রসঙ্গত উল্লেখ্য, ছাত্র-ছাত্রীদের সমস্যার সমাধানকে সহজতর করার লক্ষ্যে এবং তাদের শিখনকে আরো সহজ ও সাবলীল করার জন্য রাজ্য সরকার একটি উদ্যোগ গ্রহণ করেছে, যার নাম 'প্রয়াস'। এই প্রকল্পের অধীনে এস সি ই আর টি এবং জেলা শিক্ষা আধিকারিকরা বিশিষ্ট শিক্ষকদের সহায়তা গ্রহণের মাধ্যমে প্রথম থেকে দ্বাদশ শ্রেণির ছাত্র-ছাত্রীদের জন্য ওয়ার্ক বুকগুলো সুচারুভাবে তৈরি করেছেন। ষষ্ঠ থেকে অষ্টম শ্রেণি পর্যন্ত বিজ্ঞান, গণিত, ইংরেজি, বাংলা ও সমাজবিদ্যার ওয়ার্ক বুক তৈরি হয়েছে। নবম দশম শ্রেণির জন্য হয়েছে গণিত, বিজ্ঞান, সমাজবিদ্যা, ইংরেজি ও বাংলা। একাদশ দ্বাদশ শ্রেণির ছাত্র-ছাত্রীদের জন্য ইংরেজি, বাংলা, হিসাবশাস্ত্র, পদার্থবিদ্যা, রসায়নবিদ্যা, অর্থনীতি এবং গণিত ইত্যাদি বিষয়ের জন্য তৈরি হয়েছে ওয়ার্ক বুক। এইসব ওয়ার্ক বুকের সাহায্যে ছাত্র-ছাত্রীরা জ্ঞানমূলক বিভিন্ন কার্য সম্পাদন করতে পারবে এবং তাদের চিন্তা প্রক্রিয়ার যে স্বাভাবিক ছন্দ রয়েছে, তাকে ব্যবহার করে বিভিন্ন সমস্যার সমাধান করতে পারবে। বাংলা ও ইংরেজি উভয় ভাষায় লিখিত এইসব অনুশীলন পুস্তক ছাত্র-ছাত্রীদের মধ্যে বিনামূল্যে বিতরণ করা হবে।

এই উদ্যোগে সকল শিক্ষার্থী অতিশয় উপকৃত হবে। আমার বিশ্বাস, আমাদের সকলের সক্রিয় এবং নিরলস অংশগ্রহণের মাধ্যমে ত্রিপুরার শিক্ষাজগতে একটি নতুন দিগন্তের উন্মেষ ঘটবে। ব্যক্তিগত ভাবে আমি চাই যথাযথ জ্ঞানের সঙ্গে সঙ্গে শিক্ষার্থীর সামগ্রিক বিকাশ ঘটুক এবং তার আলো রাজ্যের প্রতিটি কোণে ছড়িয়ে পড়ুক।

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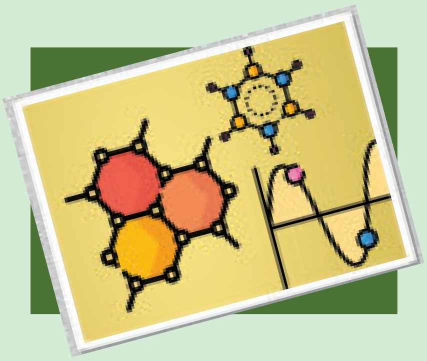
CONTENTS



Unit- I
Chapter- 1
Electric Charges and Fields

- Electrostatic Charge.
- Coulomb's Law.
- Electric field.
- Electric field lines.
- Electric Dipole.
- Electric field due to adipole.
- Torque.
- Electric Flux.
- Gauss theorem and its application.

Electrostatic Charge

⇒ The intrinsic property of elementary particles which give rise to electric force between various object.

SI unit of charge is coulomb (C).

Charging by Induction :

⇒ Charging by induction means charging without the Contact, between inducing charge and induced one.

Properties of Electric Charge :

(i) Addition of charges : If a system contains three point charges q_1, q_2 and q_3······ then the total charge of the system will be the algebraic addition of q_1, q_2 and q_3······, i.e, charges will and up.

$$q = q_1 + q_2 + q_3 + \cdots\cdots$$

(ii) Conservation of charges : Electric charge is always conserved. Charge cannot be created or destroyed in a process in isolation.

(iii) Quantization of Charges : Electric charge is always quantized i.e., electric charge is always an integral multiple of charge of electron.

Net charge q_{net} of an object = $q_{net} = \pm$ ne of

n = 1, 2, 3 ..... a natural number.

Coulomb's Law : The force of attraction or repulsion between two point charge q_1 and q_2 separated by distance 'Y' at rest is directly proportional to product of magnitude of charges and inversely proportional to square of distance between charges, written as :

$$\therefore \quad F = \frac{K'|q_1||q_2|}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{|q_1||q_2|}{r^2}$$

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{ Nm}^2\text{c}^{-2}$$

ε_0 = permittivity of vacuum = 8.854×10^{-12} $C^2N^{-1}m^{-2}$

$K = \frac{\varepsilon}{\varepsilon_0}$ = relative permittivity of medium or dielectric constant

$$\Rightarrow \quad F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} \text{ (vacuum)}$$

$$\Rightarrow \quad F = \frac{1}{4\pi\varepsilon}\frac{q_1 q_2}{r^2} \text{ (medium)}$$

$$= \frac{1}{4\pi K\varepsilon_0}\frac{q_1 q_2}{r^2}$$

Principle of Superposition :

The force on any charge due to several other charges at rest is the vector sum of all the forces on that charge due to the other charges, taken one at a time.

Electric field :

The space around a charge up to which its electric force can be experienced is called electric field.

If a test charge q_o is placed at a point where electric field is $\vec{E}$, then force on the test charge is $\vec{F} = q_o \vec{E}$

- The electric field strength due to a point source charge 'q' at an observation point 'A' at a distance 'r' from the source charge is given by :

$$E = \frac{1}{4\pi K \varepsilon_0} \frac{q}{r^2}$$

- Electric field inside the cavity of a charged conductor is zero.

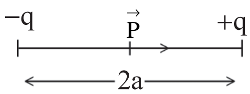
Electric field lines :

- Electric field lines are imaginary lines that extend from positive charge to infinity and infinity towards negative charge.
- The electric field lines never cross each other.

Electric Dipole :

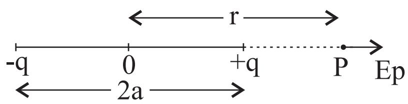
The system formed by two equal and opposite charges separated by a small distance is called and electric dipole.

Dipole moment $\vec{P} = \vec{2}aq$



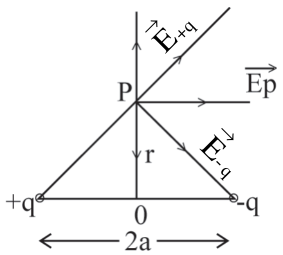
Direction of $\vec{P}$ is along –q to +q charge.
S.I unit- coulomb metre

⇒ Electric field on the axis of a dipole $E_P = \frac{2P}{4\pi\varepsilon_0 r^3}$ (if a<<r)



⇒ Electric field on the perpendicular bisector of a dipole $E_P = \frac{P}{4\pi\varepsilon_0 r^3}$

(if a<<r)

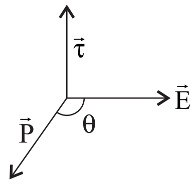


⇒ Torque on a dipole in a uniform electric field $(\tau) = PE\sin\theta$,

$\vec{\tau} = \vec{P} \times \vec{E}$

$\vec{F}_{net} = \vec{0}$

⇒ In a non uniform electric field both torque and force acts on a electric dipole.



Force on a charge due to continuous charge distribution :

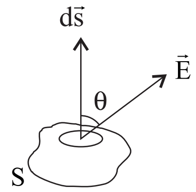
⇒ For linear charge distribution, $\vec{F} = \frac{q_0}{4\pi\varepsilon_0} \int_l \frac{\lambda}{r^2} \hat{r}\, dl$

⇒ For surface charge distribution, $\vec{F} = \frac{q_0}{4\pi\varepsilon_0} \int_l \frac{\sigma}{r^2} \hat{r}\, ds$

⇒ For Volume charge distribution, $\vec{F} = \frac{q_0}{4\pi\varepsilon_0} \int_l \frac{\rho}{r^2} \hat{r}\, dv$

Electric Flux :

⇒ Electric Flux linked with surface, $\phi = \int_s \vec{E}.d\vec{s} = \int_s E\, ds \cos\theta$



Gauss theorem :

The total flux through a closed surface is $\frac{1}{\varepsilon}$ times the net charge enclosed by the closed surface

$\oint \vec{E}.\,d\vec{s} = \frac{q}{\varepsilon}$

Gauss theorem Application of :

- Electric field due to thin infinitely long straight wire $E = \frac{2\lambda}{4\pi\varepsilon_0 r}$, r = radius of the straight wire.
- Electric field due to infinite plane sheet $E = \frac{\sigma}{2\varepsilon_0}$. σ = Surface charge density.
- Electric field due to uniformly charged thin spherical shell $E = \frac{q}{4\pi\varepsilon_0 r^2}$ [r>R] [R = Radius of the sphere]
  = 0 [r<R]

$= \frac{q}{4\pi\varepsilon_0 r^2}$ E [r=R]

A. MCQ : **Marks-1**

1. A polythene piece rubbed with wool is found to have a negative charge of 3×10^{-7}c. The number of electrons transferred is-

   (i) 1.6×10^9 (ii) 1.8×10^{10} (iii) 1.6×10^{11} (iv) 1.8×10^{12}

   Ans.

2. If two bodies are rubbed and one of them acquires q_1 charge and another acquires q_2 charge then ration of $q_1 : q_2$.

   (i) –1:1 (ii) 2:1 (iii) 3:1 (iv) 4:1

   Ans.

3. Two point charges q_1 and q_2 are such that

   (a) $q_1q_2 > 0$ (b) $q_1q_2 < 0$

   Nature of force between the charges-

   (i) attractive, repulsive (ii) attractive, attractive

   (iii) repulsive, attractive (iv) repulsive, repulsive

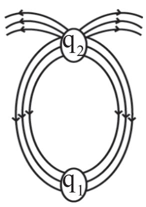
   Ans.

4. A certain charge Q is devided into two parts q and (Q - q). How the charge Q and q must be related, so that when q and (Q – q) is placed certain distance apart experience maximum electrostatics repulsion?

   (i) Q = 3q (ii) Q = q (iii) Q = 2q (iv) none of this.

   Ans.

5. What is the ratio $\left|\frac{q_1}{q_2}\right|$?



   (i) $\frac{1}{2}$ (ii) $\frac{1}{3}$ (iii) $\frac{1}{4}$ (iv) none of these.

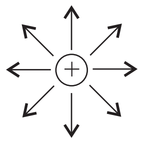
   Ans.

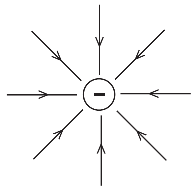
6. The ratio of electric field on the axis and at equator of an short dipole will be-

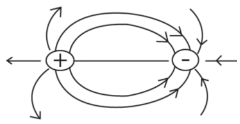
   (i) 1 : 1 (ii) 2 : 1 (iii) 1 : 2 (iv) 1 : 3

   Ans.

7. Which of the electrostatic lines of forces are correctly drawn?

(i) 

(ii) 

(iii) 

(iv) All of these.

Ans.

8. An electric dipole placed in a uniform electric field experiences, in general-

(i) A force and a torque   (ii) A force only

(iii) A torque only   (iv) No net force.

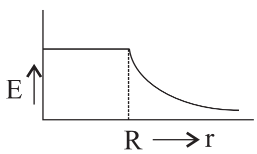
Ans.

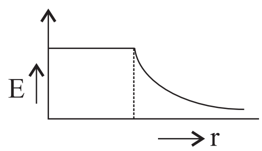
9. An infinite line charge produces of field of 18×10^4N/C at a distance of of 2 metre from it. The linear charge density is-

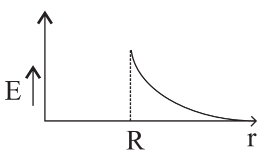
(i) 10^5 C/m   (ii) 2×10^{-5} C/m   (iii) 5×10^{-5} C/m   (iv) 4×10^5 C/m.

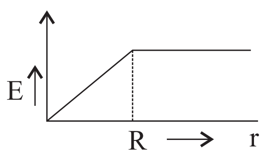
Ans.

10. An infinite field due to a uniformly charged then & spherical shell of radius R as a function of the distance 'r' from its centre is represented graphically by-

(i) 

(ii) 

(iii) 

(iv) 

Ans.

11. An electron of charge –e and mass m is placed in a uniform electric of intensity E. The value of E is such that the force on the electron due to electric field is equal to its weight. Under this condition the value of E is-

(i) $\frac{mg}{e}$ (ii) mge (iii) $\frac{e}{mg}$ (iv) $\frac{e^2 g}{m^2}$

Ans.

12. A point charge $10\mu c$ is at a distance 5 cm directly above the centre of a square of side 10 cm, as shown in fig. What is the magnitude of the electric flux through the square?

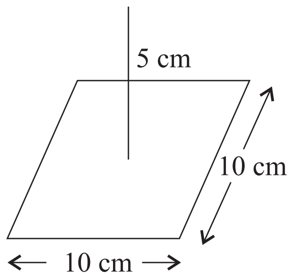


Fig.

(i) 0 (ii) $1.8 \times 10^2\ Nm^2c^{-1}$

(iii) $1.8 \times 10^4\ Nm^2c^{-1}$ (iv) $1.8 \times 10^5\ Nm^2c^{-1}$

Ans.

13. The electric flux through a closed surface area S enclosing charge Q is ϕ. If the surface area is double the flux-

(i) 2ϕ (ii) $\frac{\phi}{2}$ (iii) $\frac{\phi}{4}$ (iv) ϕ

Ans.

14. The SI unit of electric flux-

(i) $\frac{\text{Volt}}{\text{metre}}$ (ii) $\frac{\text{newton}}{\text{coulomb}}$ (iii) $\frac{\text{newton} \times \text{metre}}{\text{coulomb}}$ (iv) $\text{volt} \times \text{metre}$

Ans.

15. The given fig shows, two parallel plates A and B of charge densities $+\sigma$ and $-\sigma$ respectively. Electric intensity will be zero in region-

(i) I only (ii) II only (iii) III only (iv) I and III only

Ans.

16. What is the flux through a cube of side a, if a point charge q is one of its corner?

(i) $\frac{q}{\varepsilon_0}$ (ii) $\frac{q}{2\varepsilon_0}$ (iii) $\frac{q}{6\varepsilon_0}$ (iv) $\frac{q}{8\varepsilon_0}$

Ans.

17. Two identical spheres with charges 4q and –2q kept some distance a part exert a force F on each other. If they are made to touch each other and replaced at their old position the force between them will be -

(i) $\frac{F}{9}$ (ii) $\frac{F}{8}$ (iii) $\frac{9F}{8}$ (iv) $\frac{8F}{9}$

Ans.

18. What is the angle between the electric dipole moment and the electric field strength due to it on the equatorial line-

(i) 0^0 (ii) 90^0 (iii) 180^0 (iv) Noe of these.

Ans.

19. The distance between two charges +4q and q is 30m. At what point on the line joining the two, the intensity will be zero?

(i) At a distance 15m from 4q (ii) At a distance 20m from 4q

(iii) At a distance 7.5m from q (iv) At a distance 5m from q

Ans.

20. The ratio of electric force and Gravitational force between a proton and electron?

(i) 10^{20} (ii) 10^{10} (iii) 10^{35} (iv) 10^{39}

Ans.

B. Short Type Question : **Marks–2**

1. What is quantisation of charge?

Ans.

2. A polythene piece is rubbed with wool and it has been found to acquire a negative charge of 3×10^{-7}c.

(i) How many electrons have transfered from wool to polythene piece?

(ii) Is there a transfer of mass from wool to polythene? If yes, how much?

Ans. (i) $q = ne$

$$n = \frac{q}{e} = \frac{-3\times10^{-7}}{-1/6\times10^{-19}} = 1.875 \times 10^{12}$$

(ii) Yes, The amount of mass transferred is-

$$m = nm_e[m_e = 9.1\times10^{-31}\ \text{kg}]$$

$$= 1.875 \times 10^{12} \times 9.1 \times 10^{-31} = 17.0625 \times 10^{-19}\ \text{kg.}$$

3. Why two lines of forces can never intersect each other?

Ans.

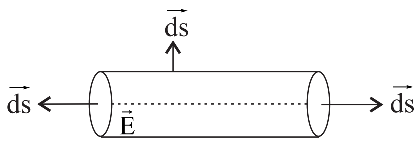
4. Plot a graph showing the variation of coulomb force (F) versus $\left(\frac{1}{r^2}\right)$ distance between the two charges of each pair of charges (1μc, 2μc) and (2μc, –3μc) intersect the graphs obtained.

Ans.

5. Why do the electric field lines do not form closed loops?

Ans.

6. Find the electric flux passing through the eylinder of cross sectional area S.



Ans.

7. Define electric flux? If $\vec{E} = \left(6\hat{i} + 2\hat{j} + 2\hat{k}\right)$ calculate the electric flux through a surface of area 20 units in Y-Z plane.

Ans.

8. Sketch the field lines of -

(i) a positive point charge (ii) a negative point charge

(iii) two equal and Opposite charge (iv) Uniform electric field.

Ans.

9. Using Gauss's theorem calculate the electric field due to an infinite plane sheet of charge.

Ans.

10. A and B are changed metallic sphere. charge of A and B are 10c and 20c repectively. Note:- C and D are uncharged.

(i) Find the repulsive force between A and B in fig (a)

(ii) Find the repulsive force between A and B in fig (b)

Ans.

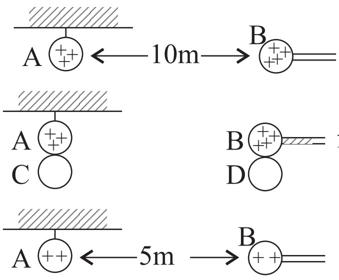


fig (a)

fig (b)

fig (c)

11. Using Gauss's theorem, derive an expression for the electric field itensity due to an infinitely long, straight wire of linear charge density λcm^{-1}.

Ans.

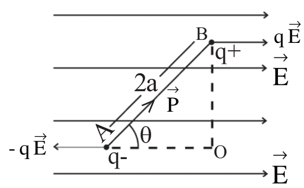
C. Long answer type question : **Marks : 5**

1. (a) An electric dipole of dipole moment $\vec{P}$ is placed in a uniform electric field $\vec{E}$. Obtain an expression for the torque Y experienced by the dipole?

(b) Write down Vector form of torque?

(c) What happnes if the field is non-uniform?

3+1+1=5



Ans.

(a) Consider an electric dipole AB placed in a uniform electric field $\vec{E}$ making an angle θ with it. 2a = Length of the dipole, and dipole moment, P = 2aq

Net translating force on a dipole $\vec{F}_{net} = +q\vec{E} - q\vec{E} = \vec{O}$

But two equal parallel and opposite force act at different points of the dipole. They form a couple which exerts a torque.

∴ Torque = Either force Perpendicular distance between two force (OB)

$$\tau = qE \times OB$$

$$\tau = qE \times 2a \, Sin\theta$$

$$\tau = PE \, Sin\theta$$

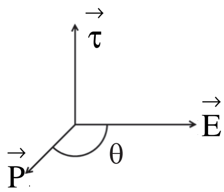
[From fig. $Sin\theta = \frac{OB}{AB}$

$OB = AB \, Sin\theta$

$= 2a \, Sin\theta$]

(b) Vector form of torque :

$$\vec{\tau} = \vec{P} \times \vec{E}$$

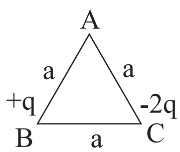


(c) Dipole in a non-uniform electric field :

In a non uniform electric field a net force acts on the dipole also a net torque acts. On the dipole which depends on the location of the dipole in the non-uniform field.

2. (a) Derive an expression for the electric field at any point on the equatorial line of an electric dipole compare it with that of the field on its axial line.

(b) Two point charges +q and –2q are placed at the vertices B and C of an equilateral triangle ΔABC. Obtain expression for magnitude and direction of the resultant electric field at the vertex A due to these two charges.



Ans.

3. (a) Using Gauss's theorem, deduce the expression for the electric field due to a uniformly Charged thin spherical shell of radius R at point-

   (i) Outside the shell ($r>R$)

   (ii) inside the shell ($r<R$)

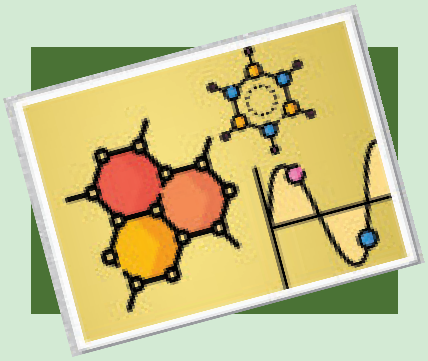
   (b) Plot a graph showing the variation of electric field as a function of r.

   r = distance between centre of spherical shell and the point at which electric field obtained. 3+2=5

   Ans.

3. A charge is distributed uniformly over a ring of radius 'a'. Obtain an expression for the electric field intensity 'E' at a point on the axis of the ring. Hence show that for points at large distances from the ring, it behaves like a point charge.

   Ans.



