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KASIDIH HIGH SCHOOL

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XII-PHYSICS

Chapterwise Topicwise Worksheets with Solution

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CBSE TEST PAPER-01
CLASS - XII PHYSICS (Unit – Electrostatics)

1. Show does the force between two point charges change if the dielectric constant of the medium in which they are kept increase? [3]
2. A charged rod P attracts rod R where as P repels another charged rod Q. What type of force is developed between Q and R? [1]
3. A free proton and a free electron are placed in a uniform field. Which of the two experience greater force and greater acceleration? [2]
4. No two electric lines of force can intersect each other? Why? [2]
5. A particle of mass m and charge q is released form rest in a uniform electric field of intensity E. calculate the kinetic energy it attains after moving a distance s between the plates? [3]
6. Two point charges +q and +9q are separated by a distance of 10 a. Find the point on the line joining the two changes where electric field is zero? [3]
7. Define the term dipole moment $\vec{P}$ of an electric dipole indicating its direction. Write its S.I unit. An electric dipole is placed in a uniform electric field $\vec{E}$. Deduce the expression for the Torque acting on it. [3]
8. (1) The electric field $\vec{E}$ due to a point change at any point near to it is defined as: $\vec{E} = \lim_{q \to c} \frac{\vec{F}}{q}$ where q is the test charge and $\vec{F}$ is the force acting on it. [5]

   What is the significance of $\lim_{q \to o}$ in this expression?

   (2) Two charges each 2 x 10^{-7} C but opposite in sign forms a system. These charges are located at points A (0,0, -10) cm and B(0,0, +10) cm respectively. What is the total charge and electric dipole moment of the system?
9. (a) Sketch electric lines of force due to (i) isolated positive change (ie q>0) and (ii) isolated negative change (ie q<0) [5]

   (b) Two point changes q and –q are placed at a distance 2a apart. Calculate the electric field at a point P situated at a distance r along the perpendicular bisector of the line joining the charges. What is the field when r >> a?

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Unit – Electrostatics)

[ANSWERS]

Ans 01. Since $K = \frac{FV}{FM} = \frac{\textit{force}\text{ between the charges in vaccuum}}{\text{force between two charges in medium}}$

$\Rightarrow \quad Fm = \frac{FV}{k}$

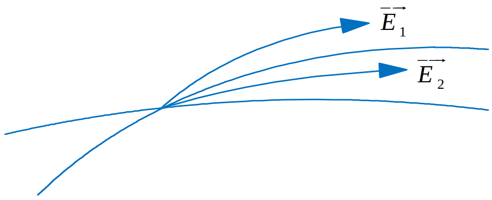
$\Rightarrow$ if k increases, Fm decreases.

Ans 02. Suppose rod P be negatively charged since it attracts rod R $\Rightarrow$ R is positively charged since it repels rod Q $\Rightarrow$ Q is negatively charged. So force between Q and R is attractive in nature.

Ans 03. Since F = q E and a = F/m

Since charge on proton and electron are same but mass for electron is smaller, hence force and acceleration experienced by an electron is greater.

Ans 04. Two electric lines of force never intersect each other because if they intersect then at the point of intersection there will be two tangents which is not possible as the two tangents represents two directions for electric field lines.



Ans 05. Since F = qE

$\therefore \; a = \frac{F}{m} = \frac{qE}{m}$ ---------1

Using third equation of motion

$v^2 - u^2 = 2as$

Initially charged particle is at rest $\therefore$ u = o

$\Rightarrow v^2 = 2as$

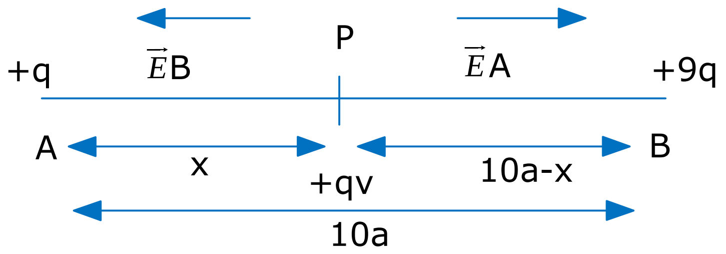
$KE = \frac{1}{2} mv^2 = \frac{1}{\cancel{2}} m (\cancel{2} as) = mas$ ----- 2

Substituting 1 in eq. 2

$KE = \cancel{m} \times \frac{qE}{\cancel{m}} \times S$

$KE = qES$

Ans 06. Let P be the pt where test charge (+qo) is present then electric field at pt. P will be zero if Field at pt. P due to +q = field at p+. P due to + 9q-----------1



$\vec{E}$

$\Rightarrow$ E$\vec{A} = \frac{K(+q)}{x^2}$ E$\vec{B} = \frac{K(+9q)}{(10a-x)^2}$

Substituting in eq. 1

$\frac{K(+q)}{x^2} = \frac{K(+9q)}{(10a-x)^2}$

$(10a-x)^2 = 9x^2 \quad \Rightarrow \quad 10a - x = 3x$

$10a = 4x \quad \Rightarrow \quad x = \frac{10}{4}9$

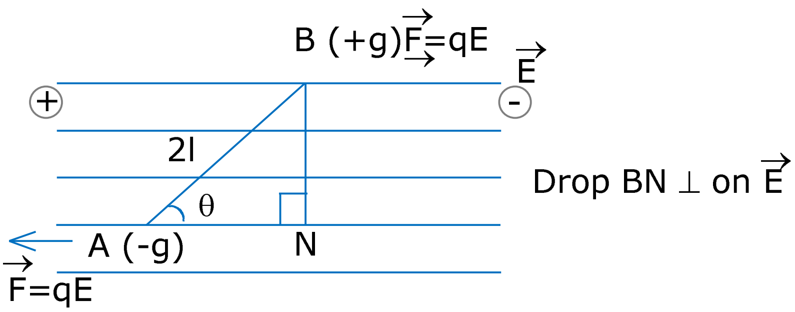
$x = 2.5$ a from change (+q)

Or

10 a - x = 10a - 2.5a = 7.5a from change (+9q)

Ans 07. Electric dipole moment is defined as the product of the magnitude of either charge and the length of dipole.

$\vec{P} = q(2\vec{l})$ Its S.I. unit is coulomb meter (cm)



Consider a dipole placed in uniform electric field and makes an angle (θ) with the electric field $(\vec{E})$ Since two forces acts on the charges constituting an electric dipole which are equal and opposite in direction, thus a torque acts on the dipole which makes the dipole rotate.

And Torque τ = Ethier force X $\perp$ distance

Here force (F) = qE

$And \ \frac{BN}{AB} = \sin\theta \quad \Rightarrow BN = AB \sin\theta = 2\ell \sin\theta$

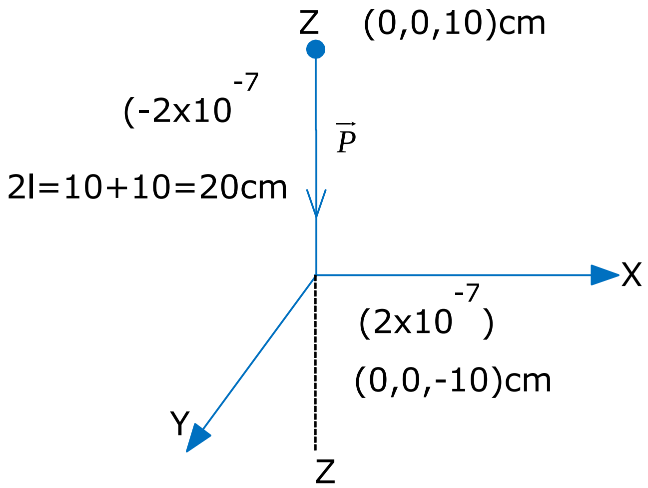
(τ) = qE x 2 ℓ sin θ

(τ) = PE Sin θ $(\because \vec{P} = q(2\vec{l}))$

In vector form

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

Ans 08. (1) The Significance of writing $\lim_{q \to o}$ means the test charge should be vanishingly small so that it should not disturb the presence of source charge.

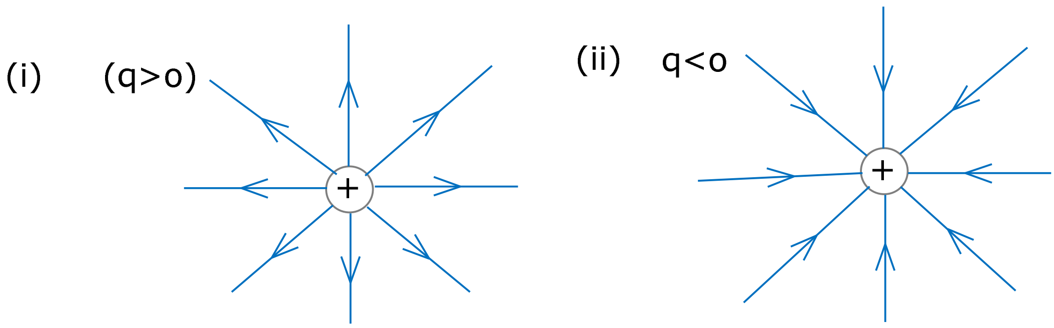


(2) (i) Total charge of the system

$= 2 \times 10^{-7} + (-2 \times 10^{-7})$
= zero. $\vec{P}$

(ii) $\vec{P} = q \times 2\vec{l}$
$P = 2 \times 10^{-7} \times 20 \times 10^{-2}$
$P = 4 \times 10^{-8}$ cm
Direction of Dipole moment – Along negative x-axis.

Ans 09. (a)

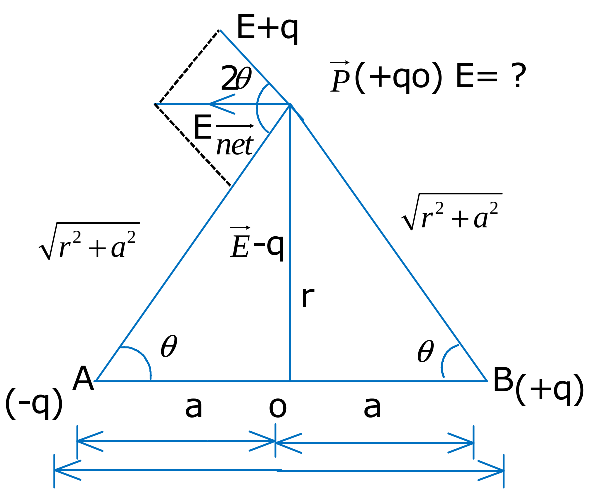


(b)

$$|\vec{E}+q| = \frac{Kq}{(r^2+a^2)}$$

$$|\vec{E}-q| = \frac{Kq}{(r^2+a^2)}$$

$$Since\ |\vec{E}+q| = |\vec{E}-q|$$



$\therefore \vec{E}net$ can be calculated by using a parallelogram law of vector addition.

$$\left|\vec{E}net\right| = \sqrt{E+_q{}^2 + E_{-q}{}^2 + 2E_{+q}\ \mathrm{E}_{-q}}\ \cos 2\theta$$

$$\left|\vec{E}net\right| = \sqrt{2E+_q{}^2 + 2E_{+q}{}^2 \cos 2\theta}$$

$$\left|\vec{E}net\right| = \sqrt{2E+_q{}^2\,(1+\cos 2\theta)}$$

$$\left|\vec{E}net\right| = \sqrt{2E+_q{}^2\, 2\cos^2\theta} = \sqrt{4E+_q{}^2}\ \cos^2\theta$$

$$\left|\vec{E}net\right| = 2E + \cos\theta \qquad \cos\ \theta = \frac{a}{\sqrt{r^2} + a^2}$$

$$\left|\vec{E}net\right| = 2E + \frac{a}{\sqrt{r^2} + a^2}$$

$$\left|\vec{E}net\right| = 2\frac{kq}{r^2 + a^2}\frac{a}{\sqrt{r^2} + a^2}$$

$$\left|\vec{E}net\right| = \frac{k2aq}{(r^2 + a^2)^{3/2}} = \frac{K\vec{P}}{(r^2 + a^2)^{3/2}}$$

For r >>> a (a can be neglected)

Enet = $\frac{KP}{r^3}$

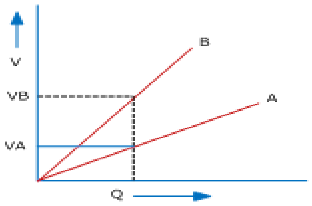
CBSE TEST PAPER-02

CLASS - XII PHYSICS (Unit – Electrostatics)

1. Which physical quantity has its S.I unit (1) Cm (2) N/C [1]

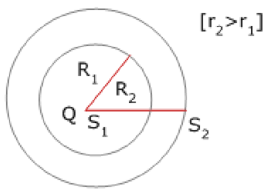
2. Define one coulomb? [1]

3. 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 two capacitors have higher capacitance? Give reason for your answer? [2]



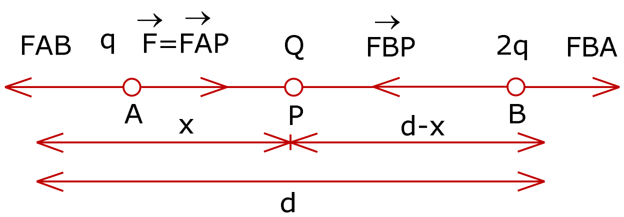
4. An electric dipole when held at 30^0 with respect to a uniform electric field of 10^4 N/C experienced a Torque of 9 x 10^{-26} Nm. Calculate dipole moment of the dipole? [2]

5. A sphere of radius r_1 encloses a change Q. If there is another concentric sphere S_2 of radius r_2 ($r_2 > r_1$) and there is no additional change between S_1 and S_2. Find the ratio of electric flux through S_1 and S_2? [3]



6. Electric charge is uniformly distributed on the surface of a spherical balloon. Show how electric intensity and electric potential vary (a) on the surface (b) inside and (c) outside. [3]

7. Two point electric charges of value q and 2q are kept at a distance d apart from each other in air. A third charge θ is to be kept along the same line in such a way that the net force acting on q and 2q is zero. Calculate the position of charge θ in terms of q and d. [3]



8. (a) What is an equi-potential surface? Show that the electric field is always directed perpendicular to an equi-potential surface. [5]

   (b) Derive an expression for the potential at a point along the axial line of a short electric dipole?

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Unit – Electrostatics)

[ANSWERS]

Ans 01. (1) Electric dipole moment

(2)Electric field Intensity

Ans 02. Charge on a body is said to be 1 coulomb if two charges experiences a force of repulsion of 9×10^9 N when they are separated by a distance of 1 m.

Ans 03. Since C=Q/V

For a given charge Q

$C \chi \frac{1}{V}$

and since VA< VB

$\because$ CA > CB

Ans 04. Given

$\theta = 30^0$

$\tau = 9 \times 10^{-26}$ Nm

E=10^4 N/c

$\vec{P} = ?$

τ (Torque) = PE sinθ

P = $\frac{\tau}{E \sin \theta}$

$\Rightarrow P = \frac{9 \times 10^{-26}}{10^4 \times \sin 30^0} = \frac{9 \times 10^{-26} \times 10^{-4}}{1/2}$

$\Rightarrow P = 18 \times 10^{-30} Cm$

Ans 05. θ = q/$\in$ o

For sphere S_1

$$\theta S_1 = \frac{Q}{Eo}$$

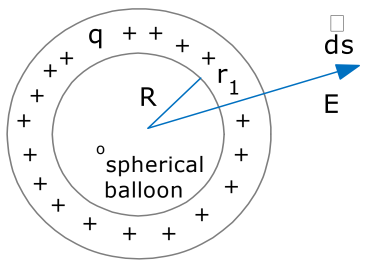
For sphere S_2

$$\theta S_2 = \frac{Q}{\in o}$$ (since no additional charge is given to S_2)

Now $\frac{\theta S_1}{\theta S_2} = \frac{Q/\notin o}{Q/\notin o}$

$$\frac{\theta S_1}{\theta S_2} = 1:1$$

Ans 06. Electric field intensity on the surface of a shell

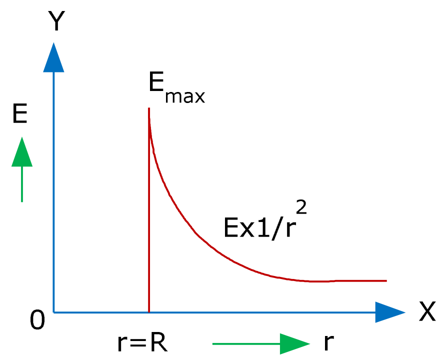


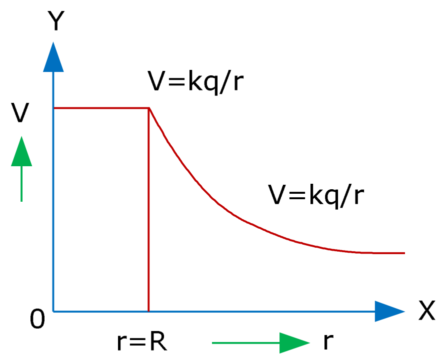
E = σ /Eo & V = Kq/R

Inside E = o & V = Kq/R

Outside E = $\frac{\sigma}{Eo}\frac{R^2}{r^2}$ & V = Kq/r

Graphically





Ans 07. Net force on charge q and 2q will be zero if the third charge is negative (i.e. of opposite sign) and q and 2q are positive, Force on change q will be zero if

$$\left|F\vec{AB}\right| = \left|F\vec{AP}\right|$$

$$\frac{Kq(2q)}{d^2} = \frac{Kq(Q)}{x^2}$$

$$\frac{Q}{q} = \frac{2x^2}{d^2} ----(1)$$

Force on charge 2q to be zero

if $\left|F\vec{B}A\right| = \left|F\vec{B}P\right|$

$$\frac{Kq(2q)}{d^2} = \frac{K(2q)Q}{(d-x)^2}$$

$$\frac{Q}{q} = \frac{(d-x)^2}{d^2} -----(2)$$

comparing equation 1 and 2

$$\frac{2x^2}{d^2} = \frac{(d-x)^2}{d^2}$$

$$x^2 = \frac{(d-x)^2}{2}$$

$$x^2 = \frac{(d-x)^2}{(\sqrt{2})^2}$$

$$\Rightarrow x = \frac{d-x}{\sqrt{2}} or\Gamma 2x + x = d$$

$$x(\sqrt{2}+1) = d$$

$$\Rightarrow x = \frac{d}{\sqrt{2}+1}$$

Ans 08. (a) The surface which has same potential through out is called an equipotential surface.

Since $dw = \vec{F}.d\vec{x}$

$dw = (-qoE).d\vec{x}$

(force on the test chage qo $\vec{F}$ = q o $\vec{E}$)

Since work done is moving a test charge along an equipotential surface is always zero.

$\Rightarrow$ -qo $\vec{E}.\overrightarrow{dx} = 0$

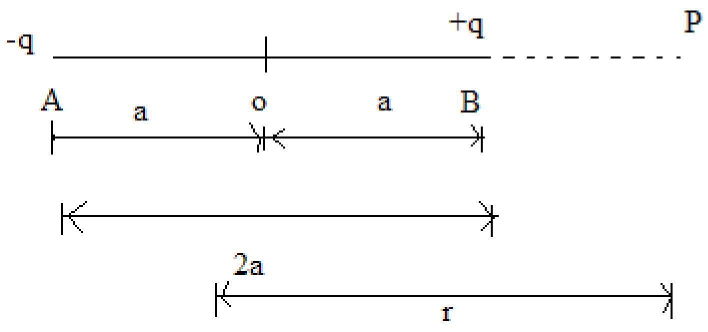
or

$\vec{E}.\overrightarrow{dx} = 0$

$\Rightarrow E \perp \vec{d}x$

(b) Consider an electric dipole of dipole length 2a and point P on the axial line such that OP= r where O is the center of the dipole.

Electric Potential at point P due to the dipole



$$V = V_{PA} + V_{PB}$$

$$V = \frac{K(-q)}{(r+a)} + \frac{K(+q)}{(r-a)}$$

$$V = Kq\left[\frac{1}{r-a} - \frac{1}{r+a}\right]$$

$$V = Kq\left[\frac{(r+a)-(r-a)}{(r-a)(r+a)}\right]$$

$$V = Kq\left[\frac{\not{r}+a-\not{r}+a}{r^2-a^2}\right]$$

$$V = Kq\frac{(2a)}{r^2-a^2} \qquad (\because \vec{P} = 2aq)$$

$$V = \frac{KP}{r^2-a^2}$$

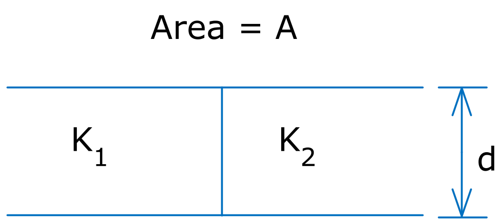
For a short electric dipole (a) can be neglected

$$\Rightarrow \text{V} = \frac{KP}{r^2}$$

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Unit – Electrostatics)

1. Why does the electric field inside a dielectric decrease when it is placed in an external electric field? [1]
2. What is the work done in moving a 2μ C point change from corner A to corner B of a square ABCD when a 10μC charge exist at the centre of the square? [1]
3. Show mathematically that the potential at a point on the equatorial line of an electric dipole is Zero? [2]
4. A parallel plate capacitor with air between the plates has a capacitance of 8 pF (1pF = 10^{-12} F). What will be the capacitance if the distance between the plates is reduced by half and the space between them is filled with a substance of dielectric constant 6? [2]
5. Two dielectric slabs of dielectric constant 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? Area of each plate = A/2 [3]



6. Prove that the energy stored in a parallel plate capacitor is given by ½ CV^2? [3]
7. State Gauss's Theorem in electrostatics? Using this theorem define an expression for the field intensity due to an infinite plane sheet of change of charge density σ c/m^2? [3]
8. (a) Define dielectric constant in terms of the capacitance of a capacitor? On what factor does the capacitance of a parallel capacitor with dielectric depend? [5]

   (b) Find the ratio of the potential differences that must be applied across the

   (1) parallel

   (2) Series combination of two identical capacitors so that the energy stored in the two cases becomes the same.

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Unit – Electrostatics)

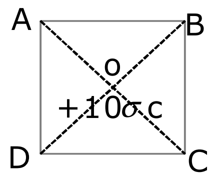
[ANSWERS]

Ans 01: The electric field, inside a dielectric decrease when it is placed is an external electric field due to polarisation as it creates an internal electric field inside a dielectric due to which net electric field gets reduced.

Ans 02: Since pt. A & B are at the same distance from the pt. O

VA = VB

➔ Work done = Zero.

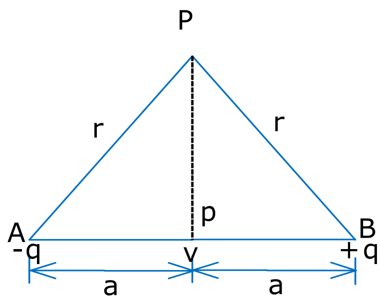


Ans 03: Electric potential at point P doe to the dipole

$V = Vp_A + Vp_B$

$V = \frac{K(-q)}{r} + \frac{K(+q)}{r}$

V=o



Ans 04: For air $C_o = \frac{A\in_o}{d}$

$C_o = 8 \times pF = 8 \times 10^{-12}F$

$\therefore \frac{AC_o}{d} = 8\times10^{-12}$

Now d' = d/2 and K = 6

$\Rightarrow C' = \frac{AC_o}{d'}\times K$

$C' = \frac{AC_o}{d'}\times K = 8\times10^{-12}\times2\times6$

$$\boxed{C' = 96 \times 10^{-12} \text{ pF}}$$

Ans 05: Here the two capacitors are in parallel

$\therefore$ Net capacitance $C = C_1 + C_2$

$C_1 = \frac{K_1 \in_o A/2}{d} = \frac{K_1 \in_o A}{2d}$

$C_2 = \frac{K_1 \in_o A/2}{2d} = \frac{K_2 \in_o A}{2d}$ $\Rightarrow C = \frac{K_1 \in_o A}{2d} + \frac{K_2 \in_o A}{2d}$

$$\boxed{C = \frac{\in_o A}{2d}(K_1 + K_2)}$$

Ans 06: Suppose a capacitor is connected to a battery and it supplies small amount of change dq at constant potential V, then small amount of work done by the battery is given by dw = Vdq

$\Rightarrow$ dw = q/cdq (Since q = CV)

Total work done where capacitor is fully changed to q.

$$\int dw = W = \int_0^q q/c\, dq \quad \Rightarrow \quad W = \frac{1}{C}\int_o^q q dq \quad \Rightarrow \quad W = \frac{q^2}{2C} = \frac{C^2V^2}{2C}$$

$$\boxed{W = ½\, CV^2}$$

This work done is stored in the capacitor in the form of electrostatic potential energy.

$$\Rightarrow \quad \boxed{W = U = \frac{1}{2}\, CV^2}$$

Ans 07: Gauss's Theorem states that electric flux through a closed surface enclosing a charge q in vacuum is $1/\in_o$ times the magnitude of the charge enclosed

Is $\boxed{\phi = q/\in_o}$

Consider a change is distributed over an infinite sheet of area S having surface change density σ c/m^2.

To enclose the charge on sheet an imaginary Gaussian surface cylindrical in shape is assumed and it is divided into three sections S_1, S_2, & S_3

According to Gauss's theorem

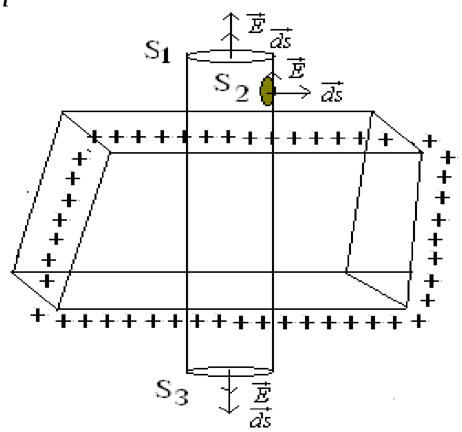
$$\phi = q/\in_o = \frac{\sigma S}{\in_o} \text{...........(1)}$$

We know $\phi = \int E.ds$

For the given surface $\phi = \int_{S_1} \vec{E}.\vec{ds} + \int_{S_2} \vec{E}.\vec{ds} + \int_{S_3} \vec{E}.\vec{ds}q$

$$\Rightarrow \phi = \int_{S_1} E.ds\cos o^{\bullet} + \int_{S_3} Eds\cos o^{\bullet} +$$

$$\left(\because \theta = 90^o \; for S_2 \; \therefore \int_{S_2} \vec{E}.\vec{ds} = o \right)$$



$$\phi = E\int_{S_1} ds + E\int_{S_2} ds$$

$$\phi = E\left[\int_o^S ds + \int_o^S ds\right]$$

$$\phi = E.2S\text{.........(2)}$$

Combined eq. (1) & (2)

$$E.2S = \frac{\sigma S}{\in_o}$$

$$\boxed{E = \frac{\sigma}{2\in_o}}$$

Ans 08: (a) Dielectric constant is defined as the ratio of capacitance of a capacitor when the dielectric is filled in between the plates to the capacitance of a capacitor when these is vaccuum in between the plates

In K = $\frac{Cm}{Co}\frac{\text{Capacitance of a capcitor when dielectric is in between the plates}}{\text{Capacitance of a capcitor with vaccuum in between the plates.}}$

Capacitance of a parallel plate capacitor with dielectric depends on the following factors $C_m = \frac{KA\in_o}{d}$

(1) Area of the plates

(2) Distance between the plates

(3) Dielectric constant of the dielectric between the plates

(b) Let the capacitance of each capacitor be C

Cp = C + C = 2C

$C_S = \frac{C \times C}{C + C} = \frac{C}{2}$

Let Vp and V_S be the values of potential difference

This $Up = \frac{1}{2}CpVp^2 = \frac{1}{2} \times 2C \times Vp^2 = CVp^2$

$$Us = \frac{1}{2}CsVs^2 = \frac{1}{2} \times \frac{C}{2} \times Vs^2 = \frac{CVs^2}{4}$$

But $U_P = U_S$ (given)

$CVs^2 = \frac{CVs^2}{4}$

$\frac{Vp^2}{Vs^2} = 1/4 \Rightarrow$ **Vp : Vs = 1 : 2**

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Unit – Electrostatics)

1. Force of attraction between two point electric charges placed at a distance d in a medium is F. What distance apart should these be kept in the same medium, so that force between them becomes F/3? [1]

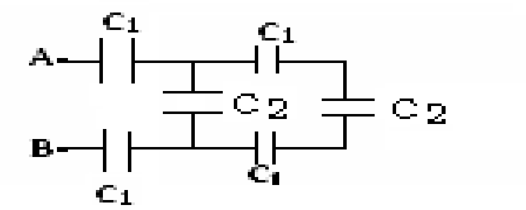
2. The distance of the field point on the equatorial plane of a small electric dipole is halved. By what factor will the electric filed due to the dipole change? [1]

3. Draw one equipotential surface (1) In a uniform electric field (2) For a point change (θ < o)? [2]

4. If the amount of electric flux entering and leaving a closed surface are ϕ_1 and ϕ_2 respectively. What is the electric charge inside the surface? [2]

5. Derive an expression for the total work done in rotating an electric dipole through an angle θ in a uniform electric field? [3]

6. If C_1 = 3pF and C_2 = 2pF, calculate the equivalent capacitance of the given network between points A & B? [3]



7. Prove that energy stored per unit volume in a capacitor is given by $\frac{1}{2}\in_o E^2$, where E is the electric field of the capacitor? [3]

8. (a) An air capacitor is given a charge of 2 μC raising its potential to 200 V. If on inserting a dielectric medium, its potential falls to 50 V, what is the dielectric constant of the medium? [5]

   (b) A conducting stab of thickness‘t’ is introduced without touching between the plates of a parallel plate capacitor separated by a distance d (t<d). Derive an expression for the capacitance of a capacitor?