Unit- I
Chapter- 2
Electric Potential, Capacitance

- Electric potential.
- Potential difference.
- Electric potentail due to point charge.
- Dipole and system of charges.
- Equipotential surface.
- Conductor insulator, free and bound charges.
- Dielectrics, polarisation.
- Capacitor, Capacitance.
- Combination of capacitors.
- Parallel plate capacitor.
- Energy stored in capasitor.

1) Coulamb force between two (stationary) charges is a conservative force.

2) Workdone by an external force (equal and opposite to the electrostatic force) in Bringing a charge q from point B to a point A is = q (V_A - V_B) which is the difference in potential energy of charge q between the final and initial points.

3) Potential at a point is the workdone per unit charge in bringing a test charge from infinity to that point without any acceleration. It can be expressed as -

$$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

4) The S.I unit of potential is volt.

5) I ev = 1.6×10^{-19} joule.

6) The electrostatic potential at a point with position vector (r) due to a point dipole of dipole moment P can be expressed as :

$$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{\vec{P}.\vec{r}}{r^2}.$$

7) If r_1, r_2, r_3 .... r_n charges are situated at distances of q_1, q_2, q_3 .... q_n from a point p, then the potential can be expressed as -

$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \ldots\ldots\ldots\ldots \frac{q_n}{r_n}\right]$$

$$= \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{n} \frac{q_i}{r_i}$$

8) Potential energy of two charges q_1, q_2, at a distance r_1, r_2 can be expressed as - $U_{12} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r_{12}}$ [r_{12} is distance between q_1, q_2]

In an external electric field, $U = U_{12} + q_1 v(r_1) + q_2 v(r_2)$

9) Any surface over which the potential is constant is called an equipotential surface.

10) Field lines act perpindicularly at all points on the equipotential surface.

11) There exist no electric field at the interior of a conductor due to electrostatic sheilding.

12) The potential energy of a dipole moment $\vec{P}$ in a uniform electric field $\vec{E}$ is = $-\vec{P}.\vec{E}$

13) Electrostatic field $\vec{E}$ is zero in the interior of a conductor. Just outside the surface of a charged conductor $\vec{E}$ is normal to the surface given by -

$$\therefore \vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$$

σ = surface charge density.

$\hat{n}$ = unit vector along the outward normal to the surface.

14) The capacitance $C = \frac{Q}{V}$ [Q = charge, V = Potential difference.]

15) A capacitor is a system of two conductors separated by an insulator.

16) The S.I unit of capacitance is Farad.

17) 1 F = $1CV^{-1}$

18) For a parallel plate capacitor (with vacuum between the plater) capacitance :

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

[A = Area of each plate
d = Separation between the plates]

19) For a parallel plate capacitor with a dielectric medium the capacitance can be expressed as, $C = \dfrac{\varepsilon o \ A}{\dfrac{d - t}{K_1} + \dfrac{t}{K_2}}$

[A = Area of the plates.
d = the distance between the plates
t = thickness of dielectric]

[K_1 = dielectric constant between the plates at distance.
K_2 = dielectric constant of the dielicric of thickness 't'.]

20) For capacitors in series combination, the total capacitance C is given by -

$$\frac{1}{C} + \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

For the capacitors in parallel combination, the total capacitance is,

$$C = C_1 + C_2 + C_3 + \ldots\ldots\ldots\ldots$$

21) The energy U stored in a capacitor of capacitance C, with charge Q and voltage V is - $U = \frac{1}{2} QV = \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q^2}{C}$

Total energy stored in a serious/parallel combination capacitor is equal to the sum of the energy store across the individual capacitor.

22) A vande graff generator is a high voltage electrostatic generator which is used to accelerate charged particles. It can generate (6 - 8) millions voltages. It's working is based on -

i) discharging action of pointed conductor raised to a high potential (corona discharge)

ii) collecting action of hollow spherical conductors that is charges move from the interior to the outer surface.

A. Object Type Question : Marks : 1

1. A unit positive charge is brought at a particular point from infinity by an external force the essential work done would be = ________ .

   Ans.

2. Unit positive charge is displaced X cm an equipotential surface; the amount of work done is ________.

   Ans.

3. 1eV = ________ J.

   Ans.

4. Any charged object is connected to earth, the potential of the object would be ________.

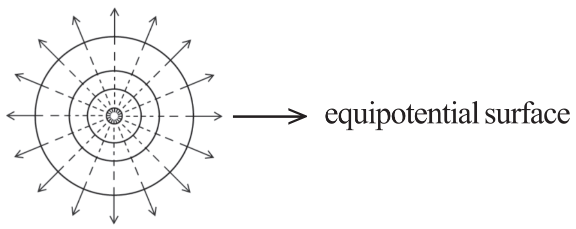
   Ans.

5. Maximum work is done in deflecting a dipole from its stationary parallel position at an angle of ________.

   Ans.

6. Draw the equipotential surface of a unit charge?

   ⇒



7. Write down the relation between volt and stat volt.

   Ans.

8. Write the unit of potential gradient.

   Ans.

9. q′ charge is centered of a circle radius r what will be the work done if q charge is circulated once?

   Ans.

10. If an electron is placed to an another electron, then what will be the change of its total electric potential?

Ans.

11. A charge q is moving through the potential differece V, then what will be he kinetic energy gained by it?

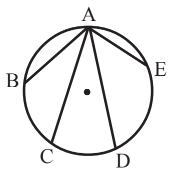
Ans.

12. Write down the relation between electric potential and electric potential energy?

Ans.

13. If the equation of electric field be $\mathrm{E} = y\,\hat{i} + x\,\hat{j}$; then write the equation of electric potentials.

Ans.

14. 

A charge q is at centre of circle ABCD, another charge q is being brought from A to B, C, D, E point respectively then what will be the work done?

Ans.

15. Define negative potential?

Ans.

16. What kind of physical electric potential is?

Ans.

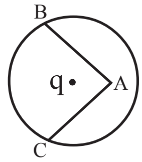
17. An electron is accelerated at a potential difference V from rest what will be the final velocity of the electron ?

Ans.

18. A hollow sphere of radius 2cm, potential on its surface is 5v, how much potential at its centre?

Ans.

19. An electric point charge q, as shown and another test charge (q_o) is displaced from the point A to B and A to C, what will be the amount of work done in both case?



Ans.

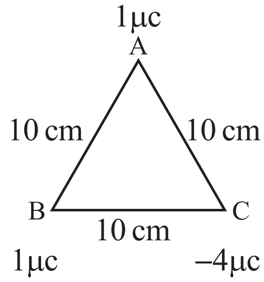
20. What will be the nature of equipotential surface for a point charge?

Ans.

B. Short Answer Type Question : **Marks : 2**

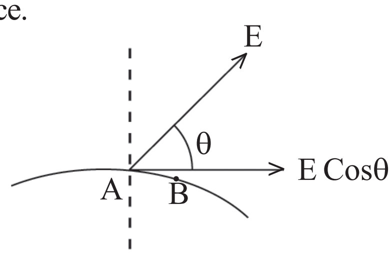
1. Write the two characteristics of equipotential surface?
2. Draw the picture of equipotential surface for a separated point charge?
3. Three point charges $1\mu c$, $1\mu c$ and $4\mu c$ are placed at the veritices of an equilaleral triangle of side10 cm. Culculate the work done to seperate them.

$\Rightarrow$ Hins -



4. Electric field lines intersects equipotential surfaces normaly- Prove it.

$\Rightarrow$ Let A and B are very closed point in a equipotential surface S. Let the electric field intensity E makes angle θ with equipotential surface.



The component of E along AB is ECosθ.

$\therefore$ The workdone to move a

+ ve charge from A to B is $E\cos\theta \times AB$

$\therefore$ The surface is equipotential then,

$\Rightarrow E\cos\theta \times AB = 0$

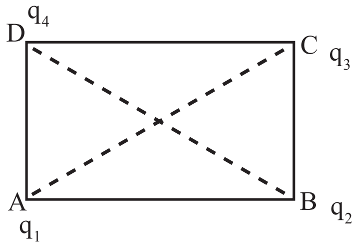
$\Rightarrow \cos\theta = 0$

$$\Rightarrow \theta = \frac{\pi}{2}$$

∴ The electric field line intersect equipetential surface normally.

5. Four point charges 2×10^{-9}c, 1×10^{-9}c, -2×10^{-9}c and 3×10^{-9}c are placed at the corners of a square of side $\sqrt{2}$ m . Find the electric potential at the centre of the square.

⇒



Sides of the square $AB = BC = CD = DA = \sqrt{2}$ m

$$\therefore \quad AC = \sqrt{AB^2 + BC^2} = \sqrt{(\sqrt{2})^2 + (\sqrt{2})^2} = 2\,m = BD$$

$$\therefore \quad AO = BO = CO = DO = 1m$$

∴ Potential at the centre.

$$V_O = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{AO} + \frac{q_2}{BO} + \frac{q_3}{CO} + \frac{q_4}{DO}\right)$$

$$= 9 \times 10^9 . \left(\frac{2\times10^{-9}}{1} + \frac{1\times10^{-9}}{1} - \frac{2\times10^{-9}}{1} + \frac{3\times10^{-9}}{1}\right)$$

$$= 9 \times (2+1-2+3)\,V$$

$$= 36\,V.$$

6. Is Electrostatic field conservative or non-conservative – Explain.

7. Find the final velocity of an electron if it starts moving rest at a potential difference of 180V ?

8. Why two equipotential surfaces can never be intersected?

9. An electric dipole of dipole moment 5×10^{-8} cm is placed at an electric field of intensity 4×10^{-5} N/C. If it is rotated at an angle of 60°; How much work would be done?

$$\Rightarrow \quad W = PE\,(1-\cos\theta)$$
$$= 5\times10^{-8}\times4\times10^{5}\times(1-\cos60^\circ)\,J$$
$$= 2\times10^{-2}(1-\frac{1}{2})\,J$$
$$= 10^{-2}\,J.$$

10. Find the electric potential for a point charge in an electric field.

C. Long Answer Type Question : Marks : 5

1. (a) Establish the relation between electric potential and potential gradient. 2

   (b) Show that, the amount of work done is minimum and maximum when an electric dipole is deflected in an electric field at an angle of 90° and 180° respectively. 3

2. (a) Show that, the surface of equipotential of powerful electric field are more closer than the weaker surface of equipotential. Draw the picture of electric equipontential surface. 2+1

   (b) Arrange these three charges +q, +q, –q whose mutual distandces are r, 2r, 2r, So that the electric potential energy, be zero, of system of charge. 2

3. (a) 'Electric field intensity inside a conductor is zero'- explain.

   What is electrostatic shielding?

   (b) A charge of 8 mC is placed of origin. Another small charge -2×10^{-9}C is moved from the point P (0, 0, 3cm) to Q (0, 4cm, 0) via R (0, 6 cm, 9 cm). Calculate the total work done.

Capacitance

A. Very Short Type Question : Marks : 1

1. Write the SI unit of capacitance.

   Ans.

2. Write the dimension of capacitance.

   Ans.

3. What is the net charge on a charged capacitor?

   Ans.

4. How the capacitance of a conductor depends on area and shape of the conductor?

   Ans.

5. In what form is the energy stored in a charged capacitor?

   Ans.

6. Write the expression for energy stored in a charged capacitor.

   Ans.

7. Radius of a earth is 6400 Km. What is its capacitance μF in?

   Ans.

8. Write the value of permittivity of air (ε_0)

   Ans.

9. Write the unit of di-electric contant.

   Ans.

10. What is the dielectric constant of conducting materials?

    Ans.

11. Write the dimensional formula of ε_0.

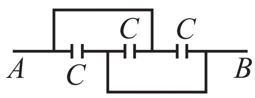
    Ans.

12. How can two capacitors be connected so that the charges on them are equal?

    Ans.

13. How can three capacitors be connected so that the potential differences between them are equal?

    Ans.

14. 

    Write the equivalent capacitance between A and B.

    Ans.

15. What is the basic purpose of using a capacitor?

    Ans.

B. Fill in the blanks : **Marks : 1**

1. _______ is the name of physical quantity whose unit is Coulomb.Volt^{-1} |

   Ans.

2. The dielectric constant of conducting material is _______ |

   Ans.

3. In the distance between the two plates of a parallel plate capacitor is increased. Then the potential difference between the plates will be _______.

   Ans.

4. The capacitance of a spherical conductor is equal to its______.

   Ans.

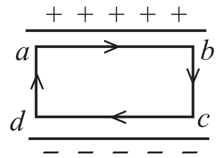
5. Van de Graaff generator in used to produce _______ .

   Ans.

C. Short answer question : **Marks : 2**

1. Obtain the expression for the energy stored per unit volume in a charged parallel plate capacitor.

   Ans.

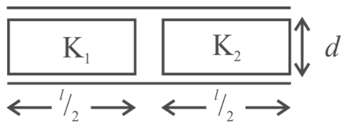
2. 

The electric field inside a parallel plate capacitor in E. Find the amount of workdone in moving a charge q over a closed rectangular loop abcda.

Ans.

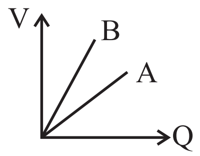
3. Distinguish between polar and non-ploar dielectrics. Give one example of each.

Ans.

4. 

Two di-electric slabs of di-electric constants K_1 and K_2 are filled in between the two plates, each of area A of the parallel plate capacitor as shown in the figure. Find the net capacitance of the capacitor.

Ans.

5. 

The graph shows the variation of voltage V across the plates of two capacitors A and B versus increase of charge Q stored on them. Which of the capacitors has higher capacitance? Give reason for your answer.

Ans.

6. Three capacitors of capacitances 2PF, 3PF and 4 PF are connected in parallel. What is the total capacitances of the combination. Determine the charge on each capacitors if the combination is connectecd to a 100V supply.

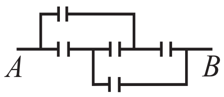
Ans.

7. Is it possible to charge a capacitor to any high potential?

Ans.

8. The radius of a sphere is 10 cm. It has 10 esu of charge. What amount of work has to be done to increase its charge by 2 esu.

   Ans.

9. 

   Five capacitors have been arranged in a circuit. Capacitor is C. Determine the equivallent capacitance between A and B.

   Ans.

10. A capacitor bears the mark 0.04μF – 200V. What does it mean.

    Ans.

D. Long answer type question : Marks : 5

1. Find the expression for the capacitance of a parallel plate capacitor. If the distance between the plates of the capacitor increases, does the capacitance also increase? Discuss.

   Ans.

2. When two charged conductors having different capacities and different potentials are joined together, then find the distribution of charge between the conductors. Show that there is always a loss of energy.

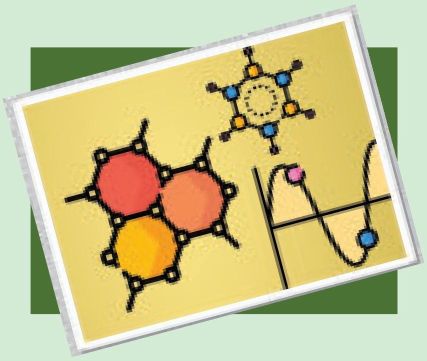
   Ans.

3. Find the equivallent capacitance of three capacitors are connected in series and parallel combination.

   Ans.

4. Consider two conducting spheres of radii R_1 and R_2 with $R_1 > R_2$. If the two are at the same potential, the larger sphere has more charge than the smaller sphere. State whether the charge density of the smallest sphere is more or less than that of the larger one.

   Ans.



Unit- II
Chapter- 3
Current Electricity

Checklist :

- Electric Current.
- Ohm's Law.
- Drift Velocity, Mobility.
- Electrical resistance, resistivity, conductivity.
- Colour Codes of carbon resistors.
- Temperature dependence of resistance.
- Electric cell and its internal resistance, potential difference of emf and internal resistance.
- Combination of cells in series, parallel and mixed.
- Kirchhoff's law and its application.
- Potentiometer and its applications.

Key Point :

- Electric current : It is the rate of flow of electric charges through the section of a conductor.

$$I = \frac{dq}{dt}$$

$$I = \frac{q}{t} = \frac{n.e}{t}$$

[n = number of electrons]

- Current density : Current density is the amount of charge per unit time that flows through a unit area of a chosen cross section around a point in the conductor. It is a vector quantity.

$$J = \frac{I}{A}$$

$$\therefore \quad I = \int_s \vec{J} . \vec{ds}$$

- Ohm's law : A linear relationship between potential differences across a conductor and current I flowing through it under identical physical condition (temp)

$$V \propto I$$

$V = IR$ [V = Potential difference

[I = Current flowing

$$R = \frac{V}{I}$$ [R = Resistance of the conductor

Microscopic form of Ohm's law : $J = \sigma E$ (σ = conductivity, J = current density, E = electric field)

- Resistance : Ratio of potential difference across a conductor to current flowing through it.

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

The S.I unit of resistance is ohm.

- Factors affecting resistance :-

$R \; \alpha \; l$ (l = length of conductor)

$R \; \alpha \; \frac{1}{A}$ (A = cross sectional area of conductor)

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

ρ = Specefic resistance of the material.

- For metals resistance increases with rise in temparature.
- For insulators and semiconductor resistance decreases with rise in temperature.
- For alloys temperature co-efficient of resistance is small.
- Temperature coefficient of resistance - $\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)}$
- Drift velocity : $\vec{V}_d = \frac{e\vec{E}}{m} . \tau$

[τ = relaxation time
E = Electri field
m = mass
e = Charge of electron]

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

[n = number density of electron
e = electronic charge
A = Area of cross section]

- Mobility : $\mu = \frac{V_d}{E} = \frac{q.\tau}{m}$ [τ = (tou)
- Resistivity : $\rho = \frac{m}{ne^2\tau}$ [τ = relaxation time.
- Combination of resistances :-

  In series, $R_S = R_1 + R_2 + ...$

  In parallel, $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + ...$

  Combination of identical cells -

  In series , $I = \frac{nE}{R + nr}$

  In parallel, $I = \frac{nE}{r + nR}$

  In mixed, $I = \frac{mnE}{nr + mR}$

- **Kirchhoff's :**

  Junction rule - At any junction, the sum of the encountered currents entering the junction is equal to the sum of currents leaving the junction. It is based on principle of conservation of charge.

  Loop rule- The algebraic sum of changes in potential encountered around any closed loop involving resistors and cells in the loop is zero. It is based on principle of conservation of energy.

  [Sign convertion : rise in potential positive and fall in potential negetive.]

- If four resistance P, Q, R and S at the four sides of a quadrilateral are so adjusted that no current flows through the galvanometer then in such a balanced Wheatstone bridge : $\frac{P}{Q} = \frac{R}{S}$
- Meter bridge :- It is a practical application of wheat stone bridge circuit. It's working is based on Wheatstone bridge principle. If 'l' be the balanced length when an unknown resistance 'x' connected at the right gap of the metre bridge and R be the resistance at the left gap (put in the resistance box).

$$\text{Then, } x = \left(\frac{100 - l}{l}\right) R$$

- Potentiometer :- Principle : V a l

$$V = Kl$$

$$V = E$$

$$E = Kl \qquad \Rightarrow E_1 = Kl_1 \ \& \ E_2 = Kl_2$$

$$\therefore \boxed{\frac{E_1}{E_2} = \frac{l_1}{l_2}}$$

[l_1 = balance length of E_1]

[l_2 = balance length of E_2]

- Internal resistance of a primary cell -

[l_1 = balance length in open circuit for cell of emf E.

l_2 = balance length for terminal potential difference of the circuit]

$$E = V + Ir$$

$$\Rightarrow r = \frac{E - V}{I}$$

$$\Rightarrow r = \left(\frac{E}{V} - 1\right) R \qquad [\because V = RI]$$

$$\Rightarrow r = \left(\frac{l_1}{l_2} - 1\right) R \qquad [\because \frac{E}{V} = \frac{l_1}{l_2}]$$

A. Multiple Choice Question : **Maks : 1**

1. The relation between electric current density (J) and drift velocity (V_d) is-

   (a) $J = nev_d$ (b) $J = \frac{ne}{v_d}$

   (c) $J = \frac{n_d . e}{n}$ (d) $J = nev_d^2$

   Where, e is the charge of electron and n is the number density of electrons.

   Ans.

2. If drift velocity of electron is V_d and intensity of electric field is E, then which of the following relation obeys the ohm's law?

   (a) $V_d = \text{const}$ (b) $V_d \propto E$

   (c) $V_d = \sqrt{E}$ (d) $V_d \propto E^2$

   Ans.

3. The dimensional formula of resistance is -

   (a) $[ML^2T^{-2}A^{-2}]$ (b) $[M^2L^3T^{-2}A^{-2}]$

   (c) $[ML^2T^{-3}A^{-2}]$ (d) $[ML^2T^{-3}A^{-2}]$

   Ans.

4. The resistance of a 10m long wire is 10Ω. Its length is increased by 25% by stretching the wire uniformly. The resistance of wire will change to-

   (a) 12.5 Ω. (b) 14.5 Ω.

   (c) 15.6 Ω. (d) 16.6 Ω.

   Ans.

5. Multiplication of resistivity and conductivity of any conductor depends on-

   (a) Cross-section (b) temperature

   (c) length (d) None of these.

   Ans.

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

(a) 0.2 Ω (b) 0.5 Ω

(c) 0.8 Ω (d) 1.0 Ω

Ans.

7. The cell has an emf of 2V and the internal resistance of this cell is 0.1 Ω, it is connected to resistance of 3Ω, the voltage across the cell will be -

(a) 1.95 V (b) 1.5 V

(c) 2V (d) 1.8V

Ans.

8. Kirchhoff's current law based on conservation of -

(a) energy (b) momentum

(c) charge (d) mass.

Ans.