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Unit – Electrostatics)

[ANSWERS]

Ans 01: If two point changes are q_1 and q_2 separated by distance d

$F = \frac{Kq_1q_2}{d^2}$

Suppose if force becomes F/3 let the distance be x

$F/3 = \frac{Kq_1q_2}{x^2}$

$\Rightarrow \frac{Kq_1q_2}{3d^2} = \frac{kq_1q_2}{x^2}$

$x^2 = 3d^2$

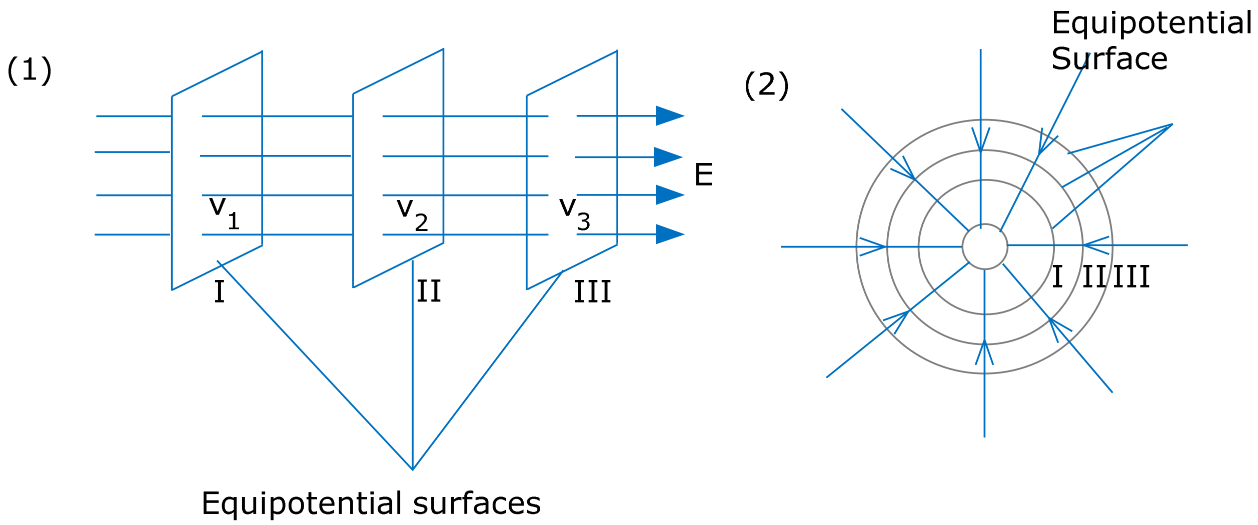
$\Rightarrow$ $\boxed{x = \sqrt{3}\, d}$

Ans 02: Since $E \propto \frac{1}{r^3}$

$\therefore E \propto \frac{1}{(r/2)^3} \Rightarrow E \propto 8/r^3$

$\Rightarrow$ Electric field becomes eight times

Ans 03:



Ans 04: Net flux = ϕ_2 - ϕ_1

Since $\phi = \theta / \in_0$

Q = $\phi \in_0$

$\boxed{\theta = (\phi_2 - \phi_1)\in_0}$

Ans 05: We know τ = PE sin θ

If an electric dipole is rotated through an angled θ against the torque acting on it, then small amount of work done is

dw = $\tau\, d\theta$ = PE sin $\theta\, d\theta$

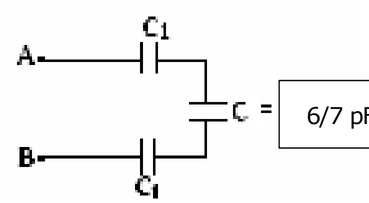
For rotating through on angle θ

$$w = \int_{90^0}^{\theta} PE \sin\theta$$

$$w = PE\left|-\cos\theta\right|_{90}^{\theta}$$

w = - PE cos θ

Ans 06: Since C_1, C_2 and C_1 are in series



$$\therefore \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_1}$$

$$\Rightarrow \frac{1}{C} = \frac{1}{3} + \frac{1}{2} + \frac{1}{3}$$

$$\frac{1}{C} = \frac{2+3+2}{6}$$

$$C = \frac{6}{7}\, pF$$

C_2 and C are in series

$$\Rightarrow C' = \frac{2}{1} + \frac{6}{7} = \frac{14+6}{7} = \frac{20}{7}\, pF$$

Here C1, C' and C1 are in series

$$\therefore \frac{1}{Cnet} = \frac{1}{C_1} + \frac{1}{C'} + \frac{1}{C_1} \qquad \frac{1}{Cnet} = \frac{1}{3} + \frac{7}{20} + \frac{1}{3}$$

$$\frac{1}{Cnet} = \frac{20+21+20}{60} = \frac{61}{60} \qquad \Rightarrow$$

Cnet = 60/61 pF

Ans 07: We know capacitance of a parallel plate capacitor, $C = \frac{A\epsilon_o}{d}$, electric filed in between the plates $E = \frac{\sigma}{\epsilon_o}$ where σ is the surface charge density of the plates.

Energy stored per unit volume = $\frac{Energy \text{ stored}}{Volume}$

Energy stored per unit volume = $\frac{\frac{1}{2}\frac{q^2}{C}}{Ad}$ (Volume of the capacitor = Ad)

$$= \frac{\frac{\frac{1}{2} \times \frac{(\sigma A)^2}{A \in_0}}{d}}{Ad} = \frac{\frac{1}{2} \times E^2 \in_o^2 A^2 d}{A^2 \in_o d}$$

$\Rightarrow$ Energy stored/volume $= \frac{1}{2} \in_o E^2$ Hence proved

Ans 08: (a) $K = \frac{V}{V^1} = \frac{200}{50} = 4$

(Where V = 200 V for air capacitor V^1 = 50 after insertion of a dielectric)

(b) For a parallel plate capacitor when air/vaccuum is in between the plates

$$C_o = \frac{A \in^o}{d}$$

Since electric field inside a conducting stab is zero, hence electric field exist only between the space (d-t) $\Rightarrow V = E_0 (d - t)$

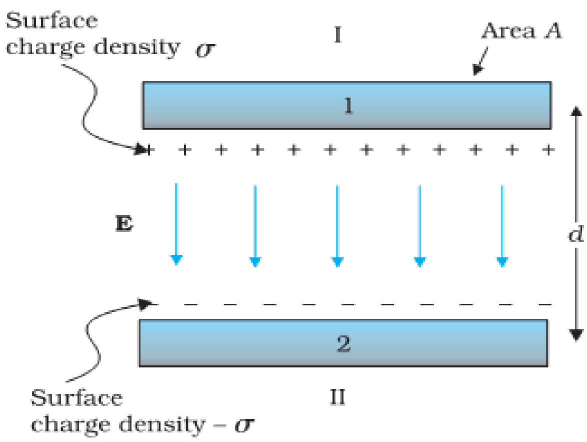
Where E_o is the electric field exist between the plates

And $E_o = \frac{\sigma}{\in_o} = \frac{q}{A \in_o}$

Where A is the area of each plates

$$\Rightarrow V = \frac{q}{A \in_o} (d - t)$$

Hence capacitor of a parallel plate capacitor



$$C = \frac{q}{V} = \frac{q}{q(d-t)} A \in_o$$

$$C = \frac{A \in_o}{d - t}$$

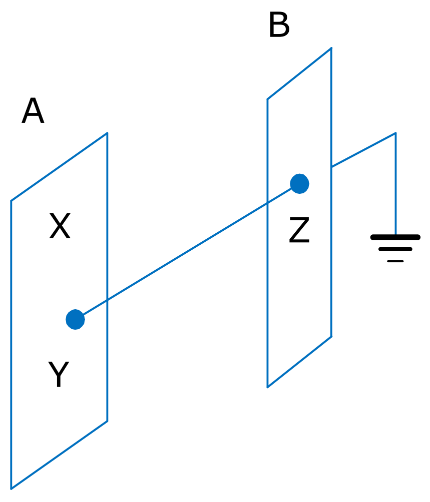
$$C = \frac{A \in_o}{d(1 - t/d)}$$

$$\boxed{C = \frac{C_o}{\left(1 - \frac{t}{d}\right)}}$$

CBSE TEST PAPER-05

CLASS - XII PHYSICS (Unit – Electrostatics)

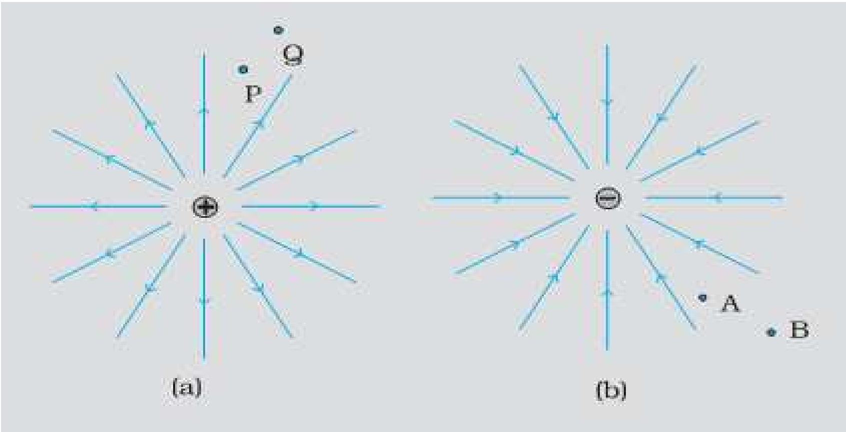
1. The Plates of a charged capacitor are connected by a voltmeter. If the plates of the capacitor are moved further apart. What will be the effect on the reading of the voltmeter? [1]
2. What is the function of dielectric in a capacitor? [1]
3. A steam of electrons travelling with speed $\upsilon\ {}^{m}\!/_{s}$ at right angles to a uniform electric field E is deflected in a circular path of radius r. Prove that $\frac{e}{m} = \frac{v^2}{rE}$? [2]
4. The distance between the plates of a parallel plate capacitor is d. A metal plate of thickness (d/2) is placed between the plates. What will be the effect on the capacitance? [2]
5. Keeping the voltage of the charging source constant. What would be the percentage change in the energy stored in a parallel plate capacitor if the separation between its plates were to be decreased by 10%? [3]
6. Two identical plane metallic surfaces A and B are kept parallel to each other in air separated by a distance of 1.0 cm as shown in the figure. Surface A is given a positive potential of 10V and the outer surface of B is earthed. [3]



   (a) What is the magnitude and direction of uniform electric field between point Y and Z? What is the work done in moving a change of 20 μc from point X to Y?

   (b) Can we have non-zero electric potential in the space, where electric field strength is zero?

7. Figure (a) and (b) shows the field lines of a single positive and negative changes respectively [5]



(a) Give the signs of the potential difference : $Vp - Vq$ and V_B -- V_A

(b) Give the sign of the work done by the field in moving a small positive change from Q to P.

(c) Give the sign of the work done by the field in external agency in moving a small negative change from B to A.

8. With the help of a labelled diagram, explain the principle, construction and working of a vandegraff generator. Mention its applications? [5]

[ANSWERS]

Ans 01. Since $C = \frac{A \in o}{d} \Rightarrow C \propto \frac{1}{d}$

which means if distance increases, capacitance deceases.

Since $V = \frac{Q}{C}$ and charge on the capacitor is constant.

Hence reading of the voltmeter increases.

Ans 02. The introduction of dielectric in a capacitor reduces the effective charge on plate and hence increases the capacitance.

Ans 03. The path of the electron traveling with velocity $\upsilon\ {}^{m}\!/\!{}_{s}$ at right angles of $\vec{E}$ is circular.

$\therefore$ It requires a centripetal force $f = \frac{mv^2}{r}$

which is provided by an electrostatic force f = eE

$$\Rightarrow \text{eE} = \frac{mv^2}{r}$$

$$\frac{e}{m} = \frac{v^2}{Er}$$

Ans 04. For air $C = \frac{A \in o}{d}$

Thickness t = d/2 only when $k = \infty$

$$\therefore C_{nef} = \frac{\in_o A}{d - t(1 - 1/k)} = \frac{\in_o A}{d - d/2(1 - 1/\infty)} = \frac{2\in_o \text{A}}{d} = 2\text{C}$$

Hence capacitance will get doubled.

Ans 05. $U = \frac{1}{2}CV^2$

For parallel plate $U = \frac{1}{2}\ \frac{A\in o}{d}V^2$

When d' = d – 10% of d == 0.9 d

Then $U' = \frac{1}{2}\ \frac{A\in o}{0.9d}V^2$

Change in energy = U'-U = $\frac{1}{2}\frac{AEo}{d}V^2(\frac{1}{0.9}-1)$

$U'-U` = U(\frac{0.1}{0.9}) = U/9$

% change == $\frac{U'-U}{U}\ \times 100$ %= $U/9\ \times\ \frac{1}{U}$ X 100%= $\frac{100\%}{9}$

% change == 11.1%

Ans 06. (a) Since $E = \frac{d\upsilon}{dr} = \frac{10V}{1x10^{-2}} = 1000V/m.$

(ii) Since surface A is an equipotential surface ie $\Delta V = 0$

$\therefore$ Work done from X to Y = Zero .

(b) $E = \frac{-dV}{dr}$ if E=0

$\frac{dV}{dr} = 0 \Rightarrow$ dv = 0 or V= constant (non zero).

Ans 07. (a) We know $V\ \alpha\ \frac{1}{r}$

Vp $>Vq \Rightarrow$ Vp -- Vq -- Positive

VA $<V_B \Rightarrow$ V_B -- V_A -- Positive

Because V_B is less negative then V_A.

(b) In moving a positive change form Q to P work has to be done against the electric field so it is negative.

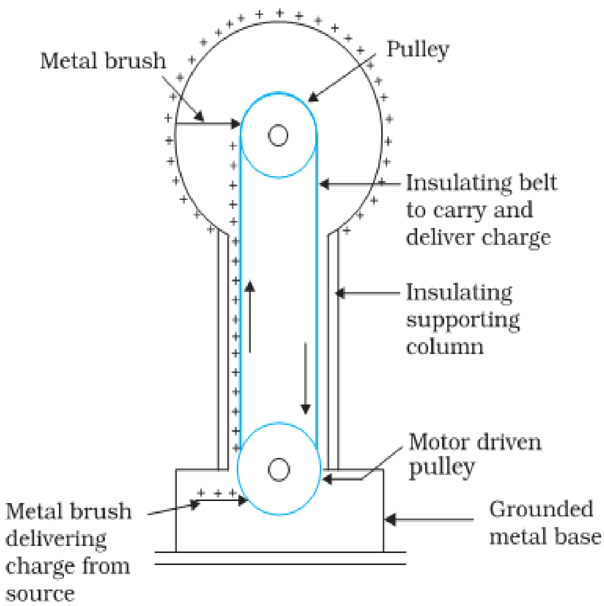
(c) In moving a negative change form B to A work is done along the same direction of the field so it is positive.

Ans 08. Vandegraff generator is a device which is capable of producing a high potential of the order of million volts.

Principle (1) The charge always resides on the outer surface of hollow conductor.

(2) The electric discharge in air or gas takes place readilly at the pointed ends of the conductors.

Construction:- It consist of a large hollow metallic sphere S mounted on two insulating columns A and B and an endless belt made up of rubber which is running over two pulleys P_1 and P_2 with the help of an electric motor. B_1 and B_2 are two sharp metallic brushes. The lower brush B_1 is given a positive potential by high tension battery and is called a spray brush while the upper brush B_2 connected to the inner part of the Sphere S.



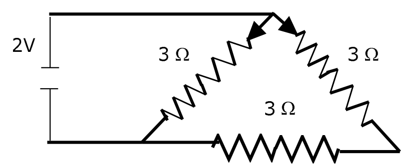
Working :- When brush B_1 is given a high positive potential then it produces ions, due to the action of sharp points. Thus the positive ions so produced get sprayed on the belt due to repulsion between positive ions and the positive charge on brush B_1. Then it is carried upward by the moving belt. The pointed end of B_2 just touches the belt collects the positive change and make it move to the outer surface of the sphere S. This process continues and the potential of the shell rises to several minion volts.

Applications – Particles like proton, Deutrons, α-- particles etc are accelerated to high speeds and energies.

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Unit – Current Electricity)

1. If the temperature of a good conductor decreases, how does the relaxation time of electrons in the conductor change? [1]
2. If potential difference V applied across a conductor is increased to 2V, how will the drift velocity of the electron change? [1]
3. Two electric bulbs A and B are marked 220V, 40 w and 220V, 60 W respectively. Which one has a higher resistance? [2]
4. A Carbon resistor has three strips of red colour and a gold strip. What is the value of resistor? What is tolerance? [2]
5. Determine the voltage drop across the resistor R_1 in the circuit given below with E= 60V, R_1=18 Ω, R_2=10 Ω R_3=5 Ω and R_4 = 10 Ω ? [3]
6. What happens to the resistance of the wire when its length is increased to twice its original length? [3]
7. Mark the direction of current in the circuit as per kirchoff's first rule. What is the value of main current in the shown network? [3]



8. (a) Why do we prefer potentiometer to measure the emf of cell than a voltmeter? [1]
   (b) With suitable circuit diagram, show how emfs of a cell can be compared using a potentiometer? [2]

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Unit – Current Electricity)

[ANSWERS]

Ans 01. We know $\rho = \frac{m}{ne^2 \tau}$

When temperature decreases, collision decreases and thus relaxation time increases which in turn decreases the resistivity.

Ans 02. $Vd = \frac{e E \tau}{m}$

$Vd = \frac{e V \tau}{\ell \text{ m}}$

$\therefore$ Double the P.D means drift velocity gets doubled.

Ans 03. We know $R \ \frac{V^{2}}{p}$

For Bulb A $R_1 = \frac{(220)^2}{40}$ $= 1210\ \Omega$

For Bulb B $R_2 = \frac{(220)^2}{60}$ $= 806.67\ \Omega$

Bulb A has higher resistance because its power is less.

Ans 04. R R R Gold

$(22 \times 10^2\ \Omega\ ) \pm 5\ \%$

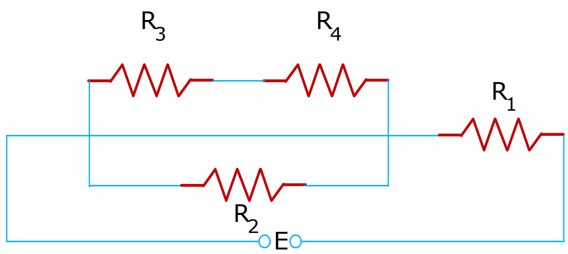
Value of the Resistor = 2200 Ω

Tolerance = $\pm 5\ \%$

Ans 05. R_3 & R_4 are in series

$= R^1 = 5 + 10 = 15\ \Omega$

Now R^1 and R_2 are parallel



$$\therefore \frac{1}{R''} = \frac{1}{R^1} + \frac{1}{R_2}$$

$$\frac{1}{R''} = \frac{1}{15} + \frac{1}{10} = \frac{4+6}{60} = 10/60$$

$R'' = 60/10 = 6\ \Omega$

Now R_1 and R^{11} are series

Rnet = $R'' + R_1$

$\Rightarrow$ Rnet = 6+18 = 24 Ω

I= V/R = $\frac{60}{24}$ *Ampere*

Now voltage drop across $R_1 = IR_1 = \frac{60}{24}\times 18$

$$\boxed{V = 45 \text{ Volts}}$$

Ans 06. $R = P\frac{\ell}{A} = P\left(\frac{\ell}{\pi r^2}\right)$

Now $\ell^1 = 2\ell$ and radius becomes r^1

Since volume of the wire remains the same

$\therefore \quad \pi r^2 \ell = \pi r'^2 \ell 1 = \pi r'^2\ 2\ell$

$$r'^2 = r^2/2$$

$\therefore$. New Resistance

$$R' = P\left(\frac{\ell'}{\pi r'^2}\right)$$

$$R' = P\left(\frac{2\ell}{\pi r^2/2}\right)$$

$$R' = 4\rho\left(\frac{\ell}{\pi r^2}\right)$$

$\therefore$ New Resistance becomes four times.

Ans 07. R2 and R3 are in series

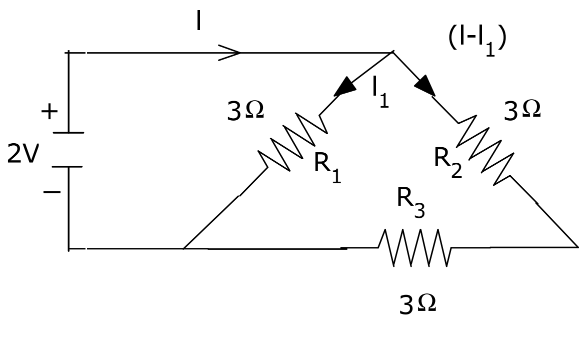
$R' = 3+3 = 6\,\Omega$

R and R1 are in parallel

$$\frac{1}{R_{net}} = \frac{1}{R'} + \frac{1}{R'}$$

$$\frac{1}{Rnet} = \frac{1}{6} + \frac{1}{3} = \frac{3+6}{18}$$

$Rnet = 18/9 = 2\Omega$



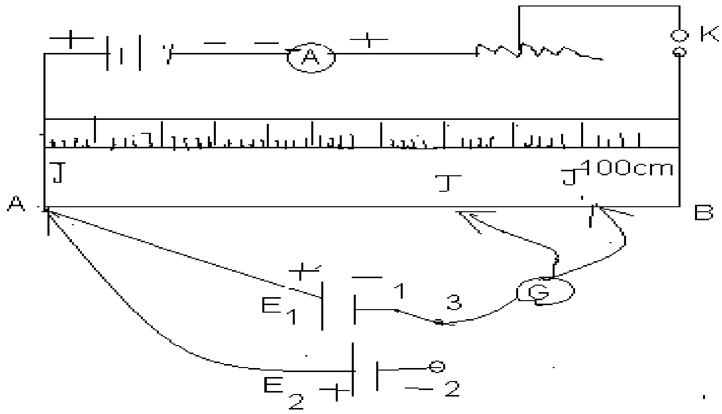
Net Current

I=V/R

I= 2/2 =1A

Ans 08. (a) Since potentiometer is based on null method i.e. it draws no current form the cell therefore potentiometer is preferred to measure the emf of a cell than a voltmeter because emf of a cell is equal to terminal potential difference when no current flows form the cell.

(b) Potentiometer works on the principle that when a constant current flows through the wire of Uniform area of cross- section then



(Condition – close the switch and 3 such that E1 comes in the circuit)

P.D. across AJ is $V_{AJ} \alpha\ l_1$

Since no current flows between E1 and VAJ

= V_{AJ} = El

= E1 α l_1 $\Rightarrow$ E1 = kl_1 ----------------(1)

Close the switch 2 and 3 , cell E2 comes in the circuit and balance point is obtained of J_1

= Since no current flows because A and J1 are at same potential then V AJ 1 = E2

=$V_{AJ1} = E_2 = Kl_2$ -----------------(2)

Comparing eg. (1) and (2)

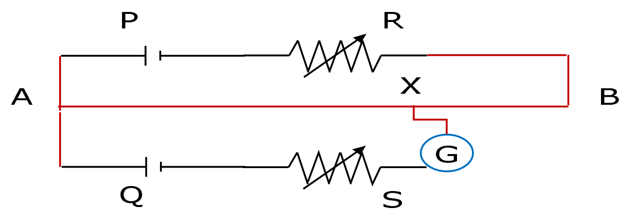
$$\frac{E_1}{E_2} = \frac{\not{K}l_1}{\not{K}l_2}$$

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

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Unit – Current Electricity)

1. What is the value of current I in the adjoining circuit ? [1]
2. State one condition for maximum current to be drawn from the cell ? [1]
3. Two heated wires of same dimensions are first connected in series and then it's parallel to a source of supply. What will be the ratio of heat produced in the two cases? [2]
4. V.I graph for a metallic wire a two different temperatures T1 and T_2 is shown in figure. Which of these two temperatures is higher and why? [2]
5. Potential difference V is applied across the ends of copper wire of length (l) and diameter D. What is the effect on drift velocity of electrons if [3]
   (1) V is doubled (2) ℓ is doubled (3) D is doubled
6. What is drift velocity? Derive expression for drift velocity of electrons in a good conductor in terms of relaxation time of electrons? [3]
7. The potentiometer circuit shown, the balance (null) point is at X. State with reason, where the balance point will be shifted when [3]



   (1) Resistance R is increased, keeping all parameters unchanged.
   (2) Resistance S is increased, keeping R constant.
   (3) Cell P is replaced by another cell whose emf is lower than that of cell Q.

8. (a) Using the principle of wheat stone bridge describe the method to determine the specific resistance of a wire in the laboratory. Draw the circuit diagram and write the formula used ? [3]
   (b) In a whetstone bridge experiment, a student by mistake, connects key (k) in place of galvanometer and galvanometer (G) in place of Key (K). What will be the change in the deflection of the bridge.

CBSE TEST PAPER-02

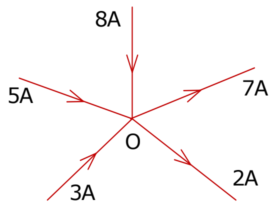
CLASS - XII PHYSICS (Unit – Current Electricity)

[ANSWERS]

Ans 1. $i = 5 + 3 - 2 - 7 + 8$

$i = 16 - 9$

$i = 7A$



Ans 2. Since $I = \frac{E}{R + r}$ for maximum current, external resistance should be Zero.