9. Which of the following draws no current from the voltage source being measured?

(a) Meter bridge (b) wheatstone bridge

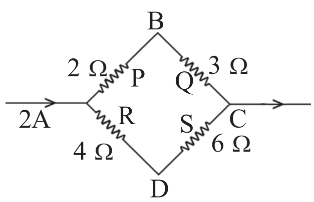
(c) Potentiometer (d) None of these.

Ans.

10. If 2A Current is flowing in the shown circuit, then the potential difference $(V_B - V_D)$ is –

(a) 12 V (b) 6 V

(c) 4 V (d) Zero.



Ans.

11. The wheatstone bridge and its balance condition provide a potential method for determination of an-

(a) Known resistance (b) Unknown resistance

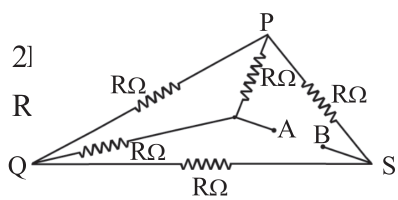
(c) Both (a) and (b) (d) None of the above.

Ans.

12. If each of the resistance in the network is R, the equivalent resistance between terminals and B is-

(a) 5R (b) 2

(c) 4R (d) R



Ans.

13. 2mA current is flowing in the wire of potentiometer of 5m long and $5\,\Omega$ resistance. The potential gradient is-

(a) 2×10^{-3} V/m. (b) 2.5×10^{-2} V/m.

(c) 1.6×10^{-3} V/m. (d) 2.3×10^{-3} V/m.

Ans.

14. A potential difference V is applied to a copper wire of length l and diameter d. If V is doubled, then the drift velocity.

(a) is doubled (b) is halved

(c) remains same (d) becomes zero.

Ans.

15. Unit of specific resistance is-

(a) $ohm^{-1} . m^{-1}$ (b) $ohm^{-1} . m$

(c) $ohm . m^{-1}$ (d) ohm . m

Ans.

16. Corresponding to the resistance $4.7 \times 10^6 \Omega \pm 5\%$ which is order of colour coding on carbon resistors?

(a) yellow, violet, blue, gold (b) yellow, violet, green, gold

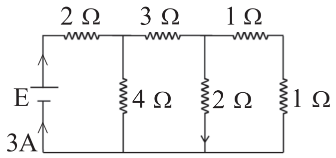
(c) orange, blue, green, gold (d) orange, blue, violet, gold

Ans.

17. The emf of the battery shown in figure is-

(a) 12v (b) 13v

(c) 16v (d) 18v



Ans.

18. Kirchhoff's laws are valid for-

(a) linear circuits only

(b) non-linear circuit

(c) both linear and non-linear circuit

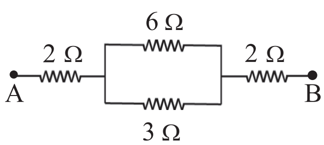
(d) non- of the above.

Ans.

19. Equivalent resistance between A and B is -

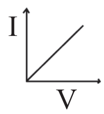
(a) $3\,\Omega$ (b) $4\,\Omega$

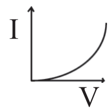
(c) $6\,\Omega$ (d) $11\,\Omega$

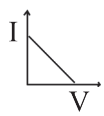


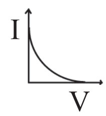
Ans.

20. Which of the following graphs represents the variation of current (I) and potential difference (V) through a metallic conductor.

(a)


(b)


(c)


(d)


Ans.

B. Very Short answer question : Marks : 1

1. Write the SI unit of electromotive force.

Ans.

2. Name the colours corresponding to the digits 4 and 7 in the colour code scheme for carbon resistors.

Ans.

3. What is the average velocity of free electrons is a metal at room temperature?

Ans.

4. Define temperature coefficient of resistivity.

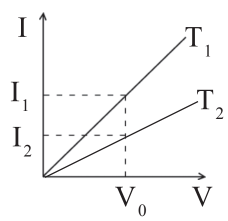
Ans.

5. Write the expression for the drift velocity of charge carriers in a conductor of length 'l' across which a potential differents 'V' is applied.

Ans.

6. Plot a graph showing variation of resistivity of a conductor with temperature.

Ans.



7. Show on a graph, the variation of resistivity with temperature for a typical semiconductor Si.

   Ans.

8. Name two materials whose resistivity decreases with temperature.

   Ans.

9. How does the resistance of a carbon resistor change with temperature.

   Ans.

10. On what conservation principle is the Kirchhoff's first law based?

    Ans.

11. On what conservation principle is the Kirchhoff's 2nd law based?

    Ans.

12. State the principle on which a metre bridge works.

    Ans.

13. Two resistors of 2Ω and 4Ω are connected in parallel to a constant dc voltage. In which case more heat is produced?

    Ans.

14. Write any two factors on which the internal resistance of a cell depends.

    Ans.

C. Fill in the blanks : Marks : 1

(i) Kirchhoff's law of voltage is based o n the the principle of conservation of ____________.

Ans.

(ii) Internal resistance of a secondary cell is ____________ than that of primary cell.

Ans.

(iii) The SI unit of temperature coefficient of resistance is ____________.

Ans.

(iv) Equivalent resistance in a parallel combination is __________ than the least value of the resistance in combination.

Ans.

(v) Value of electric current is much more higher than the drift velocity of free electrons in a metallic conductor due to higher value of __________ of the conductor.

Ans.

D. Short answer question : Marks : 2

1. Define mobility of charge carrier. Write the relation between electric current and mobility for conductor.

   Ans.

2. The resistance of a conductor at 20°c is 3.15Ω and at 100°c is 3.75Ω. Determine the temperature coefficient of resistance of the conductor.

   Ans.

3. What are ohmic and non-ohmic conductor. Give example of each.

   Ans.

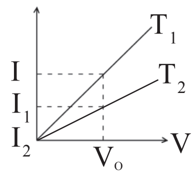
4. Two wires of equal cross sectional area, one of copper and other of manganin have the same resistance which one will be longer?

   Ans.

5. Two users of the same material having length in the ratio1:2 and diameter in the ratio 2:3 are connected in series with an accumulator. Complete the ratio of P.d across the two wires.

   Ans.

6. I-V graph for a metallic wire at two different temperatures, T_1 and T_2 is shown in fig. which of the two temperatures is lower and why.



   Ans.

7. Under what condition will the strength of current in a wire be the same for connection in series and in parallel of identical cells?

   Ans.

8. Explain with reason, how the internal resistance of a cell changes in the following cases.

   (i) When area of anode is decreased.

   (ii) When temperature of the electrolyte is in creased.

   Ans.

9. Three resistors of 1, 2 and 3 are combined in series. What is the total resistance of the combination? If the combination is connected to a battery of emf 12V and negligible internal resistance, obtain the potential drop across each resistor?

   Ans.

10. A wire of resistance 4R is bent in the form of a circle what is the effective force and terminal potential differnece of a cell.

   Ans.

11. Distinguish between electromotive force and terminal potential difference of a cell.

   Ans.

12. Three resistors R_1, R_2, R_3 are connected in parallel. Find the equivalent resistance in the combination.

   Ans.

13. Two identical cells each of emf E and internal resistance r are connected in parallel to an external resistance R. Find the expression for the total current flowing in the circuit.

   Ans.

14. Length, diameter and specific resistance of two wires of different materials are each in the ratio 2:1. One of the wires has a resistance of 10 ohm. Find the resistance of other wires.

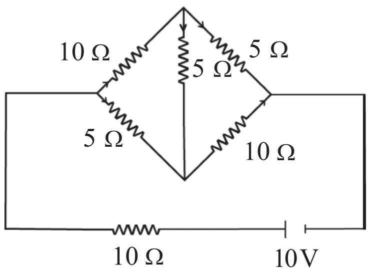
   Ans.

15. Prove that the equivalent resistance of two resistors connected in parallel is less than each of the individual resistances.

   Ans.

E. Short Answer Question : **Marks : 3**

1. Define drift velocity, Obtain the expression for the current through a conductor in terms of drift velocity?
2. Use Kirchhoff's rules to obtain the conditions for the balance condition of wheatstone bridge.
3. Determine the current in each branch of the network shown in fig.

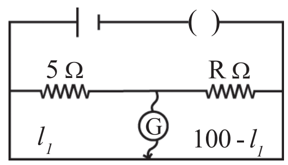


4. In a potentiometer arrangement, a cell of emf 1.25V gives a balance point at 35.0cm length of the wire. If the cell is replaced by another cell and the balance point shift to 63.0cm, what is the emf of the second cell.

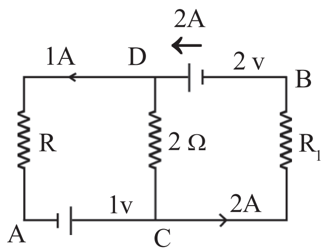
5. State Kirchhoff's laws in a network of conductors carrying current. State which law obeys the principle of conservation of energy?

6. State the principle of potentiometer. Explain how a potentiometer can be used to measure potential difference between two points.

7. The resistance in the two arms of the metre bridge are 5Ω and RΩ respectively. When the resistance R is shunted with an equal resistance, the new balance point is a $1.6l_1$. Find the resistance R.



8. In the given circuit, assuming point A to be at zero potential, use Kirchhoff's rules to determine the potential at point B.

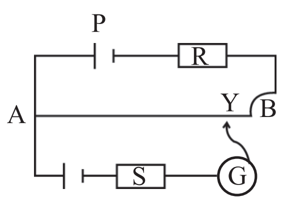


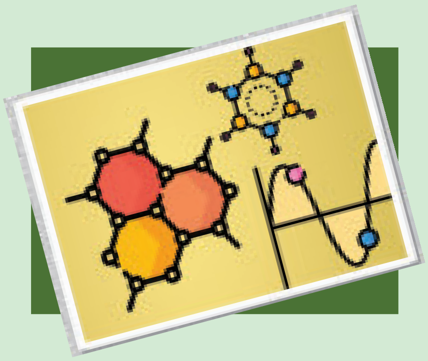
9. Describe briefly, with the help of a circuit diagram, how a potentiometer is used to determine the internal resistance of a cell.

10. In the potentiometer circuit shown, the null point at 'Y'. State with reason; where the balance point will be shifted when-

(i) ressistance R is increased, keeping all other parameters unchanged.

(ii) resistance S is increased, keeping R constant.





Unit- III

Chapter- 4 Moving Charge

Chapter- 5 Magnetism

Check list :

- Force on moving charge particle moving in Magnetic field.
- Force on current carrying wire placed in magnetic field.
- Biot-Savart law.
- Force between two current carrying straight parallel conductors.
- Ampere's Circuital law.
- Bar magnet.
- Earth's Magnetic field.
- Magnetic materials.

- According to Biot-Savart law

$$dB = K.\frac{I.dl\sin\theta}{r^2}$$

$$\text{In SI, } dB = \frac{\mu_o}{4\pi}.\frac{I.dl\,Sin\theta}{r^2} \text{ [For free space]}$$

- Magnetic field at any point near a straight

conductor; $B = \frac{\mu_o}{4\Pi}.\frac{I}{r}(Sin\theta_1 + Sin\theta_2)$

Due to infinite straight conductor, $B = \frac{\mu_o}{4\Pi}.\frac{2I}{r}$

At the centre of circular conductor of N terns,

$$B = \frac{\mu_o NI}{2r}$$

On the axis of circular conductor.

$$B = \frac{\mu_o NI}{2}.\frac{r^2}{(r^2 + x^2)^{3/2}}$$

Magnetic permeability of free space, $\mu_o = 4\pi \times 10^{-7}\, T.m.A^{-1}$

Due to long straight solenoid, $B = \mu_o nI, \quad n = \frac{N}{l}$

Due to toroid, $B = \mu_o nI, \quad n = \frac{N}{2\pi r}$

- When a moving charge particle entering in a uniform magnetic field perpendicularly,

Radius of the circular path, $r = \frac{mv}{qB}$

Time period of revolution, $T = \frac{2\pi m}{qB}$

Frequency of circular motion $n = \frac{1}{T} = \frac{qB}{2\pi m}$

- Electric force, $\vec{F}_e = q\vec{E}$

Magnetic force, $\vec{F}_m = q.(\vec{v}\times\vec{B})$

Lorentz force, $\vec{F} = q(\vec{E}+\vec{v}\times\vec{B})$

- $F = BIl \ Sin\theta$
- Torque $(\tau) = BINA$
- Force between two parallel conductor, $F = \frac{\mu_o}{4\pi} \cdot \frac{2 I_1 I_2}{r} . l$
- Shunt Resistance, $S = \frac{I_G}{I - I_G} . G = \frac{G}{n-1}$

$$n = \frac{I}{I_G}.$$

- To convert Voltmeter, the resistance connected to Galvanometer,

$$R = \frac{V}{I_G} - G$$

$$= G\ (n-1), \quad n = \frac{V}{V_G}.$$

- Magnetic Moment of current loop,

$$M = NIA$$
$$M = q_m . 2l$$
$$M = \frac{qvr}{2} = \frac{q}{2m} . L$$

- Magnitude of magnetic field,

At end-on position, $B = \frac{\mu_o}{4\pi} . \frac{2Md}{(d^2 - l^2)^2}$.

At Broadside on position,

$$B = \frac{\mu_o}{4\pi} . \frac{M}{(d^2 + l^2)^{3/2}}.$$

- $\mu_r = 1 + K$

μ_r = Relative Permeability

K = Susceptibility

- $B_V = B \sin\theta$, B_V = Vertical Component.

$B_H = B \cos\theta$, B_H = Horizontal Component

B = magnetic field intensity

$\therefore$ $B_V = B_H \tan,.$

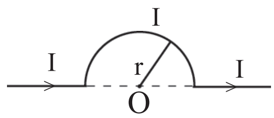
$$B = \sqrt{B_V{}^2 + B_H{}^2}$$

A. Very short answer question : **Marks : 1**

1. Write the vector form of Biot-Savart law.

   Ans :

2. What is the magnetic field at the point O of the figure, due to the current I flowing through the wire.



   Ans :

3. A magnetic needle is kept below a very long conducting wire. If current is sent through the wire from south to north, in which direction will the north pole of the needle be defected ?

   Ans :

4. When 1A current flows through a circular conductor, the magnetic field generated at its centre is 10^{-7} T. For what value of the current the magnetic field will be 10^{-6} T.

   Ans :

5. Which physical quantity has unit $Wb.m^{-2}$?

   Ans :

6. What is the magnetic field produced at a distance 1m from a long straight conductor carrying 1A current ?

   Ans :

7. A solenoid carrying 1A current has a length of 1m and contains 1000 turns. What is the magnetic field on the axis of the solenoid ?

   Ans :

8. A charge q moves with velocity $\vec{v}$ at an angle θ to a magnetic field $\vec{B}$. What is the force experienced by the particle ?

   Ans :

9. What is the nature of mutual action between two unlike parallel currents?

   Ans :

10. How should a resistance be connected with a galvanometer to convert it into a voltmeter ?

   Ans :

11. What is the nature of magnetic field in a moving coil galvanometer.

    Ans :

12. What is the unit of magnetic susceptibility ?

    Ans :

13. If the relative magnetic permeability of a material be 1.00004. What will be its magnetic susceptibility ?

    Ans :

14. Relative permeability of iron is 5500. What is its magnetic susceptibility ?

    Ans :

15. Name a material which is used as the core of an electromagnetic ?

    Ans :

16. For which type of material the magnetic susceptibility is negative ?

    Ans :

17. For which type of material, the magnetic susceptibility is independent of temperature.

    Ans :

18. How does the magnetic susceptibility per unit mass (X) of a paramagnetic gas depend on absolute temperature T ?

    Ans :

19. Where on the surface of the earth, the value of angle of dip is zero?

    Ans :

20. Where on the earth's surface, the value of angle of dip is 90^0 ?

    Ans :

B. Short answer questions : **Marks : 2**

1. What are the values of magnetic permeability and susceptibility for paramagnetic, diamagnetic and ferromagnetic material. What is Curie point.

   Ans :

2. For what kind of magnetic material the magnetic susceptibility is negative. Give example.

In which groups of magnetic materials nickel and copper belong to ?

Ans :

3. Explain with diagram the pattern of magnetic lines of force when a sphere made of (i) Paramagnetic and (ii) diamagnetic material is place in a uniform magnetic field.

Ans :

4. Define angle of dip and angle of declination at a place on earth's surface.

Ans :

5. Explain the use of Horizontal and Vertical component of earth magnetic field.

Ans :

6. If a permanent bar magnet is cut along its breadth into two equal parts, what will be the pole-strength and magnetic moment of each part ?

Ans :

7. If a permanent bar magnet is cut along the length into two equal parts, what will be the pole-strength and magnetic moment of each part.

Ans :

8. In a hydrogen atom, an electron of charge e revolves in an orbit of radius r with speed v. Find the magnetic moment associated with the electron.

Ans :

9. *I* ampere current is flowing through a *l* meter long conducting wire. If the wire is shaped into a circular loop, then what will be its magnetic moment :

Ans : Let r be the radius of the circular loop.

$$\therefore \quad 2\pi r = l$$

$$\Rightarrow \quad r = \frac{l}{2\pi}$$

$$\therefore \text{ Area of the loop } (A) = \pi R^2 = \frac{l^2}{4\pi}$$

$\therefore$ Magnetic moment of the circular loop $= I . A$

$$= I . \frac{l^2}{2\pi}$$

10. An electron and a proton are revolving along circular paths of equal radii in equal magnetic fields. Compare their kinetic energies.

    Ans :

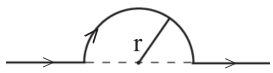
11. The ratios of the masses and charges of a proton and alpha particle are respectively 1:4 and 1:2. They enter a uniform magnetic field of magnitude B normally with same velocity. What will be the ratio of the radii of the circular paths described by the particles.

    Ans :

12. A charged particle is revolving along a circular path of radius *r* normal to the direction of the uniform magnetic field B. How much time will the particle take to complete one revolution ?

    Ans :

13. If a current *i* flows through the wire what will be the magnetic field at the centre of the circle?



    Ans :

14. At a place the vertical component of earth's magnetic field is $\sqrt{3}$ times its horizontal component. What will be the angle of dip at the place ?

    Ans :

15. The angle of dip at a place is 30^0 and the horizontal component of earth's magnetic field at that place is 0.39 cgs unit. Determine the vertical component of earth's magnetic field at that place.

    Ans :

C. Short answer question : Marks : 3

1. Derive an expression for the force acting on a current carrying straight conductor kept in a uniform magnetic field. Under what condition this force is maximum and zero ?
2. State the Biot-Savart law. Use it to obtain an expression for magnetic field at the centre of a current carrying circular loop.
3. A rectangular coil of sides *l* and '*b*' carrying a current *I* is subjected to a uniform magnetic field $\vec{B}$ acting perpendicular to its plane. Obtain the expression for torque acting on it.

4. Deduce the expression for magnetic dipole moment of an electron revolving around the nucleus in a circular orbit of radius '*r*'.

5. With the help of a diagram, explain the principle and working of a moving coil galvanometer.

6. How does a voltmeter differ from ammeter ? What is the main function of soft iron core used in a moving coil galvanometer ?

7. (i) Calculate the magnetic field at a distance of 5 cm from an infinite straight conductor carrying a current of 10A.

   (ii) A circular coil of radius 0.2 m is having 1000 turns of wire. Current of 0.1 A is flowing through it. Find magnetic field at the centre of the coil.

8. Using Ampere's circuital law find the magnetic field inside a long current carrying solenoid.

9. A particle carrying charge q enters a uniform magnetic field with velocity $\vec{v}$. Discuss the nature of the path described by the particle in each of current carrying the following cases.

   (i) When $\vec{V}$ and $\vec{B}$ are parallel to each other.

   (ii) When $\vec{V}$ and $\vec{B}$ are perpendicular to each other.

   (iii) When $\vec{V}$ and $\vec{B}$ remain inclined at any angle.

10. Compare between Ferromagnetic, Paramagnetic and diamagnetic material in terms of (i) Behavior of external magnetic field. (ii) Susceptibility, (iii) Permeability.

D. Long Answer Question : Marks : 5

1. State Biot-Savart law. Using Biot-Savart law derive the expression for the magnetic field at a point on the axis of circular current loop.

2. State Ampere's circuital law. Using this law find the magnetic field due to straight infinite current carrying wire.

3. State the principle of cyclotron. Show that the time period of revolution of particles in a cyclotron is independent of their speeds. Why cyclotron is used to accelerate the charged particle.

4. Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working. State the factors effecting its sensitivity.

5. Obtain an expression for the torque acting on a current carrying rectangular coil placed in a uniform magnetic field when the plane of the coil remains parallel to the magnetic lines of force. State Fleming's left hand rule.

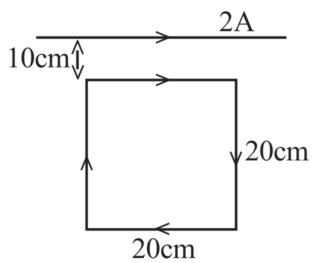
6. (i) A charge q is revolving along a circular path of radius r with velocity V. Determine its magnetic moment.

   (ii) A copper wire of length l meter is bent to form a circular loop. If i ampere current flows through the loop, find out the magnitude of magnetic moment of the loop.

7. Derive a mathematical expression for the force acting on a current carrying conductor kept in a magnetic field. State the rule to determine the direction of this force. Under what conditions is this force zero and maximum?

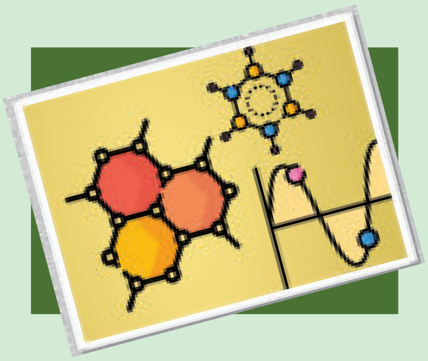
8. Two straight long parallel conductors carry currents I_1 and I_2 in a same direction. Deduce the expression for the force per unit length between them. Define 1 Ampere.

9. A square loop of side 20 cm carrying current of 1A is kept near an infinite long straight wire carrying a current of 2A in the same plane shown in the figure.



   Calculate the magnitude and direction of the net force exerted on the loop due to the current carrying conductor.

10. Establish the expression for work-done in rotating a magnetic dipole placed in uniform magnetic field. Define Lorentz force. Write its expression.



Unit- IV

Chapter- 6 Electromagnetic Induction

Chapter- 7 Alternating Current

In this unit :

- Magnetic flux.
- Faraday's law and Lenz's law.
- Conservation of energy.
- Eddy current.
- Self Induction and mutual Induction.
- Alternating Potential difference and Electric current.
- AC circuit.
- Power in AC circuit.
- Resonance.
- LC Oscillation.
- Transformer.

Key Formula

- Magnetic flux $\phi_B = \vec{B}.\vec{A}$

  $= BA\cos\theta$

  (i) If $\theta = 0^0$, then magnetic flux is maximum.

  $\therefore \quad \boxed{\phi_B = BA}$

  (ii) If $\theta = 90^0$, then magnetic flux is zero.

  (iii) If $\theta < 90^0$, then magnetic flux is positive.

  (iv) If $\theta > 90^0$, then magnetic flux is negative.

- Induced emf, $e = -\frac{d\phi_B}{dt}$.

  Induced current $I = \frac{e}{R}$.

  When a conductor is moved with a velocity V inside a magnetic field B, the emf induced in the conductor.

  $\boxed{e = BlV}$

If the moving conductor is a part of the closed circuit then the current in the circuit. $I = \frac{BlV}{R}$.

The magnitude of the force is- $F = \frac{B^2 l^2 V}{R}$.

The rate at which the energy is supplied to the conductor is- $P = \frac{B^2 l^2 V^2}{R}$.

- Self Inductance of a coil, $\mathbf{L} = \mu_0 \mathbf{n}^2 \mathbf{A} l.$

$$\mathbf{L} = -\frac{\varepsilon}{\frac{d\mathbf{I}}{dt}}$$

$$\mathbf{L} = \frac{\phi}{\mathbf{I}}$$

- Equivalent Inductance of Inductor in series, $L_S = L_1 + L_2 + ...$

Equivalent Inductance of inductor in parallel, $\frac{1}{L_p} = \frac{1}{L_1} + \frac{1}{L_2} + ...$

Energy stored, $U = \frac{1}{2} LI^2$

Mutual inductance, $\mathbf{M} = \mu_0 \mathbf{n}_1 \mathbf{n}_2 \mathbf{A} l$

- For an a.c generator associated with a coil,

magnetic flux, $\phi = NBA \cos\omega t$

Induced emf, $\varepsilon = -\frac{d\phi}{dt} = NBA\, \omega \sin\omega t$

Maximum induced emf, $\varepsilon_{max} = \mathbf{NBA\omega}$

Maximum current, $I = \frac{NBA\omega}{R}$

- Average value of current for one cycle of AC, $I_{av} = 0$.

Average value of current for half cycle of AC, $I_{av} = \frac{2I_0}{\pi} = 0.637\, I_0$

Effective / rms value of current. $I_{rms} = \frac{I_0}{\sqrt{2}} = 0.707\, I_0$.

- Average value of emf for one cycle of AC, $E_{av} = 0.$

  Average value of emf, $E_{av} = \frac{2E_0}{\pi}$ for half cycle.

  Effective / rms value of emf for half cycle, $E_{rms} = \frac{E_0}{\sqrt{2}}$

- Capacitive reactance $X_C = \frac{1}{\omega C}$.
- Inductive reactance $X_L = \omega L$.
- In a series LCR impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

  Peak value of current, $i_0 = \frac{E_0}{\sqrt{R^2 + (X_L - X_C)^2}}$

- Average Power, $P_{av} = E_{rms}\, i_{rms} \cdot \cos\theta$.
- For L-R circuit, impedance, $Z = \sqrt{R^2 + (\omega L)^2}$

  For C-R circuit, impedance, $Z = \sqrt{R^2 + \frac{1}{(\omega C)^2}}$

- Power factor $\cos\phi = \frac{R}{Z}$.
- Resonant frequency $f_0 = \frac{1}{2\Pi\sqrt{LC}}$.
- Q factor $= \frac{1}{R}\sqrt{\frac{L}{C}}$.
- In a transformer,

$$\frac{I_P}{I_S} = \frac{V_S}{V_P} = \frac{N_S}{N_P} = K.$$

For an ideal Transformer,

Input power = Output power.

$\therefore \quad V_P I_P = V_S I_S.$

$$\text{Efficiency} = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

A. **Very short answer question :** **Mark : 1**

1. Name the SI unit of magnetic flux and magnetic induction.

   Ans.

2. Write the dimensional formula of magnetic flux.

   Ans.

3. A wire cuts across a flux of 0.2×10^{-2} wb in 0.12 sec what is the emf induced in the wire ?

   Ans.

4. Define the unit of self-inductance.

   Ans.

5. If the number of turns of a solenoid is doubled, keeping the other factors constant, how does the self inductance of the solenoid change?

   Ans.

6. Write three factors on which the self-inductance of coil depends.

   Ans.

7. What will be the dimensions of L/R, if L is inductance and R is resistance ?

   Ans.

8. Mention any one useful application of eddy currents.

   Ans.

9. The instantaneous current from an ac source is I = 5 Sin 314t. What is the rms value of the current ?

   Ans.

10. How does the capacitive reactance depend on frequency of a.c.?

    Ans.

11. What is the SI unit of $\frac{1}{\omega C}$?

    Ans.

12. What is the phase relationship between current and voltage in an inductor?

    Ans.

13. What is the phase difference between the voltage across L and C in a series LCR-circuit connected to an a.c. source?

    Ans.

14. A LCR circuit with L = 0.12 H, C = 4.8×10^{-7} F, R = 23 Ω is connected to a variable frequency supply. At what frequency is the current maximum?

    Ans.

15. In an a.c. circuit R = 4Ω, z = 5Ω, V_{rms} = 200 V and I_{rms} = 1.5 A. Calculate the average power consumed over full cycle.

    Ans.

16. Define power factor.

    Ans.

17. Define Wattless current.

    Ans.

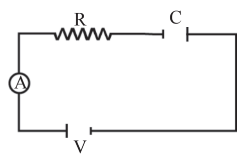
18. What is copper loss in a transformer?

    Ans.

19. When a transformer is are called step-up and step down?

    Ans.

20. State the steady value of the reading of the ammeter in the circuit shown in-



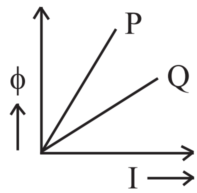
    Ans.

B. Short answer question : **Marks : 2**

1. State Lenz's Law of electro-magnetic induction and show that it is in accordance with law of conservation of energy.

   Ans.

2. Given a graph of magnetic flux (ϕ) versus current (I) for two inductors P and Q. Out of P and Q, which will have more value of self inductance and why?



   Ans.

3. A bar magnet is falling from some height through a metal ring.

   (i) Will its acceleration be equal to acceleration due to gravity (g)?

   (ii) If the metal ring is cut, what will be the value of acceleration in that case?

   Ans.

4. A rectangular loop on 'n' turns of length 'l', width 'b' rotated with an angular velocity ω in a uniform magnetic field of induction B. Show that induced emf is given by-

$$\varepsilon = n.B.l.\ b.\ \omega.\ \sin\omega t.$$

   Ans.

5. A metallic rod of length l is rotated at a constant angular speed ω, normal to a uniform magnetic field B. Derive an expression for the current induced in the rod, if the resistance of the rod is R.

   Ans.

6. What is eddy current ? Write their two application. How eddy current can be minimized ?

   Ans.

7. Find the magnetic flux linked with a rectangular loop having area 10 cm × 20 cm which is placed in a magnetic field of 0.2 T with its plane.

   (i) at an angle 60^0 to the field.

   (ii) at an angle 45^0 to the field.

(iii) Parallel to the field.

Ans.

8. Find the induced current through a coil at t = 2sec if the magnetic flux through a coil is $\phi = 6t^3 + 12t^2 + 5$ and resistance of the coil is 5Ω.

Ans.

9. A train is moving towards north-south with a velocity 108 km/h. What is the amount of induced emf between two wheels ? Distance between two wheels is 2 m and vertical component of magnetic field is 0.3G.

Ans.

10. Define non-inductive coil and choke. Write the use of choke coil.

Ans.

11. Define Peak Value and root mean square value of alternating current. Derive an expression for the root mean square value of alternating current.

Ans.

12. Prove that the voltage and current always vary in the same phase in an a.c. circuit containing resistance only. Show the phasor diagram.

Ans.

13. An a.c. voltage $E = E_0 \sin\omega t$ is applied across an inductance L, obtain an expression for the current I. Show the phase relationship between current and voltage in a phasor diagram.

Ans.

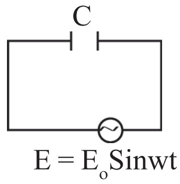
14. A source of ac voltage $V = V_0 \sin\omega t$ is connected to a series combination of resistor 'R' and a capacitor 'C'. Draw the phasor diagram and use it to obtain the expression for impedance of the circuit and phase angle.

Ans.

15. An alternative emf $E = E_0 \sin\omega t$ is applied to a capacitor C as shown in the fig.

(i) Sketch a graph showing variation of voltage and current in the circuit with time.

(ii) What is the reactance of the capacitance ?



Ans.

16. (i) For a given ac $i = i_0 \sin\omega t$, show that the average power dissipated in a resistor R over a complete cycle is $= \frac{1}{2} i_0^2$ R.

(ii) A light bulb is rated at 120 W for a 240 V ac supply. Calculate the resistance of the bulb.

Ans.

17. An alternating voltage given by V = 140 Sin 314t is connected across a pure resistor of 50 Hz. Find frequency of the source and rms current through the resistor.

Ans.

18. A capacitor of capacitance 100 μF and a coil of resistance 50 ohm and inductance 0.5 henry are connected in series with 110 volt and 50 Hz source. Calculate the impedance of the circuit.

Ans.

19. In a series LCR circuit with an AC source of effective voltage 50V, frequency ν = 50/π, R = 300Ω, C = 20 μF and L = 1.0H. Find the rms current in the circuit.

Ans.

20. The number of the turns in the primary coil of transformer is 10 times than the same in the secondary coil. If the voltage across the primary is 20V, then find the voltage across the secondary.

Ans.

C. Long Answer Questions : Marks : 5

1. Describe briefly the concept of magnetic flux. Under what conditions it is (i) maximum (ii) minimum? What are its SI and CGS units. What is the relation between these units. Also write the dimensional formula of magnetic flux.

2. (i) State Faraday's law of electromagnetic induction.

   (ii) The current flowing through an inductor of self-inductance L is continuously increasing. Plot a graph showing the variation of-

   (a) Magnetic flux versus the current.

   (b) Induced emf versus $\frac{dI}{dt}$

   (c) Magnetic potential energy stored versus the current.

3. Define mutual inductance of a pair of coils. Deduce an expression for the mutual inductance of two long co-axial solenoids but having different radii and different number of turns.

4. Define self-inductance of a coil. Obtain an expression for the energy stored in a solenoid of self-inductance 'L' when the current through it grows from zero to I.

5. Establish an expression for self-inductance of a solenoid. Self-inductance of a coil is 1H. What do you mean by this statement.

6. What do you mean by rms value and mean value of AC? Derive an expression for rms value of AC.

7. (a) Show that in a purely inductive AC circuit, the voltage is ahead of current by a phase angle of $^{\pi}/_{2}$.

   (b) A horizontal straight wire of length L extending from east to west is falling with speed v at right angles to the horizontal component of the Earth magnetic field B.

   (i) Write the expression for the instantaneous value of the emf induced in the wire.

   (ii) What is the direction of the emf?

   (iii) Which end of the wire is at the higher potential?

8. A 2μF capacitor, 100Ω resistor and 8H inductor are connected in series with an AC source.

(i) What would be the frequency of the source such that current drawn in the circuit is maximum? What is this frequency called?

(ii) If the peak value of emf of the source is 200V, find the maximum current.

(iii) Draw a graph showing the variation of amplitude of circuit current with changing frequency of applied voltage in as series LCR circuit for two different values of resistances R_1 and R_2 ($R_1 > R_2$).

9. Give the principle and working of a transformer. Explain the different losses in a transformer.

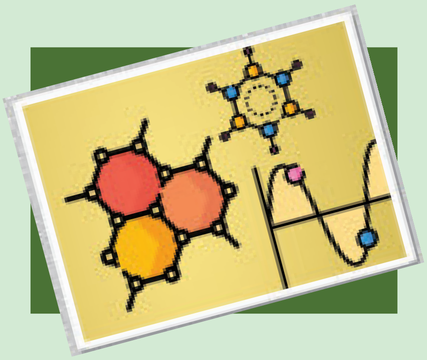
10. A Device 'X' is connected across an ac source of voltage $V = V_0 \sin\omega t$. The current through X is given as $I = I_0 \text{ Sin}(\omega t + \pi/2)$

(i) Identify the device 'X' and write the expression for its reactance.

(ii) Draw graphs showing variation of voltage and current with time over one cycle of AC for 'X'.

(iii) How does the reactance of the device 'X' vary with frequency of the AC ?

(iv) Draw the phasor diagram for the device 'X'.



Unit- V
Chapter- 8
Electromagnetic Waves

Unit Summary :

- Origin of Electromagnetic Wave and displacement current.
- Basic equations of electromagnetic waves.
- Electromagnetic waves and its properties.
- Electromagnetic spectrum : Radio wave, UV ray, Visible light, Infrared ray, X-ray, γ-ray.

1) Maxwell vividly explained set of equations involving electric and magnetic fields, and their sources, the charge and current densities. These equations are known as Maxwell's equations.

2) Maxwell's equation :

(a) $\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\varepsilon_0}$ (Gauss law in electrostatics)

(b) $\oint \vec{B} \cdot d\vec{A} = 0$ (Gauss law in magnetism)

(c) $\oint \vec{E} \cdot d\vec{l} = \frac{-d\phi_B}{dt}$ (Faraday's law in electromagnetic induction)

(d) $\oint_c \vec{B} \cdot d\vec{l} = \mu_0 I_0 + \mu_0 \varepsilon_0 \frac{d\phi_\varepsilon}{dt}$ (Maxwell's modified form of Ampere's circuiltal law)

3) Electromagnetic waves are waves which can travel through the space.

→ E.M wave is one increase there occurs sinosuidal variations of electric and magnetic field vectors mutually perpindicular to each other and acting as a source of each other.

$$C = \frac{E_o}{B_o} \qquad \left[\begin{array}{l} E_o = \text{Electric field vector.} \\ B_o = \text{Magnetic field vector} \end{array}\right]$$

4) The relation of the speed C of electromagnetic wave in vaccum with μ_o and ε_0 (the free space permeability and permittivity constant :

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

5) Electromagnetic weves are transverse in nature.

6) The different regions of electronagnetic waves are known as- γ–rays, X-rays, ultraviolet rays, visible rays, infrared rays, microwaves and radiowaves.

7) Electromagnetic waves carry energy and momentum.

8) The magnitude of the total momentum of electromagnetic wave- $P = \frac{U}{C}$

[U = Total energy]

A. Objective Type Question : Marks : 1

1. Write the velocity of electormagnetic waves.

   Ans.

2. Name a electromagnetic wave which is used in medical treatment?

   Ans.

3. Arrange the following rays in ascending order,

   IR ray, micro wave ray, γ –ray, Uv ray.

   Ans.

4. The magnetic permeability and electric permittivity are μ_0 and ϵ_0 respectively, in any Gauss's plane ϕ is the electri c flux, then what will be the displacement current?

   Ans.

5. How electromagnetic waves being produced?

   Ans.

6. By which phenomena it is known that electromagnetic wave is a transverse wave?

   Ans.

B. Short Answer Type Questions : Marks : 3

1. "Electromagnetic wave exerts radiation pressure"- explain.

   Ans.

2. (a) How electromagnetic waves is produced.

   (b) An Electromagnetic wave is forwarded towards Z-axis. Draw the electromagnetic wave for changing electric field and magnetic field.

   Ans.

3. Write the name of electro magnetic wave whose wave length is 10nm -10^{-3}. Write its production and uses.

   Ans.

4. What is displacement current? Write the faraday's law of

electromagnetic induction.

Ans.

5. Write four characteristics of electromagnetic waves.

Ans.

6. (a) Light wave can propagate through vaccum but sound wave can not-Why?

(b) What do you mean by the statement "Electromagnetic waves transport momentum".

Ans.

7. Electormagnetic wave is a tansverse wave– explain.

Ans.

8. Write one similarity and one differnce of visible light and radio wave.

Ans.

9. What kind of electormagnetic waves is produced in the process given below–

(i) Radio active decay

(ii) Acceleration and deceeleration of electron.

(iii) Stick of metal objects by high power electrons.

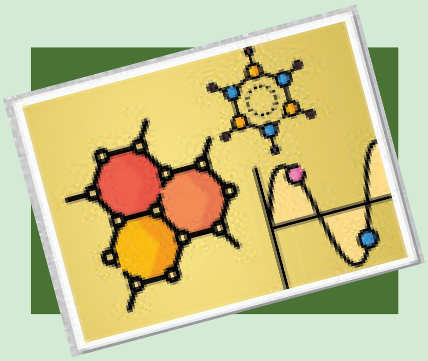
Ans.

10. What kind of electromagnetic wave is essential for ______ radar, treatment of muscles and diagnosis of diseases.

Ans.

11. How are electromagnetic waves produced by accelerating charge? Depict an electromagnetic wave propagating in z -direction?

Ans.



Unit- VI

Chapter- 9

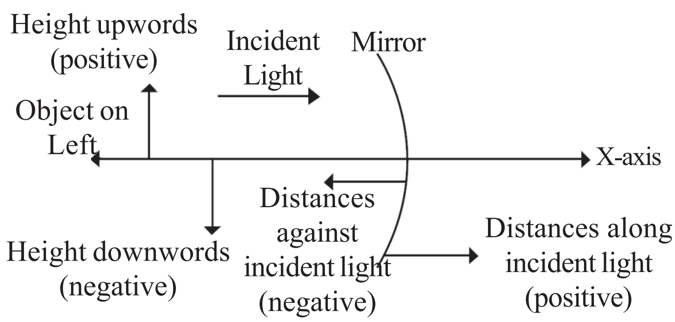
Ray Optics and Optical Instruments

Unit Summary :

- Spherical mirror-Reflection, its equation, uses.
- Refraction, Total internal reflection

  -Natural phenomena, optical fibre.
- Prism- Refraction and dispersion.
- Human eye- Diseases and correction.
- The Microscope, Telescope.

- Ray : It represents the direction of propogation of light in a medium/free space.
- Beam : Collection of rays is called bean.
- Reflection of light : The phenomenon of bouncing back of light in the same medium on striking the surface of any object.
- Laws of reflection :
  - i) The angle of incidence is equal to the angle of reflection.
  - ii) The incident ray, the reflected ray and normal at the point of incidence, all lie in the same plane.
- Spherical Mirror : The reflection also takes place at spherical mirror in accordance with the laws of reflection. Sign convention :



- Focal length of a spherical Mirror : The focal length of a mirror (concave or convex) is equal to half of the radius of curvature of the mirror, i.e.,

$$f = \frac{R}{2}$$

- Mirror formula : $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

  u = object distance.

  v = image distance

  f = focal length of the mirror.

  $f = \frac{R}{2}$, R is the radius of curvature of the mirror.

- Magnification :

  Linear magnification,

$$m = \frac{I}{O} = -\frac{v}{u} = \frac{f-v}{f} = \frac{f}{f-u}$$

  Where, I = size of image.

  O = size of object.

  'm' is possitive, implies that the image is real and inverted.

  'm' is negetive, implies that the image is virtual and erect.

- Refraction : The phenomenon of change in the path of light when it travels from one medium to another.

  Laws of reflection :

  i) The incident ray, the refracted ray and normal at the point of incidence all lies in the same plane.

  ii) The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant i.e.,

$$\frac{\text{Sin i}}{\text{Sin r}} = {}_a\mu_b$$

  Where, i is the angle of incidence in medium a.

  r is the angle of refraction in medium b.

  ${}_a\mu_b$ is a constant known as refractive index of the medium b with respect to medium a.

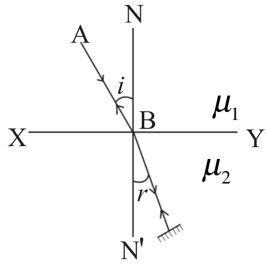
- Refractive index :

$$\mu = \frac{c}{v} = \frac{\lambda_{vac}}{\lambda_{med}}$$

where, c = speed of light in vacuum.

v = speed of light in medium.

- Principle of reversibility of light :



$${}_1\mu_2 \times {}_2\mu_1 = 1$$

or, $${}_1\mu_2 = \frac{1}{{}_2\mu_1}$$

- Relation between refractive index and critical angle :

$$\mu = \frac{1}{Sin\, i_c}$$

where, i_c is the critical angle.