Ans 3.

$H = I^2 Rt \qquad (\because I = \frac{V}{R})$

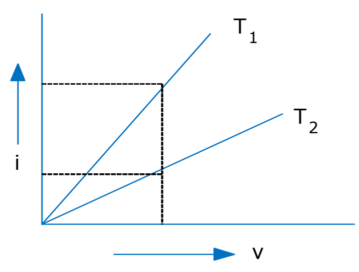
$H = \frac{V^2}{R^2} \times R \times t$

$H = \frac{V^2}{R} t$

$\Rightarrow H \alpha \frac{1}{R}$

$$\frac{Hseries}{Hparallel} = \frac{Rparallel}{Rseries} = \frac{\left(\frac{1}{R} + \frac{1}{R}\right)^{= \frac{1}{R'}}}{R + R} \frac{R/2}{2R} = \frac{R}{2R \times 2} = \frac{1}{4}$$

Ans 4. Slope $\frac{i}{V} = \frac{1}{R}$



= Smaller the slope larger is the resistance and since resistance increases with the increases in temperature. Slope is small for T_2

T_2 temperature is higher

Ans 5. (1) Since $V_d = V_d = \frac{I}{neA} = \frac{V}{R(neA)} = \frac{V}{\left(P\frac{\ell}{A}\right)(neA)} = \frac{V}{nep\ell}$

If V is doubled, drift velocity gets halved.

(2) If ℓ is doubled, drift velocity gets halved.

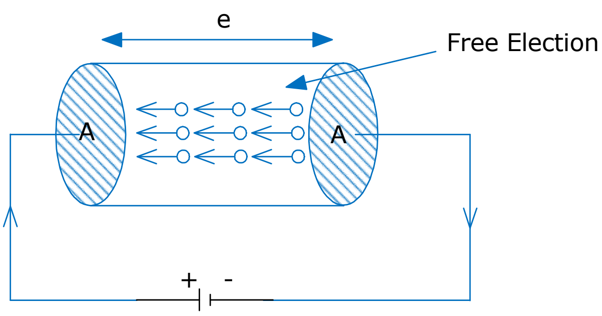
(3) Since V of is independent of D, drift velocity remains unchanged.

Ans 6. If is defined as the average velocity with which free electrons gets drifted in a direction opposite to that of electric field

If m is the mass of the electron and e be the charge of electron

Then on application of the electric field E, acceleration acquired by the electron is

$a = \frac{eE}{m}$



first eg of motion $v =$ u + a t

since average initial velocity

u = 0 V= vd

t = τ

(relaxation time)

=>vd = aτ

$vd = \frac{e\,E\tau}{m}$

where e is the change on electron

E os the electric field intensity

τ is the relaxation time

m is the mass of electron.

Ans 7 (a) When resistance R is increased, the current through potentiometer wire AB will decrease, hence potential difference across A will decrease, so balance point shifts towards B.

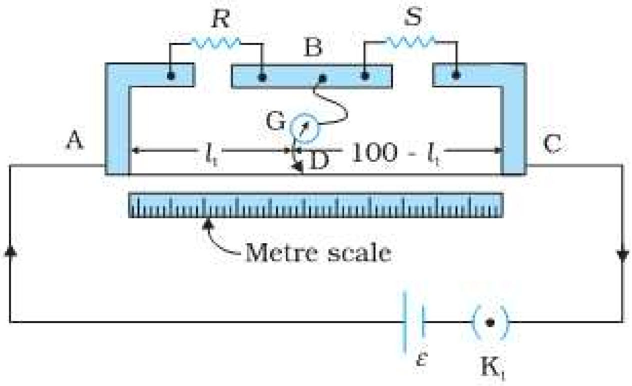
(b) When resistance S is increased terminal potential difference of the battery will decrease, so balance point will be obtained at smaller length and hence shifts towards A.

(c) When cell P is replaced by another cell whose emf is lower than that of cell Q, the P.D. across AB will be less than that of emfQ so balance point will not be obtained.

Ans 8.

(a) Close the Key (k) and jockey is moved along the wire till a certain point B is reached where galvanometer shows no deflection. Then the bridge is said to be balanced.

If Rcm is the resistance per can length of the wire then.



$$\frac{R}{X} = \frac{l\ \text{Rcm}}{(100-l)Rcm}$$

$$\boxed{X = \frac{R\,(100-\ell)}{\ell}}$$

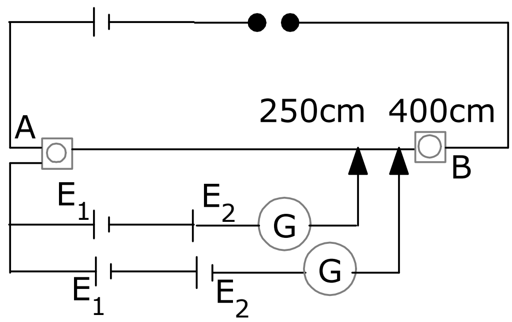
Since $P = \dfrac{XA}{\ell^1}$ Where ℓ^1 is the length of the wire.

$$= \boxed{P = \frac{R(100-\ell)A}{\ell\,(\ell')}}$$

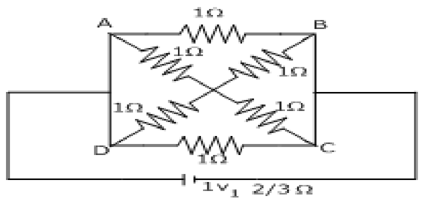
(b) When the bridge is balanced, there will be no current in key, therefore constant current flows through the galvanometer and hence no change in deflection on pressing the key.

CBSE TEST PAPER-03
CLASS - XII PHYSICS (Unit – Current Electricity)

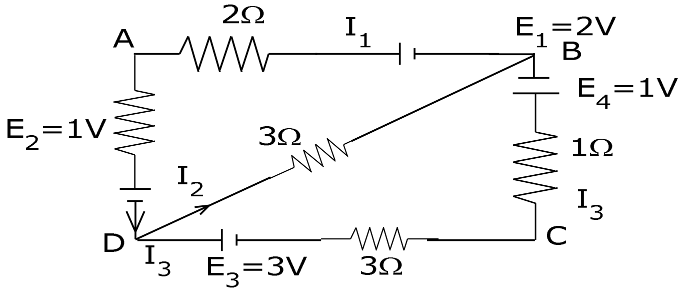
1. Resistivites of copper, silver and manganin are $1.7\times10^{-8}\ \Omega\,m$, $1.0\times10^{-8}\ \Omega\,m$ and $44\times10^{-8}\ \Omega\,m$. respectively which of these is the best conductor ? [1]
2. Draw the graph showing the variation of conductivity with temperature for a metallic conductor? [1]
3. A set of n-identical resistors , each of resistance R ohm when connected in series have an effective resistance of X ohm and when the resistors are connected in parallel the effective resistance is Y ohm. Find the relation between R , X and Y ? [3]
4. Show the resistance of a conductor is given by $R = \dfrac{ml}{ne^2\tau A}$ [3]
5. Two primary cells of emf's E_1 and E_2 are connected to the potentiometer wire AB as shown in the figure if the balancing length for the two combinations of the cells are 250 cm and 400 cm. find the ratio of E_1 and E_2 . [3]



6. Explain with the help of a circuit diagram, how the value of an unknown resistance can be determined using a wheat stone bridge? [3]
7. Find the current drawn from a cell of emf IV and internal resistance $2/3\,\Omega$ connected to the network shown in the figure. E = 1v r = $2/3\ \Omega$ [3]



8. (a) State and explain kirchoff's law? [3]
   (b) In the network shown, find the values of current I_1 , I_2 and I_3.



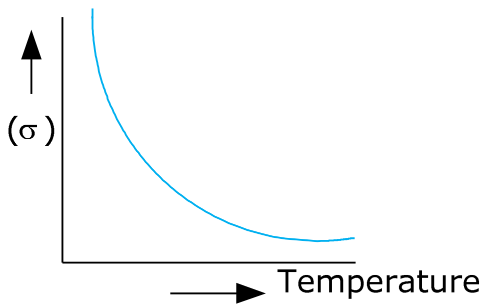
CBSE TEST PAPER-03

CLASS - XII PHYSICS (Unit – Current Electricity)

[ANSWERS]

Ans 01. For a particular length and area of cross-section , The resistance is directly proportionate to, specific resistance .
$\therefore$ silver is the best conductor because its specific resistance is less.

Ans 02. The conductivity decreases with the increase in temperature.



Ans 03. n – resistors connected in series

$X = nR$ ----------------1)

n – Resistors connected in parallel

$Y = \frac{R}{n}$ ----------------2)

Multiply eg. (1) & (2)

$$XY = \cancel{n}R \times \frac{R}{\cancel{n}}$$

$XY = R^2$ $\boxed{R = \sqrt{XY}}$

Ans. 4 For a conductor of length l and area A if (E2) electric field is applied, Then the digit velocity of electrons is given by

$$vd = \frac{eE}{m}\tau$$

Since $I = neAvd$

$I = neA\ (\frac{eE}{m}\tau)$

$I = neA\ (\frac{eV}{ml}\tau)$ $(\because E = v/\ell)$

$\frac{V}{I} = \frac{ml}{ne^2A\zeta}$

$\boxed{R = \frac{m}{ne^2\tau}\left(\frac{l}{A}\right)}$ $(\because V / I = R)$

$\boxed{or\ R = \frac{ml}{ne^2\tau A}}$

Ans 05. $E_1 - E_2 = K \times 250$ ---------- (1)

$E1 + E2 = K \times 400$ ----------- (2)

Adding eg. (1) &(2)

$2E_1 = 250K + 400K$

$2E_1 = 250K + 400K$

$2E_1 = 650K$

$E_1 = \frac{650}{2}K$

$E_1 = 325\ K$ ----- (3)

Subtracting eg. (1) & (2)

$E_2 = 75K$

$\therefore \frac{E_1}{E_2} = \frac{325K}{75K}$

=> $\boxed{\frac{E_1}{E_2} = 4.33}$

Ans 06. Here P , Q , R are known resistance and X is an unknown resistance. Applying kirchoff's law for closed path ABDA .

$I_1P + I_3\ G - I_2\ R = 0$ ------ (1)

For closed path BCDB

$(I_1 - I_3)\ Q - (\ I_2+I_3) \times -I_3G$ ------(2)

Now the bridge is said to be balanced when no current flows through the galvanometer

$\Rightarrow Ig = 0$

$\therefore$ Eg. (1) & (2) becomes

$I_1 P = I_2 R$

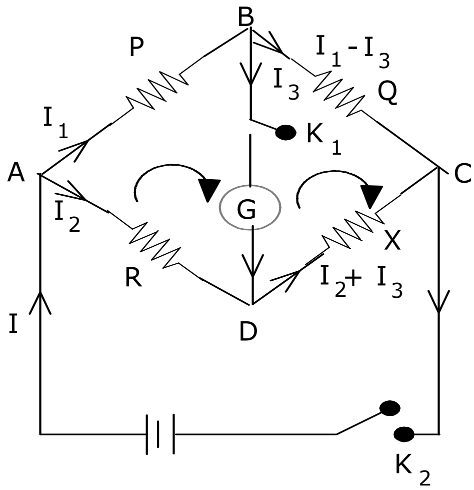
$$\boxed{\frac{I_1}{I_2} = \frac{R}{P}} \quad \text{--------} \ (3)$$

$I_1 Q = I_2 X$

$$\boxed{\frac{I_1}{I_2} = \frac{X}{Q}} \quad \text{-----------} \ (4)$$

Equating (3) & (4)

$$\frac{R}{P} = \frac{X}{Q} \Rightarrow \boxed{X = \frac{RQ}{P}}$$

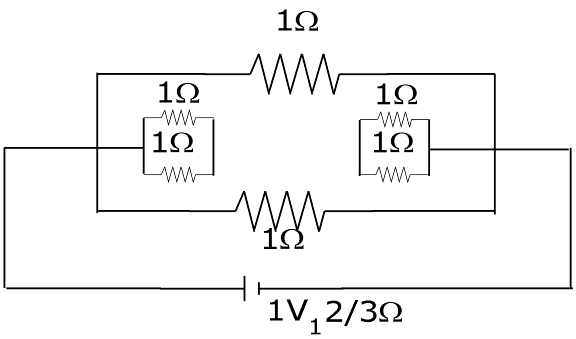


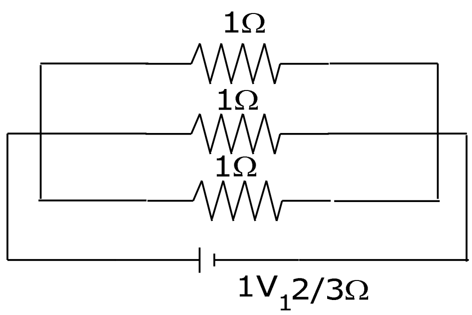
Ans 07. $\frac{I}{R_1} = \frac{1}{1} + 1/1$

$\frac{1}{R_1} = 2 \quad \Rightarrow R_1 = 1/2$

$R_2 = 1/2$

$R = R_1 + R_2 \quad \Rightarrow \quad R = \frac{1}{2} + \frac{1}{2} \quad \Rightarrow R = 1\,\Omega$





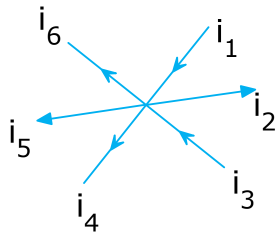
Now $1\,\Omega$, R and $1\,\Omega$ are in parallel

$\Rightarrow \frac{1}{Rnet} = \frac{1}{1} + \frac{1}{1} + \frac{1}{1}$

$\frac{1}{Rnet} = 3/1 \Rightarrow Rnet = 1/3\,\Omega$

$I = \frac{E}{R + r} = \frac{1}{1/3 + 2/3} = 3/3 = 1A \qquad \boxed{I = 1A}$

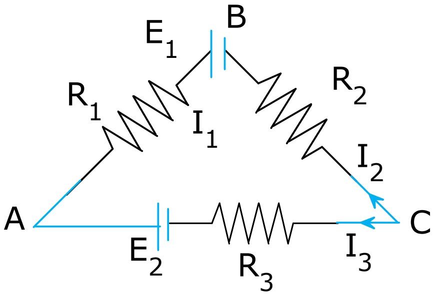
Ans 08. (a) Kirchoff's first law – it states that the algebraic sum of the currents meeting at a point in an electrical circuit is always zero.



=> $i_1 - i_2 + i_3 - i_4 - i_5 - i_6 = 0$

Kirhoff's second law – it states that in any closed part of an electrical circuit , the algebraic sum of emf & is equal to the algebraic sum of the products of resistances and current flowing through them for eg.

For closed path ABCA



$R_1 I_1 - R_3 I_3 + R_2 I_2 - E_1 + E_2 = 0$

Or $\boxed{E_1 - E_2 = R_1 I_1 - R_3 I_3 + R_2 I_2}$

(b) Applying kirchoff's law at point -D

$$I_1 = I_2 + I_3$$

For closed path ABDA

$$2I_1 + 1 - 2 + I_1 + 3I_2 = 0$$
$$3I_1 + 3I_2 - 1 = 0$$
$$3I_1 + 3I_2 = 1 \quad \text{----------- (2)}$$

For closed path DBCD

$$3I_2 - 1 - I_3 - 3I_3 + 3 = 0$$
$$3I_2 - 4I_3 + 2 = 0$$
$$\text{Or } 4I_3 - 3I_2 - 2 = 0$$
$$4I_3 - 3I_2 = 2 \quad \text{-------------(3)}$$

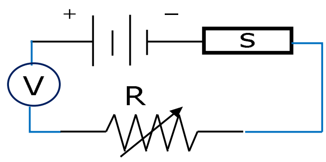
Solving eg. (1) , (2) & (3)

$$I1 = \frac{13}{33}A\ ,\ I_2 = \frac{-2}{33}A \text{ and } I_3 = \tfrac{5}{11}A$$

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Unit – Current Electricity)

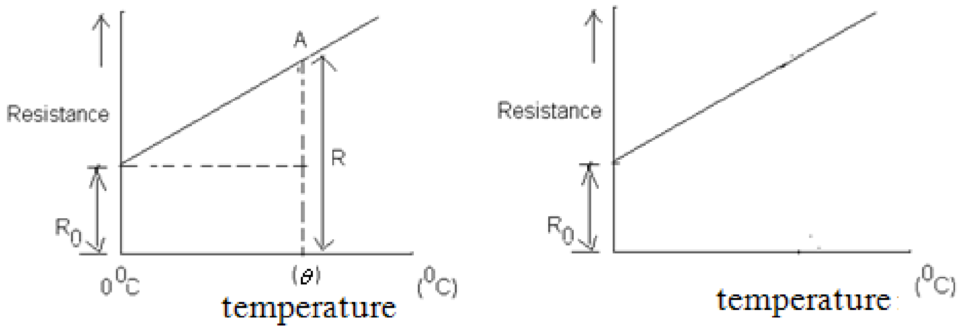
1. If a wire is stretched to double of its length. What will be its new resistivity? [1]
2. Name any one material having a small value of temperature coefficient of resistance. Write one use of this material? [1]
3. Figure shows a piece of pure semiconductor S in series with a variable resistor Rand a source of constant voltage V. Would you increase and decrease the value of R to keep the reading of ammeter (A) constant, when semiconductor S is heated ? Give reasons. [2]



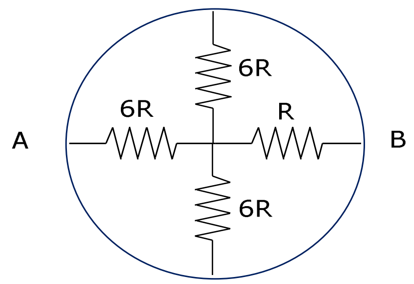
4. The variation of resistance of a metallic conductor with temperature is given in figure. [3]

   (a) Calculate the temperature coefficient of resistance from the graph.

   (b) State why the resistance of the conductor increases with the rise in temperature.

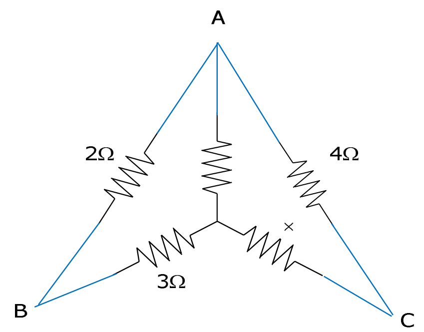


5. A circle ring having negligible resistance is used to connect four resistors of resistances 6R , 6R , 6R and R as shown in the figure. Find the equivalent resistance. between points A & B [3]



6. A battery of emf E and internal resistance r sends a current I_1 and I_2, when connected to an external resistance of R1 and R2 respectively .Find the emf. and internal resistance of the battery? [3]

7. Find the value of unknown resistance X in the circuit shown in the figure if no current flows through the section AO. Also calculate the current drawn by the circuit from the battery of emf. 6v and negligible internal resistance. [3]



8. (a) Obtain ohm's law from the expression for electrical conductivity. [3]

(b) A cylindrical wire is stretched to increase its length by 10% calculate the percentage increase in resistance?

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Unit – Current Electricity)

[ANSWERS]

Ans 1. No change in its resistivity because resistivity depends only on the nature of the material.

Ans 2. Nichrome, an alloy has small value of temperature coefficient of resistance. It is used for making standard resistance coil.

Ans 3. Resistance of a semi conductor decreases on increasing the temperature, so in order to increase the temperature, s is heated and in order to maintain the ammeter current constant total resistance is the above circuit should remain unchanged, hence value of r has to be increased.

Ans 4. (a) Temperature coefficient of Resistance

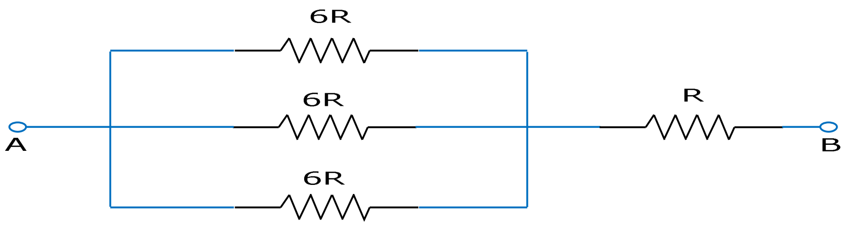
$$\alpha = \frac{R - R_0}{R_0 \theta}$$

Where R is the resistance of the conductor and Ω is the temperature corresponding to pt.A

(b) Since R = $p\frac{l}{A} = \frac{m}{ne^2\tau}\left(\frac{t}{A}\right)$ P=Resistivity

When temperature increases, no of collisions increases average relaxation time decreases, hence resistance Increases.

Ans 5.



6R , 6Rand 6R are in parallel

$$\frac{1}{R_s} = \frac{1}{6R} + \frac{1}{6R} + \frac{1}{6R}$$

$$\frac{1}{R_s} = \frac{3}{6R}$$

$$R_s = \frac{\cancel{6}R}{\cancel{3}}\ 2R$$

$R_s = 2R$ => 2R and R are in series

$\therefore\ R_{net} = 2R + R$

$$\boxed{R_{net} = 3R}$$

Ans 6. $I_1 = \frac{E}{R_1 + r} = I_1(R_1 + r)$ ---(1)

Similarly $E = I_2 (R_2 + r)$ ---(2)

From (1) & (2)

$I_1 (R_1 + r) = I_2 (R_2 + r)$

$I_2 r - I_1 r = I_1 R_1 - I_2 R_2$

$r (I_2 - I_1) = I_1 R_1 - I_2 R_2$

$$\boxed{r = \frac{I_1 R_1 - I_2 R_2}{I_2 - I_1}}$$

Emf. (E) = $I_1 (R_1 + r)$

$$E = I_1 \left[R_1 + \frac{I_1 R_1 - I_2 R_2}{I_2 - I_1} \right]$$

$$E = I_1 \left[\frac{I_2 R_1 - \cancel{I_1 R_1} + \cancel{I_1} R_1 - I_2 R_2}{I_2 - I_1} \right]$$

$$E = \frac{I_1 I_2 (R_1 - R_2)}{I_2 - I_1}$$

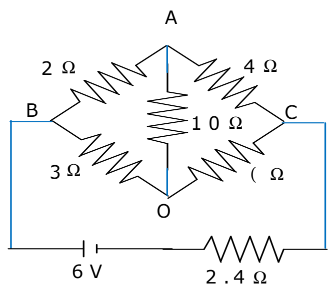
Ans 7.

As no current flows through AO then the circuit is said to be balanced wheat Stone bridge.

$$\frac{2}{4} = \frac{3}{X}$$

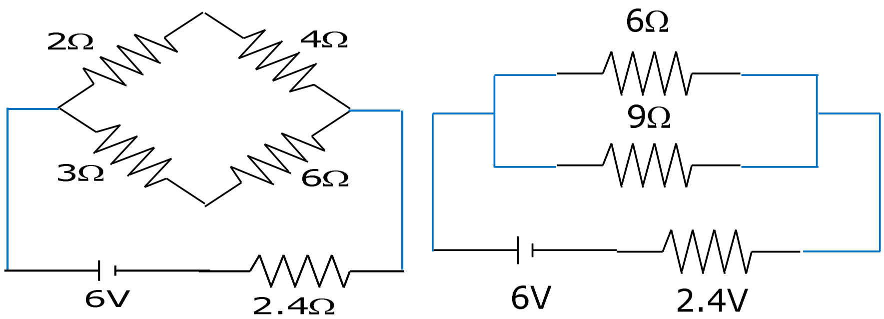
$X = {}^{12}/_{2} = 6$

$X = 6\,\Omega$



Since in branch AO , I=0

$\therefore$ Resistance of 10 Ω between A and O is ineffective and the circuit reduce to



2 Ω and 4Ω are in series 3Ω and 6Ω are in series

6 Ω and 9 Ω are in parallel

$$\therefore \frac{1}{R_p} = \frac{1}{6} + \frac{1}{9} = \frac{9+6}{54} = \frac{15}{54}$$

$$R_p = \frac{54}{15}\Omega$$

Rp and 2.4 λ are in parallel

$$Reff = 2.4 + \frac{54}{15}$$

$$Reff = \frac{24}{10} + \frac{54}{15} = \frac{360+540}{150} = \frac{\not{9}\not{0}\not{0}^{\not{1}\not{8}\,6}}{1\not{5}\not{0}_{\not{3}}}$$

$$\boxed{Re\,ff = 6\Omega}$$

Current I = $\frac{v}{r} = \frac{6}{6} = 1$

=> $\boxed{I = 1A}$

Ans 8. (a) We know I = neAvd

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

$$Vol = \frac{cE\tau}{m}$$

=> J = $\dfrac{ne^2E\tau}{m}$

Since J = σ E $\quad \therefore \ \sigma = \dfrac{T}{E} = \dfrac{ne^2\tau}{m}$

Let l and A be the length and area of the write.

I = JA

I = $\dfrac{ne^2E\tau}{m}\times A \quad \left(\therefore E = {}^{v}\!/_{e}\right)$

=> I = $\dfrac{ne^2v\tau}{m\ell}A$ => V = $\left(\dfrac{m}{ne^2\tau}\right)\left(\dfrac{\ell}{A}\right)I$

$\boxed{V = RI}$

=> R = $\dfrac{\ell}{A}$ where ρ = $\dfrac{m}{ne^2\tau}$(*specific* resistance of a wire)

(b) $\ell^1 = \ell + \dfrac{10}{100}\ell = 1.1\ell \qquad \dfrac{\ell^1}{\ell} = 1.1$

Since volume of the wire remains the same

Al = $A^1 \ell^1 \qquad \dfrac{A^1}{A} = \dfrac{\ell}{\ell}$

Since R = $\rho\dfrac{\ell}{A}$ and $R^1 = \rho \ \dfrac{\ell^1}{A^1}$

$\therefore \ \dfrac{R^1}{R} = \dfrac{\ell^1}{A^1}\times\dfrac{A}{\ell} = \dfrac{\ell^1}{\ell}\times\dfrac{\ell^1}{\ell} = \left(\dfrac{\ell^1}{\ell}\right)^2$

$\dfrac{R^1}{R} = (1.1)^2 = 1.21$

$\therefore$ Percentage increase in Resistance is

$\dfrac{R^1 - R}{R}\times 100 = 21\%$

CBSE TEST PAPER-05
CLASS - XII PHYSICS (Unit – Current Electricity)

1. Two wires A and B are of the same metal and of same length have their areas of cross section in the ratio 2:1 if the same potential difference is applied across each wire in turn, what will be the ratio of current flowing in A & B? [1]

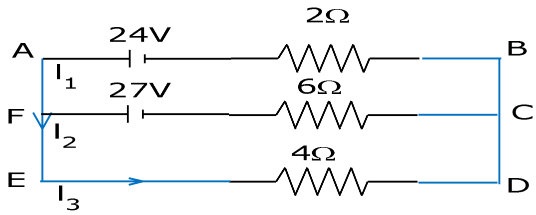
2. Why is constantan or manganin used for making standard resistors? [2]

3. What are ohmic and non-ohmic resistors? Give one example of each? [2]

4. The current I flows through a wire of radius r and the free electron drift with a velocity vd what is the drift velocity of electrons through a wire of same material but having double the radius ,when a current of 2I flows through it? [3]

5. Three identical cells, each of emf. 2v and unknown internal resistance are connected in parallel .This combination is connected to a 5ohm resister. If the terminal voltage across the cell is 1.5volt. What is the internal resistance of each cell .hence define internal resistance of a cell? [2]

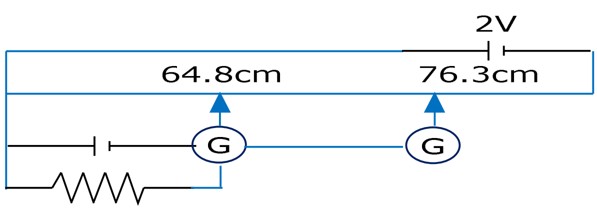
6. Using kirchoff's law, determine the current I_1 , I_2 and I_3 for the network shown. [2]



7. Show that when a current is divided between two resistances in accordance with kirchoff's laws, the heat provided is minimum? [3]

8. (a) Define emf. of a cell? On what factors does it depend? [3]

   (b) Figure below shows a 2.0v potentiometer used for the determination of internal resistance of a 1.5v cell. The balance point of the cell in open circuit is 76.3cm. When a resistance of 9.5 Ω is used in external circuit of the cell the balance point shifts to 64.8cm length of the potentiometer. Determine the internal resistance of the cell.



Ans 1. Since $R = \frac{1}{A}$ => if area are in the ratio 2:1 resistance will be in the ratio1:2.

And $I = V/R$ => $I = \frac{1}{R}$

$\therefore$ current will be in the ratio 2:1

Ans 2. The alloys such as constantan or manganin are used for making standard resistors because their resistivities are high and has low temperature coefficient of resistance.

Ans 3. A resistor which obey ohm's law are called ohmic resistors for eg -> metals
A resistor which do not obey ohm's law are called non-ohmic resistors .eg -> semiconductor diode , transistor etc.

Ans 4. I = ne A vd

$\Rightarrow$ vd = $\frac{I}{neA} = \frac{I}{ne\pi r^2}$ ~~(1)~~

If vd' is the drift velocity of electrons in the second wire

Vd' = $\frac{I'}{nA'e} \Rightarrow vd' = \frac{2I}{n4\pi r^2 e} = \frac{1}{2}\left(\frac{I}{n\pi r^2 e}\right)$ ------------- (2)

From eq . (1) & (2) $\boxed{vd' = vd/2}$

Ans 5. E = 2v V=1.5v R = 5 Ω

Total internal resistance = $r/3$

Since $r = \left(\frac{E}{V} - 1\right)R$

$$\frac{r}{3} = \left(\frac{2}{1.5} - 1\right)5$$

$$\frac{r}{3} = \left(\frac{2-1.5}{1.5} - 1\right)5$$

$$r = 15\left(\frac{0.5}{1.5}\right)$$

$$\boxed{r = 5ohm}$$

The resistance offered by the electrolyte of the cell, when the electric current flows through it , is called as internal resistance of a cell.

Ans 6. Applying junction rule at point F

$I1 = I2 + I3$ -------------- (1)

Loop rule for BAFCB

$2I_1 + 6I_2 - 24 + 27 = 0$

$2I_1 + 6I_2 + 3 = 0$ ------- (2)

Loop rule for FCDEF

$27 + 6I_2 - 4I_3 = 0$ -------- (3)

solving eg. (1), (2) & (3) we get

$I_1 = 3A$, $I_2 = -1.5A$, $I_3 = 4.5A$

Ans 7. Consider two resistance R1 and R2 in parallel and i_1 and i_2 be the current.

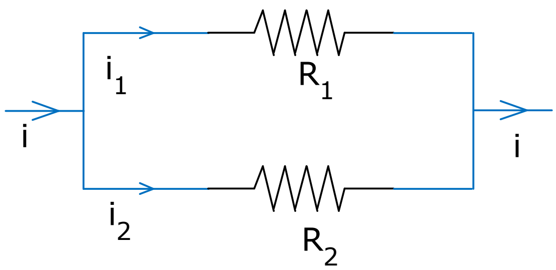
Using kirchoff's first law

$i = i_1 + i_2$ --------- (1)

kirchoff's second law

$i_1R_1 - i_2R_2 = 0$

$\frac{i_1}{i_2} = \frac{R_2}{R_1}$ -------(2)



Heat produced in the circuit in t second is

$H = i_1^2R_1t + i_2^2R_2t$

$H = i_1^2R_1t + (i-i_1)^2 R_2 t$ (using eg.(1))

If the heat produced is minimum then $\frac{dH}{di_1} = 0$

$\therefore\ 0 = 2i_1R_1t + 2(i-i_1)(-1)R_2t$

$\cancel{2}(i-i_1)R_2\cancel{t} = \cancel{2}i_1 R_1\cancel{t}$

$(i-i_1)R_2 = i_1 R_1$

$\boxed{\frac{i_1}{i_2} = \frac{R_2}{R_1}}$ This is in accordance with kirchoff's law.

Ans 8. (a) It is defined as the potential difference between the two electrodes of the cell in open Circuit (when no current is drawn) It depends on the following factors

(i) Nature of Electrodes

(ii) Nature and concentration of the Electrolytes

(iii) Temperature of the cell.

(b) Internal resistance of the cell.

$r = R\left(\frac{\ell 1 - \ell_2}{\ell_2}\right)$

Here $\ell_1 = 76.3cm$

$\ell_2 = 64.8cm$

$R = 9.5\,\Omega$

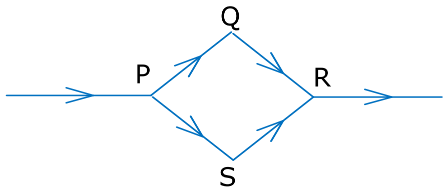
$\Rightarrow r = 9.5\left(\frac{76.3 - 64.8}{64.8}\right)$

$\boxed{r = 1.68\Omega}$

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

1. State two properties of the material of the wire used for suspension of the coil in a moving coil galvanometer? [1]
2. What will be the path of a charged particle moving along the direction of a uniform magnetic field? [1]
3. A steady current flows in the network shown in the figure. What will be the magnetic field at the centre of the network? [2]



4. An $\propto$ - particle and a proton are moving in the plane of paper in a region where there is uniform magnetic field B directed normal to the plane of paper. If two particles have equal linear momenta, what will be the ratio of the radii of their trajectories in the field? [2]
5. Derive an expression for the force acting on a current carrying conductor placed in a uniform magnetic field Name the rule which gives the direction of the force. Write the condition for which this force will have (1) maximum (2) minimum value? [3]
6. A straight wire carries a current of 10A. An electron moving at 10^7 m/s is 2.0 cm from the wire. Find the force acting on the electron if its velocity is directed towards the wire? [3]
7. State Biot- Savarts law. Derive an expression for magnetic field at the centre of a circular coil of n-turns carrying current – I? [3]
8. (a) What is cyclotron? Explain its working principle? [5]

   (b) A cyclotron's oscillator frequency is 10MHz what should be the operating magnetic field for accelerating protons? If radius of its dees is 20cm, what is the K.E .of the proton beam produced by the accelerator?($e = 1.6 \times 10^{-19}c$, $mp = 1.6 \times 10^{-27}kg$ $1Mev = 1.602 \times 10^{-13}J$)?

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

[ANSWERS]

Ans 1. (a) Non-Brittle conductor

(b) Restoring Torque per unit Twist should be small.

Ans 2. The path of a charged particle will be a straight line path as no force acts on the particle.

Ans 3. Zero , because magnetic field at the centre of the loop is just equal and opposite i.e. magnetic field due 1- PQR is equal and opposite to that of PSR.

Ans 4. Since radius of the path (R) = $\frac{mv}{Bq}$

$$=> R \propto \frac{1}{q}$$

$$=> \frac{R \propto}{RP} = \frac{qp}{q \propto} = \frac{e}{2e} = \frac{1}{2}$$

$$=> R\propto : Rp = 1:2.$$

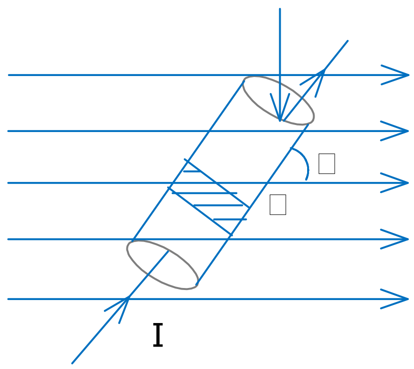
Ans 5. A conductor is placed in a uniform magnetic field $\vec{B}$ which makes and angle θ with $\vec{B}$.

Let I current flows through the conductor.

If n is the no. of electrons per unit volume of the conductor, then Total no. of electrons in small current element $d\ell l$ = nAdl

=> θ = Ne

=> θ = nAdl e



$\vec{f}$ be the force experienced by each electron

$$\vec{f} = e\ (\vec{vd} \times \vec{B})$$

Force experienced by small current element

$$\vec{dF} = \text{neAdl}\ (\vec{vd} \times \vec{B})$$

dF = neAvd dl B sin θ

(I = neAvd)

=> df = IdlBsin θ

Hence total force experienced

$$F = \int_o^l dF = \int_o^l IdlB\sin\theta$$

$F = IBl\sin\theta$

In vector form $\vec{F} = I\,(\vec{l} \times \vec{B})$

(a)Force will be maximum when $\theta = 90^0$

(b) Force will be minimum when $\theta = 0^0$

Ans 6. Here $I = 10A$

$V = 10^7$ m/s

$R = 2.0$ cm $= 2\times10^{-2} m$

Force acting on moving electron (F) = qVBsinθ

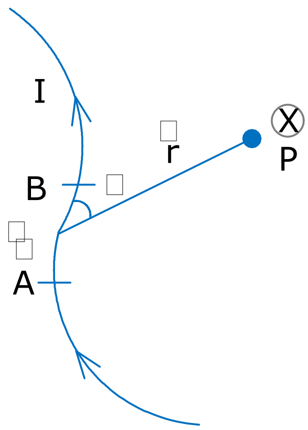
$\Rightarrow B = \frac{\mu 0}{4\pi}\frac{2I}{r}$

$B = \frac{10^{-7}\times \not{2}\times 10}{\not{2}\times 10^{-2}}$ = 10-4 tesla and $\perp$ to the plane of paper and directed downwards.

Now $F = 1.6\times10^{-19}\times10^{7}\times10^{-4}\sin 90^0$

$F = 1.6\times10^{-16}$ Newton.

Ans 7. Biot – Savart law states that the magnetic field db due to a current element $\vec{dl}$ at any point is



ie $dB \propto I$

$dB \propto dl$

$dB \propto \sin\theta$

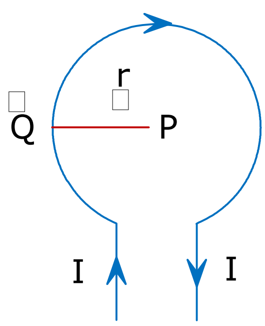
$dB \propto \frac{1}{r^2}$

Combining all we get

$$dB \propto \frac{Idl\sin\theta}{r^2}$$

$$\boxed{dB = \frac{\mu 0}{4\pi}\frac{Idl\sin\theta}{r^2}}$$

Consider a circular loop of radius r carrying a current I.



Since $dl \perp \vec{r}$

$\Rightarrow \theta = 90^0$

Applying Biot Savart law

$$dB = \frac{\mu 0}{4\pi}\frac{Idl\sin 90^0}{r^2}$$

For entire closed circular loop

$$B = \int_0^{2\pi r}\frac{\mu 0}{4\pi}\frac{Idl\sin 90^0}{r^2}$$

$$B = \frac{\mu 0}{4\pi}\frac{I}{r^2}\int_0^{2\pi r} dl = \frac{\mu o}{4\pi}\ \frac{I}{r^{\not 2}}\times 2\pi \not r$$

For n turns of a coil $\boxed{B = \frac{\mu 0}{4\pi}\ \frac{2\pi n I}{r}}$

<u>Ans 8.</u> (a) It is a device used to accelerate charged particles like protons, deutrons , $\propto$ - particle etc.

It is based on the principle that a charged particle can be accelerated to very high energies by making it pass through a moderate electric field a number of times and applying a strong magnetic field at the same time.

(b) $v = 10\text{MHz} = 10\times10^6$ Hz

$e = 1.6\times10^{-19}$ C

$m_p = 1.6\times10^{-27}$ kg

$r = 20\text{cm} = 20\times10^{-2}$m

$$KE = \frac{q^2B^2r^2}{2m}$$

Using $v = \frac{qB}{2\pi m}$

$$B = \frac{2\pi m V}{q}$$

$$B = \frac{2\times3.14\times1.6\times10^{-27}\times10^7}{1.6\times10^{-19}}$$

$$B = 0.628\ T$$

$$KE = \frac{\left(1.6\times10^{-19}\right)^2\times\left(0.66\right)^2\times\left(0.2\right)^2}{2\times1.67\times10^{-27}}$$

$KE = 13.35\times10^{-13}$ J

$1.602\times10^{-13}\ Joules$ = 1MeV

Since

=> 12.02×10^{-13}J has $\frac{12.02\times10^{-13}}{1.602\times10^{-13}} MeV$

$\boxed{KE = 8.3 MeV}$

CBSE TEST PAPER-02
CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

1. Two wires of equal lengths are bent in the form of two loops. One of the loop is square shaped whereas the other loop is circular .These are suspended in a uniform magnetic field and the same current is passed through them. Which loop will experience greater torque? Give reasons? [1]
2. A cyclotron is not suitable to accelerate electron. Why? [1]
3. Give one difference each between diamagnetic and ferromagnetic substances. Give one example of each? [2]
4. Write the expression for the force acting on a charged particle of charge q moving with velocity is in the presence of magnetic field B. Show that in the presence of this force. [2]
   (a) The K.E. of the particle does not change.
   (b) Its instantaneous power is zero.
5. An electron of kinetic energy 25KeV moves perpendicular to the direction of a uniform magnetic field of 0.2 millitesla calculate the time period of rotation of the electron in the magnetic field? [2]
6. It is desired to pass only 10% of the current through a galvanometer of resistance 90 Ω . How much shunt resistance be connected across the galvanometer? [2]
7. What is radial magnetic field? How it is obtained in moving coil galvanometer? [2]
8. Two straight parallel current carrying conductors are kept at a distanced r from each other in air. The direction for current in both the conductor is same. Find the magnitude and direction of the force between them. Hence define one ampere? [3]
9. (a) Draw a labelled diagram of a moving coil galvanometer. Prove that in a radial magnetic field, the deflection of the coil is directly proportional to the current flowing in the coil. [6]
   (b) A galvanometer can be converted into a voltmeter to measure upto
   (i) V volt by connecting a resistance R_1 series with the coil
   (ii) $V/2$ volt by connecting a resistance R_2 in series with coil Find R in terms of R_1 and R_2 required to convert – it into a voltmeter that can read upto '2v' volt.

CBSE TEST PAPER-02
CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

[ANSWERS]

Ans 1. since τ = NIAB

since Area of - circular loops is more Than of a square loop

=> Torque experienced by a circular loop is greater.

Ans 2. A cyclotron is not suitable to accelerate electron because its mass is less due to which they gain speed and step out of the dee immediately.

Ans 3. Diamagnetic substances are weakly repelled by a magnet eg. Gold.
Ferromagnetic materials are strongly attracted by a magnet eg. Iron.

Ans 4. Since $F = q\,(\vec{v} \times \vec{B})$

(a) Since direction of force is perpendicular to the plane containing $(\vec{v} \times \vec{B})$

=> $w = Fs\cos\theta \quad (\theta = 90^0)$

$w = Fs\cos 90^0 = 0$

=> KE = 0 $\therefore$ KE will not – change

(b) since $p = Fv\cos\theta = Fv\cos 90^0 = 0$ => Instantaneous power is also zero.

Ans 5. $B = 0.2\,T = 0.2 \times 10^{-3} T$

Time Period $T = \dfrac{2\pi M}{QB}$

$$T = \frac{2 \times 3.14 \times 9.1 \times 10^{-31}}{1.6 \times 10^{-17} \times 0.2 \times 10^{-3}}$$

$T = 1.787 \times 10^{-7}$ second

Ans 6. $IG = 10\%$ of $I = \dfrac{10I}{100}$ $G = 90\Omega$

$$S = \frac{IgG}{I - Ig} = \frac{\frac{10 I}{100} \times 90}{I - \frac{10 I}{100}}$$

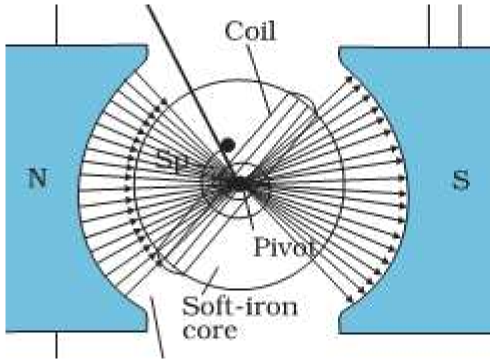
$$S = \frac{9I}{\frac{10I - I}{10}}$$

$$S = \frac{90I}{90I} = 10$$

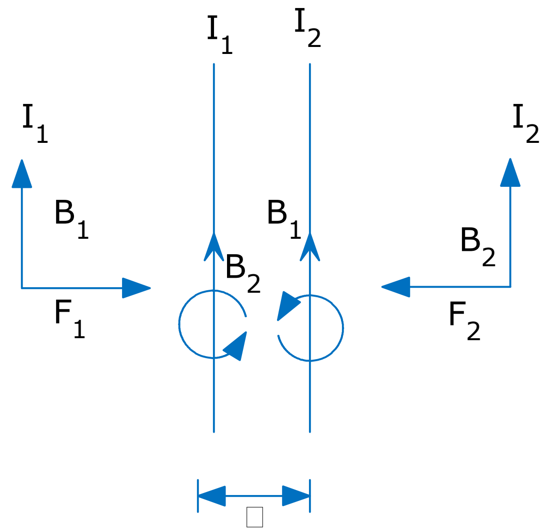
=> $\boxed{s = 10\Omega}$

Ans 7. A radial magnetic field is one in which plane of the coil always lies in the direction of the magnetic field. It can be obtained by

(a) Properly cutting the pole pieces concave in shape.
(b) Placing soft iron cylindrical core between the pole pieces.



Ans 8. Consider two parallel conductors carrying or current – I_1 & I_2 and is separated by a distance'd'.



Magnetic field due to current I_1 at any paint on conductor (2) is

$$B1 = \frac{\mu 0}{4\pi}\frac{2I1}{d} \quad \text{----(1)}$$

(⊥ to the plane&Downwards(×))

Since current carrying conductor is placed at right angles to the magnetic field

=> $F = BI\,l \sin 90^0$

$F = B\,I\,l$

=> Force experienced per unit length of conductor ------ (2)

Is $F_2 = B_1 I_2 \times 1$

$$F_2 = \frac{\mu 0}{4\pi}\frac{2I_1 I_2}{d} \quad \text{----------- (2)}$$

Fleming's left hand Rule says F_2 is directed towards conductor (1)

Similarly $F_1 = \frac{\mu 0}{4\pi}\frac{2I_1 I_2}{d}$ (Directed Towards conductor (2))

Since F_1 and F_2 are equal and opposite so two parallel current carrying conductor attract each other.

$$\text{Since } F = \frac{\mu 0}{4\pi}\left(\frac{2I_1 I_2}{d}\right)$$

If $I_1 = I_2 = 1A \quad d = 1m$

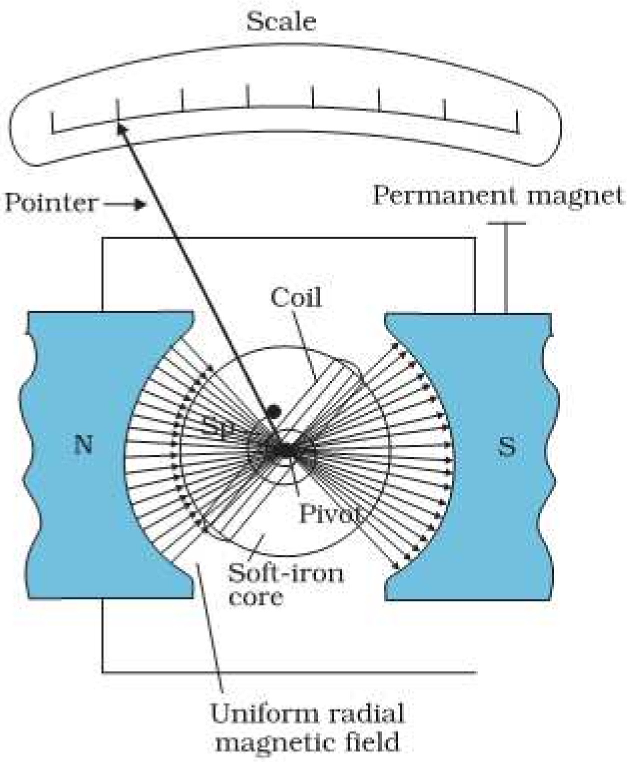
$F = 2\times 10^{-7}$m.

Thus one ampere is that current which is flowing in two infinitely long parallel conductors separated by a distance of 1 meter in vacuum and experiences a force of 2×10^{-7}N on each meter of the other wire.

Ans 9. (a) When a current I is passed through a coil two equal and opposite forces acts on the arms of a coil to form a couple which exerts a Torque on the coil.

=> τ = NIAB sinθ

If θ = 90^0 ($\sin 90^0 = 1$)



θ is the angle made by the normal to the plane of coil with B

τ = NIAB ------------ (1)

This is called as deflecting torque

As the coil deflected the spring is twisted and a restoring torque per unit twist then the restoring torque for the deflecting & is given by

τ' = k ϕ ------------(2)

In equilibrium

Deflecting Torgue = Restoring Torgue

NIAB = Kϕ

$$I = \frac{K\phi}{NAB}\phi$$

I = Gϕ where G = $\frac{K}{NAB}$ (galvanometer constant)

=> $\boxed{I \propto \phi}$

Thus deflection of the coil is directly proportional to the current flowing in the coil.

Ans 9. (b) We know Ig = $\frac{V}{R+R_G}$

=> Ig = $\frac{V}{R_1+R_G}$ -------------- (1)

And Ig = $\frac{\frac{v}{2}}{R_2+R_G}$ -------- (2)

Equating (1) & (2)

$$\frac{V}{R_1+R_G} = \frac{\frac{v}{2}}{R_2+R_G}$$

Ie $R_1+R_G = 2(R_2+R_G)$

$R_G = -2R_2 + R_1$

For conversion Ig = $\frac{2V}{R+R_G}$ => Ig $\frac{V}{R1+R_G} = \frac{2V}{R+R_G}$

Ig= $2R_1 + 2R_G = R + R_G$

$R = 2R_1 + R_G$

$R = 2R_1 + R_1 - 2R_2$

$\boxed{R = 3R_1 - 2R_2}$

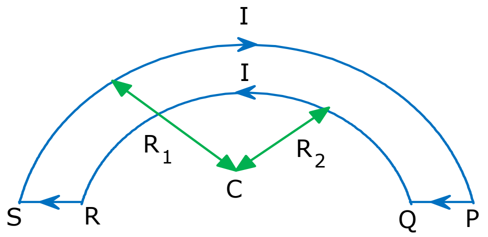
CBSE TEST PAPER-03

CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

1. How does the intensity of magnetization of a paramagnetic material vary with increasing applied magnetic field? [1]

2. An iron bar magnet is heated to 1000^0C and then cooled in a magnetic field free space. Will it retain magnetism? [1]

3. Two wires loops PQRSP formed by joining two semicircular wires of radii R_1 and R_2 carries a current I as shown in the figure. What is the magnetic of the magnetic induction at the centre C.? [1]



4. What is the magnetic moment associated with a coil of 1 turns, area of cross-section $10^{-4}m^2$ carrying a current of 2A? [1]

5. A circular coil is placed in uniform magnetic field of strength 0.10T normal to the plane of coil. If current in the coil is 5.0A. Find. [1]

   (a) Total torque on the coil

   (b) Total force on the coil

   (c) Average force on each electron due to magnetic field

   (The coil is made of copper wire of cross- sectional area 10^{-5} m^2 and free electron density in copper is 10^{29} m^{-3})

6. A particle of mass m and charge q moving with a uniform speed v normal to a uniform magnetic field B describes a circular path of radius & Derive expressions for (1) Radius of the circular path (2) time period of revolution (3) Kinetic energy of the particle? [1]

7. Using Ampere's circuital law, derive an expression for magnetic field along the axis of a Toroidal solenoid? [1]

8. Write an expression for the force experienced by the charged particle moving in a uniform magnetic field B With the help of labeled diagram explain the working of cyclotron? Show that cyclotron frequency does not depend upon the speed of the particle? [1]

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

[ANSWERS]

Ans 1. Intensity of magnetization increases with the increase in applied magnetic field.

Ans 2. Curie temperature of iron is about 770^0C but when it is heated to a very higher temperature magnetism of iron further gets lost and it will not retain magnetism.

Ans 3. Magnetic field due to semicircle QR at C. is

$$B_1 = \frac{1}{2}\frac{\mu 0}{\mu\pi}\frac{2\pi I}{R_1}$$

Magnetic field due to semicircle is at C is

$$B_2 = \frac{1}{2}\frac{\mu 0}{\mu\pi}\frac{2\pi I}{R_2}$$

Net field $B = B_1 - B_2$

$$B = \frac{1}{\not 2}\frac{\mu 0}{\not 4\pi}\not 2\pi I\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$B = \frac{\mu 0 I}{4}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Ans 4. $m = NIA$

$m = 1\times 10^{-4}\times 2$

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

Ans 5. (a) $B = 0.10T$

$\theta = 0^0$ (Normal to plane of the coil)

$I = 5.0$ A , Area $= 10^{-5}$ m2 $n = 10^{29}\ m^{-3}$

$$\tau = MB\sin\theta$$

$$\tau = MB\sin 0^0 = 0$$

(b) Total force on the coil = 0 Newton

(c) Fav = q $(\vec{vd} \times \vec{B})$

(I = neAVd)

$$Fav = \frac{\not qI}{n\not eA}\times B$$

$$Fav = \frac{IB}{nA} = \frac{5\times 0.10}{10^{29}\times 10^{-5}}$$

$$\boxed{Fav = 5\times 10^{-25}\,N}$$

Ans 6. A particle of mass (m) and change (q) moving with velocity υ normal to $\vec{B}$ describes a circular path if

$$\frac{mv^2}{r} = qBv\sin\theta \qquad (\therefore \theta = 90^0)$$

-

$$\Rightarrow \frac{mv^{\not 2}}{r} = q\not vB$$

$$\Rightarrow \boxed{r = \frac{mv}{Bq}} ----(1)$$

Since Time period of Revolution

During circular path = $\dfrac{\text{Circumference of circle}}{velocity}$

$$\Rightarrow \quad T = \frac{2\pi r}{v} \qquad (\therefore v = \frac{Bqr}{m} \text{ from eg.}(1))$$

$$\Rightarrow \quad T = \frac{2\pi \not r \times m}{Bq\not r}$$

$$\boxed{T = \frac{2\pi m}{Bq}} \text{-----}(2)$$

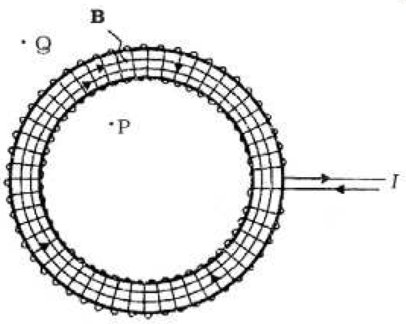
Kinetic energy K.E = $\frac{1}{2}$ mv^2

$$\Rightarrow KE = \frac{1}{2} m \left(\frac{Bqr}{m}\right)^2$$

$$\boxed{KE = \frac{B^2 q^2 r^2}{2m}} ---(3)$$

Ans 7. If n be the no, of turns per unit length I be the current flowing through the Toroid

Then from Ampere's circuital law



$$\oint \vec{B}.\,\vec{d\ell} = \mu_0 \times \text{total current flowing in the toroid}$$

$$\oint \vec{B}.\,\vec{d\ell} = \mu_0\,(2\pi rnI)$$

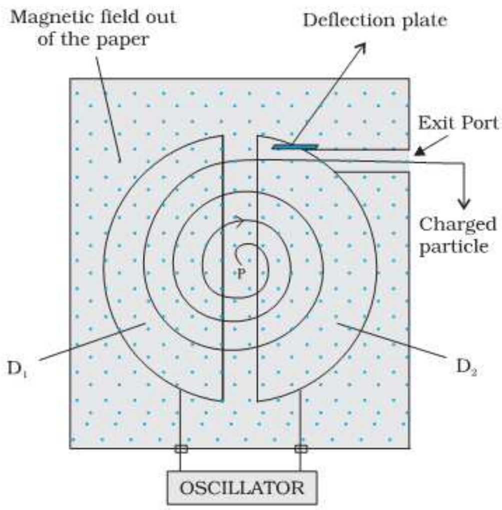
$$\int_0^{2\pi r} B\,d\ell \cos 0^0 = \mu_0\,(2\pi rnI)$$

$$B\int_0^{2\pi r} d\ell = \mu_0\,(2\pi rnI)$$

$$B.\cancel{2}\cancel{\pi}\cancel{r} = \mu_0\,(\cancel{2}\cancel{\pi}\cancel{r}nI)$$

$$B = \mu_o nI$$

Ans 8. Force experienced by the charged particle moving at right angles to uniform magnetic field $\vec{B}$ with velocity $\vec{v}$ is given by $\vec{F} = q\,(\vec{v}\times\vec{B})$



Initially Dee D_1 is negatively charged and Dee D_2 is positively charged so, the positive ion will get accelerated towards Dee D_1 since the magnetic field is uniform and acting at right angles to the plane of the Dees so the ion completes a circular path in D1 when ions comes out into the gap, polarity of the Dee's gets reversed used the ion is further accelerated towards Dee D_2 with greater speed and cover a bigger semicircular path. This process is separated time and again and the speed of the ion becomes faster till it reaches the periphery of the dees where it is brought out by means of a deflecting plate and is made to bombard the target.