- Apparent depth of a liquid :

Refractive index of the medium, $\mu = \frac{\text{Real depth}}{\text{Apparent depth}}$

- Normal shift :

$$d = t\left(1 - \frac{1}{\mu}\right)$$

- Refraction through a single spherical surface :

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \quad \text{(when object is in rare medium)}$$

$$\frac{\mu_1}{v} - \frac{\mu_2}{u} = \frac{\mu_1 - \mu_2}{R} \quad \text{(when object is in denser medium)}$$

Where, μ_1, μ_2 are the refractive indices of rare and denser media respectively.

R is the radius of curvature of spherical surface.

u and v are the object and image diatance from the centre of the refracting surface (pole).

- Refraction through a thin lens (Lens makers' formula) :

$$\frac{1}{f} = \left(\frac{\mu_2 - \mu_1}{\mu_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \begin{bmatrix} \mu_1 = 1 \ \textit{for air} \\ \mu_1 = \mu \end{bmatrix}$$

Where, R_1 and R_2 are radii of curvature of first and second refracting surfaces of a thin lens.

- Thin lens formula :

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

- Magnification : $m = \frac{h'}{h} = \frac{v}{u}$

  Where, h = height of image.

  h = height of object.

- Power of a lens :

$$P = \frac{1}{f\ (\text{in m})} = \frac{100}{f\ (\text{in cm})}$$

- Focal length of thin lenses in contact :

  The focal length (f) of thin lenses of focal lengths f_1, f_2, f_3, ... placed incontact of each other is, $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + ...$ If, 'd' be separation between two lenses of focal length f_1 and f_2 than, $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

- Refraction through prism :

  The deviation δ produced by the prism is, $\delta = i + e - A$

  Where, i = angle of incidence.

  e = angle of emergence.

  A = angle of the prism.

- Relation between refractive index and angle of minimum deviation :

$$\mu = \frac{\text{Sin}\,\frac{A + \delta m}{2}}{\text{Sin}\,\frac{A}{2}}$$

Where, δm = angle of minimum deviation.

- Deviation produced by a small angled prism is,

$$\delta = (\mu - 1)\ A$$

- Dispersion : The splitting of white light into constituent colours is called the dispersion of light.
- Angular dispersion :

$$\theta = \delta_V - \delta_R = (\mu_V - \mu_R)\ A$$

- Dispersive power :

$$\omega = \frac{\delta_V - \delta_R}{\delta} = \frac{\mu_V - \mu_R}{\mu - 1}$$

- Human eye : Human eye is a natural optical device.
- Microscope : The magnifying power of a compound microscope is,

$$M = 1 + \frac{D}{f}$$

The magnifying power of a compound mircroscope,

$$M = M_o \times M_e = \frac{V_O}{U_O}(1 + \frac{D}{f_e})$$

When image is formed atleast distance of distinct vision.

$$\text{and } M = M_o \times M_e = -\frac{L}{f_O} \times \frac{D}{f_e}$$

When image is formed at infinity.

- Telescope :

Magnifying power , $M = -\frac{f_O}{f_e}$

$$M = -\frac{f_O}{f_e}(1 + \frac{f_e}{D})$$

when image is formed at the least distance of distant vision.

The resolving power of a telescope $\theta = \frac{1.22\lambda}{d}$.

A. Objective Type Questions : Marks : 1

1. An object is placed in front of a convex mirror, distance from the pole is doubled of focal length, what will be the magnification.

   Ans.

2. What kind of reflector is being used in road tamp?

   Ans.

3. A point source of light always produces what kind of rays?

   Ans.

4. Focal length of a con cave mirror is 20 cm, if the mirror is immersed into water $(\mu = \frac{4}{3})$ what will be the focal length of the mirror?

   Ans.

5. What kind of mirror is used while shaving?

   Ans.

6. If any light ray falls on centre of curvature of a spherical mirror then in which direction the reflected ray will go?

   Ans.

7. In what situation a convex mirror forms real image?

   Ans.

8. One convex and one concave lens of focal length f-are placed together, what will be the power of lens combination?

   Ans.

9. What is the power of Sunglasses?

   Ans.

10. Plot a graph between object distance (μ) and image distance (ν) by a convex lens? Hence locate the coordinate to determine its focal length.

    Ans.

11. State the dependence of refractive index of lens material on its focal length?

    Ans.

12. For making image by lens which focus is effective?

    Ans.

13. Under what condition the first and second principal focus distance will be the same?

    Ans.

14. If two lenses of power P_1 and P_2 respectively placed together, then what will be the equivalent power of lenses.

    Ans.

15. The aperture of a camera lens is changed from $\frac{f}{8}$ to $\frac{f}{11}$; then what will be the image size?

    Ans.

16. Angle of prism of a thin prism is 3°, and its refractive index is 1.5 then what will be angle of deviation?

    Ans.

17. If the angle of incidence of a equilateral prism be 45° then find the angle of minimum deviation?

    Ans.

18. If angle of prism is 90° then find value of refractive index so that the emergent ray can hardly come out?

    Ans.

19. Refractive index of a prism is 2, find the possible value of angle of prism?

    Ans.

20. The angle of incidence and angle of emergence of a Prism in two edges be i_1 and i_2, what will be the condition of maximum deviation?

    Ans.

21. Refractive index of red and violet ray are 1.52 and 1.54 respectively, if angle of prism is 10° then find angular dispersion?

    Ans.

22. What is f- number of a camera?

    Ans.

23. Length of a compound microscope is 14 cm and angular magnification 25; focal length of eye-pice is 5 cm, find the object distance from objective?

    Ans.

24. Focal length of objective and eye-piece of a astronomical telescope are f_o and f_e respectively, find the length of pipe.

    Ans.

25. The refractive index of three different medium are μ_a, μ_b, μ_c respectively, then ${}_a\mu_b \times {}_b\mu_c$ = ___________?

    Ans.

26. Total internal reflection does not happen if light ray go from_____ medium to _____ medium.

    Ans.

27. Refractive index of core is ______ than cladding of optical fibre.

    Ans.

28. What happens in rainbow?

    Ans.

29. Band spectrum forms in ______ condition.

    Ans.

30. Angle of prism is ______ when no emergent ray is found.

Ans.

B. Short answer type question : **Marks : 2/3**

1. What will be the change in focal length if the lens is immersed into water?

2. Establish the Newton's formula in respect of lens.

3. An object is moving toward a convex lens with the velocity V, find the velocity of image.

4. Show that, for lens,

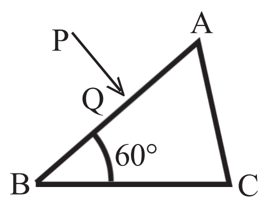
   Axial magnification = – (linear magnification)^2

5. What is total reflecting prism? Draw the ray diagram of such prism to produce the diviation of rays at 180°.

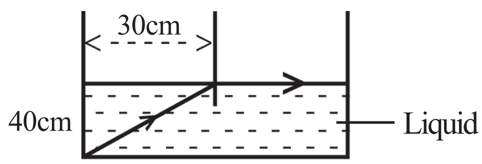
6. A prism is immersed into a certain liquid which refractive index is more than 1, find the minimum deviation of the prism.

7. Three lenses L_1, L_2, L_3 having focal length 20 cm each. An object is placed in front of L_1 lens at a distance 40 cm so that a real image is formed at the focus of L_2. Find the distances between L_1, L_2, L_3.

8. A ray PQ falls on the edge of a prism BAC normally. Refractive index of the prism is 1.5. Draw the ray diagram.



9. What is refractive index? Find the velocity of light as per figure.



10. A convex lens is placed on a plane mirror, an object is at 20cm from then and image formed also at that point. Find the focal length of the lens.

11. Write the differences between interference and diffraction.

12. The wave length of light 500nm, falls on a thin hole, so that it produces diffraction spectrum at a distance of 1m. First minimum point is at 2.5nm from screen. Find the width of hole?

13. Write the characteristics and classification of wave front.

14. The focal length of a convex mirror is 20 cm. An arrow of height 2.5 cm is placed at 10 cm from the mirror, Find the image distance and its height?

15. What kind of mirror is being used in vehicles for rear view?-Explain.

16. Write the uses of optical fibre? Also write the advantages of it than use of copper wire?

17. Calculate the lateral displacement of light ray in the parallel glass slab.

18. Establish the relation between refractive index and angle of minimum deviation of a prism.

19. Show that, for lens combination if $f_1>f_2$, then the combination acts as a concave lens.

20. Deduce the relation between radius of curvature and power of lens.

21. An object is located at 12cm from a lens. The image is formed four times of object and it is a virtual image. Find out the focal length of lens and its power.

22. Show that in real image formation by convex lens, the focal length is the four times of object and screen distance.

23. Find the focal length and power of a parallel glass slab.

24. Find the maximum value of refractive index of a right angle prism is $\sqrt{2}$.

25. Why the colour sky is blue in day light?

26. Discuss the reason of production of fraun-hofer lines.

27. Discuss the various diseases of eye and its their remeddies.

28. A person uses concave lens of power 4D. He can read the book clearly from 30 cm distance. If he does not use the spectacle, then find the minimum distance so that he can read clearly?

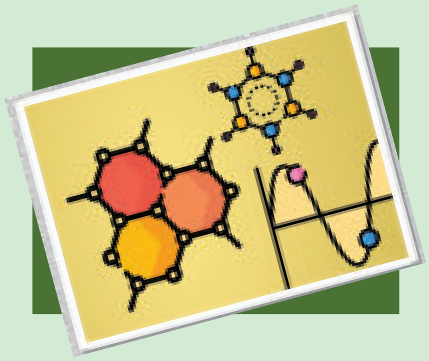
29. From Sun rise to Sun set it produces 180° angle in our eye, but for an observer who is in the water that angle is only 98° - Why?

30. Draw a ray diagram of compound Microscope. Also find out its magnification.

31. Draw a ray diagram of reflecting type telescope. State its magnifying power. State the advantages of reflecting type telescope over the refracting type?

32. A ray of light passing from air through an equilateral glass prism undergoes minimum deviation when angle of incidence is $\frac{3}{4}$ th of the angle of prism. Calculate the speed of light in the prism. (Speed of light in air is 3×10^6 n/s).

33. Calculate lens of refractive index 1.5, when it is kept in a medium of refractive index 14, to have a power of –5D?



Unit- VI

Chapter- 10

Wave Optics

Unit Summary :

- Wave front.
- Huygens Principle- Uses.
- Coherent and Incoherent Waves.
- Interference of light Young's Experiment.
- Diffraction- Single slit, Polarisation.

- **Wavefront :** It is the continuous locus of all such particles of the medium which are vibrating in the same phase of oscillation at any instant.

  Wavefront are of diffrent shapes.

  i) Plane wavefront

  ii) Spherical wavefront

  iii) Cylindrical wavefront

- **Huygen's principle :**

  According to Huygen's each point on the given wavefront acts as a fresh source of new disturbance, called secondary wavelets, tangentially in the forward direction at any instant gives the new wavefront at that instant, known as secondary wave front.

- **Doppler's effect in light :**

  The apparent frequency of light waves when source approaching or receding is,

$$n' = n\left(1 \pm \frac{V}{C}\right)$$

- **Doppler shift :**

  The change in frequency (Δn) is called Doppler shift.

$$\Delta n = \pm(\frac{v}{c})n$$

- Intensity of light due to the interference of two waves of intensities I_1 and I_2,

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\text{Cos}\phi$$

ϕ = phase difference between two waves.

- Young double slit experiment :
- Condition for constructive interference,

$$\phi = 2\lambda n, \ n = 0, 1, 2, ...$$

- Condition for destructive interference,

$$\phi = (2n + 1)\lambda$$

- Maximum intensity due to the interference of two light waves,

$$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = (a + b)^2$$

- Minimum intensity due to the interference of two light waves,

$$I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2 = (a - b)^2$$

- Distance of n-th bright fringe from the central bright fringe in the interference pattern, $Y_n = \frac{n\lambda D}{d}$

  Where, D = distance between screen and the plane of two slits.

  d = distance between two slits.

- Distance of n-th dark fringe from the central bright fringe in the interference pattern, $Y_n = \frac{(n + \frac{1}{2})\lambda D}{d}$

- Fringe width of a dark or bright fringe in interference pattern,

$$B = \frac{D\lambda}{d}$$

- Angular width of a fringe in interference pattern, $\theta = \frac{\lambda}{d}$
- **Diffraction :** The phenomenon of bending of light around the corners of an obstacle is called the diffraction of light.
- Condition for minima in diffraction pattern, $\theta_n = \frac{n\lambda}{d}$
- Condition for secondary maxima in diffraction pattern, $\theta_n = (n + \frac{1}{2})\frac{\lambda}{d}$
- Width of central maximum in diffraction pattern $= \frac{2\lambda D}{d}$
- Resolving power of telescope = $\frac{D}{1.22\lambda}$

  Where, D is the diameter of objective lens of the telescope.
- Resolving power of a microscope $\frac{2n \, Sin\beta}{1.22\lambda}$

  Where, n Sin β is the numerical aperture of the objective lens of the microscope.
- Practically, a polariser may transmit less than 50% of light incident on it.
- **Law of Malus :** Intensity of the polarised light transmitted through the analyser, $I = I_0 Cos^2 \theta$

  Where, I_o is the intensity of light transmitted through the polariser and θ is the angle between the plane of polariser and plane of analyser.
- **Brewster's law :** Refractive index of a medium, $\mu = tan i_p$.

  Where, i_p is the polarising angle or Brewster's angle.

A. Objective Type Questions : Marks : 1

1. In Young's double slit experiment the intensity of central maxima of fringe width is I, If the system is immersed into water what will be its intensity?

   Ans.

2. If the width of the two slits in Young's double slit experiment not equal, then what would be happened?

   Ans.

3. The intensity of two co-herent sources are I_1 and I_2, find their minimum intensity at interference?

   Ans.

4. Two waves having equal amplitude of A, but phase difference is 90°, If they overlap each other then find the intensity

   Ans.

5. The ratio between amplitude of two coherent sources is 3: 2, find the ratio between intensity of bright and drak spectrum when interference occurs?

   Ans.

B. Short Anawer Type Questions : Marks : 2

1. State the Huygen's principles.

Ans.

2. Prove the laws of reflection using Huygen's principles.

Ans.

3. State the conditions of good and sustained inference pattern.

Ans.

4. Why two independent similar lamp also can not produce interference fringe?

Ans.

5. If the width of double slit in Young's experiment be increased, then what will be the effect of interference fringe?

Ans.

6. The distance between the two slit in Young's experiment is 1mm and distance of screen from slit is 1m. Find out the distance of third dark spectrum from central maxima for wave length 500 nm?

Ans.

7. If the Young's experiment is done in a liquid which refractive index is 1.3, then what will be the change in fringe width?

Ans.

8. Compare between the interference and diffraction.

Ans.

9. Show the Fraunhofer diffraction for single slit.

Ans.

10. Discuss the condition for formation of central maximum and minimum.

Ans.

11. Discuss the resolving power of telescope.

Ans.

12. Draw the diagram for polarised and un-polarised light.

Ans.

13. State and explain Brewster's law.

Ans.

14. What are polaroids? Also write its uses.

Ans.

15. Prove the laws of reflection using Huygen's Principles.

Ans.

16. Derive the expression for path difference in Young's double slit experiment of interference. Also find the condition for constructive and destructive interference.

Ans.

17. The ratio between maximum and minimum intensity of fringe in Young's double slit experiment is 4 :1. Find the ratio between amplitude of two coherent sources.

Ans.

18. Find the distance between first bright spectrum and first dark spectrum in interference.

Ans.

19. Distance between Young's double slit experiment is 0.5 mm and distance of screen is 100 cm. Fourth bright spectrum is placed at 2.945 mm from second dark spectrum. Find the wave length of used light?

Ans.

20. Angular width of fringe is 0.1^0 in Young's experiment screen. Wave length of light is $6000\,\overset{o}{A}$. Find the distance between two slits?

Ans.

C. Long Answer Type Question : Marks : 5

1. (a) Two thin convex lenses placed together. Draw the ray diagram of formation of image for this lens combination. 1+1

(b) Light ray enters into a equilateral Prism with minimum deviation. Angle of Prism is thrice the of incidence. Find the velocity of light in prism? 3

Ans.

2. (a) Draw the graph between the changes of angle of deviation with angle of incidence of a Prism during refraction.

Also find the expression for refractive index with respect of angle of prism and angle of minimum deviation. 1+2

(b) Define dispersion of light? A light beam falls on a isosceles right angle Prism so that it total exibits internal reflection. Find minimum refractive index of Prism. 1+1

Ans.

3. (a) Show the formation of image for a remote object using refracting type telescope by ray diagram. When image is formed at infinity then, find the magnification power. 2+1

(b) The sum of the focal length of two lenses of a refractive telescope is 105 cm. Focal length of one lens is 20 times than the other. If image is formed at infinity then find the magnification power of telescope. 2

Ans.

4. (a) Derive the expression for fringe finge width by interference in Young's double slit experiment. 3

(b) Ratio of maximum and minimum intensity is 9:4 in Young's double slit experiment. Find the ratio of amplitude of coherent sources. 2

Ans.

5. (a) Prove that, Distance of real image formed by an object and convex lens = 4 × focal length of the lens. 3

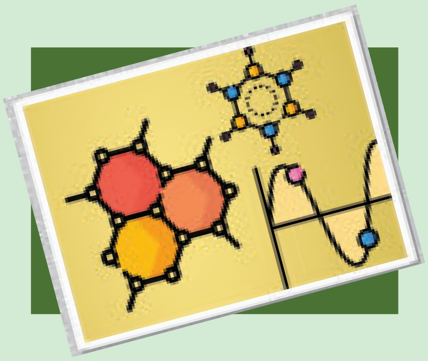
(b) Focal length of a convex lens is 20 cm. A 5cm tall object is placed co-axialy infront of the lens. Distance of nearest edge of the object is 25 cm from lens. Find the height of image? 2

Ans.

6. (a) Extablish the condition for dispersion less deviation of a Prism. 3

(b) Refractive index of a Prism for violet light is 1.69 and for red light is 1.65. Prism angle is 5^0. Find the angular dispersion? 2

Ans.



Unit- VII

Chapter- 11

Dual nature of matter and radiation

- Electron Emission.
- Photoelectric effect.
- Einstein's Photoelectric equation.
- Particle nature of light.
- Wave nature of matter.

Quick Preview of The Chapter :

♦ Electron Emission - Minimum energy required by a free electron to just come out of the metal surface (with K.E = 0) is called work function of the metal. Work function is expressed in eV.

$$1eV = 1.6 \times 10^{-19} \text{ J.}$$

♦ Electron emission is mainly following types : Thermionic emission, photoelectronic emission, secondary emission and field emission.

♦ Photoelectric effect is the phenomenon of emission of electrons from the surface of metal when exposed to the radiation of suitable frequency.

♦ Threshold frequency (λ_0) is the minimum frequency of incident light which causes photo emission with zero K.E. of photoelectrons. The corresponding wavelength of light is called threshold wavelength (λ_0).

If $\nu > \nu_0$, there will be no photoelectric emission.

If $\nu < \nu_0$, there will be no photoelectric emission.

- Stopping potential (V_0) - The negative value of potential given to the anode which repels all the electrons emitted by the cathode to reach the anode is called stopping potential. In other words photoelectric is zero at stopping potential. At stopping potential, even the fastest photo electron is unable to reach the anode, which is possible only when, $\frac{1}{2}mv_{max}^2 = eV_0$. where m is mass of electron, v_{max} is maximum velocity of electron. e is charge on an electron and V_0 is stopping potential.

- Photoelectric current depends upon the intensity of incident light but independent of the frequency of incident light.

- Photoelectric effect and wave theory of light. Wave theory of light cannot explain photoelectric effect.

- Einstein's Photoelectric equation is given by

$$\frac{1}{2}mv_{max}^2 = h\gamma - \phi_0 = h\gamma - h\gamma_0 = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

or, $$\mathbf{ev_0} = \mathbf{h}\gamma - \mathbf{h}\gamma_0 = \mathbf{hc}\left(\frac{\mathbf{1}}{\lambda} - \frac{\mathbf{1}}{\lambda_0}\right)$$

- Particle nature of light. Photon is a packet of energy. It moves with speed of light in vacuum (i.e. $3 \times 10^8\ ms^{-1}$). Rest mass of photon is zero.

Energy of photon, $$\mathbf{E} = \mathbf{h}\gamma = \frac{\mathbf{hc}}{\lambda}$$

Momentum of photon, $$\mathbf{P} = \frac{\mathbf{E}}{\mathbf{c}} = \frac{\mathbf{h}\gamma}{\mathbf{c}} = \frac{\mathbf{h}}{\lambda}$$

- Wave nature of matter. A wave associated with a moving particle is called matter wave or de-Broglie wave.

de-Broglie wavelength of a photon is given by $\lambda = \frac{h}{p}$, where p is momentum of a photon.

de-Broglie wavelength of moving material particle is given by $\lambda = \frac{h}{m\upsilon}$

de-Broglie wavelength of an electron accelerated through a potential difference of V volt is $\lambda = \frac{h}{\sqrt{2meV}} = \frac{12.27}{\sqrt{V}} \mathring{A}$

de-Broglie wavelength of particle of energy E is given by $\lambda = \frac{h}{\sqrt{2mE}}$.

de-Broglie wavelength of a particle at a temperature T K varies as $\lambda \; \alpha \; \frac{h}{\sqrt{T}}$

- Davison and Germer Experiment verifies and proves the wave nature of electron.

A. Objective type question : **Marks : 1**

1. On what factors does the work function of a metal depend?

Ans.

2. If the intensity of the incident radiation on a metal is double, what happens to the kinetic energy of electrons emitted?

Ans.

3. Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. What is the energy of a photon?

Ans.