Since F = qVBsin90^0 provides the necessary centripetal force to the ion to cover a circular path so we can say $\frac{mv^{\cancel{2}}}{r} = q\cancel{v}B$

$$\Rightarrow r = \frac{mv}{Bq} \quad \text{----- (1)}$$

$$\text{Time period} = \frac{2\pi r}{v} = \frac{2\pi \cancel{v} m}{Bq\cancel{v}} = \frac{2\pi m}{Bq}$$

$$V = \frac{1}{T} = \frac{Bq}{2\pi m} \Rightarrow \text{frequency is independent of velocity}$$

CBSE TEST PAPER-04
CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

1. How will the magnetic field intensity at the centre of a circular our carrying current change, if the current though the will is doubled and radius of the coil is halved? [1]
2. Can neutrons be accelerated in a cyclotron? Why? [1]
3. A bar magnet of magnetic moment M is aligned parallel to the direction of a uniform magnetic field B. What is the work done to turn the magnet, so as the align its magnetic moment [1]
   (i) Opposite to the field direction (ii) Normal to the field direction?
4. An electron in the ground state of hydrogen atom is revolving in anti - clock wise direction in a circular orbit. The atom is placed normal to the electron orbit makes an angle of 30^o in the magnetic induction. Find the torque experienced by the orbiting electron? [1]
5. A short bar magnet of magnetic moment 0.9 J/T is placed with its axis at 60^o to a uniform magnetic field. It experience a torque of 0.063 Nm. (i) calculate the strength of the magnetic field and (ii) what orientation of the bar magnet corresponds to the equilibrium position in the magnetic field? [1]
6. A beam of electrons is moving with a velocity of 3×10^6 m/s and carries a current of 1 μ A. [1]
   (a) How many electrons per second pass a given point?
   (b) How many electrons are in 1m of the beam?
   (c) What is the total force on all the electrons in 1m of the beam if it passes through the field of $0.1 NA^{-1} m^{-1}$?
7. What is the main function of soft iron core used in a moving coil galvanometer? A galvanometer gives full deflection for Ig. Can it be converted into an ammeter of range I < Ig? [1]
8. (a) Obtain an expression for the torque acting on a current carrying circular loop. [1]
   (b) What is the maximum torque on a galvanometer coil 5 cm $\times$12 cm of 600 turns when carrying a current of 10^{-5} A. in a field where flux density is 0.10 Wb / m^2?

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

[ANSWERS]

Ans 1: Since B = $\frac{\mu_o}{4\pi}\frac{2\pi I}{r}$

$$B' = \frac{\mu_o}{4\pi}\frac{2\pi(2I)}{r/2}$$

$$B' = 4\left(\frac{\mu_o}{4\pi}\frac{2\pi I}{r}\right)$$

B'= 4B

Ans 2: No, neutrons cannot be accelerated in a cyclotron because neutron is neutral and cyclotron can accelerate only charged particles.

Ans 3: Since work done W = MB $(\cos\theta_1 - \cos\theta_2)$

(i) $\theta_1 = 0^o$ and θ_2 = 180°

$\rightarrow W = MB(\cos 0 - \cos 180^o)$

W = MB [1- (-1)]

W = 2MB

(ii) $\theta_1 = 0^o$ and θ_2 = 90°

W = MB (cos 0 - cos 90°)

W = MB

Ans 4: Magnetic moment associated with electron M = $\frac{eh}{4\pi m_e}$

$\theta = 30^o$

$and \;\; \tau = MB\sin\theta$

$$\tau = \frac{eh}{4\pi m_e}B\times\sin 30^o = \frac{eh}{4\pi m_e}B\times\frac{1}{2}$$

$\tau = \frac{ehB}{8\pi m_e}$

Ans 5: (i) Since $\tau = MB\sin\theta$

Here $\theta = 60^o$

$\tau = 0.063 Nm$

$M = 0.9 \; J/T$

$$\Rightarrow B = \frac{\tau}{M\sin\theta} = \frac{0.063}{0.9\times\sin 60^o}$$

$$\Rightarrow B = 0.081T$$

(ii) The magnet will be in stable equilibrium in the magnetic field if $\tau = 0$

$\Rightarrow MB\sin\theta = 0 \Rightarrow \theta = 0^o$

i.e When magnet aligns itself parallel to the field

Ans 6: $\upsilon = 3\times10^6 m/A$

$I = 1\mu A = 1\times10^{-6} A$

(a) $n = \frac{I}{q} = \frac{10^{-6}}{1.6\times10^{-19}C} = 6.25\times10^{12}$

(b) Electrons traverse a distance of 3×10^6 m in 1 s

∴ No. of electrons in 1 meter of the beam

$= \frac{6.25\times10^{12}}{3\times10^6} = 2.08\times10^6 m^{-1}$

(c) Force on 1 meter of the beam of electrons

Ans 7: Soft iron core is used the moving coil galvanometer because it increases the strength of the magnetic field thus increases the sensitivity of the galvanometer.

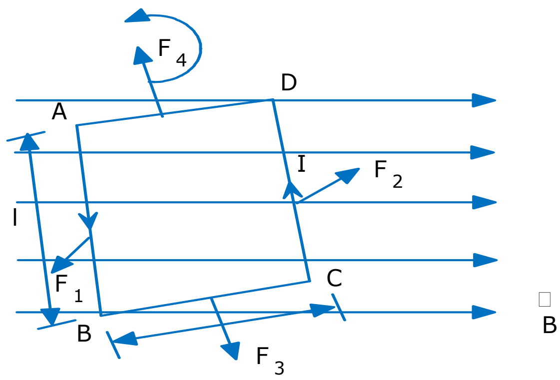
We know S = $\frac{GIg}{I - Ig}$

For I < Ig, S becomes negative

Hence it cannot be converted into an ammeter of range I < Ig.

Ans 8: ABCD is a rectangular loop of length (L), breadth (b) and area (A). Let I be the Current flowing in the anti clockwise direction. Let θ be the angle between the normal to the loop and magnetic field $\vec{B}$

Force acting on arm AB of the loop



$\vec{F}_1 = I(\vec{L}\times\vec{B})(outwards)$

Force on arm CD

$\vec{F}_2 = I(\vec{L}\times\vec{B})(inwards)$

Force on arm BC

$\vec{F}_3 = I(\vec{b}\times\vec{B})(downwards)$

Force on arm DA

$\vec{F}_4 = I(\vec{b}\times\vec{B})(upwards)$

Since F_3 and F_4 are equal and opposite and also acts along the same line, hence they cancel each other.

F_1 and F_2 are also equal and opposite but their line of action is different, so they form a couple and makes the rectangular loop rotate anti clockwise.

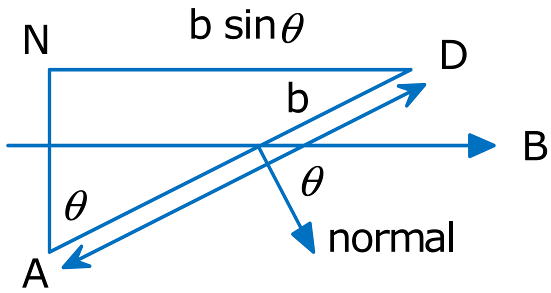
Thus τ = either force $\times\perp$ distance

$$\tau = I(\vec{L}\times\vec{B})\times DN$$

$$\tau = I(\vec{L}\times\vec{B})\times b\sin\theta$$

$$\tau = I\ LB\sin 90^o b\sin\theta$$

$$\tau = I\ A\,B\,\sin\theta$$



For loop of N turns

$$\tau = NIAB\sin\theta$$

$$\tau = MB\sin\theta(\because M = NIA)$$

$$\vec{\tau} = \vec{M}\times\vec{B}$$

Where M is magnetic moment of the loop.

$$\tau = NIAB\sin\theta$$

Torque will be maximum when θ = 90°

$$\Rightarrow \tau_{\max} = NIAB(\because Sin90^o = 1)$$

$$\tau_{\max} = 600\times10^{-5}\times(0.10)(60\times10^{-4})$$

$$\boxed{\tau_{\max} = 3.6\times10^{-6}\,Nm}$$

CBSE TEST PAPER-05

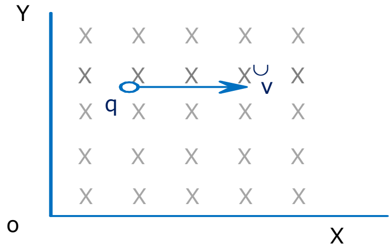
CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

1. What type of magnetic material is used in making permanent magnets? [1]

2. Which physical quantity has the unit wb/m^2? Is it a scalar or a vector quantity? [1]

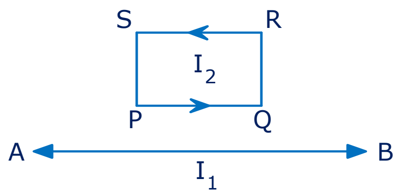
3. Define angle of dip. Deduce the relation connecting angle of dip and horizontal component of earth's total magnetic field with the horizontal direction. [2]

4. A point change +q is moving with speed υ perpendicular to the magnetic field B as shown in the figure. What should be the magnitude and direction of the applied electric field so that the net force acting on the charge is zero? [2]



5. The energy of a charged particle moving in a uniform magnetic field does not change. Why? [2]

6. In the figure, straight wire AB is fixed; white the loop is free to move under the influence of the electric currents flowing in them. In which direction does the loop begin to move? Justify. [2]



7. State two factors by which voltage sensitivity of a moving coil galvanometer can be increased? [2]

8. The current sensitivity of a moving coil galvanometer increases by 20% when its resistance is increased by a factor of two. Calculate by what factor, the voltage sensitivity changes? [3]

9. (a) Show how a moving coil galvanometer can be converted into an ammeter? [5]

   (b) A galvanometer has a resistance $30\,\Omega$ and gives a full scale deflection for a current of 2mA. How much resistance in what way must be connected to convert into?

   (1) An ammeter of range 0.3A

   (2) A voltammeter of range 0.2V.

CBSE TEST PAPER-05

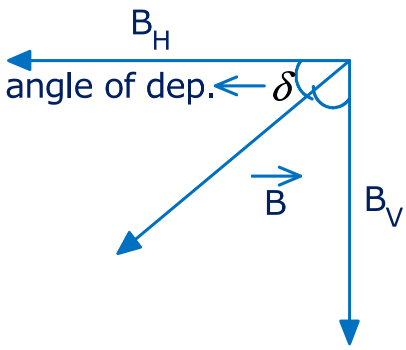
CLASS - XII PHYSICS (Magnetic effects of current and magnetism)

[ANSWERS]

Ans 1: Material having high coercivity is used in making permanent magnets.

Ans 2: Magnetic field. It is a vector quantity.

Ans 3:
$$\frac{BH}{B} = \cos\delta$$
$$\frac{BV}{B} = \sin\delta$$
$$\Rightarrow \frac{\sin\delta}{\cos\delta} = \frac{BV}{B} \times \frac{B}{BH}$$
$$\boxed{Tan\delta = \frac{BV}{BH}}$$



Ans 4: Force on the charge due to magnetic field = qVB sin θ

Since $\vec{B}$ is $\perp$ to the plane of paper and in words

$\therefore$ F = qVB sin 90^o

F = qVB (along OY)

Force on the charge due to electric field

F = qE

Net force on change is zero if $\Rightarrow$ qE = qVB

$\boxed{E = VB}$ (along YO)

Ans 5: The force on a charged particle in a uniform magnetic field always acts in a direction perpendicular to the motion of the charge. Since work done by the magnetic field on the charge is zero, hence energy of the charged particle will not change.

Ans 6: Since current in AB and arm PQ are in same direction therefore wire will attract the arm PQ with a force (say F_1)

But repels the arm RS with a force (say F_2)

Sine arm PQ is closer to the wire AB

$F_1 > F_2$ i.e. the loop will move towards the wire.

Ans 7: Voltage sensitivity = $\frac{nBA}{kR}$

It can be increased by

(1) increasing B using powerful magnets

(2) decreasing k by using phosphor borne strip

Ans 8: Current sensitivity $\frac{\alpha}{I} = \frac{nBA}{k} ------(i)$

Voltage sensitivity $\frac{\alpha}{V} = \frac{nBA}{kR} ------(ii)$

Resistance of a galvanometer increases when n and A are changed

Given $R' = 2R$

Then n = n' and A = A'

New current sensitivity

$$\frac{\alpha'}{I'} = \frac{n'A'B}{k} ------(iii)$$

New voltage sensitivity

$$\frac{\alpha'}{V} = \frac{\alpha'}{I'R'} = \frac{n'A'B}{2kR} -----(iv)$$

$$Since \frac{\alpha'}{I'} = \frac{120}{100}\frac{\alpha}{I} ------(v)$$

From (i) and (iii)

$$\frac{n'A'B}{R} = \frac{\alpha}{I}\frac{120}{100}$$

$$\frac{n'A'\not{B}}{\not{k}} = \frac{nA\not{B}}{\not{k}}\frac{120}{100}$$

$$n'A' = \frac{6}{5}nA$$

Using equation (iv)

$$\frac{\alpha'}{V} = \frac{6}{5}\frac{nAB}{2kR}$$

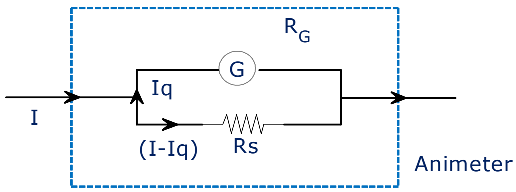
$$\frac{\alpha'}{V} = \frac{3nAB}{5kR}$$

$$\frac{\alpha'}{V} = \frac{3}{5}\frac{\alpha}{V}$$

Thus voltage sensitivity decreases by a factor of $\frac{3}{5}$.

Ans 9: (a) A galvanometer can be converted into an ammeter by connecting a low resistance called shunt parallel to the galvanometer.

Since G and R_S are in parallel voltage across then is same $I_gR_G = (I - I_g) R_S$



$\Rightarrow$ $$Rs = \left(\frac{Ig}{I - Ig}\right) R_G$$

(b) (1) I = 0.3A G = 30 Ω Ig = 2mA = 2×10^{-3} A

Sheent (S) = $\frac{IgG}{I - Ig}$

$$S = \frac{2\times10^{-3}\times30}{(0.3 - 2\times10^{-3})}$$

S = 0.2 Ω

(2) G = 30 π, Ig = 2mA = 2×10^{-3}A, V = 0.2V

Shunt Resistance (R) $\left(\frac{V}{Ig} - G\right)$

$$R = \left(\frac{0.2}{2\times10^{-3}} - 30\right)$$

R = 70 Ω

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)

1. A metallic wire coil is stationary in a non – uniform magnetic field. What is the emf. Induced in the coil? [1]

2. Why does metallic piece becomes very hot when it is surrounded by a coil carrying high frequency (H.F) alternating current? [1]

3. IF the rate of change of current of 2A/s induces an emf of 1omV in a solenoid. What is the self inductance of the solenoid? [1]

4. A circular copper disc. 10 cm in radius rotates at a speed of 2π rad/s about an axis through its centre and perpendicular to the disc. A uniform magnetic field of 0.2T acts perpendicular to the disc. [3]

   1) Calculate the potential difference developed between the axis of the disc and the rim.

   2) What is the induced current if the resistant of the disc is $2\,\Omega$?

5. How is the mutual inductance of a pair of coils affected when [3]

   (1) Separation between the coils is increased.

   (2) The number of turns of each coil is increased.

   (3) A thin iron sheet is placed between two coils, other factors remaining the same. Explain answer in each case.

6. Distinguish between resistances, reactance and impedance of an a.c. circuit? [3]

7. A sinusoidal voltage V = 200 sin 314t is applied to a resistor of $10\,\Omega$ resistance. Calculate [3]

   (1) rms value of the voltage

   (2) rms value of the current

   (3) Power dissipated as heat in watt.

8. (a) State the condition under which the phenomenon of resonance occurs in a series LCR circuit. Plot a graph showing the variation of current with frequency of a.c. sources in a series LCR circuit. [3]

   (b) Show that in a series LCR circuit connected to an a.c. source exhibits resonance at its natural frequency equal to $\frac{1}{\sqrt{LC}}$?

Ans 1: NO emf is induced in the coil as there is no change in the magnetic flux linked with the secondary coil.

Ans 2: When a metallic piece is surrounded by a coil carrying high frequency (H.F) alternating current, it becomes hot because eddy currents are produced which in turn produces joule's heating effect.

Ans 3: $L = \frac{\in}{dI/dt} = \frac{10\times10^{-3}}{2} = 5\times10^{-3} Henry$

$\Rightarrow$ $\boxed{L = 5\times10^{-3} H}$

Ans 4: (1) Radius = 10cm, B = 0.2T w = 2π rad/s

$\in = \frac{1}{2} Bwr^2$

$\in = \frac{1}{2}\times0.2\times2\pi\times(0.1)^2$

$\in = 0.00628\ volts$

$I = \frac{\in}{R} = \frac{0.0628}{2}$ $\boxed{I = 0.0314\ A}$

Ans 5: (1) When the Separation between the coils is increased, the flux linked with the secondary coils decreases, hence mutual induction decreases.

(2) Since m = $\frac{\mu o N_1 N_2 A}{l}$, so when N_1 and N_2 increases, mutual induction increase.

(3) Mutual induction will increase because $M \propto \mu r$ (Relative permeability of material)

Ans 6:

	Resistance	**Reactance**	**Impedance**
1	Opposition offered by the resistor to the flow of current	Opposition offered by the inductor or capacitor to the flow of current	Opposition offered by the combination of resistor, inductor or capacitor
2	It is independent of the frequency of the source.	It depends on the frequency of the source	It depends on the frequency of the source

Ans 7: V = 200 sin 314t

V = Vo sin wt

Vo = 200V, w = 314 rad/s.

R = 10 Ω

(1) V rms = $\sqrt{2}Vo$

V rms = $\sqrt{2}\times 200$ = 282.8 V

(2) $I\ \text{rms} = \dfrac{V\ \text{rms}}{R} = \dfrac{282.8}{10}$

I rms = 28.28 A

(3) Since circuit is purely resistive

$\therefore \phi = 0$

$\Rightarrow P = EvIv\cos\phi$

$P = EvIv$

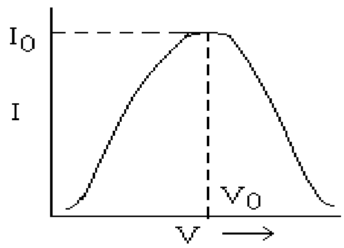
$P = 282.8 \times 28.28$

P = 7.998 watt

Ans 8: (a) In a series LCR circuit

Resonance occurs when $X_L = X_C$.

The variation of current with frequency of a.c. source in series LCR circuit



(b) Electrical resonance takes place in a series LCR circuit when circuit allows maximum alternating current for which

$X_L = X_C$

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

$$I = \frac{E}{Z} - \frac{E}{\sqrt{R^2 + (X_L - X_C)^2}}$$

For electrical resonance

$X_L = X_C$

$$WL = \frac{1}{WC} \ \ or\ \ W^2 = \frac{1}{LC}$$

$$W = \frac{1}{\sqrt{LC}}$$

Where w is the natural frequency of the circuit.

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)

1. An electrical element X when connected to an alternating voltage source has current through it leading the voltage by $\frac{\pi}{2}$ radian. Identify X and write expression for its reactance? [1]

2. A transformer steps up 220 V to2200 V. What is the transformation ratio? [1]

3. An ideal inductor consumer no electric power in a.c. circuit. Explain? [2]

4. Capacitor blocks d.c. why? [2]

5. Obtain an expression for the self inductance of a long solenoid? Hence define one Henry? [3]

6. A conducting rod rotates with angular speed w with one end at the centre the other end circumference of a circular metallic ring of radius R, about an axis passing through the centre of the coil perpendicular to the plane of the coil A constant magnetic field B parallel to the axis is present everywhere. Show that the emf. between the centre and the metallic ring is $\frac{1}{2}BwR^2$. [3]

7. (a) At a very high frequency of a.c. capacitor behaves as a conductor. Why? [3]

(b) Draw the graph showing the variation of reactance of

(i) A capacitor

(ii) An inductor with a frequency of an a.c. circuit.

8. In a step up transformer, transformation ratio is 100. The primary voltage is 200 V and input is 1000 watt. The number of turns in primary is 100. Calculate [5]

(1) Number of turns in the secondary

(2) Current in the primary

(3) The voltage across the secondary

(4) Current in the secondary

(5) Write the formula for transformation ratio?

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)
[ANSWERS]

Ans 1: X is a purely capacitive circuit

$$X_C = \frac{1}{2\pi\upsilon c} = \frac{1}{wC}$$

Ans 2: $$K = \frac{Ns}{Np} = \frac{Es}{Ep} = \frac{2200}{220} = 10$$

Ans 3: P = E rms I rms cos ϕ

But for an ideal inductor $\phi = \frac{\pi}{2}$

$\Rightarrow \cos\phi = \cos\frac{\pi}{2} = 0$

$\Rightarrow$ $\boxed{P = 0}$

Ans 4: The capacitive reactance

$$X_C = \frac{1}{wC} = \frac{1}{2\pi Vc}$$

For d.c. υ = 0

$\Rightarrow X_C = \infty$

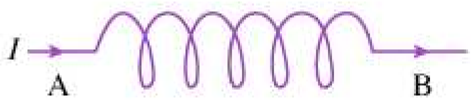
Since capacitor offers infinite resistance to the flow of d.c. so d.c. cannot pass through the capacitor.

Ans 5: Consider a long solenoid of area A through which current I is flowing
Let N be the total number of turns in the solenoid
Total flux ϕ = NBA
Here = B = μonI
Where n is no. of turns per unit length of the solenoid
N = nl

$\Rightarrow \phi = nl \times \mu onIA$

$\phi = \mu on^2 AlI$ ------ (1)

Also ϕ=LI-------------(2)



Equation (1) & (2)

$\mu on^2 Al\cancel{I} = L\cancel{I}$

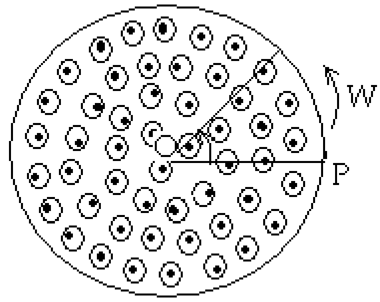
$L = \mu on^2 Al$

$\Rightarrow$ $$\boxed{L = \frac{\mu o N^2 A}{l}}$$ [n = N/ ℓ]

One henry – if current is changing at a rate of 1A/s in a coil induces an emf. of 1 volt in it then the inductance of the coil is one henry.

Ans 6: consider a circular loop connect the centre with point P with a resistor.
The potential difference across the resistor = induced emf.
$\in = B\times$ Rate of change of area of loop.
If the resistor QP is rotated with angular velocity w and turns by an angle θ in time t then

Area swept $A = \frac{1}{2}\times R\times R\theta$



$$A = \frac{1}{2}R^2\theta$$

$$\phi = BA\cos\theta^o = BA$$

$$\varphi = B\times\frac{1}{2}R^2\theta$$

$$\in = \frac{d\phi}{dt} = \frac{d}{dt}\left(\frac{1}{2}BR^2\theta\right) = \frac{1}{2}BR^2\left(\frac{d\theta}{dt}\right)$$

$$\boxed{\in = \frac{1}{2}BwR^2}$$

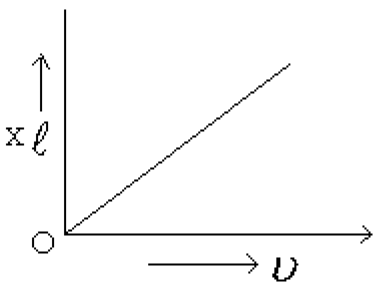
Ans 7: (a) $X_C = \frac{1}{2\pi\upsilon c}$
For a.c. when $\upsilon \to \infty$ $X_C = 0$
Thus at a very high frequency of a.c. capacitor behaves as a conductor

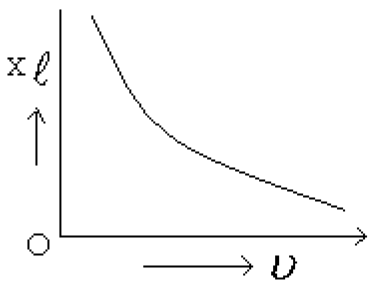
(b) $X_C = \frac{1}{2\pi\upsilon c}$

$$\Rightarrow X_C \propto \frac{1}{\upsilon}$$

$$X_L = WL = 2\pi\upsilon L$$

$$XL \propto \upsilon$$





Ans 8: (1) k = 100, Ep = 200V

EpIp = 1000 W, Np = 100

$$K = 100 = \frac{Ns}{Np}$$

$$\Rightarrow Ns = 100\times Np$$

$$Ns = 100\times 100$$

$$\boxed{NS = 10,000}$$

(2) EpIp = 1000W

$$Ip = \frac{1000}{Ep}$$

$$Ip = \frac{1000}{200} = 5A$$

Ip = 5A

(3) $\frac{Es}{Ep} = \frac{Ns}{Np}$

$$\therefore Es = Ep \times \frac{Ns}{Np}$$

$$Es = 200 \times 100$$

Es = 20000 Volt

(4) $\frac{Es}{Ep} = \frac{Ip}{Is}$

$$Is = \frac{IpEp}{Es}$$

$$Is = \frac{1000}{20000} = \frac{1}{20}$$

Is = 0.05 A

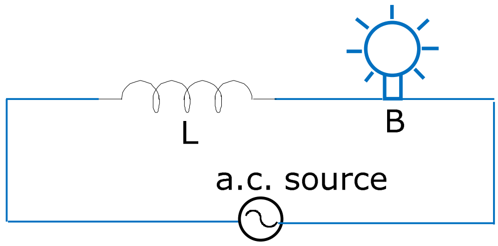
(5) For step up Trans former k > 1

$$K = \frac{Ns}{Np}$$

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)

1. The induced emf is also called back emf. Why? [1]
2. Why the oscillations of a copper disc in a magnetic field are lightly damped? [1]
3. Why is the emf zero, when maximum number of magnetic lines of force pass through the coil? [2]
4. An inductor L of reactance X_L is connected in series with a bulb B to an a.c. source as shown in the figure. [2]



Briefly explain how does the brightness of the bulb change when

(a) Number of turns of the inductor is reduced.

(b) A capacitor of reactance $X_C = X_L$ is included in series in the same circuit.

5. Calculate the current drawn by the primary of a transformer which steps down 200 V to 20 V to operate a device of resistance $20\,\Omega$. Assume the efficiency of the transformer to be 80%? [3]
6. An a.c. voltage E = Eo sin wt is applied across an inductance L. obtain the expression for current I? [3]
7. A series circuit with L = 0.12H, C = 0.48mF and R = $25\,\Omega$ is connected to a 220V variable frequency supply. At what frequency is the circuit current maximum? [3]
8. Drive an expression for the average power consumed in a.c. series LCR circuit. Hence define power factor? [5]

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)

[ANSWERS]

Ans 1: it is because induced emf produced in a circuit always opposes the cause which produces it.

Ans 2: Copper disc oscillates because of the production of eddy currents which opposes its oscillating motion and as a result the motion gets damped.

Ans 3: The magnetic flux will be maximum in the vertical position of the coil. But as the coil rotates $\frac{d\phi}{dt} = 0$

Hence produced emf $\in = \frac{d\phi}{dt} = 0$

Ans 4: (a) Since Z = $\sqrt{R^2 + X_L{}^2}$

When number of turns of the inductor gets reduced X_L and Z decreases and in turn current increases

Hence the bulb will grow more brightly

(b) When capacitor is included in the circuit

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

But $X_L = X_C$ (given)

$\Rightarrow$ Z = R (minimum)

Hence brightness of the bulb will become maximum.

Ans 5: η = 80% Ep = 200V Es = 20V Z = 20 Ω

$Is = \frac{Es}{Z} = \frac{20}{20} = 1A$

$Now\ \eta = \frac{EsIs}{EpIp}$

$\eta = \frac{80}{100} = \frac{20\times1}{200\times Ip}$

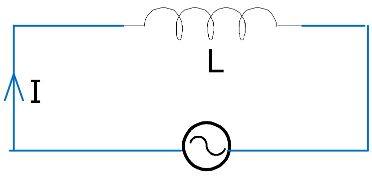
$\Rightarrow Ip = \frac{2000}{80\times200}$

Ip = 0.125 A

Ans 6: E = Eo sin wt (Given)

Emf produced across L = $\frac{-LdI}{dt}$

Total emf of the circuit = $E+\left(\frac{-LdI}{dt}\right)$



Since there is no circuit element across which potential drop may occur

$$\therefore E+\left(\frac{-LdI}{dt}\right)=0$$

$$\Rightarrow E=\frac{LdI}{dt}$$

$$dI=\frac{E}{L}dt$$

$$dI.\frac{Eo}{L}\sin wt\ \mathrm{dt}$$

Integrating

$$I=\frac{Eo}{L}\int \sin wt\ \mathrm{dt}$$

$$I=\frac{Eo}{L}\left(\frac{-\cos wt}{w}\right)$$

$$I=\frac{-Eo}{wL}\cos wt$$

$$I=\frac{Eo}{wL}\sin\left(wt-\frac{\pi}{2}\right)$$

$$I=\frac{Eo}{X_L}\sin\left(wt-\frac{\pi}{2}\right)$$

$$where\ \frac{Eo}{X_L}=Io(\text{peak value of current})$$

$$\Rightarrow \boxed{\mathrm{I = Io\ sin}\left(wt-\frac{\pi}{2}\right)}$$

Ans 7: L = 0.12H, C = 0.48mF = 0.48 $\times 10^{-3}$F

R = 25 Ω Ev = 220V

$$Iv=\frac{Ev}{\sqrt{R^2+(X_L-X_C)^2}}$$

In the circuit when I is maximum, R will be minimum

$$\Rightarrow X_L=X_C$$

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

$$and\ \ \mathrm{f}=\frac{1}{2\pi\sqrt{LC}}=\frac{1}{2\times 3.14\sqrt{0.12\times 0.48\times 10^{-3}}}$$

$$\boxed{\mathrm{f = 21Hz}}$$

Ans 8: For an a.c. series circuit

E = Eo sin wt

And I = Io sin (wt + ϕ)

Where ϕ is the phase angle by which current leads the emf.

Now using dw = EIdt

dw = (Eo sin wt) (Io sin (wt + ϕ))dt

dw = EoIo sin wt (sin wt cos ϕ + cos wt sin ϕ)dt

dw = EoIo (sin^2 wt cos ϕ + sin wt cos wt sin ϕ)dt

$$\left[\because \sin^2 wt = 2\sin wt \cos wt\right]$$

$$\Rightarrow dw = EoIo\left(\frac{1-\cos 2wt}{2}\cos\phi + \frac{\sin 2wt}{2}\sin\phi\right)$$

$$\left[\therefore \sin^2 wt = \frac{1-\cos 2wt}{2}\right]$$

$$dw = \frac{EoIo}{2}(\cos\phi - \cos\phi\cos 2wt + \sin\phi \sin not)dt$$

Integrating within limits t = o to t = T

$$W = \frac{EoIo}{2}\left[\cos\phi\int_O^T dt - \cos\phi\int_O^T \cos 2wtdt + \sin\phi\int_O^T \sin 2wtdt\right]$$

$$\Rightarrow W = \frac{EoIo}{2}\cos\phi\int_O^T dt\left[\because \int_O^T \sin 2wtdt = \int_O^T \cos 2wtdt = 0\right]$$

$$W = \frac{EoIo}{2}T\cos\phi$$

Hence average power consumed in a.c circuit is given by

$$Pav = \frac{W}{T} = \frac{EoIo}{2}\cos\phi$$

Pav = EvIv cos ϕ	------ (1)

Power factor – In the above expression

Cos ϕ is termed as power factor

When cos ϕ = 1 ϕ = 0^o

It means circuit is purely resistive and Pav = EvIv

When cos ϕ = 0 ϕ = 90^o

It means circuit is purely capacitive or inductive.

Hence **Pav = 0**

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)

1. Two identical loops, one of copper and another of aluminum are rotated with the same speed in the same magnetic field. In which case, the induced (a) emf. (b) current will be more and why? [1]

2. A transformer cannot be used to step up d.c. voltage? [1]

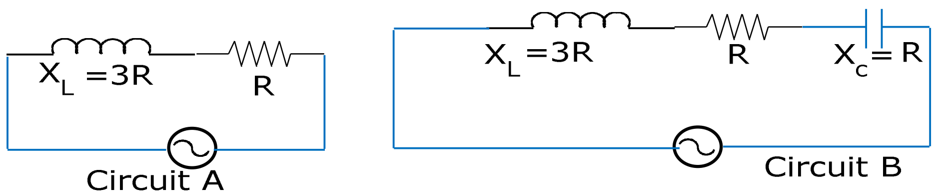
3. A coil of inductance L, a capacitor of capacitance C and a resistor of resistance R are all put in series with an alternating source of emf E = (Eo sin wt). Write an expression for the [2]

   (1) Total impedance of the circuit

   (2) Frequency of the source emf for which the current carrying circuit will show resonance.

4. Obtain the resonant frequency wr of series LCR circuit with = L =2 H, C = 32 μF and R = 10 Ω. What is the ϕ – value of this circuit? [2]

5. Figure shows two electric circuits A and B. calculate the ratio of power factor of the circuit B to the power factor of the circuit A? [3]



6. A horizontal straight wire l0 m long is extending along east and west and is falling with a speed of 5.0 m/s at right angles to the horizontal component of the earth's magnetic field of strength 0.30 $\times 10^{-4}$ wb/m^2. [3]

   (a) What is the instantaneous value of the emf induced in the wire?

   (b) What is the direction of the emf?

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

7. A circular coil of N turns and radius r is kept normal to a magnetic field, given by B = Bo cos wt. Deduce an expression for emf. Induced in the coil. State the rule which helps to detect the direction of induced current. [3]

8. Explain with the help of labeled diagram, the principle construction and working of a transformer? [5]

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)

[ANSWERS]

Ans 1: the induced emf will be same in both the loops but induced current will be more in copper loop because its resistance is less.

Ans 2: A transformer cannot be used to step up d.c. voltage because in d.c. the magnetic flux will not vary with time hence no induced emf is produced in the secondary coil.

Ans 3: (1) Total impedance of the circuit

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

(2) $f = \dfrac{1}{2\pi\sqrt{LC}}$

Ans 4: L = 2H, C = 32 μ F = 32 $\times 10^{-6}$ F, R = 10 Ω

$$wr = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2\times32\times10^{-6}}}$$

Wr = 125 rad/sec.

θ – Value of the circuit

$$\theta = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{2}{32\times10^{-6}}}$$

$$\Rightarrow \boxed{\theta = 25}$$

Ans 5: Power factor of circuit A

$$\cos\phi A = \frac{R}{\sqrt{R^2 + X_L{}^2}} = \frac{R}{\sqrt{R^2 + 9R^2}}$$

$$\cos\phi A = \frac{\cancel{R}}{\sqrt{10}\cancel{R}}$$

$$\cos\phi A = \frac{1}{\sqrt{10}} -------(1)$$

Power factor of circuit B

$$\cos\phi B = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}} = \frac{R}{\sqrt{R^2 + (3R - R)^2}}$$

$$\cos\phi B = \frac{R}{\sqrt{R^2 + 4R^2}} = \frac{R}{\sqrt{5R^2}}$$

$$\cos\phi B = \frac{1}{\sqrt{5}} -----------(2)$$

$$\frac{\cos\phi B}{\cos\phi A} = \frac{\frac{1}{\sqrt{5}}}{\frac{1}{\sqrt{10}}}$$

$$\cos\phi B : \cos\phi A = \sqrt{2}$$

Ans 6: length of the wire, l =10m

υ = 5.0m/s.

$B_H = 0.30 \times 10^{-4}$ wb/m^2

(a) Induced emf $E = B_H l \upsilon$

$E = 0.30 \times 10^{-4} \times 10 \times 5$

$E = 1.5 \times 10^{-3}$ V

(b) Induced emf sets up from west to east.

(c) The potential will be more for eastern end.

Ans 7: B = Bo cos wt (given)

$$E = \frac{-Nd\phi}{dt}$$

$$E = \frac{-NAd}{dt}(Bo\cos wt)$$

$$E = -NABo(-\sin wt)(wt)$$

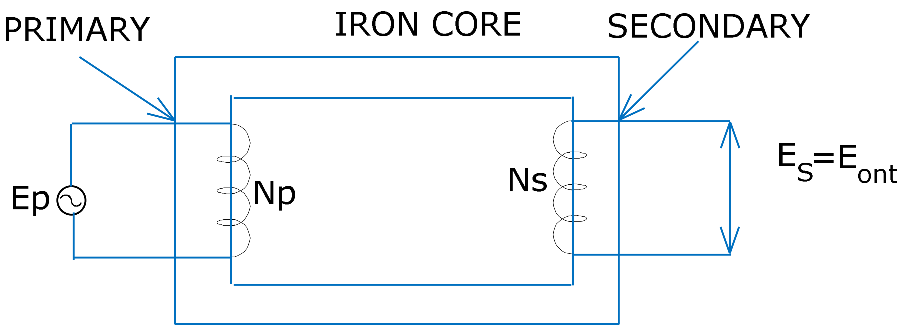
$$E = NABo(-\sin wt)(w)$$

$$E = NABow\sin wt$$

($A = \pi R^2$) $\quad$ $E = NBo\pi R^2 w \sin wt$

Lenz's law is used to fuid the direction of induced emf. It states the direction of induced emf is opposite to the cause producing the induced emf.

Ans 8: Principle – A transformer coverts low a.c. voltage to high a.c. voltage or vice – versa. It is based on the principle of mutual induction i.e. emf is induced in a coil when a changing current is produced in the neighboring coil



Construction –It consist of two coils wounded on a soft iron core. One of the coils called the primary is connected to an a.c. source. The other coil called the secondary is connected to the load.

Working – When an alternating emf is applied across the primary coil the input voltage keeps on changing with time due to which magnetic flux through the primary coil changes. This changing magnetic flux gets linked up with the secondary coil also which in turn produces induced emf in the secondary coil.

$$Es = Ns\frac{d\phi s}{dt} ----(1)$$

$$Ep = Np\frac{d\phi p}{dt} ----(2)$$

If all the magnetic flux generated in the primary coil gets linked up with the secondary coil

i.e. $\phi s = \phi p$

Then ef. (1) & (2) becomes

$$\frac{Es}{Ep} = \frac{Ns}{Np} \qquad \boxed{Es = \frac{Ns}{Np}Ep} \text{ -------------- (3)}$$

$\frac{Ns}{Np} = K$ Is called transformation ratio

k > 1 for step up transformer

k < 1 for step down transformer

if there is no less of energy

EsIs = EpIp

$$\boxed{\frac{Es}{Ep} = \frac{Ip}{Is}}$$

CBSE TEST PAPER-05

CLASS - XII PHYSICS (Electromagnetic Induction and Alternating current)

1. Power factor of an a.c. circuit is 0.5. What will be the phase difference between voltage and current in the circuit? [1]
2. Weber is the unit of which physical quantity? Hence define it? [1]
3. A magnet is moved in the direction indicated by an arrow between two coil AB and CD as shown in the figure. Suggest the direction of current in each coil. [2]
4. How does the self induction of a coil change when? [2]

   (1) The number of turns in a coil is decreased

   (2) An iron rod is introduced into it. Justify.
5. A variable frequency 230V alternating voltage source is connected across a series combination of L = 5H, C = 80 μ F and R = 40 Ω. Calculate [3]

   (a) Angular frequency of the source which drives the circuit in resonance

   (b) Impedance of the circuit

   (c) Amplitude of current at resonance.
6. Show that in the free oscillations of an LC circuit, the sum of the energies stored in the capacitor and the inductor is constant in time? [3]
7. Define mutual inductance? What is its S.I. unit? Write the expression for the mutual inductance between a pair of circular coils of radius r and R (R > r). [3]
8. (a) Why is electric power generally trans milted over long distances at high a.c. voltage? [5]

   (b) An a.c. generator consist of a coil of 50 turns, area 2.5m^2 rotating at an angular speed of 60 rad/s in uniform magnetic field of B = 0.3 T between two fixed pole pieces. Given R = 500 Ω .

   (i) Find the maximum current drawn from the generator?

   (ii) What will be the orientation of the coil wrt. B to have max and zero magnetic flux?

   (iii) Would the generator work if the coils were stationary and instead the pole pieces rotated together with the same speed?

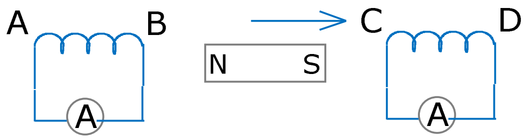
Ans 1: $\cos\phi = 0.5$

$\phi = \cos^{-1}(0.5)$

$\phi = 60^o$

Ans 2: Magnetic flux has the unit Weber.

It is defined as the number of magnetic field lines passing normally through the surface.



Ans 3: For coil AB since N – pole is moving away from the coil so end B should behave as S – pole according to Lenz's law therefore from the end A the current appear to be anti clockwise. For coil CD the end C should be South Pole thus from end D direction in coil CD will be anti clockwise.

Ans 4: (1) L = $\mu o n^2 l A$

When no. of turns decreases self induction will decrease.

(2) When iron rod is introduced

$L = \mu o \mu r n^2 l A$

Since for iron $\mu r > 1$

$\Rightarrow$ Self induction will increase

Ans 5: Ev = 230V, L = 5H

C = 80 μ F = 80 $\times 10^{-6}$ F and R = 40 Ω

(a) For resonance

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$f = \frac{1}{2\times3.14\sqrt{5\times80\times10^{-6}}}$$

f = 7.96 Hz

(b) Impedance of the circuit at resonance

Z = R $\boxed{Z = 40\ \Omega}$

(c) Peak value of current

$$Io = \frac{Eo}{R}$$

$$Io = \frac{\sqrt{2}Ev}{R} = \frac{\sqrt{2}\times 230}{40}$$ $\boxed{Io = 8.13\text{ A}}$

Ans 6: Energy stored in capacitor

$$= \frac{1}{2}\frac{q_2}{C}$$

$$(\because q = q0\cos wt)$$

$$= \frac{1}{2}q0^2\cos^2 wt ------(1)$$

Energy stored in an inductor = $\frac{1}{2}LI^2$

$$\Rightarrow \text{E=}\ \frac{1}{2}L\left(\frac{dq}{dt}\right)^2\left(I = Io\cos wt \because I = \frac{dq}{dt}\right)$$

$$E = \frac{1}{2}L\left[\frac{d}{dt}(q_o\cos wt)\right]^2$$

$$E = \frac{1}{2}Lq_0^2w^2\sin^2 wt$$

$$E = \frac{q_0^2}{2}\sin^2 wt\cancel{L}\left(\frac{1}{\cancel{L}C}\right)\left(\because w^2 = \frac{1}{LC}\right)$$

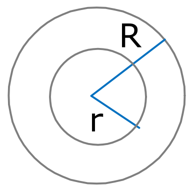
$$E = \frac{q_0^2}{2C}\sin^2 wt$$

Combining (1) & (2) to get total amount of energy

$$E = \frac{q_o 2}{2C}\left[\sin^2 wt + \cos^2 wt\right]$$

(Constant) $\boxed{E = \frac{q_o{}^2}{2C}}$

Ans 7: It is defined as the phenomenon of inducing emf in a coil due to the rate of change of current in a near by coil. Its S.I. unit is henry (H).



Let two coaxial concentric coils of radio r and R (R > r) be placed in air. If current I_2 flows through R, the magnetic flux gets linked up with secondary coil (coils of radius r) & is given by

$$\phi s = BA = \left(\frac{\mu_o I_2}{2R}\right)\left(\pi r^2\right)$$

$$\phi s = \frac{\mu_o \pi r^2 I_2}{2R} \text{------}(1)$$

$$Also\ \ \phi s = MI_2 \text{------}(2)$$

Combining equation (1) & (2)

$$MI_2 = \frac{\mu_o \pi r^2 I_2}{2R}$$

$$\boxed{M = \frac{\mu_o \pi r^2}{2R}}$$

Ans 8: (a) Electric power is Transmitted over long distances at high a.c. voltage so that small current flows through the transmission line because it reduces the power loss (I^2R).

(b) n = 50, A = 2.5m^2, w = 60 rad/s B = 0.3 T R = 500 Ω

(i) Eo = nABw

Eo = 50 × 2.5 × 0.3 × 60 $\boxed{Eo = 2250\ V}$

$$\Rightarrow Io = \frac{Eo}{R} = \frac{2250}{500}$$ $\boxed{Io = 4.5\ A}$

(ii) Magnetic flux will be maximum if the coil is in the vertical position and it will be zero when the coil is in the horizontal position.

(iii) The generator will work whenever there is relative motion between the coil and magnet.

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Electro magnetic waves)

1. What is the role of ozone in the atmosphere? [1]
2. What is the nature of waves used in radar? [1]
3. Write the application of Infra-red radiations? [2]
4. Which constituent radiation of the electromagnetic spectrum is used? [2]

   (1) To photograph internal parts of human body.

   (2) For air aircraft navigation
5. Electric field in a plane electromagnetic wave is given by [2]

   $$E_Z = 60 \sin\left(\frac{10^3 x}{2} + \left(10^{11}\right)\frac{3t}{2}\right) V/m.$$

   (a) Write an expression for the magnetic field

   (b) What is the magnitude of wavelength and frequency of the wave?
6. In a plane electromagnetic wave, the electric field oscillates sinusoid ally with a frequency of 2×10^{10} Hz and amplitude 48V/m. [3]

   (a) What is the wavelength of the em. wave?
   (b) Calculate the amplitude of the oscillating magnetic field.
   (c) Calculate average energy density of the electromagnetic field of the wave?
7. Find the wavelength of electromagnetic waves of frequency 6×10^{12} Hg in free space. Give two applications? [3]
8. A plane monochromatic wave lies in the visible region. It is represented by the sinusoidal variation with time by the following components of electric field [3]

   $$Ex = 0,\ Ey = 4 \sin\left[\frac{2\pi}{\lambda}\left(x - vt\right)\right],\ Ez = 0$$

   Where $\upsilon = 5 \times 10^{14}$ Hg And λ is the wavelength of light.

   (a) What is the direction of propagation of the wave?
   (b) What is its amplitude?
   (c) Compute the component of magnetic field?
9. Write the characteristics of em waves? Write the expression for velocity of electromagnetic waves in terms of permittivity and permeability of the medium? [3]

CBSE TEST PAPER-01
CLASS - XII PHYSICS (Electro magnetic waves)

[ANSWERS]

Ans 1: It absorbs all the harmful ultraviolet radiations thus protecting us from reaching the dangerous effects of uv radiations.

Ans 2: Microwaves are used in Radar.

Ans 3: (1) infra-red radiations are used to take photographs under foggy conditions.
(2) Infra-red radiations are used in revealing the secret writings on the ancient walls.

Ans 4: (1) X -Rays
(2) Microwaves

Ans 5: (a) $C = \frac{E_O}{B_O}$

$B_O = \frac{E_O}{C} = \frac{60}{3 \times 10^8}$ $\boxed{B_O = 2 \times 10^{-7} \text{ T}}$

Since magnetic field and electric field are $\perp$ to each other

$\Rightarrow$ By = 2×10^{-7} T sin $\left(\frac{10^3}{2}x + \left(10^{11}\right)\frac{3t}{2}\right)$ ---------------- (1)

Compare e.g. (1) with standard equation

By = B_0 sin $2\pi\left(\frac{x}{\lambda} + \frac{t}{T}\right)$ $\boxed{\lambda = 4\pi \times 10^{-3} m}$

$Also\ 2\pi\frac{1}{T} = (10)^{11}\frac{3}{2}$

$\frac{1}{T} = \upsilon = \frac{3 \times 10^{11}}{2 \times 2\pi}$ $\boxed{\upsilon = \frac{3}{4\pi} \times 10^{11} Hz}$

Ans 6: (a) V = 2×10^{10} Hz
E_0 = 48 V/m

$\lambda = \frac{C}{V} = \frac{3 \times 10^8}{2 \times 10^{10}}$ $\boxed{\lambda = 1.5 \times 10^{-2} m}$

(b) $E_0 = cB_0$

$$B_O = \frac{E_O}{C} = \frac{48}{3\times10^8}$$

$$\boxed{B_O = 16\times10^{-8} \text{ Tesla}}$$

(c) Energy density

$$U = \frac{1}{2}\in_O E^2$$

$$U = \frac{1}{2}8.85\times10^{-12}\times48\times48$$

$$\boxed{U = 1\times10^{-8} \text{ J/m}^3}$$

Ans 7: $V = 6\times10^{12}$ Hz

Using $\lambda = \dfrac{c}{v}$

$$\lambda = \frac{3\times10^8}{6\times10^{12}}$$

$$\boxed{\lambda = 5\times10^{-5} m}$$

These are infra-red radiations

Applications

(1) It keeps the earth warm.

(2) Infra-red lamps are used to treat muscular strains.

Ans 8: (a) The direction of propagation of wave is along + x – axis.

(b) Amplitude = 4 units

(c) Component of magnetic of field

$$Bz = \frac{Eo}{C} = \frac{4}{3\times10^8}$$

$$\boxed{Bz = 1.33\times10^{-8} \text{ Tesla}}$$

Ans 9: Characteristics of em waves

(1) It travels in free space with speed of light c = 3 x 10^8 m/s.

(2) Electromagnetic waves are transverse in nature.

Velocity of em waves in vacuum C = $\dfrac{1}{\sqrt{\mu_o \in_o}}$

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Electro magnetic waves)

1. The charging current for a capacitor is 0.25A. What is the displacement current across its plates? [1]
2. Write the following radiations in a descending order of frequencies: red light, x – rays, microwaves, radio waves [1]
3. How does the frequency of a beam of ultraviolet light change, when it goes from air into glass? [1]
4. What is the ratio of speed of gamma rays and radio waves in vacuum? [1]
5. It is necessary to use satellites for long distance TV transmission. Why? [1]
6. IF the earth did not have atmosphere would its average surface temperature be higher or lower than what it is now? [2]
7. Sky waves are not used in transmitting TV signals, Why? Suggest two methods by which range of TV transmission can be increased? [2]
8. "Greater the height of a TV transmitting antenna, greater is its coverage." Explain. [2]
9. The electric field of a plane electromagnetic wave in vacuum is represented by. [3]

   Ex = 0, Ey = 0.5 cos $\left[2\pi\times10^8\left(t-x/c\right)\right]$ and Ez = 0

   (a) What is the direction of propagation of electromagnetic wave?

   (b) Determine the wavelength of the wave?

   (c) Compute the component of associated magnetic field?
10. Find the wavelength of electromagnetic waves of frequency 5×10^{19} Hg in free space. Give its two applications. [3]
11. (1) State the condition under which a microwave oven heats up food items containing water molecules most efficiently? [3]

    (2) Name the radiations which are next to these radiations in em. Spectrum having (a) Shorter wavelength (b) Longer wavelength

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Electro magnetic waves)

[ANSWERS]

Ans 1: Displacement current remains the same as charging current and is equal to 0.25A.

Ans 2: X – rays, Red light, Microwaves and Radio waves.

Ans 3: There is no effect on the frequency of ultraviolet light.

Ans 4: One.

Ans 5: Television signals are not reflected back by the layer of atmosphere called ionosphere thus TV signals from air earth station are reflected back to the earth by means of an artificial satellite

Ans 6: The infra-red radiations get trapped inside the earth's atmosphere due to green house effect which makes the earth warm. Therefore average temperature of the earth would have been low.

Ans 7: Sky waves are not used in transmitting TV signals as they are not reflected by the ionosphere.
Methods of increasing range of TV transmission
(1) Tall antenna
(2) Geostationary satellites

Ans 8: Since d = $\sqrt{2hR}$
If height is increased distance upto which TV coverage can be done will increases.

Ans 9: (a) The equation Ey = 0.5 cos $\left[2\pi\times10^8\left(t-x/c\right)\right]$
Represents wave is propagating along + x – axis
(b) Comparing equation with the standard one
Ey = E_0 cos w $\left(t-x/c\right)$

$$w=2\pi\times10^8$$

$$\not{2}\not{\pi}\upsilon=\not{2}\not{\pi}\times10^8$$

$$\upsilon=10^8$$

$$\Rightarrow\lambda=\frac{c}{v}=\frac{3\times10^8}{10^8} \qquad \boxed{\lambda=3m}$$

(c) Associated magnetic field is $\perp$ to electric field and the direction of propagation.
Since wave is propagating along x – axis, electric field is along, y – axis
Thus, magnetic field is along z – axis

$\Rightarrow Bx = 0, By = 0$

$Bz = B_O \cos[2\pi \times 10^8 (t - x / x)]$

$Bz = \frac{E_O}{c} \cos 2\pi \times 10^8 (t - x / x)]$

Ans 10: Using C = $\lambda \upsilon$

υ = 5×10^{19}Hz

$\lambda = \frac{3 \times 10^8}{5 \times 10^{19}}$

$\lambda = 0.6 \times 10^{-11} = 6 \times 10^{-12} m$

These are Gamma Rays.