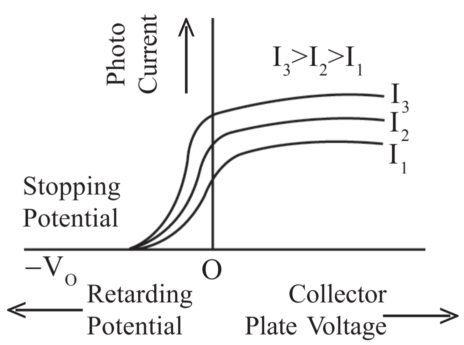
4. Two metal A, B have work function 2eV and 4eV respectively. Which metal has a lower threshold wave length for Photoelectric effect?

Ans.

5. If photon of energy 6 eV are incident on a metallic surface, the Kinetic energy of fastest electrons become 4 eV. What is the value of stopping potential?

Ans.

6. In an experiment on photoelectric effect, the following graphs are obtained between the photoelectric current (I) and the anode potential (V). Name the characteristic of the incident radiation that was kept constant in this experiment.



Ans.

7. Draw the graph showing the variation of particle momentum and associated de-Broglie wavelength?

   Ans.

8. Draw a plot showing the variation of de-Broglie wavelength of electron as a function of its K.E.

   Ans.

9. Plot a graph of photocurrent versus anode potential for the radiation of frequency ν and intensities I_1 and I_2 ($I_1 < I_2$).

   Ans.

10. Plot a graph of photoelectric current with collector plate potential for different frequencies but same intensity of incident radiation.

    Ans.

11. If the frequency of incident radiation is equal to the threshold frequency, what will be value of stopping potential?

    Ans.

12. An electron and a proton have the same kinetic energy. Identify the particle whose de-Broglie wavelength would be greater?

    Ans.

13. An electron is accelerated through a potential difference V. Write the expression for its final speed, if it was initially at rest.

    Ans.

14. Which photon is more energetic : A red one or a violet one.

    Ans.

15. Find the ratio of de-Broglie wavelengths associated with two electron beams a accelerated through 25V and 36V respectively?

    Ans.

B. Fill in the blanks : **Mark : 1**

16. The photoelectric emission could be explained by the _______nature of light.

Ans.

17. If kinetic energy of free electron is double, its de-Broglie wave length will change by factor_______.

Ans.

18. Two particle have equal momenta. The ratio of their de-Broglie wavelength _______.

Ans.

19. In case of photoelectric emission, the maximum kinetic energy of emitted electrons depends linearly on the _______ of the incident radiation.

Ans.

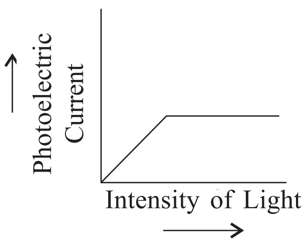
20. Photon energy is independent _______ of radiation.

Ans.

C. Multiples Choice Question : **Mark : 1**

1. Variation of photoelectric current with intensity of light is correctly depicted in-

(i)



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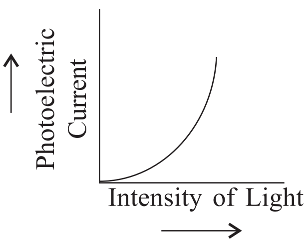

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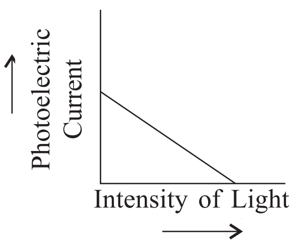

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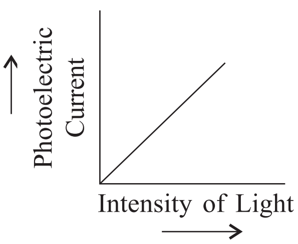


Ans.

2. The work function of a metal is $\frac{hc}{\lambda_0}$. If light of wavelength λ is incident on its surface, then the essential condition for the electron to come out from the metal surface is –

(i) $\lambda \geqslant \lambda_0$ (ii) $\lambda \geqslant \lambda_0$ (iii) $\lambda \leqslant \lambda_0$ (iv) $\lambda \leqslant \frac{\lambda_0}{2}$

Ans.

3. Sodium and Copper have work functions 2.3 eV and 4.5 eV, respectively. Then the ratio of their threshold wavelength is –

(i) 1 : 2 (ii) 2 : 1 (iii) 1 : 4 (iv) 4 : 1

Ans.

4. The momentum of a photon (frequency = f, rest mass = 0) is –

(i) $\frac{hf}{C}$ (ii) $\frac{h\lambda}{C}$ (iii) $\frac{hC}{\lambda}$ (iv) Zero.

Ans.

5. In photoelectric effect, if the intensity of light is doubled, then maximum kinetic energy of photoelectrons will become –

(i) double (ii) half (iii) four times (iv) no change.

Ans.

6. The de-Broglie wavelength of a neutron at 927^{0}C is. What will be its wavelength at 27^{0}C –

(i) $\frac{\lambda}{a}$ (ii) λ (iii) 2λ (iv) 4λ

Ans.

7. The de-Broglie wavelength of a neutron is thermal equilibrium with heavy water at a temperature T (Kelvin) and mass m, is –

(i) $\frac{h}{\sqrt{mkT}}$ (ii) $\frac{h}{\sqrt{3mkT}}$ (iii) $\frac{2h}{\sqrt{3mkT}}$ (iv) $\frac{2h}{\sqrt{mkT}}$

Ans.

8. Work function is least for which metal ?

(i) Cesium (ii) Aluminium (iii) Silver (iv) Platinum.

Ans.

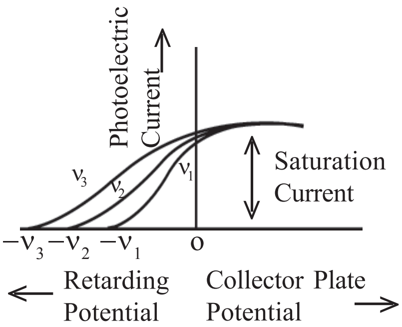
9. The variation of photocurrent with collector potential for different frequencies of incident radiation λ_1, λ_2 and λ_3 is as shown in the graph, then-

(i) $\nu_1 = \nu_2 = \nu_3$

(ii) $\nu_1 < \nu_2 < \nu_3$

(iii) $\nu_1 > \nu_2 > \nu_3$

(iv) $\nu_1 = \nu_2 + \nu_3$



Ans.

10. de-Broglie wave length of an alpha particle accelerated through a potential difference of 100V is –

(i) 1.23 $\overset{o}{A}$ (ii) 2.23 $\overset{o}{A}$ (iii) 4 $\overset{o}{A}$ (iv) 4.6 $\overset{o}{A}$

Ans.

11. The time taken by a photoelectron to come out after the photon strikes is approximately –

(i) 10^{-4} sec (ii) 10^{-10} sec (iii) 10^{-16} sec (iv) 10^{-1} sec

Ans.

12. Rest mass of the photon is –

(i) zero (ii) 13.6 eV (iii) 1 MeV (iv) 3.1×10^{-27}Kg

Ans.

13. If the kinetic energy of a particle is increased by 16 times. The percentage change in the de-Broglic wave length of –

(i) 25% (ii) 60% (iii) 50% (iv) 75%

Ans.

14. If an electron and proton are propagating in the form of waves having the same λ, it implies that they have the same –

(i) energy (ii) momentum (iii) velocity (iv) angular momentum.

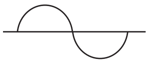
Ans.

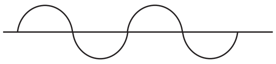
15. Which of the following waves can produce photoelectric effect?

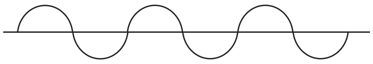
(i) ultrasound (ii) infrared (iii) radio waves (iv) X-ray.

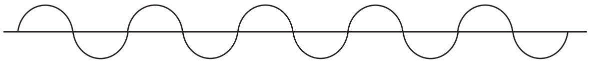
Ans.

16. The de-Broglie wave present in fifth Bohr orbit is –

(i) 

(ii) 

(iii) 

(iv) 

Ans.

17. When photon of energy $h\nu$, fall on an aluminium plate (of work function E_0), photo electrons of maximum kinetic energy K are rejected. If the frequency of radiation is doubled the maximum Kinetic energy of the ejected photoelectron will be –

(i) $2K$ (ii) K (iii) $K + h\nu$ (iv) $K + E_0$

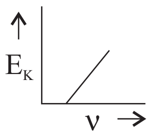
Ans.

18. The de-Broglie wave of a moving particle does not depend on –

(i) mass (ii) charge (iii) momentum (iv) velocity.

Ans.

19. The graph of kinetic energy of emitted electron with frequency of incident radiation is plotted as shown in figure.



The slope of curve is –

(i) $\frac{h}{\nu}$ (ii) h (iii) hC (iv) $\frac{h}{e}$

Ans.

20. The stopping potential, when a metal with work function 0.6 eV is illuminated with light of energy 2 eV will be –

(i) 1.4 V (ii) 2.8 eV (iii) 4.2 eV (iv) 0.7 V

Ans.

D. Short Answer Question : Marks : 2

1. Define 'Stopping Potential' and 'threshold frequency' in Photoelectric emission. Give an graph between stopping Potential and Frequency of incident radiation?

Ans.

2. Why photoelectric effect cannot be explained on the basis of wave nature of light? Give two reason.

Ans.

3. Write Einstein's photoelectric equation in terms of stopping potential and threshold frequency?

4. Draw a graph showing the variation of Photoelectric current with anode potential of a photocell for –

(i) the same frequencies but different intensities $I_3 > I_2 > I_1$ of incident radiation.

(ii) the same intensity but different frequencies $\nu_1 > \nu_2 > \nu_3$ of incident radiation.

Ans.

5. Show that the de-Broglie wavelength λ of electrons accelerated through a potential difference of V volts can be expressed as $\lambda = \frac{h}{\sqrt{2meV}} = \frac{12.3}{\sqrt{V}} \mathring{A}$.

Ans.

6. An electron and a proton have the same kinetic energy. Which of the two has greater wave length ? Justify your answer.

Ans.

7. The work function of Cs is 2.14 eV. Find its threshold frequency.

Ans :

8. The following table gives the values of work function for a new photo sensitive metals :-

Sl. No.	Metal	Work Function (eV)
1	Na	1.92
2	K	2.15
3.	Mo	4.17

If each of this metal is exposed to radiations of wavelength 300 nm, which of them will not emit photoelectrons and why?

Ans.

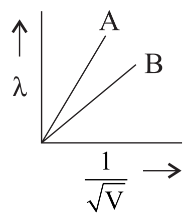
9. Monochromatic light of frequency 6×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. Estimate

(i) the number of photons emitted per second on an average by the source?

(ii) Energy of a photon in the light beam.

Ans.

10. The two lines marked A and B in the given fig. show a plot of de-Broglie wavelength λ vs $\frac{1}{\sqrt{V}}$, where V is the accelerating potential for two nuclei ${}_1H^2$ and ${}_1H^3$.



(i) What does the slope of the lines represent?

(ii) Identify which of the lines corresponded to these nuclei.

Ans.

11. A proton and a deuteron are accelerated through the same accelerating potential which one of the two has –

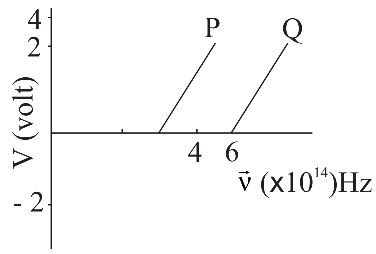
(i) greater value of de-Broglie wavelength associated with it .

(ii) less momentum ?

Give reasons to justify your answer.

Ans.

12. The graph between the stopping potential (V) and frequency of the incident radiation of two different metals P and Q shown in fig. –



(i) Determine the work function of the metal which as greater value.

Ans :

(ii) Find the maximum Kinetic energy of electron emitted by light of frequency 8×10^{14} Hz for this metal.

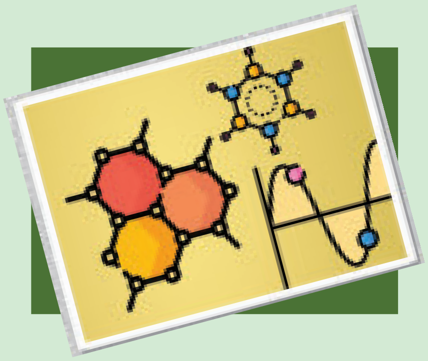
Ans.

13. Two particles A and B of de-Broglie wavelength λ_1 and λ_2 combine to form a particle C. The process conserves momentum. Find the de-Broglie wave length of C. (The motion is one dimension)

Ans.

14. Find the de-Broglie wavelength associated with an electron in a metal at 42^0C of temperature. Take $m_e = 9.11 \times 10^{-31}$ kg.

Ans.



Unit - VIII
Chapter- 12
Atoms

- Alpha particle scattering experiment.
- Rutherford atomic model of atom.
- Bohr's atom model.
- Hydrogen spectrum.
- Energy levels.

Rutherford atomic model :

The number of α - particles per unit area that reach the screen at a scattering angle θ is given by- $N(\theta) = \frac{N_i ntZ^2e^4}{(4\pi\varepsilon_0)^2 4r^2 E_k^2 \sin^4(\frac{\theta}{2})}$

N_i = No of incident particle in target

n = No of atom per unit vol^m target.

t = Thikness of target.

Z = Atomic no of target.

r = Distance of the ditector from the object.

E_k = Kinetic energy of particle.

θ = Scattering angle.

$\Rightarrow$ If r_0 be the nearest distance of α -particle from the nucleus. Then the kinetic energy is-

$$E_k = \frac{1}{4\pi\varepsilon_0} \frac{2Ze^2}{r_0}$$

⇒ Impact parameter $b = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{E_k}\cot\frac{\theta}{2}$

⇒ Distance of closest appraoch $r_0 = \frac{1}{4\pi\varepsilon_0}\frac{4Ze^2}{mv^2}$

Bohr's atom model :

⇒ Force between electron and nucleous, $F_e = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Ze^2}{r_n^2}$

⇒ The centripetal force to keep the in circular orbits $F_e = \frac{mv_n^2}{r_n}$

⇒ The angular momentum of electon in n-th orbit $L_n = mv_n r_n$ where, n = 1, 2, 3 ....

⇒ Kinetic energy of electron $E_k = \frac{1}{2}mv_n^2 = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{2r_n}$

⇒ Potential energy of electron $E_p = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r_n}$

⇒ Total energy $E_n = E_k + E_p = \frac{me^4Z^2}{8\varepsilon_0^2h^2n^2} = -\frac{RchZ^2}{n^2} = -\frac{13.6Z^2}{n^2}$

Where, Rydberg constant, $R = \frac{me^4}{8\varepsilon_0^2ch^3} \approx 1.096\times10^7\,m^{-1}$

⇒ Radius of n-th orbit $r_n = \frac{\varepsilon_0h^2n^2}{\pi me^2Z} = \frac{a_0n^2}{Z}$

1st Bohr radius, $a_0 = 0.53\,\overset{o}{A}$

⇒ Volocity of electron in n-th orbit $v_n = \frac{e^2}{2\varepsilon_0h}\frac{Z}{n} = \frac{\alpha cZ}{n}$

Sommer feld fine structure const, $\alpha = \frac{e^2}{4\pi\varepsilon_0c\left(\frac{h}{2\pi}\right)} = \frac{1}{137}$

⇒ Time period of electron in n-th orbit, $T_n = \frac{2\pi r_n}{v_n} = \frac{4\varepsilon_0^2h^3}{me^4}\cdot\frac{n^3}{Z^2}$

Hydrogen spectrum :

⇒ When an electron makes a transition from a higher energy level E_i then

$$E_i - E_f = h\nu \text{ or } h\nu = Rch\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \text{ or } \frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

⇒ **Hydrogen emission spectrum :**

Series	Primary Energy level	Wave number	Region
Lyman	n_i = 2, 3, 4, 5, 6, ...	$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{n_i^2}\right)$	uv region
Balmer	n_i = 3, 4, 5, 6, 7, ...	$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n_i^2}\right)$	Visible region
Paschen	n_i = 4, 5, 6, 7, 8, ...	$\frac{1}{\lambda} = R\left(\frac{1}{3^2} - \frac{1}{n_i^2}\right)$	infrared region
Brackett	n_i = 5, 6, 7, 8, 9, ...	$\frac{1}{\lambda} = R\left(\frac{1}{4^2} - \frac{1}{n_i^2}\right)$	infrared region
P-Fund	n_i = 6, 7, 8, 9, 10, ...	$\frac{1}{\lambda} = R\left(\frac{1}{5^2} - \frac{1}{n_i^2}\right)$	infrared region

The electron in a hydrogen atom is excited to the n-th excited state. Total no of possible spectral lines can it emit in transition to the ground state = ${}^{n}C_2 = \frac{n(n-1)}{2}$

A. Very Short Answer Type Question : Mark : 1

1. Why a thin gold foil is used in Rutherford's alpha scattering experiment?

Ans.

2. The large angle scattering of the α-panticle is possible under which condition?

Ans.

3. The ground state energy of hydrogen atom is– 13.6 eV. What are the kinetic energies of electron in this state?

Ans.

4. Write the value of 1st Bohr radius in hydrogen atom?

Ans.

5. What is the ratio of radii of the orbits corresponding to 1st excited state and ground state in a hydrogen atom?

Ans.

6. Name the spectral series of hydrogen spectrum which lies in the visible region of the e.m spectrum?

Ans.

7. Name the series of hydrogen spectrum lying in the ultraviolet region.

Ans.

8. What is the ratio of minimum to maximum wave length in Balmer series.

Ans.

9. If an α-particle collides head on with a nucleus, What is impact parameter?

Ans.

10. When is $H\alpha$ line of the Balmer series in the emission spectrum of hydrogen atom obtained?

Ans.

11. What is the value of fine structure constant?

Ans.

12. Find the value shortest wavelength which can be obtained in hydrogen spectrum ($R = 10^7\ m^{-1}$).

Ans.

13. The ground state energy of hydrogen atom is–13.6 ev. When its electron is in the first excited state, then what is the value of its excitation energy in ev unit?

Ans.

14. The wave length limit of Lymar, Balmer and Paschen series are λ_L , λ_B and λ_P . Arrange these wavelengths in increasing order.

Ans.

15. Find the value of shortest wave length present in the Pachen series of spectral line?

Ans.

16. The electron in a hydrogen atom is excited to the n-th excited state. How many possible spectral lines can it emit in transition to the ground state?

Ans.

B. Fill in the blanks : **Marks:1**

1. The energy of hydrogen atom in the first excited state is ________ .

Ans.

2. The size of the nucleus is of the order of ________ metre.

Ans.

3. The ratio of Kinetic energy to the total energy of an electron in a Bohr orbit of the Hydrogen atom ________.

Ans.

4. In a hydrogen atom, ratio of the radius of fourth orbit to second orbit is ________.

Ans.

5. Bohr's model is applicable only to ________ atoms.

Ans.

6. The atomic hydrogen emits a ________ spectrum consisting of various series.

Ans.

7. The ratio between the electron velocities in the second and in the third orbit of a hydrogen atom is ________.

Ans.

8. According to classical electromagnetic theory, an accelerating charged particle emits radiation in the form of ________ waves.

Ans.

C. Multiple Choice Question : Maks : 1

1. An electron is in the 3rd orbit of a hydrogen atom. Its orbital angular momentum is -

(a) $1.98 \% 10^{-33}$ J.s (b) $3.15 \% 10^{-34}$ J.s

(c) $2.2 \% 10^{-34}$ J.s (c) $1.05 \% 10^{-34}$ J.s

Ans.

2. According to Rutherford's atomic model, Which of the following is correct?

(a) atom is stable (b) majority of space in an atom is empty

(c) E = hf (d) non of these.

Ans.

3. The speed of electron in the n-th orbit of hydrogen atom is -

(a) $V_n = \frac{C}{137n^2}$ (b) $V_n = \frac{C}{137n}$

(c) $V_n = \frac{C}{137}$ (d) $V_n = \frac{137n^2}{C}$ [c=speed of light in vacuum]

Ans.

4. Which of the following series of H-atom lies in visible range?

(a) Paschen (b) Lymer (c) Balmer (d) Pfund

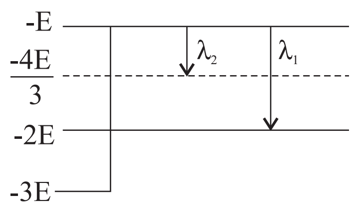
Ans.

5. The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is -

(a) 2 : 1 (b) 1 : 1 (c) 4 : 1 (d) 0.5 : 1

Ans.

6. Same energy levels of a molecule are shown in the figure. The ratio of the wave length = $\frac{\lambda_1}{\lambda_2}$ in given by -



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

Ans.

7. Energy required for the electron excitation in Li^{++}éfrom the 1st to the 3rd Bohr orbit is-

(a) 12.1 ev (b) 36.3 ev (c) 108.8 ev (d) 122.4 ev

Ans.

8. Bohr's theory of hydrogen atom did not explain fully-

(a) diameter of H-atom (b) emission spectra

(c) ionisation energy (d) the fine structure of even hydrogen spectrum.

Ans.

9. Which one of the relation is correct between time period and number of orbits while an electron is revolving in a orbit?

(a) $T \propto \frac{1}{n^2}$ (b) $T \propto n^2$ (C) $T \propto n^3$ (d) $T \propto \frac{1}{n}$

Ans.

10. According to Rutherford's atomic model, the electrons inside on atom are-

(a) stationary (b) centralized (c) non-stationary (d) Non of these.

Ans.