Applications

(1) These rays are used to get information regarding atomic structure.

(2) They have very high penetrating power so they are used for detection purpose

Ans 11: (1) Frequency of the microwaves must be equal to the resonant frequency of the water molecules present in the food item.

(2) (a) visible light

(b) Microwaves

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Ray Optics)

1. A person is standing before a concave mirror cannot see his image, unless he is beyond the centre of curvature? [1]

2. For what angle of incidence, the lateral shift produced by a parallel sided glass plate is maximum? [1]

3. What are optical fibres? Give their one use? [2]

4. How the focal lengths of a lens change with increase in the wavelength of the light? [2]

5. Find the radius of curvature of the convex surface of a plane convex lens, whose focal length is 0.3m and the refractive index of the material of the lens is 1.5? [3]

6. Show that the limiting value of the angle of prism is twice its critical angle? Hence define critical angle? [3]

7. Draw a labeled diagram of telescope when the image is formed at the least distance of distinct vision? Hence derive the expression for its magnifying power? [3]

8. Prove that $\frac{n_2}{\upsilon} = \frac{n_1}{\upsilon} = \frac{n_2 - n_1}{R}$

   When refraction occurs of a convex spherical refracting surface and the ray travels from rarer to denser medium. [5]

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Ray Optics)

[ANSWERS]

Ans 1: When man stands beyond focus is i.e. between focus and centre of curvature, his real and inverted image is formed beyond C is beyond him and thus he cannot see the image. But when he stands beyond C, image is formed between focus and centre of curvature is in front of him and thus he is able to see his image.

Ans 2: We know $d = \frac{t}{\cos r}\sin(90^o - r)$ $(when\ \text{Li} = 90^o)$

$d = \frac{t}{\cos r}\cos r$

d = t

Lateral shift is maximum

Ans 3: Optical fibres consist of thin and long strands of fine quality glass or quartz coated with a thin layer of material of refractive index less than the refractive index of strands. They work on the principle of total internal reflection so they do not suffer any loss.

Uses

The optical fibres are used in medical investigations i.e. one can examine the inside view of stomach and intestine by a method called endoscopy.

Ans 4: $\delta = A(\mu - 1)$

$\delta \propto \mu$ $\quad \sin ce \mu \propto \frac{1}{\lambda 2}$

i.e. when wavelength increases $\mu -$ decreases and according to

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

Ans 5: $\mu = 1.5$ f=0.3m

For plane convex lens

$f \quad R_1 = R$

$R_2 = -\infty$

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

$$\frac{1}{0.3} = (1.5 - 1)\left(\frac{1}{R} + \frac{1}{\infty}\right)$$

$$\Rightarrow \left(\frac{1}{R}\right) 0.5 = \frac{1}{0.3}$$

R = 0.15 m

Ans 6: Angle of the prism (A)= $r_1 + r_2$

For limiting $A_{max} = (r_1)_{max} + (r_2)_{max}$

(Maximum)

Value of angle of prism for $(r_1)_{max}$ means $i = 90^o$

But when $i = 90^o$ $(r_1)_{max} = C$

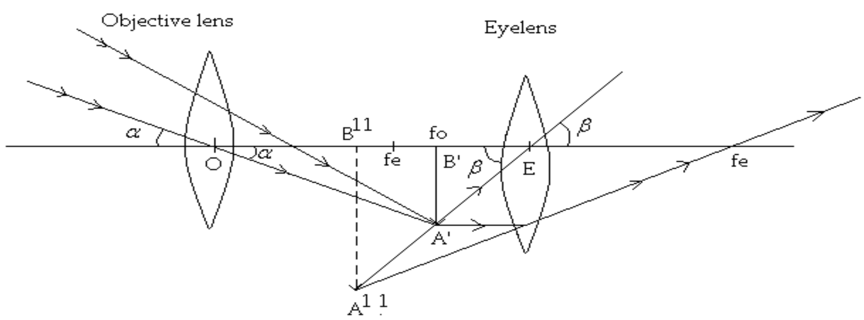
$A_{max} = C + C$

$A_{max} = 2C$

The angle of incidence for which angle of refraction is 90^o is called critical angle.

Ans 7: magnifying power = $\dfrac{\text{angle subtended by the image at the eye}}{\text{angle subtended by the object at the eye}}$

$$\text{MP}=\frac{\tan\beta}{\tan\alpha} = \frac{\beta}{\alpha} \quad (\text{since angles are very very small})$$



$$\tan\beta \frac{A'B'}{B'E} \textit{ and } \tan\alpha = \frac{A'B'}{B'O}$$

$$MP = \frac{A'B'}{B'E} \times \frac{A'B'}{B'O}$$

$$MP = \frac{B'O}{B'E} = \frac{fo}{-\upsilon e}$$

$$\boxed{MP = \frac{-fo}{\upsilon e}} \text{---------- (i)}$$

For eye piece

$$\frac{1}{\upsilon} - \frac{1}{\upsilon} = \frac{1}{fe}$$

$$-\frac{1}{D} - \frac{1}{-\upsilon e} = \frac{1}{fe}$$

Multiply by D

$$-1 + \frac{D}{\upsilon e} = \frac{D}{fe}$$

$$\frac{D}{\upsilon e} = \frac{D}{fe} + 1$$

$$\frac{1}{\upsilon e} = \frac{1}{fe} + \frac{1}{D} = \frac{1}{fe}\left(1 + \frac{fe}{D}\right)$$

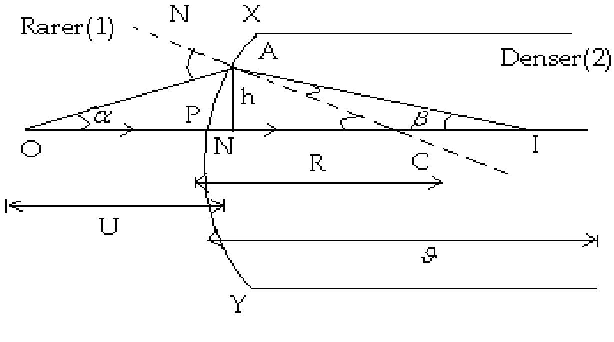
Substituting in e.g. (i)

$$\boxed{MP = \frac{-fo}{fe}\left(1 + \frac{fe}{D}\right)}$$

Ans 8: From $\Delta AOC\ i = \alpha + \gamma ------(i)$

similarly from $\Delta AIC\ \gamma = \gamma + \beta$

$r = \gamma - \beta ---(2)$



From $\Delta ANO \tan\alpha = \frac{h}{NO}$

$\Delta ANI \tan\beta = \frac{h}{NI}$

$\Delta ANC \tan\gamma = \frac{h}{NC}$

Same aperture of the spherical surface is small so point N lies close to P and since angles α, β *and* γ are very small $\therefore \tan\alpha \approx \alpha, \tan\beta \approx \beta$ *and* $\tan\gamma \approx \gamma$

$$\Rightarrow \alpha = \frac{h}{PO}, \beta = \frac{h}{PI} \text{ and } \gamma = \frac{h}{PC}$$

Applying sign conventional

$$\alpha = \frac{h}{-U}, \beta = \frac{h}{\upsilon} \text{ and } \gamma = \frac{h}{R}$$

Substituting these values in e.g. (1) & (2)

$$i = \frac{h}{U} + \frac{h}{R}$$

$$r = \frac{h}{R} - \frac{h}{\upsilon}$$

According to snell's law

$$n_{21} = \frac{n_2}{n_1} = \frac{\sin i}{\sin r} = \frac{i}{r} \quad (\text{since angles are very very small})$$

$$\frac{n_2}{n_1} = \frac{i}{r}$$

$$n_2 r = n_1 i \quad or \quad n_2\left(\frac{+h}{R} - \frac{h}{\upsilon}\right) = n_1\left(\frac{-h}{U} + \frac{h}{R}\right)$$

$$\frac{n_2}{R} - \frac{n_2}{\upsilon} = \frac{-n_1}{U} + \frac{n_1}{R}$$

$$\frac{n_2}{R} - \frac{n_2}{\upsilon} = \frac{-n_1}{U} + \frac{n_1}{R}$$

$$\boxed{\frac{n_2 - n_1}{R} = \frac{n_2}{\upsilon} - \frac{n_1}{U}}$$

CBSE TEST PAPER-02
Class - XII Physics (Ray Optics)

1. You read a newspaper, because of the light if reflects. Then why do you not see even a faint image of yourself in the newspaper? [1]

2. A substance has critical angle of 45^o for yellow light what is its refractive index? [1]

3. Show with a ray diagram, how an image is produced in total reflecting prism? [2]

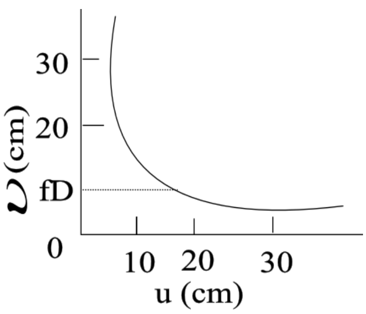
4. The radii of the curvature of the two spherical surfaces which is a lens of required focal length are not same. It forms image of an object. The surfaces of the lens facing the object and the image are inter-changed. Will the position of the image change? [3]

5. Drive the expression for the angle of deviation for a ray of light passing through an equilateral prism of refracting angle A? [3]

6. Draw a ray diagram to illustrate image formation by a Newtonian type reflecting telescope? Hence state two advantages of it over refracting type telescopes? [3]

7. The magnifying power of an astronomical telescope in the normal adjustment position is 100. The distance between the objective and the eye piece is 101cm. calculate the focal length of the objective and the eye piece. [3]

8. A lens forms a real image of an object. The distance of the object. From the lens is U cm and the distance of the image from the lens is υ cm. The given graph shows the variation of υ and U [5]



(a) What is the nature of the lens?

(b) Using the graph find the focal length of the lens?

Draw a ray diagram to show the formation of image of same size as that of object in case of converging lens hence derive lens equation?

CBSE TEST PAPER-02
Class - XII Physics (Ray Optics)

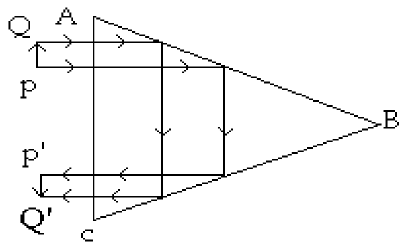
[ANSWERS]

Ans1: The image is produced due to regular reflection of light but when we read a newspaper, because of diffused (irregular) reflection of light we are not able to see even a faint image.

Ans2: $\mu = \frac{1}{\sin C}$

$\mu = \frac{1}{\sin 45^o} = \frac{1}{\frac{1}{\sqrt{2}}}$ $\boxed{\mu = \sqrt{2}}$

Ans3: the two rays from the object PQ undergoes total internal reflection firstly at the face AB and then at BC forming the find image $P'Q'$ (real and inverted image)



Ans4: As we know $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

When R_1 and R_2 gets interchanged focal length of the lens remains the same hence position of the image will not change.

Ans5: At the surface AB

$\delta_1 = i - r_1$

At the surface AC

$\delta_2 = e - r_2$

Thus $\delta = \delta_1 + \delta_2$

$\delta = i + e - (r_1 + r_2) ----(1)$

In quadrilateral AQOR

$\angle A + \angle Q + \angle O + \angle R = 360^o$

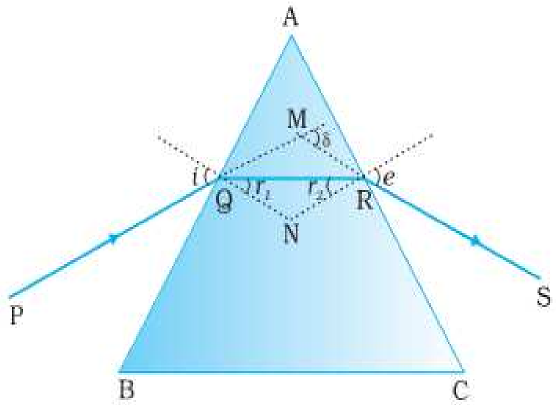
$But \quad \angle Q = \angle R\left(each\ 90^o\right)$

$\Rightarrow \angle A + \angle O = 180^o ----(2)$

$Now \ \ in \ \ \Delta QOR$

$\angle Q + \angle O + \angle R = 180^o$

$or \qquad r_1 + r_2 + \angle O = 180^o -----(3)$



From (2) and (3)

$r_1 + r = A -----(4)$

Substituting equation (4) in equation (1)

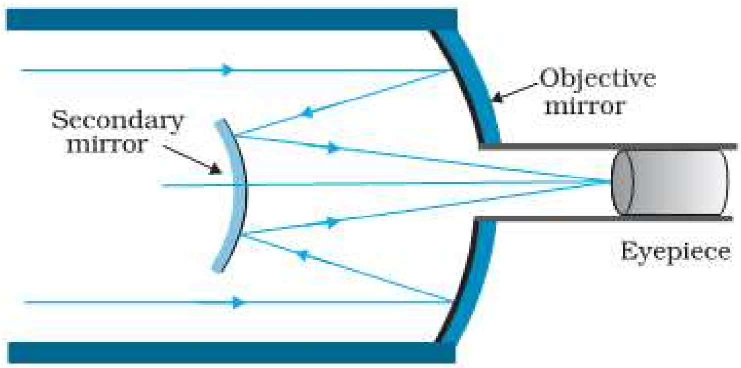
δ = i + e – A Or $A + \delta = i + e$

Ans6: Advantages

(1) The image formed in reflecting type telescope is free from chromatic aberrations

(2) The image formed is very bright due to its large light gathering power.

NEWTONIAN TELESCOPE (REFLECTING TYPE)



Ans7: fo + fe = 101 --------- (1)

$$M = \left|\frac{fo}{fe}\right| = 100$$

fo = 100 fe ---------- (2)

Substituting equation. (2) in equation (1)

fe + 100fe = 101

101fe = 101

fe = 1cm

Substituting fe in equation (2)

fo = 100 $\times$1

fo = 100cm

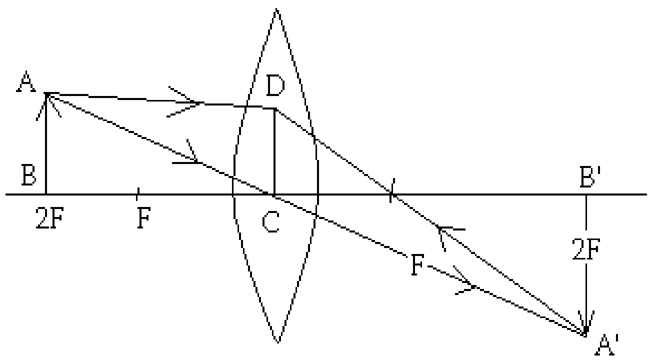
Ans8: (a) convex lens

(b) $\frac{1}{\upsilon} - \frac{1}{U} = \frac{1}{f}$

$When \quad U \to \infty$

$\frac{1}{\upsilon} = \frac{1}{f}$ i.e $\upsilon = f$

In the given graph f = 10cm.



$\Delta ABC \text{ and } A'B'C \text{ are similar}$

$$\therefore \frac{A'B'}{AB} = \frac{B'C}{BC} ----(1)$$

$\Delta DCF \text{ and } A'B'F \text{ are similar}$

$$\therefore \frac{A'B'}{DC} = \frac{B'F}{FC}$$

$$\Rightarrow \frac{A'B'}{DC} = \frac{B'F}{FC} = \frac{A'B'}{AB} ----(2)(\because DC = AB)$$

Combining equation (1) & (2)

$$\frac{B'C}{BC} = \frac{B'F}{BF}$$

Using sign conventions

$B'C = +\upsilon$

$BC = -U$

$B'F = B'C = FC$

$B'F = +\upsilon - f$

$FC = +f$

$$\Rightarrow \frac{\upsilon}{-U} = \frac{\upsilon - f}{f}$$

$\upsilon f = -\upsilon U + fU$

Divide by U υ f

$$\frac{1}{U} = \frac{-1}{f} + \frac{1}{\upsilon}$$

Or $$\boxed{\frac{1}{f} = \frac{1}{\upsilon} - \frac{1}{U}}$$

Hence derived

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Ray Optics)

1. An object is placed between the pole and focus of a concave mirror produces a virtual and enlarged image. Justify using mirror formula? **[1]**

2. A converging and diverging lens of equal focal lengths are placed coaxially in contact. Find the focal length and power of the combination? **[1]**

3. A thin converging lens has focal length when illuminated by violet light. State with reason how the focal length of the lens will change if violet light is replaced by red light **[2]**

4. Thin prism of angle 60^o gives a deviation of 30^o. What is the refractive index of material of the prism? **[2]**

5. A convex lens made up of refractive index n_1 is kept in a medium of refractive index n_2. Parallel rays of light are incident on the lens. Complete the path of rays of light emerging from the convex lens if **[3]**

(1) $n_1 > n_2$

(2) $n_1 = n_2$ (3) $n_1 < n_2$

6. Derive the relation $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ **[3]**

Where f1 and f2 are focal lengths of two thin lenses and F is the focal length of the combination in contact.

7. A convex lens has a focal length 0.2m and made of glass is immersed in water $(\mu = 1.33)$ find the change in focal length of the lens? **[3]**

8. By stating sign conventions and assumptions used derive the relation between u, v *and* f in case of a concave mirror? **[5]**

CBSE TEST PAPER-03
CLASS - XII PHYSICS (Ray Optics)

[ANSWERS]

Ans1: $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

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

For a concave

$f=-ve$

$u=-ve$

Given V < f so ϑ is positive, hence image is virtual. Now magnification $m=\frac{v}{u}$

since v > o and u < o

$\therefore m=+ve$, Hence enlarged image is produce

2. $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$

For converging lens f_1 = +f

For diverging lens f_2 = -f

$\Rightarrow \frac{1}{F}=\frac{1}{f}-\frac{1}{f} \Rightarrow \boxed{F=\frac{1}{0}} \Rightarrow \boxed{\infty = F}$

Now P = $\frac{1}{F}=\frac{1}{\infty}=0$

Hence $\boxed{P=0}$

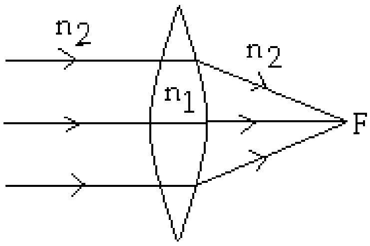
3. Since $\frac{1}{f}=(n-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

n for violet is more that n for red colour hence focal length of the lens will increases when violet light is replaced by blue light.

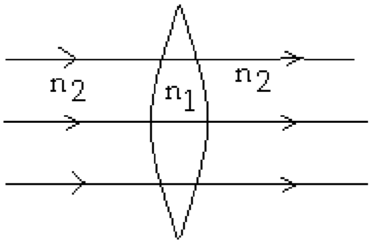
4. $$n = \frac{\sin \frac{A+Sm}{2}}{\sin \frac{A}{2}} = \frac{\sin\left(\frac{60+30}{2}\right)}{\sin \frac{60}{2}} = \frac{\sin 45^o}{\sin 30^o}$$

$n = 1.41$

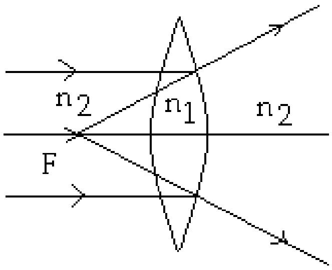
5. (1) When n1 > n2 the lens behaves as a convex lens.



(2) When n1 = n2 the lens behaves as a plane plate so no refraction takes place



(3) When n1 < n2 the lens behave as a convex lens



6. Consider two thin lenses in contact having focal length
f_1 and f2
For the first lens
$$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1} ------(1)$$
For the second lens I_1 acts as an object which forms the final image I
$$\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2} -----(2)$$
Adding equation (1) & (2)

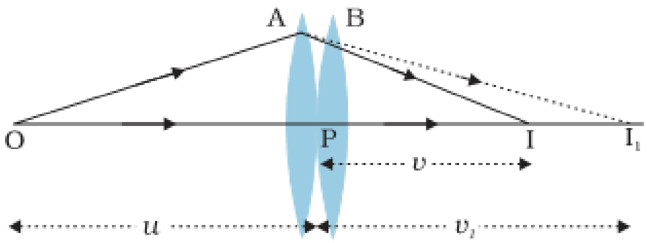
$$\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{\upsilon}-\frac{1}{u}+\frac{1}{\upsilon_1}-\frac{1}{\upsilon_1}$$

$$\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{\upsilon}-\frac{1}{u}$$

Using lens formula

$$\left(\because \frac{1}{\upsilon}-\frac{1}{u}=\frac{1}{F}\right)$$

$$\boxed{\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{F}}$$



For n no. of thin lenses is contact

$$\boxed{\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}+..................}$$

7. Fair = 0.2m a μ g = 1.50

$$\frac{1}{fair}=(a\mu g-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{0.2}=(1.50-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$or\ \frac{1}{R_1}-\frac{1}{R_2}=10--------(1)$$

$$Now\ \text{w}\mu\text{g} = \frac{a\mu g}{a\mu w}=\frac{1.50}{1.33}=1.128$$

$$\Rightarrow \frac{1}{fn}=(\text{w}\mu\text{g}-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

Where too is the focal length of the lens when immersed in water?

$$\frac{1}{fw}=(1.128-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{fw}=(0.128)=\times 10=1.28$$

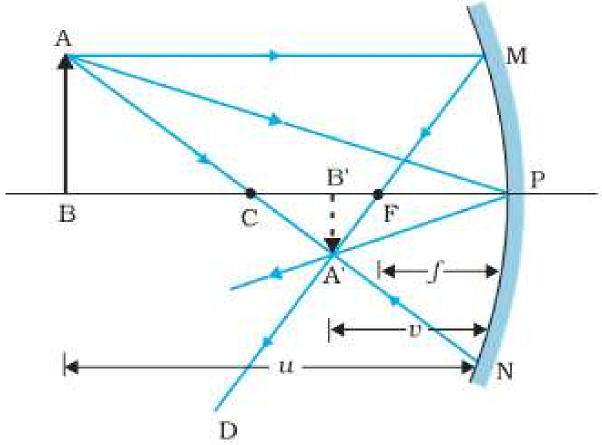
$$\Rightarrow fw=\frac{1}{1.28} \qquad \boxed{\text{fw = 0.78m}}$$

Ans 8: Sign conventions

(1) All distances are measured from the pole of the mirror.
(2) Distance measured in the direction of incident light is positive and those measured in the direction opposite to the incident light are negative.
(3) Height measured upwards is positive and height measured downwards is negative.

Assumptions

(1) Aperture of the spherical mirror is considered to be very small.



In $\Delta A'B'F$ *and* MDF

$\angle A'FB' = \angle MFD$ (*Vertically* opp.$\angle$'s,)

$\angle D = \angle B'$ (each 90°)

$\Rightarrow$ Remiaining angles equal

$\therefore$ A'B'F and MDF are similar

$$\therefore \frac{A'B'}{MD} = \frac{B'F}{FD}$$

$$or \ \frac{A'B'}{AB} = \frac{B'F}{FP} ------(1) (\therefore \text{Dlies closetol AB} = MD)$$

similarly ΔAPB *and* $A'PB'$ *are also similar*

$$\therefore \frac{A'B'}{AB} = \frac{B'P}{FP} --------(2)$$

Combining equation (1) & (2) and using sign conventions

$$\frac{B'F}{FP} = \frac{B'P}{BP} \begin{pmatrix} \because B'F = B'P - FP = -v + f \\ FP = -f \quad BP = -u \\ B'P = -v \end{pmatrix}$$

$$\Rightarrow \frac{-v+f}{-f} = \frac{-v}{-u}$$

$$or \ (-v+f)u = -fv$$

$$or \ -vu + fu = -fv$$

Divide by we uvf get $\boxed{\frac{1}{f} = \frac{1}{v} + \frac{1}{u}}$

CBSE TEST PAPER-04

CLASS - XII PHYSICS (Ray Optics)

1. The refractive index of a material of a convex lens is n_1 it is immersed in a medium of refractive index n_2. A parallel beam of light is incident on the lens. Trace the path of the emergent rays when $n_2 > n_1$. [1]

2. In a telescope the focal length of the objective and the eye piece are 60cm and 5cm respectively. What is? (1) Its magnification power (2) Tube length [1]

3. Although the surfaces of a goggle lens are curved it does not have any power. Why? [2]

4. A ray of light in incident normally on one face of the prism of apex angle 30^o and refractive index $\sqrt{2}$. Find the angle of deviation for the ray of light? [2]

5. A reflecting type telescope has a concave reflector of radius of curvature 120cm. calculate the focal length of eye piece to secure a magnification of 20? [3]

6. Show that a convex lens produces an N time magnified image, when the object distances from eh lens have magnitude $\left(f \pm \frac{f}{N} \right)$. Here f is the magnitude of the focal length of the lens. Hence find two values of object distance. For which a convex lens of power 2.5 D will produce an image that is four times as large as the object? [3]

7. Define total infernal reflection of light? Hence write two advantages of total reflecting prisms over a plane mirror? [3]

8. (a) A person looking at a mesh of crossed wires is able to see the vertical lines more distinctly than the horizontal wires. What is the effect due to? How is such a defect of vision corrected? [2]

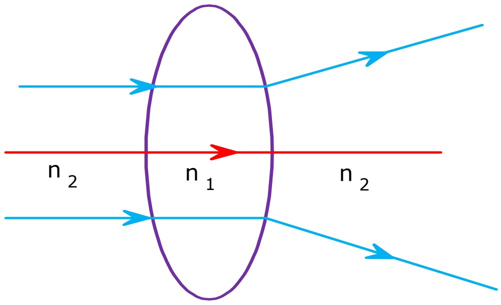
   (b) A man with normal near point (25cm) reads a book with small print using a magnifying glass: a thin convex lens of focal length 5cm. [3]

   (i) What is the closest and the farthest distance at which he can read the book when viewing through the magnifying glass ?

   (ii) What is the maximum and minimum angular magnificent (magnifying power) possible using the above simple microscope?

[ANSWERS]

Ans1: When $n_2 > n_1$ then the convex lens behaves as a concave



Ans2: magnification $M = \frac{-fo}{fe} = \frac{-60}{5} = -12$

$L = fo + fe$

Tube length $L = 60 + 5 = 65cm.$

Ans3: The two surface of the goggle lens are parallel i.e. one surface convex and the other concave thus the power of the two surfaces and equal but of opposite sign.