11. Which of the following series of H-atom lies in ultraviolet region-

(a) Lyman series (b) Paschen series (c) Brakett series (d) Non of these

Ans.

12. The radius of the innermost electron orbit of a hydrogen atom is 5.3 % 10^{-11}m. What are radius of the n = 3 orbit.

(a) 2.12 % 10^{-10} m (b) 4.77 % 10^{-10} m

(c) 8.28 % 10^{-10} m (d) 10.23 % 10^{-10} m

Ans.

13. Accroding to classical theory of Rutherford's model, the path of electron will be -

(a) parabolic (b) hyperbolic (c) circular (d) elliptical

Ans.

14. In terms of Rydberg constant R, the waves number of the first Balmer line is-

(a) R (b) 3R (c) $\frac{5R}{36}$ (d) $\frac{8R}{9}$

Ans.

15. An electron jumps from the 1st excited state to the ground state of hydrogen atom. What will be the percentage change in the speed of electron?

(a) 25 (n) 50 (c) 100 (d) 200.

Ans.

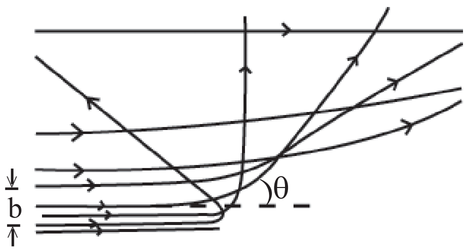
16. If the electron in a hydrogen atom is raised to the 3rd orbit, how many protons of different energies may be emitted-

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

Ans.

D. Short Answer Type Questions : **Marks : 2**

1.



(a) What names are given to the symbols 'b' and 'v' shown here?

(b) What can we say about the values of 'b' for (i) $\theta \approx 0^0$ (ii) $\theta \approx \pi$ radian.

Ans.

2. Define the distance of closest approach- Write down expression for distance of closest approach?

Ans.

3. Write two important limitations of Rutherford's nuclear model of the atom?

Ans.

4. The energy of an electron in the n^{th} orbit is $E_n = \frac{-13.6}{n^2}$ eV. Calculate the energy required to excite an electron from ground state to the second excited state?

Ans.

5. State Bohr's quantization condition of angular momentum. Calculate the shortest wave length of the Brcaket series?

Ans.

6. Explain why the spectrum of hydrogen atom has many lines, although a hydrogen atom contains only one electron?

Ans.

7. State two limitations of Bohr's theory of hydrogen atom?

Ans.

8. Show that radius of the orbit in hydrogen atom varies as n^2. Where n is the principal qauantum number of atom.

Ans.

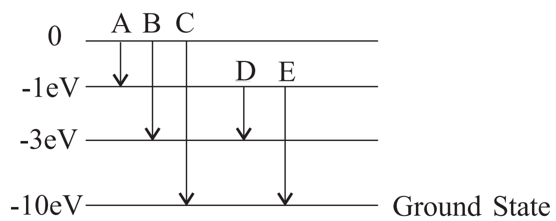
9. Define ionisation energy and Ionisation potential.

Ans.

10. Show that the energy of the first excited state of He^+ atom is equal to the energy of the ground state of hydrogen atom.

Ans.

11. The energy levels of an atom of an element 'X' are shown is diagram. A photon of wave length 620 nm is emitted. This corresponds to which of the transitions : A, B, C, D or E ?



Ans.

12. The wave length of the first line of Lyman series for hydrogen atom is equal to that of the 2nd line of Balmer series for a hydrogen like ion. Find the atom no of hydrogen like ion.

Ans.

13. Find the wave length of the electron orbiting in the ground state of hydrogen atom?

Ans.

14. Calculate the shortest wavelength of the Brackett series and state to which part of the electromagnetic spectrum does it belong.

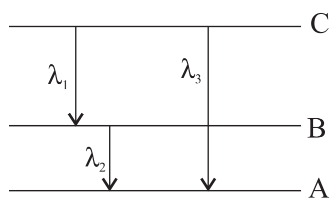
Ans.

D. Long Answer Type Question : Marks : 3

1. Using Bohr's postulates, derive the expression for the total energy of the electron in the stationary states of hydrogen atom. Why the total energy is negative?

Ans.

2. (i) Find the relation between the three wavelength λ_1, λ_2 and λ_3 from the energy level diagram shown below :



(ii) State Bohr's postulate to define stable orbits in hydrogen atom.

Ans.

3. State the postulates or Bohr's theory of hydrogen atom.

Ans.

4. In Rutherford's α- particle scattering experiment-

(i) Draw the graph between number of particles scattered VS scattering angle θ.

(ii) Why a few α -particles, about 1 in 8000, get deflected through 90^0.

(iii) Why most of α -particle pass through almost unscatterd.

Ans.

5. (i) Define impact parameter?

(ii) When the value of impact parameter is O. large and small?

Ans.

6. Show the speed of an electron in the innermost orbit of H-atom is $\frac{C}{137}$ times the speed of light.

Ans.

7. Draw the energy level diagram showing how the line spectra corresponding to Lyman Series and Paschen series occur due to transition between energy levels.

Ans.

8. The ground state energy of the hydrogen is –13.6 ev.

(i) The kinetic energy of the electorn in the 1^{st} excited state.

(ii) The potential energy of the electron in the 3^{rd} excited state.

(iii) Frequency of the photon emitted if the electron jumps form the 3^{rd} excited state to 1^{st} excited state.

Ans.

9. Calculate the longest wave lengths belonging to Lyman and Balmer series. Which of these wavelengths will lie in the visible region .

Ans.

10. Define the distance of closest approach. An α-panicle of kinetic energy K is bombarded on a thin gold foil. The distance of the closest approach is r. What will be the distance of closest approach for an α-particle of double the kinetic energy.

Ans.

11. Using postulates of Bohr's theory of hydrogen atom, show that-

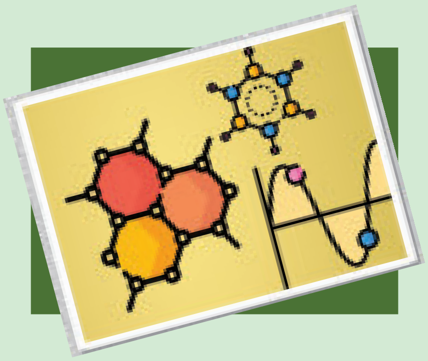
(i) The radil of orbits increases as n^2.

(ii) The total energy of the electron increases as $\frac{1}{n^2}$. Where n is the principal quantum number of the atom.

Ans.

12. Show that the shortest wave length lines in Lyman, Balmer and Paschen series have their wave length in tue ratio $1:4:9$.

Ans.



Unit - VIII
Chapter- 13
Nuclei

- Composition and size of nucleus.
- Mass energy relation.
- Mass defect.
- Nuclear fission.
- Nuclear fusion.

Quick Preview of the Chapter :

⇒ Nucleons : Protons and neutrons which are present in the nuclei of the atoms are collectively known as nucleons.

Nuclide :

A nuclide is a specific nucleus of an atom characterised by its atomic number Z and mass number A. It is represented as

$${}^{A}_{Z}X$$

Z = atomic number, and

A = mass number.

⇒ Atomic mass unit (a.m.u.) : It is defined as $\frac{1}{12}$ th of the mass of one carbon atom. Its value is given by

$$1 \text{ amu} = 1.660565 \times 10^{-27} \text{ kg} = 931 \text{ MeV}.$$

⇒ Electron volt : 1 eV = 1.602×10^{-19} J,

1 MeV = 10^6 eV = 1.602×10^{-13} J.

Size of nucleus and mass number

Radius of a nucleus $r = r_0 A^{1/3}$,

where $r_0 = 1.2 \times 10^{-15}$m

= 1.2 fermi for electrons as probes.

Nuclear density :

$$\rho_{nu} = \frac{\text{Nuclear mass}}{\text{Nuclear volume}} = \frac{m_{nu}}{\frac{4}{3}\pi R^3}$$

The nuclear density is of the order of 10^{17} kg m^{-3}.

⇒ Nuclear forces : These are the strong attractive forces which hold protons and neutrons together in a tiny nucleus. These are short range forces.

⇒ Mass defect : The difference between the rest mass of a nucleus and the sum of the rest masses of its constituent nucleons is called its mass defect. It is given by

$$\Delta m = Zm_p + (A - Z)m_n - M \qquad | \; M \rightarrow \text{Rest mass of nucleus}$$

⇒ Binding energy : It may be defined as the energy required to break up a nucleus into its constituent protons and neutrons and to separate them to such a large distance that they may not interact with each other.

The binding energy of a nucleus ${}^{A}_{Z}X$ is given by

$$\Delta E_b = [Zm_p + (A-Z)m_n - M)c^2 .$$

⇒ **Binding energy per nucleon :** It is obtained by dividing the binding energy of a nucleus by its mass number.

$$\vec{B} = \frac{B.E.}{A} = \frac{[Zm_H + (A-Z)m_n - M]c^2}{A}$$

⇒ **Radioactivity :** It is the phenomenon of spontaneous disintegration of the unstable nucleus of an atom with the emission of one or more radiations like α-particles, β-particles or γ-rays.

⇒ **Alpha decay :**

$$^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He + Q$$

⇒ **Beta decay :**

$$^{A}_{Z}X \rightarrow {}_{Z+1}^{A}Y + \beta^{-} + \bar{\nu}$$

$$^{A}_{Z}X \rightarrow {}_{Z-1}^{A}\gamma + \beta^{+} + \nu$$

⇒ **Gamma decay :**

$$^{A}_{Z}X \rightarrow {}^{A}_{Z}X + \gamma$$

(Excited state) (Ground state)

⇒ **Radioactive decay law :** The number of atoms of a radioactive sample disintegrating per second at any instant is directly proportional to the number of undecayed radioactive nuclei present at that instant.

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

The law may also be expressed as $N = N_0 e^{-\lambda t}$ where N_0 is the number of nuclei at t = 0 and λ is decay constant.

⇒ **Half-life :**

$$T_{1/2} = \frac{0.693}{\lambda}$$

t = half life of the radioative element.

⇒ **Mean-life :**

$$\tau = \frac{1}{\lambda} = \frac{T_{1/2}}{0.693} = 1.44 T_{1/2}.$$

Its unit are s, day, year, etc.

⇒ **Decay rate or activity of a sample :** It is the number of radioactive disintegrations taking place per second in a given sample.

$$R=\left|\frac{dN}{dt}\right|=\lambda N=\lambda N_0\, e^{-\lambda t} \text{ or } R=R_0 e^{-\lambda t}$$

⇒ **Becquerel :** It is the SI unit of activity.

1 bequerel = 1 bq = 1 decay per second.

⇒ **Nuclear fission :** It is the process in which a heavy nucleus (A>230) when excited gets split up into two smaller nuclei of nearly comparable masses. For example,

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n + Q$$

⇒ **Nuclear reactor :** It is a device in which a nuclear chain reaction in initiated, maintained and controlled. The reaction is controlled by using neutron absorbing materials like cadmium rods.

⇒ **Nuclear fusion :** It is the process of fusion of two smaller nuclei into a heavier nucleus with the liberation of large amount of energy. For example,

$$^{2}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He + Q$$

A. Objective Type Questions : **Marks : 1**

1. Two nuclei have mass numbers in the ratio 27 : 125. What is the ratio of their nuclear radii?

Ans.

2. Two nuclei have mass number in the ratio 5:2. What is the ratio of their nuclear densities?

Ans.

3. How does the nuclear mass density depend on the size of the nucleus?

Ans.

4. Among alpha, beta and gamma radiation which get deflected by the electric field?

Ans.

5. Define the term "mirror isobars".

Ans.

6. If the nuclear force between two protons, two neutrons and between proton and neutron is denoted by F_{pp}, F_{nn}, F_{pn} respectively then what are the relation between these forces.

Ans.

7. A nucleus $_{92}U^{238}$ undergoes α-decay and transforms to thorium. What is the mass number and atomic number of the nucleus produced ?

Ans.

8. A radioactive substance has a half-life period of 30 days. What is the disintegration constant?

Ans.

9. How one Rutherford related to one Curie ?

Ans.

10. A nucleus disintegrates into two nuclear parts, which have their velocities in the ratio 2:1. Find the ratio of their nuclear sizes ?

Ans.

11. In the nuclear reaction, Find the value of a and b.

$_0n^1 + {}_{92}U^{235} \rightarrow {}_{54}Xe^a + {}_bSr^{94} + 2{}_0n^1$

Ans.

12. Write the reaction equation for β^+ decay of $_6C^{11}$.

Ans.

13. What is the role of control rods in nuclear reactor?

Ans.

14. Name one substance which is used as a moderator in nuclear reactor?

Ans.

15. A radioactive element has half-life of 600 yr, what amount will remain in 3000 yr?

Ans.

16. Which one has more ionising power : α-particle and β-particle ?

Ans.

17. Arrange α-rays, β-rays and γ-rays in ascending order of their penetrating power.

Ans.

18. What is the source of energy in stars?

Ans.

19. Binding energy per nucleon of the following nucleus given below :-

$^{209}_{83}Bi = 7.85$ MeV

$^{56}_{26}Fe = 8.79$ MeV

$^{14}_{7}N = 7.42$ MeV

Which one is more stable.

Ans.

20. Which is unstable among electron, neutron, proton and α-particle?

Ans.

B. Fill in the blanks : **Marks : 1**

1. 1 u = _______ Kg.

   Ans.

2. The nuclear force is much _______ than the Coulomb force acting between charges.

   Ans.

3. The SI unit of activity _______ .

   Ans.

4. $^{32}_{15}P \rightarrow ^{32}_{16}S + \_\_\_\_\_\_\_ + \bar{\nu}$

   Ans.

5. In a reactor, the value of the neutron multiplication factor K is maintained at _______ .

   Ans.

6. All nuclides with same mass number are called _______ .

   Ans.

7. The density of nuclear matter is approximately _______ $kg.m^{-3}$.

   Ans.

8. If λ is decay const and N is the number of radioactive nuclei of an element, then the decay rate R of that element is _______ .

   Ans.

9. Hydrogen bomb is based on _______ .

   Ans.

10. Typically, a gamma ray is emitted when a α and β decay results in a daughter nucleus in an _______ state.

    Ans.

C. Answer the questions : **Marks : 2**

1. Show that the density of nucleus over a wide range of nuclei is constant and independent of mass number.

   Ans.

2. What are nuclear forces? Give their important properties?

3. Define mean life of a radioactive, substance ? Write the relation between half-life and mean life.

4. Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation.

   Mark the region where the nuclear force is

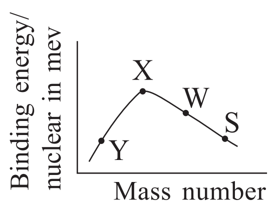
   (i) attractive

   (ii) repulsive.

5. A nucleus with mass number A = 240 and $\left(\frac{BE}{A}\right) = 7.6\,MeV$ breaks into two fragments each of A = 120 with $\left(\frac{BE}{A}\right)$ = 8.5 MeV. Calculate the released energy ?

6. Binding energy per nucleon versus mass number curve is as shown :

   ${}^{A}_{Z}S$, ${}^{A1}_{Z1}W$, ${}^{A2}_{Z2}X$, ${}^{A3}_{Z3}Y$ are four nuclei indicated on the curve.



   (i) Arrange X, W and S in the increasing order of stability.

   (ii) Explain why binding energy for heavy nuclei is low.

7. The half-life of radioactive substance is 20 sec. Calculate :-

   (i) The decay constant.

   (ii) Time taken for the sample to decay by $\frac{7}{8}$ th of the initial value?

8. Why is nuclear fusion not possible in a laboratory?

9. Define the Q-value of a nuclear reaction. When can a nuclear process not proceed spontaneously?

10. Find the Q-value for the nuclear reaction :

$${}^{4}_{2}He + {}^{14}_{7}N \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$$

m $\left({}^{4}_{2}He\right)$ =4.0039 amu, m $\left({}^{17}_{8}O\right)$ = 17.0045 amu

m $\left({}^{14}_{7}N\right)$ = 14.0075 amu, m $\left({}_{1}H^{1}\right)$ = 1.0082 amu.

11. A radioactive nucleus 'A' undergoes a series off decays as given below :

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

The mass number and atomic number of A_2 are 176 and 71 respectively. Determined the mass and atomic number of A_4 and A.

12. In a nuclear reaction

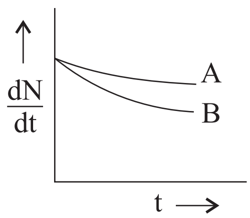
$${}^{3}_{2}He + {}^{3}_{2}He \rightarrow {}^{4}_{2}H + {}^{1}_{1}H + {}^{1}_{1}H + 12.86 \text{ Mev}$$

although the number of nucleons is conserved on both sides of the reaction yet the energy is released. How? Explain.

13. Why heavy water is generally used as a moderator in a nuclear reactor?

14. What is multiplication factor (K) of a fissionable material? For what value of K, a chain reaction will grow?

15. Which sample, A or B, shown in the following figure has shorter mean life? Explain.



16. Two stable isotopes of lithium ${}_3Li^6$ and ${}_3Li^7$ have respective abundances of 7.5% and 92.5%. These isotopes have masses 6.01512 U and 7.01600 u respectively. Find the atomic mass of lithium.

D. Long Answer Question : Marks: 3

1. How are protons which are positively charged, held together inside a nucleus? Draw a graph between potential energy of a pair of nucleons as a function of their separation.

2. Draw a plot showing the variation of binding energy per nucleon with mass number A. Write two important conclusions which you can draw from this plot. Explain with the help of this plot, the release in energy in the processes of nuclear fusion and fission.

3. (a) Define binding energy?

   (b) Write the relation for binding energy (BE) (in MeV) of a nucleus of mass, atomic number (Z) and mass number (A) in terms of the masses of its constituents – neutrons and protons.

4. (a) Draw the energy level diagram showing the emission of β-particles followed by γ-rays by a ${}^{60}_{27}Co$ nucleus.

   (b) Plot the distribution of kinetic energy of β-particle and state why the energy spectrum is continuous.

5. Deduce the expression, $N = N_0 e^{-\lambda t}$, for the law of radioactive decay.

6. State the law of radioactive decay. Plot a graph showing the number (N) of undecayed nuclei as a function of time (t) for a given radioactive sample having half life $T_{\frac{1}{2}}$.

   Depict in the plot the number of undecayed nuclei at (i) $t = 3T_{\frac{1}{2}}$ and (ii) $t = 5T_{\frac{1}{2}}$.

7. (a) Define the activity of a radioactive nucleus and state its SI unit.

   (b) Two radioactive nuclei X and Y initially contain equal number of atoms. The half-life is 1 hour and 2 hours respectively. Calculate the ratio of their rates of disintegration after two hours.

8. Define the term decay constant of radioactive nucleus. The nuclei P, Q have equal number of atoms at t = 0. Their half-lives are 3 hours and 9 hours respectively. Compare their rates of disintegration after 18 hours from the start.

9. (a) Write two distinguishing nuclear fission and fusion.

(b) Complete the following nuclear reactions for α and β decay :

(i) ${}^{238}_{92}U \rightarrow \longrightarrow ? + {}^{4}_{2}He + Q$

(ii) ${}^{22}_{11}Na \rightarrow {}^{22}_{10}Ne + ? + \nu$

10. Define half-life of a radioactive nucleus. Deduce the relation between half life and decay constant.

11. What is nuclear reactor ? What are the main parts of nuclear reaction? What are the role of control rods in a nuclear reaction?

12. Find Q-value and Kinetic energy of the emitted α-particle in α-decay of ${}^{226}_{88}Ra$.

Given- $m\left({}^{226}_{88}Ra\right) = 226.02540$ u

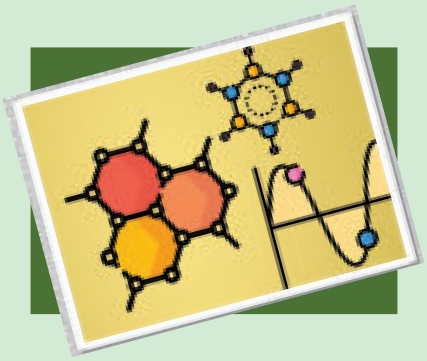
$m\left({}^{222}_{86}Rn\right) = 222.01758$ u

$m\left({}^{4}_{2}He\right) = 4.00260$ u

Hints : ${}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He + Q$

$$Q = \left[m\left({}^{226}_{88}Ra\right) - m\left({}^{222}_{86}Rn\right) - m\left({}^{4}_{2}He\right)\right] \times 931 \text{ Mev}$$

Kinetic energy $K_{\alpha} = \dfrac{A-4}{A} Q$

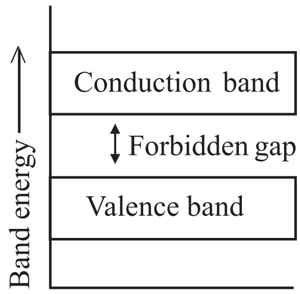


Unit- IX
Chapter- 14
Electronic Devices

- Energy Bands.
- Semiconductors and insulators.
- Semiconductors diode I-V characteristics in forward and reverse bias.
- Diode as rectifier.
- Special purpose P-n junction diode.
- LED, photodiode, solar cell.

Energy Bands :

⇨ In solids, there are three important energy bands such as Valence band, Conduction band, Forbidden Energy gap.



Energy bands in Conductors :

⇨ The overlapping of conduction and valence bands without energy gap forms a conduction band. i.e. Eg ≈ 0

Energy bands in insulators :

⇨ A material in which conduction band and valence band have large forbidden energy gap. Eg > 3ev

Energy bands in Semiconductors :

⇨ Semiconductors are materials in which, conduction band and valence band are neither overlapped nor have wide gap. $E_g < 3ev$

Intrinsic Semiconductors :

⇨ Pure semiconductors are called intrinsic semiconductors.

⇨ For intrinsic semiconductors, the number of free electrons is equal to the number of holes. $n_e = n_n$

Exrinsic semiconductors :

⇨ When a small suitable amount of impurity atoms are deliberately introduced into an intrinsic semiconductors to increase its conductivity, such adopted semiconductor is known as extrinsic semiconductor.

⇨ In extrinsic semiconductors, the number of free electrons is not equal to number of holes. $n_e \neq n_n$.

n-Type Semiconductors :

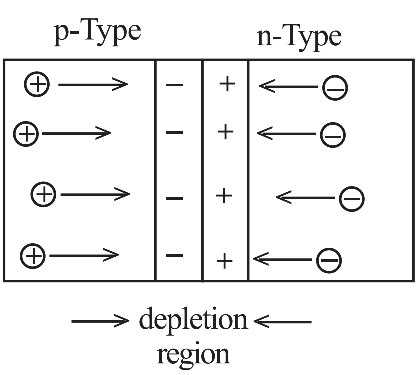
⇨ On doping a semiconductor with pentavalent impurity like Antimony (Sb) or Arsenic (As), extrinsic semiconductor so obtained is known as n-Type Semiconductor $n_e >> n_h$, Electrons are majority carriers.

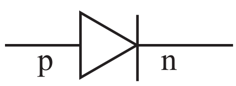
p-Type Semiconductors :

⇨ On doping a semiconductor with trivalent impurity like Indium (In) or Gallium (Ga), extrinsic semiconductor so obtained is known as p-Type semiconductor $n_e << n_h$, holes are majority carriers.

p - n Junction Semiconductor :

⇨ It is a single crystal of Ge on Si dopped in such a manner that one side portion of it acts as p-type semiconductor and other side functions as n-type semiconductor.



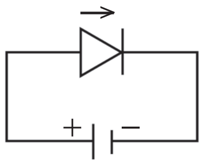


Symbol

Semiconductor diode :

- ⇨ The small region in the vicinity of the junction which is depleted of free charge carriers and has only immobile on is called depletion region.
- ⇨ The accumulation of negative charges in the p-region and positive charges in the n-region set up a potential difference across the junction. This is known as barrier potential.

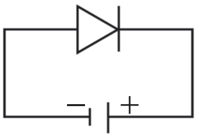
Forward Bias :



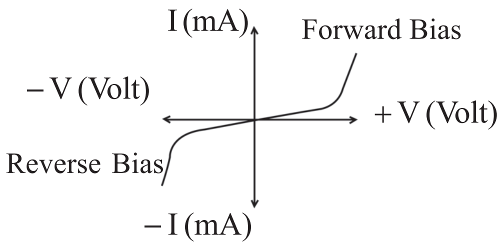
- ⇨ Width of depletion layer is reduced.
- ⇨ Height of barrier potential decreases.

Reverse Biasing :

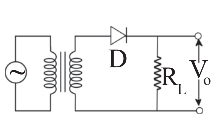
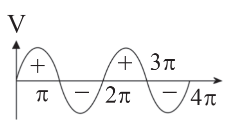
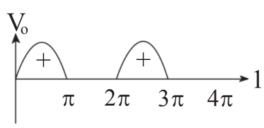
- ⇨ Width of depletion layer is increased and height of barrier potential increases.



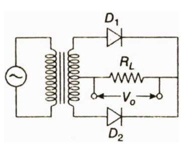
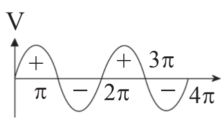
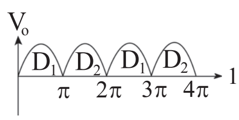
V-I characteristics of P-n junction diode :



Half wave rectifier :

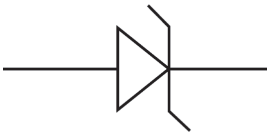
Curcuit	Input Wave Form	Output Wave Form
		

Full wave rectifier :

Curcuit	Input Wave Form	Output Wave Form
		

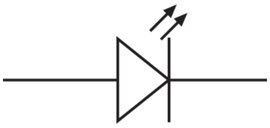
Different diodes :

Zener diode: Heavily doped specially designed to operate in reverse biased mode.



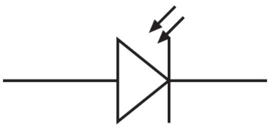
It is used as voltage regulator.

LED : (Light emitting diode)



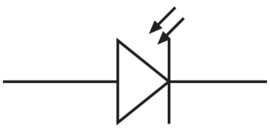
It is a specially designed diodes when used in forword biased it emits light.

Photodiode :



It is a special type reverse biased p-n junction diode where current carriers are generated by photon.

Solar cell :



It is a P – n junction diode that converts, solar energy into electrical energy.

A. Very Short Answer Question : **Marks : 1**

1. At what temperature would an intrinsic semiconductor behave like a perfect insulaton?

   Ans.

2. What are acceptor impurity atoms?

   Ans.

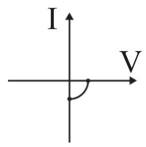
3. Name the type of biasing of a p-n junction diode so that the junction offers very high resistance?

   Ans.

4. Give an approximate value for the potential barrier of a silicon type junction diode?

   Ans.

5. Name the junction diode whose I-V characterstics are drawn below :

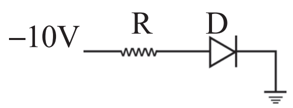


   Ans.

6. What is dark Current?

   Ans.

7. In the given diagram, is the diode D forward or reversed biased?

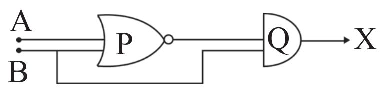


   Ans.

8. Under what condition does a junction diode work as open switch?

   Ans.

9.



   Write down the Output at X for -

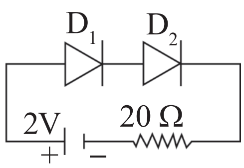
   (i) A = 1, B = 1

   (ii) A = 0, B = 0

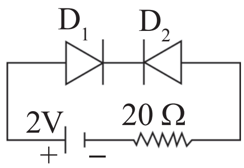
   Ans.

10. Find the current through the resistance of the circuits below :

(i)



(ii)



Ans.

11. Which gate is calledc inverter?

Ans.

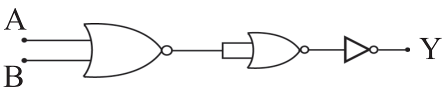
12. Draw energy band diagram of n-type semiconductor at T > OK.

Ans.

13. Write down the approximate value of Cut-in-Voltage for germanium and silicon diode?

Ans.

14. The given electrical network is equivalent to which circuit?



Ans.

15. In ful-wave rectification, what is the output fraquency if the input fraquency is 50Hz?

Ans.

16. Zener diode have higher dopant densities as compared to ordinary p-n junction diodes. How does it affect the width of depletion layer?

Ans.

17. The given truth table for which logic gate :

A	B	Y
1	1	0
0	1	1
1	0	1
0	0	1

Ans.

18. Draw the circuit symbol of Zener diode.

Ans.

19. If the two ends of a p-n junction and joined by a wire, will there be a steady current in the circuit?

Ans.

20. State the factor which control the light emitted by LED wave length.

Ans.

B. Fill in the blanks : **Marks : 1**

(1) The highest energy level occupied by electrons at OK is called _______.

Ans.

(2) In forward biased, width of depletion region _______.

Ans.

(3) Zener diode is used for _______.

Ans.

(4) The semiconductor used for fabrication of visible LED must at least have a band gap of _______.

Ans.

(5) The resistivity of a semiconductor _______ with the increase in temperature.

Ans.

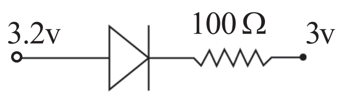
(6) The forbidden energy gap for Si is _______eV and while for Ge is _______ eV.

Ans.

(7) As, P, Sb etc are called _______ impurities.

Ans.

(8) The current in the circuit shown in fig. considering ideal diode is ______.



Ans.

(9) For the diode in reverse bias, the current is very small and almost remains constant which is called _______ current.

Ans.

(10) In P-type semiconduction $n_h >> n_e$ in n-type semiconductor _______.

Ans.

C. Short Answer Question : **Marks : 2**

1. Define intrinsic semiconductor? Why does the conductivity of an intrinsic semiconductor increases with increase in temperature?

Ans.

2. Distinguish between extrinsic and intrinsic semiconductor?

Ans.

3. Distinguish between P-type and n-type semiconductor?

Ans.

4. Draw the energy band diagram of a n-type semiconductor and p-type semiconductor at T > OK.

Ans.

5. A student wants to use two p-n junction diodes to convert alternating current into direct current. Draw the labelled circuit diagram he would use.

Ans.

6. Draw the V-I characteristics curve of a junction diode. Indicate cut-in-voltage and reverse saturation current.

Ans.

7. What is LED? Write the advantages of LED's over conventional incondescent lamp?

Ans :

8. Why photodiodes are required to operate in reverse biase?

Ans.

9. Define solar cell? Draw V-I characteristis curve of solar cell?

Ans.

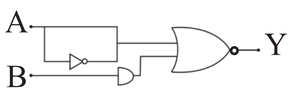
10. Why does a semiconductor get domaged when a heavy current flows through it?

Ans.

11. Write four important criteria required for the selection cell fabrication?

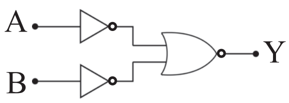
Ans.

12. What is the equivalent circuit of the combination given below? Answer with proper truth table.



Ans.

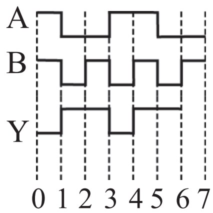
13.



Which logic gate is represented by the following combination of logic gate and write truth table?

Ans.

14. The following fig shows the input (A,B) and the output waveform (Y) of a gate. Indentify the gate, write its truth table and draw its logic symbol.

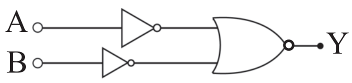


Ans.

15. Draw the input and output wave form

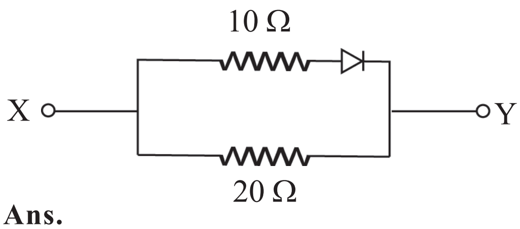
when (i) A = 0, B = 0 (iii) A = 0, B = 1

(ii) A = 1, B = 1 (iii) A = 1, B = 0



Ans.

16. Compute the equivalent resistance of the circuit shown below between the points X and Y.



Ans.

D. Long Answer Question : **Marks : 3**

1. On the basis of energy band diagrams, distinguish between metals, insulators and semiconductors.

Ans :

2. Define the terms 'potential barrier' and 'depletion region' for a p-n junction diode. Explain how the thickness of depletion region will charge when the p-n junction diode is (i) forward biased (ii) reverse biased.

Ans :

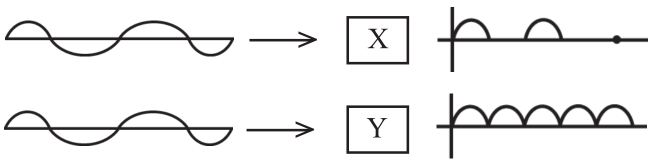
3. Exkplain briefly with the help of necessary diagrams, the forward and the reverse biasing of a p-n junction diode. Also draw their characteristic curves in the two cases.

Ans :

4. Draw the circuit diagram of a full wave rectifier and explain its working. Also, give the input and output waveforms.

Ans.

5. An a.c. signal is fed in to two circuits X and Y and the corresponding output in the two cases have the waveforms shown in Fig. Name the circuits X and Y. Also draw their detailed circuit diagrams.



Ans.

6. (a) With the help of a circuit diagram explain the use of zener diode as a voltage regulator.

(b) Draw its I-V characteristics.

Ans.

7. (a) Three photodiodes D_1, D_2 and D_3 are made of semiconductors having band gaps of 2.5 eV, 2eV and 3eV respectively. Which of them will not be able to detect light of wavelength 600nm.

(b) Why Photodiodes are required to operate in reverse bias? Explain.

Ans.

8. (a) Explain three basic processes involved in the generation of emf in a solar cell.

(b) Why are Si and GaAS preferred materials for solar cells?

Ans.

9. Give reasons for the following :

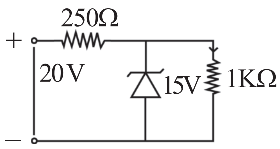
(a) High reverse voltages do not appear across LEDs.

(b) Sunlight is not always required for the working of a solar cell.

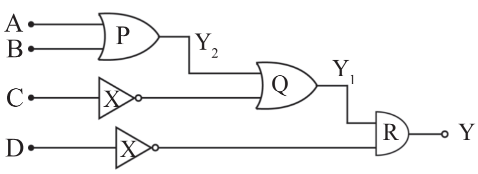
(c) The electric field, of the junction of a Zener diode, is very high even for a small reverse bias voltage of about 5V.

10. Give the reason to explain why n and p regions of a Zenerdiode are heavily doped

Find the current through the zenerdiode in the circuit given below (Zener breakdown voltage is 15V).



11.



(a) Identify the gate P, R, X

(b) Find the gate Y_1, Y_2 and Y_3

When, (i) A = 1, B = 1, C = 1, D = 0

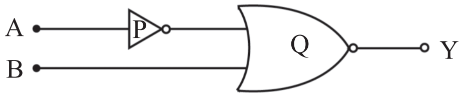
(ii) A = 0, B = 1, C = 0, D = 1

(iii) A = 0, B = 0, C = 0, D = 1

(iv) A = 1, B = 1, C = 0, D = 1

12. (a) (i) Write the truth tables of the logic gates marked P and Q in the given circuit.

(ii) Write the truth tables for the circuit.

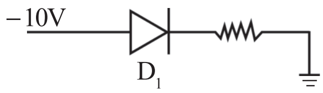


(b) Why are NOR Gates considered as universal gates?

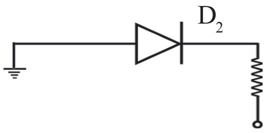
13. (i) Draw the (V - I) Charactertistic varve of a LED?

(ii) In the following circuit which one of the two diodes is forward biased and which is reverse biased?

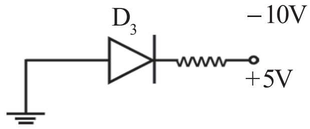
(a)



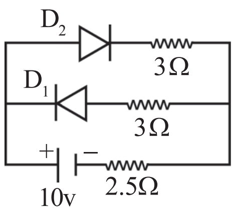
(b)



(c)

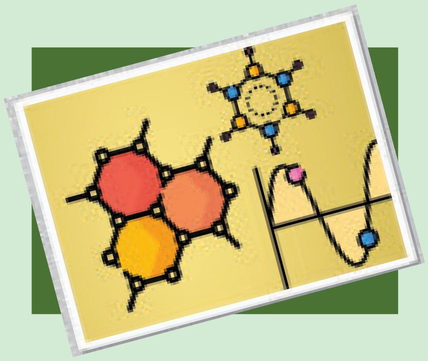


14. (a) Find the value of the current flowing through 2.5Ω resistor.



(b) Why Gallium Arsenide is used for making LED?

ANSWER



Electric Charges and Field

1.	(iv)	2.	(i)	3.	(iii)	4.	(iii)
5.	(i)	6.	(ii)	7.	(iv)	8.	(iii)
9.	(ii)	10.	(iii)	11.	(i)	12.	(iv)
13.	(iv)	14.	(iii)	15.	(iv)	16.	(iv)
17.	(ii)	18.	(iii)	19.	(ii)	20.	(iv)

Atoms

1. Because in a thick foil, the α–particle will not be able to penetrate the foil.
2. It is possible when α–particle cullicle against a heavy charged nucleus.
3. Kinetic energy =13.6 eV, Potential energy = –27.2 eV
4. 5.29×10^{-11} m
5. 4 : 1
6. Balmer Series.
7. Lyman Series.
8. 5 : 9

Answer

9. 0

10. When electron jumps from n_2=3 level to n_1=2 level.

11. $\frac{1}{137}$

12. $1000\,\mathring{A}$

13. 10.2 eV

14. $\lambda_P > \lambda_B > \lambda_L$

15. $8204.1\,\mathring{A}$

16. $\frac{1}{2}n(n-1)$

Fill in the blanks :

1. – 3.4 eV

2. 10^{-15}m

3. 1 : (–1)

4. 4 : 1

5. hydrogenic (single electrum)

6. ground

7. 3 : 2

8. Electromagnetic

MCQ :

1. (c)	2. (b)	3. (b)	4. (b)	5. (c)
6. (d)	7. (c)	8. (d)	9. (c)	10. (c)
11. (a)	12. (b)	13. (d)	14. (c)	15. (b)
16. (c)				

Nuclei

Objective Type Question : Marks : 1

1. 3 : 5

2. 1 : 1

3. Independent of size of nucleus

4. α and β

5. Two nuclei with same mass number (A) but whose atomic number differ by 1 are called mirror isobars. Er- ${}_3Li^7$ and ${}_4Be^7$

6. $F_{pp} = F_{nn} = F_{pn}$

7. ${}^{238}_{92}U \xrightarrow{\alpha-decay} {}^{234}_{90}Th + {}^{4}_{2}He$

8. 0.0231 day^{-1}

9. 1 Curie = 3.7×10^4 rutherford

10. $1 : 2^{\frac{1}{3}}$

11. a = 140, b = 38.

12. ${}^{11}_{6}C \rightarrow {}^{11}_{5}B + e^+ + 2$

13. Contral reds are used to start, stop or adjust a nuclear fission at a steady rate.

14. Heavy Water

15. $\frac{1}{32}y$

16. α-Panticle

17. γ , β and α

18. Nuclear fusion

19. ${}^{56}_{26}Fe$

20. Neutron

Fill in the blanks :

1. 1.66×10^{-27} kg

2. Stronger

3. becquerel

4. e^-

5. 1

Answer

6. Isobars

7. 2.3×10^{17}

8. λ N

9. Nuclear Fusion

10. Excited.

Dual Nature of Radiation And Matter

Objective Type Question : Marks : 1

1. Nature of metal and the condition of its sunface.

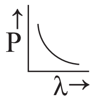
2. K.E of electron remains unaffected.

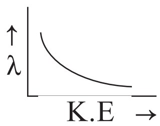
3. $E = n\upsilon$ 3.98×10^{-19} J

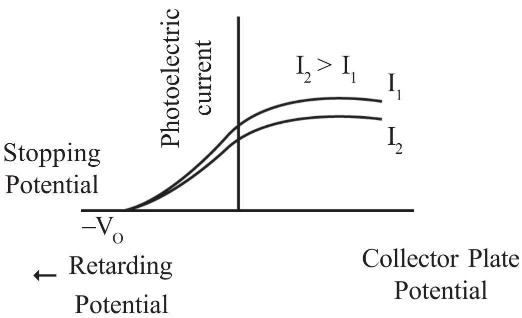
4. B metal,

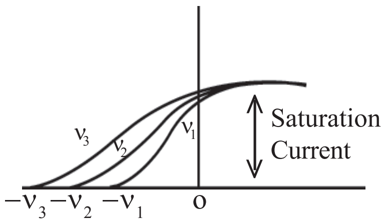
5. 4V

6. The frequency of the incident radiation is kept constant in the experiment

7. 

8. 

9. 

10. 

11. 0

12. Electron

13. $V = \sqrt{\dfrac{2eV}{m}}$

14. Violet Photon.

15. $\dfrac{\lambda_1}{\lambda_2} = 6:5$

Fill in the Blanks :

16. Panticle

17. $\dfrac{1}{\sqrt{8}}$

18. 1 : 1

19. Frequency

20. Intensity

MCQ

1. (iv)	2. (iii)	3. (ii)	4. (i)	5. (iv)
6. (iii)	7. (ii)	8. (i)	9. (iii)	10. (i)
11. (ii)	12. (i)	13. (iv)	14. (ii)	15. (iv)
16. (iv)	17. (iii)	18. (ii)	19. (i)	20. (i)

Semicorductor

Very Short Answer Question :

1. At OK

2. The trivalent impurity atoms like B, Al, Ga are called acceptor impurity atoms.

3. Reverse biasing

4. 0.7 V

5. Salar Cell

6. When a photodiode is reverse biased with a voltage less than breakdown voltage and no light is incident then a very small current developed is known as dark current.

Answer

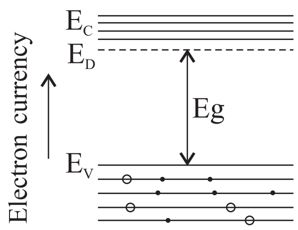
7. Reversed Biased

8. When it is reverse biased

9. (i) 0 (ii) 0

10. (i) 0.1 A (ii) 0

11. NOT Gate

12. 

13. Ge → 0.2 V

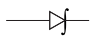
Si → 0.7 V

14. NOR Gate

15. 100 Hz

16. The width of depletion layer is small.

17. NAND Gate.

18. 

19. No net current will flow in the circuit.

20. The wavelength of light depends on the nature of semiconduction used in LED.

Fill in the blanks :

1. Fermi level.

2. Decreases.

3. Veltage regulation

4. 1.8 eV

5. Decreases.

6. 1.17 eV, 0.74 eV

7. Doner

8. 2×10^{-3} A

9. Reverse Saturation

10. $n_e >> n_n$

Note