$\Rightarrow$ **$p = p_1 + p_2 = p + (-p) = 0$**

Ans4: When ray PQ falls normally on AB then if goes straight at QR (no refraction)

$n = \sqrt{2}$

$A = 30^o$

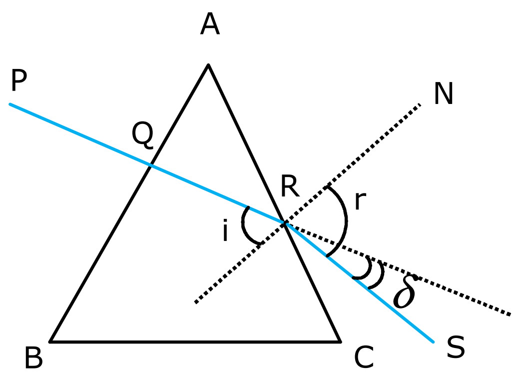
$i = 30^o$

Applying Snell's law for face AC

$n = \frac{\sin r}{\sin 30^o}$

$\sin r = \frac{1}{\sqrt{2}}$

$\Rightarrow$ $\boxed{r = 45^o}$



Now angle of deviation $\delta = r - i$

$\delta = 45^o - 30^o$

$\delta = 15^o$

Ans5: M = 20

R = 120cm (fro concave reflector)

$$fo = \frac{R}{2} = \frac{-120}{2} = -60cm$$

$$M = \frac{fo}{fe} \Rightarrow \frac{-60}{fe} = -20 \qquad \Rightarrow \boxed{fe = 3cm}$$

Ans6: Magnifying power

$$m = \frac{f}{v + f}$$

For real image m = -N

$$-N = \frac{f}{u + f} \Rightarrow u + f = \frac{-f}{N} \qquad \text{Or} \qquad \boxed{u = -\left(f + \frac{f}{N}\right)} \text{ ------------- (1)}$$

For virtual image m =N

$$N = \frac{fe}{u + f}$$

$$u + f = -f + \frac{f}{N} \qquad \text{Or} \qquad \boxed{u = -\left(f \pm \frac{f}{N}\right)} \text{ -------------- (2)}$$

From equation (1) & (2) we can say that magnification produced by a lens can be N if u = $u = -\left(f \pm \frac{f}{N}\right)$

Now power of a lens = 2.5 D

$$\therefore f = \frac{1}{p} = \frac{1}{2.5} m$$

$$f = \frac{1}{2.5} \times 100 = 40cm$$

$$m = \pm 4$$

$$\Rightarrow m \text{ equation (1)}$$

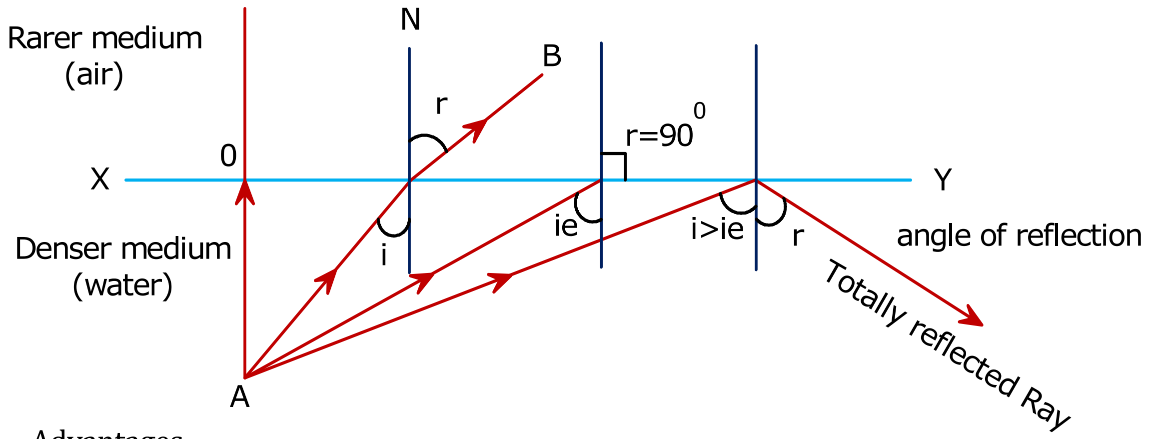
$$\pm 4 = \frac{4}{u + 40}$$

$$u + 40 = \pm 10$$

$$or \ u = -40 \pm 10$$

$$\boxed{u = 30cm \text{ or } -50cm}$$

Ans7: The phenomenon of reflection of light when a ray of light traveling from a denser medium is sent back to the same denser medium provided the angle of incidence is greater than the angle called critical angle is called total internal reflection.



Advantages

1. It does require silvering

2. Multiple reflections do not take place in a reflecting prism due to this; only one image is formed, which is very bright.

Ans8: (a) It is due to the defect called astigmatisms and is caused due to irregular surface of cornea and curvature of the eye lens is different in different planes. This type of defect can be corrected using cylindrical lens.

(b)(i) Here f = 5cm $\upsilon = -2.5cm$

For closest point $\frac{1}{f} = \frac{1}{\upsilon} - \frac{1}{u}$

$\frac{1}{5} = \frac{1}{-2.5} - \frac{1}{\upsilon}$ and thus $\frac{-1}{u} = \frac{1}{5} + \frac{1}{-2.5}$

$\frac{-1}{u} = \frac{6}{25}$ $\Rightarrow$ u = -4.2cm

A for farthest point f = 5cm $\upsilon = -\infty$

$\Rightarrow$ using $\frac{1}{5} = \frac{1}{-\infty} - \frac{1}{\upsilon}$ u = -5cm

(b) (ii) Angular magnification

$m = \frac{D}{|v|} = \frac{25}{4.2} = 6$ Maximum angular magnification

$m = \frac{25}{5} \Rightarrow m = 5$ Minimum angular magnification

CBSE TEST PAPER-05
CLASS - XII PHYSICS (Ray Optics)

1. Show the variation of u and υ in case of a convex mirror? [1]
2. Two lenses having focal length f_1 and f_2 are placed coaxially at a distance x from each other. What is the focal length of the combination? [1]
3. Following data was recorded for values of object distance and corresponding values of image distance in the experiment on study of real image formation by a convex lens of power +5 D. one of threes observation is incorrect. Identify and give reason? [2]

S. No.(u)	1	2	3	4	5	6
Object distance (υ)	25	30	35	45	50	55
Image distance	97	61	37	35	32	30

4. A bird flying high in the air appears to be higher than in reality. Explain why? [2]
5. An equi–convex lens of radius of curvature R is cut into two equal parts by a vertical plane, so it becomes a plano-convex lens. If f is the focal length of equi–convex lens, then what will be focal length of the plano –convex lens? [3]
6. A converging lens of focal length 6.25cm is used as a magnifying glass if near point of the observer is 25cm from the eye and the lens is held close to the eye. Calculate (1) Distance of object from the lens. (2) Angular magnification and (3) Angular magnification when final image is formed at infinity. [3]
7. Draw a graph to show that variation of angle of deviation Dm with that of angle of incidence i for a monochromatic ray of light passing through a glass prism of refracting angle A. hence deduce the relation? [3]

$$\mu = \sin\left(\frac{A+\delta m}{2}\right) \Big/ \sin\frac{A}{2}$$

8. Four double convex lens with following specification are available.

Lens	Focal length	Aperture	Lens	Focal length	Aperture
A	100cm	10cm	C	10cm	2cm
B	100cm	5cm	D	5cm	2cm

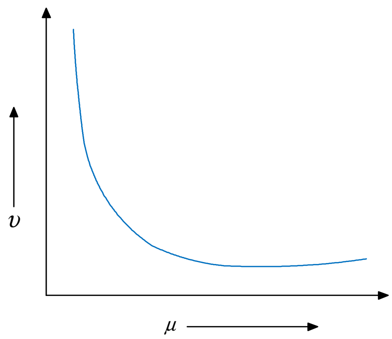
(a) Which of the given four lenses should be selected as objective and eyepiece to construct an astronomical telescope and why? What will be the magnifying power and length of the tube of this telescope? [3]

(b) An object is seen with the help of a simple microscope, firstly in red light and then is blue light. Will the magnification be same in both the cases? Why? [3]

CBSE TEST PAPER-05
CLASS - XII PHYSICS (Ray Optics)

[ANSWERS]

Ans1:

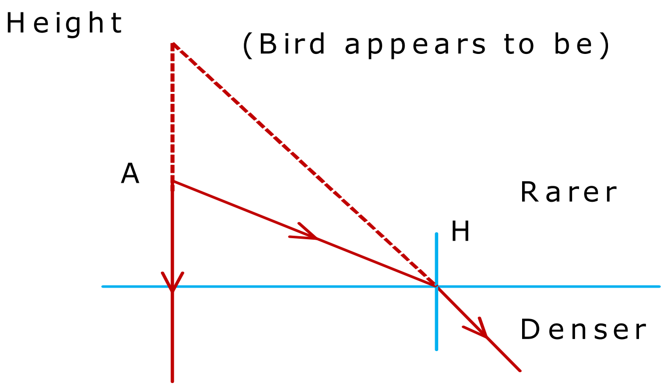


Ans2 $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{x}{f_1 f_2}$:

An3: $f=\frac{1}{P}=\frac{1}{5}=0.20m$

Observation (3) is incorrect because both object and the image here lies between f and 2f.

Ans4: Bird flying in air is in the rarer medium and if we see it from denser medium than light form bird refract towards the normal thus appears to come from the higher point. i.e. Apparent height > Real height (BIRD APPEARS TO BE)



Ans5: We know $\frac{1}{f}=(n-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

For equi –convex lens R_1 = - R_2 = R

$$\frac{1}{f}=(n-1)\left(\frac{1}{R}-\frac{1}{-R}\right)$$

$$\frac{1}{f}=(n-1)\left(\frac{1}{R}+\frac{1}{-R}\right)$$

$$\frac{1}{f}=\frac{2(n-1)}{R}------(1)$$

For plano convex lens

$$R_1=R\ and\ R_2=\infty$$

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

$$=(n-1)\left(\frac{1}{R}-\frac{1}{\infty}\right)$$

$$\frac{1}{f'}=\frac{(n-1)}{R}-----(2)$$

From (1) & (2)

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

Or $f' = 2f$

Ans6: (1) $\frac{1}{f}=\frac{1}{\upsilon}-\frac{1}{u}$

$$f=6.24cm$$

$$\vartheta=-25cm$$

$$\frac{1}{u}=\frac{-1}{25}-\frac{1}{6.25}=\frac{-1}{5}$$

u = -5cm

(2) $m = 1 + \frac{D}{F} = 1 + \frac{25}{6.25}$

m = 5cm

$m = \frac{D}{f}$

$m = \frac{25}{6.25} = 4$

$\Rightarrow$ m = 4

Ans7: For the minimum deviation position $i = \frac{\delta m + A}{2}$

$\angle i = \angle e$

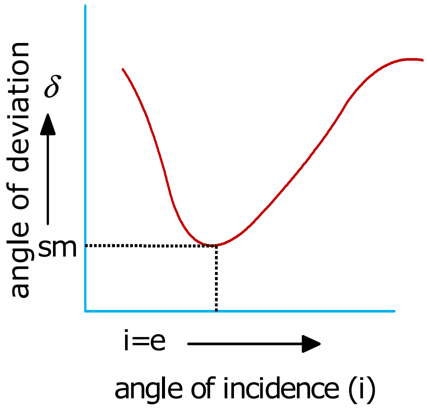
$r_1 = r_2 = r$ (Say)

We know $\angle i = \angle e = \delta + A ----(1)$

Also $r_1 + r_2 = A$

Or 2r = A

$r = \frac{A}{2}$



Applying minimum deviation condition is equation. (1)

2i = $\delta m + A$

$i = \frac{\delta m + A}{2}$

Applying Snell's law

$\mu = \frac{\sin i}{\sin r}$

Or $$\mu = \frac{\sin\left(\frac{A + \delta m}{2}\right)}{\sin\frac{A}{2}}$$

Ans8: (a) objective of the telescope should be of large aperture as it has to gather maximum light and should be of large focal length to have maximum magnification.

Hence lens A is selected as objective and lens D as eyepiece of small aperture and small focal length.

$$M.P = \left|\frac{fo}{fe}\right| = \frac{100}{5} = 20$$

M.P. = 20

(b) L = fo + fe

L = 100 + 5

L = 10.5 cm

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

$f\ \mathrm{Red} > f\ \mathrm{Blue}$

$M_{RED} < M_{Blue}$

∴ When red light as replaced by blue light, magnifying power increases.

CBSE TEST PAPER-01

CLASS - XII PHYSICS

Topic:-Wave Optics

1. What is the Brewster angle for air to glass transition? $(\mu g = 1.5)$ [1]

2. What is the shape of the wavefront when light is diverging from a point source? [1]

3. In young's double slit experiment how is the fringe width change when
(a) Light of smaller frequency is used
(b) Distance between the slits is decreased? [2]

4. Write two points of difference between interference and diffraction? [2]

5. Two coherent sources whose intensity ratio is 81:1 produce interference fringes. Calculate the ratio of intensity of maxima and minima in the interference pattern? [2]

6. Using Huygens's principle deduce the laws of refraction? [3]

7. A young's double slit experiment using light of wavelength 400 nm, interference fringes of width to 600nm, and the separation between the slits is halved. If one wants the observed fringe width on the screen to be the same in the two cases, find the ratio of the distance between the screen and the plane of the interfering sources in the two arrangements. [3]

8. (a) Coloured spectrum is seen, when we look through a muslin cloth. Why? [1]
(b) What changes in diffraction pattern of a single slit will you observe when the monochromatic source of light is replaced by a source of white light? [2]

9. A slit of width 'a' is illuminated by light of wavelength 6000 A^o. For what value of 'a' will the :-
(i) First maximum fall at an angle of diffraction of 30^o?
(ii) First minimum fall at an angle of diffraction 30^o? [3]

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Wave Optics)

[ANSWERS]

Ans1: $\mu = \tan ip$

$1.5 = \tan ip$

$\Rightarrow ip = \tan^{-1}(1.5)$

Ans2: Spherical

Ans3: $\beta = \frac{D\lambda}{d}$

If light of smaller frequency is of higher wavelength is used the fringe width will increase.

(b) If distance between the slits is decreased

i.e $\beta \alpha \frac{1}{d}$. Fringe width will increase.

Ans4:

S. No.	Interference	Diffraction
1	Interference occurs due to superposition of light coming from two coherent sources.	It is due to the superposition of the waves coming from different parts of the same wavefront.
2	All bright fringes are of equal intensity	The intensity of bright fringes decreases with increasing distance from the central bright fringes.

Ans5: $\frac{I_1}{I_2} = \frac{81}{1}$

Intensity α (Amplitude)^2

$\frac{a_1}{a_2} = \sqrt{\frac{81}{1}} = \frac{9}{1} = r$

$$\frac{I_{max}}{I_{min}} = \frac{(r+1)^2}{(r-1)^2} = \left(\frac{9+1}{9-1}\right)^2 = \left(\frac{10}{8}\right)^2$$

$$\frac{I_{max}}{I_{min}} = \frac{100}{64}$$

$$\frac{I_{max}}{I_{min}} = \frac{25}{16}$$

$I_{max} : I_{min} = 25 : 16$

Ans6: according to Huygens's theory each point on AB given rise to new wavefronts give taken by the wavelets to reach from

P to Q

$$t = \frac{PQ}{\vartheta^1} + \frac{OQ}{\vartheta^2} ------(1)$$

In PAO

$$\sin i = \frac{PO}{AO}$$

$$PO = AO \sin i$$

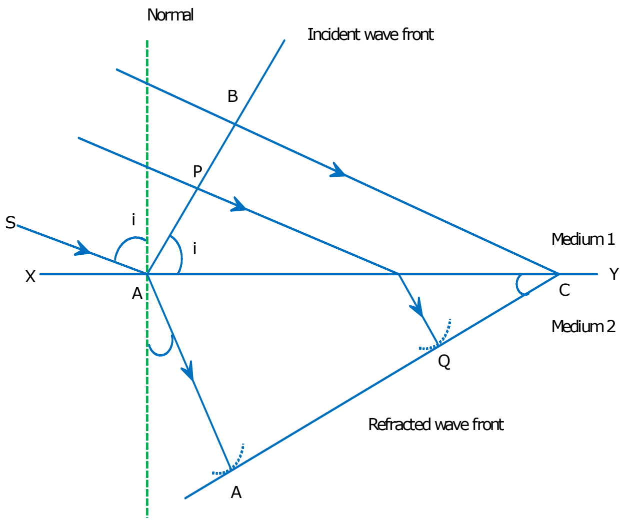
$$\sin r = \frac{OQ}{OC}$$

$$OQ = OC \sin r$$

substituting in equation(1)

$$t = \frac{AO \sin i}{\upsilon_1} + \frac{(AC - AO)\sin r}{\upsilon_2}$$

$$t = AO\left(\frac{\sin i}{\upsilon_1} - \frac{\sin r}{\upsilon_2}\right) + \frac{AC \sin r}{\upsilon_2}$$



Since time is independent of equation

∴ Term containing AO must be zero.

$$i.e \frac{\sin i}{\upsilon_1} - \frac{\sin r}{\upsilon_2} = O \Rightarrow \frac{\sin i}{\upsilon_1} = \frac{\sin r}{\upsilon_2}$$

$$\frac{\sin i}{\sin r} = \frac{\upsilon_1}{\upsilon_2} = \mu \left(\because \mu = \frac{C}{\upsilon}\right)$$

Hence proved Snell's law

Ans7: Let D_1 be the distance between the screen and the sources, when light of wavelength 400nm is used.

$$\beta = \frac{D\alpha}{d}$$

$$X = \frac{D_1 \times 400 \times 10^{-9}}{d} - - - - - - - (1)$$

In order to obtain the same fringe width

$$\frac{D_2 \times 600 \times 10^{-9}}{d} = \times - - - - - - - - (2)$$

From equation (1) and (2)

$$\frac{D_1}{D_2} = \frac{600 \times 10^{-9}}{400 \times 10^{-9}}$$

$$\boxed{\frac{D_1}{D_2} = 1.5}$$

Ans8: (a) Muslin cloth consist of very fine threads which acts as fine slits and when light pass through it, light gets diffracted giving rise to a coloured spectrum.

(b) (i) Diffracted lights consist of different colours.
(ii) It results in overlapping of different colours.

Ans9: $\lambda = 6000 A^o = 6000 \times 10^{-10}$ m

θ 1=30°, m=1

(1) For first maximum

$$\sin Q_m = \frac{\left(m + \frac{1}{2}\right)\lambda}{a}$$

$$\sin Q_1 = \frac{3\lambda}{2a}$$

$$or\ \text{a} = \frac{3\lambda}{2\sin\theta_1} = \frac{3 \times 6 \times 10^{-7}}{2 \times \sin 30^o}$$

(2) For first minimum

$$\sin Q_m = \frac{m\lambda}{a}$$

$$or \sin Q_1 = \frac{\lambda}{a}$$

$$a = \frac{\lambda}{\sin\theta_1}$$

$$a = \frac{6 \times 10^{-7}}{\sin 30^o}$$

A= 1.2 X 10^{-6}m

CBSE TEST PAPER-02

CLASS - XII PHYSICS

Topic:-Wave Optics

Marks: 20

1. Draw a diagram to show cylindrical wavefront? [1]

2. A light wave enters from air to glass. How will the following be affected: [1]
   (i) Energy of the wave
   (ii) Frequency of the wave:

3. Obtain an expression for the ratio of intensities at maxima and minima in an interference pattern. [2]

4. A slit S is illuminated by a monochromatic source of light to give two coherent sources P_1 and P_2. These given bright and dark bands on a screen. At a point R, on the screen, there is a dark fringe. What relation must exist between the lengths P_1R and P2R? [2]

5. State Brewster law? Using this law prove that, at the polarizing angle of incidence, the reflected and transmitted rays are perpendicular to each other? [3]

6. In a single slit experiment, how is the angular width of central bright fringe maximum changed when [3]
   1) The slit width increased
   2) The distance between the slit and the screen is increased.
   3) Light of smaller wavelength is used.

7. In a young's double slit experiment, the slit are repeated by 0.24mm. The screen is 1.2m away from the slits. The fringe width is 0.3cm calculate the wavelength of light used in the experiment? [3]

8. (a) State Huygens's principle for constructing wavefronts? [2]
   (b) Using Huygens's principle deduce the laws of reflection of light? [3]

   (c) What changes in diffraction pattern of a single slit will you observe when the monochromatic source of light is replaced by a source of white light? [2]

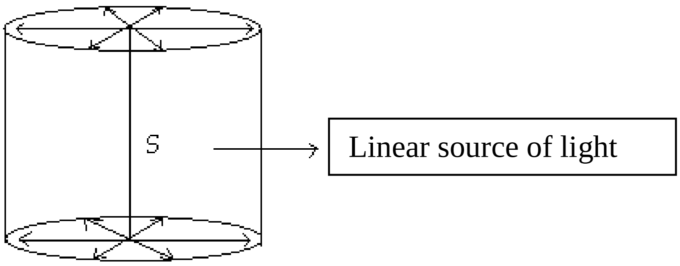
CBSE TEST PAPER-02

CLASS - XII PHYSICS

[ANSWERS]

Topic:-Wave Optics

Ans1:



Ans2: (1) A part of light is reflected back into the air. Thus energy of the wave will be lower in the glass.
(2) Frequency of the wave remains unchanged.

Ans3: Suppose a_1 and a_2 be the amplitudes and I_1 and I_2 the intensities of light waves which interfere each other

Intensity α (Amplitude)^2

$$\frac{I_1}{I_2} = \frac{a_1}{a_2}$$

After interference (applying superposition principle)

Amplitude at maxima = $a_1 + a_2$

Amplitude at minima = $a_1 - a_2$

$$\frac{\text{I}\max}{\text{I}\min} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2}$$

$$\frac{\text{I}\max}{\text{I}\min} = \frac{\left(\frac{a_1}{a_2} + 1\right)^2}{\left(\frac{a_1}{a_2} - 1\right)^2} = \left(\frac{r+1}{r-1}\right)^2$$

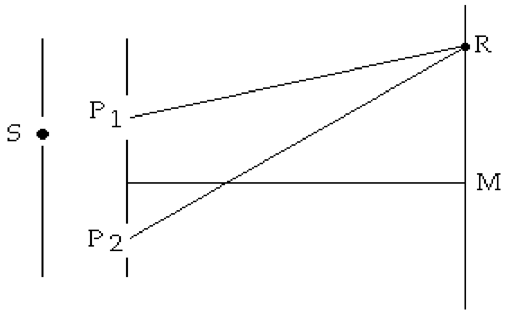
$where\ \text{r} = \frac{a_1}{a_2} = \sqrt{\frac{I_1}{I_2}}$ = amplitude ratio of two waves.

Ans4: There will be a dark fringe at point R When path difference

$= P_2R - P_1R$

$= (2n+1)\dfrac{\lambda}{2}$

Where λ is the wavelength of the light and n = 0, 1, 2, 3 -----------



Ans5: according to Brewster law the longest of the angle of polarization for transparent medium is equal to the refractive index of the medium.

i.e $\mu = \tan i_p$

Proof. Using Snell's law

$\mu = \dfrac{\sin i}{\sin r}$

When i = i_p $\mu = \dfrac{\sin i_p}{\sin r_p}$ ------ (1)

$Also = \tan i_p = \dfrac{\sin i_p}{\sin i_p}$ ------ (2)

from (1) & (2)

$\dfrac{\sin i_p}{\sin r_p} = \dfrac{\sin i_p}{\cos i_p}$

$\sin r_p = \cos i_p$

$\sin r_p = \sin(90^o - i_p)$

$\Rightarrow$ $rp + i_p = 90^o$

Ans6: In single slit diffraction

$\beta = \dfrac{2D\lambda}{d}$

(a) When slit width'd' is increased. β decreases

(b) When 'D' is increased, width of central bright fringe will become maximum i.e increase.
(c) When light of smaller wavelength is used, the width of central bright maximum decrease.

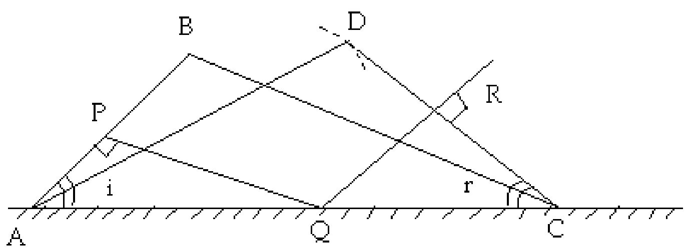
Ans7:

$$\beta = 0.3cm = 3.0\times10^{-3}m$$
$$D = 1.2m$$
$$d = 0.24mm = 2.4\times10^{-4}m$$
$$\beta = \frac{D\lambda}{d}$$
$$\Rightarrow \lambda = \frac{\beta d}{D}$$
$$\lambda = \frac{3.0\times10^{-3}\times2.4\times10^{-4}}{1.2}$$
$$\boxed{\lambda = 6.0\times10^{-7}m}$$

Ans8: (a) According to Huygens's principle
(1) Each source of light spreads waves in all directions.
(2) Each point on the wavefront give rise to new disturbance which produces secondary wavelets which travels with the speed of light.
(3) Only forward envelope which encloses the tangent gives the new position of wavefront.
(4) Rays are always perpendicular is the wavefront.

(b) A plane wave front AB incident at A hence every point on AB give rise to new waves.
Time taken by the ray to reach from P to R

$$t = \frac{PQ}{v} + \frac{QR}{v} ------(1)$$



$$In\ \Delta PAQ \sin i = \frac{PQ}{AQ}$$
$$PQ = AQ\sin i$$
$$In\ \Delta RCQ \sin r = \frac{QR}{QC}$$
$$QR = QC\sin r$$
Substituting in equation (1)

$$t = \frac{AQ\sin i}{v} + \frac{QC\sin r}{v}$$
$$t = \frac{AQ\sin i}{v} + \frac{(AC - AQ)\sin r}{v}$$
$$t = \frac{AQ\sin i}{v} + \frac{QC\sin r}{v} - \frac{AQ\sin r}{v}$$
$$\frac{AQ(\sin i - \sin r)}{v} + \frac{AC\sin r}{v}$$

Since all the secondary wavelets takes the same time to go form the incident wavefront to the reflected wavefront so it must be independent of Q
i.e sin i– sin r = 0
sin i = sin r

or $\boxed{i = r}$ → law of Reflection of light

CBSE TEST PAPER-03

CLASS - XII PHYSICS

Topic:-Wave Optics

Marks: 20

1. State the conditions that must be satisfied for two light sources to be coherent? [1]

2. In young's double slit experiment. The distance between the slits is halved, what change in the fringe width will take place? [1]

3. Consider interference between two sources of intensities I and 4I. What will be the intensity at points where phase differences is $(1)\frac{\pi}{2}$ $(2)\pi$ [2]

4. Can white light produce interference? What is the nature? [2]

5. In young's double slit experiment while using a source of light of wavelength 5000A^o, the fringe width obtained is 0.6cm. If the distance between the slit and the screen is reduced to half, calculate the new fringe width? [3]

6. What is polarization of light? What type of waves show the property of polarization? Name any two methods to produce plane polarized light? [3]

7. Draw the curve depicting, variation of intensity in the interference pattern in young's double slit experiment. State conditions for obtaining sustained interference of light? [3]

8. (a) Derive all expression for the fringe width in young's double slit experiment? [3]
   (b) If the two slits in young's double slit experiment have width ratio 4:1, deduce the ratio of intensity of maxima and minima in the interference pattern? [2]

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Wave Optics)

[ANSWERS]

Ans1: (1) They must emit waves continuously of same wavelengths.
(2) The phase difference between the waves must be zero or constant

Ans2: $\beta = \frac{\lambda D}{d}$ when $d' = \frac{d}{2}$

$\therefore \beta' = \frac{2\lambda D}{d}$

$\boxed{\beta' = 2\beta}$

Ans3: I = $a^2 + b^2 + 2ab\cos\phi$

Where a and b are amplitudes of two coherent waves having phase difference of ϕ.

Here $a^2 = I$, $b^2 = 4I$

$I = I + 4I + 2\sqrt{I}\sqrt{4I}\cos\phi$

$I = 5I + 4I\cos\phi$

(i) $When \phi = \frac{\pi}{2}$

$I = 5I + 4I\cos\frac{\pi}{2}$

$\boxed{I = 5I}$

(ii) Why $\phi = \pi$

$I = 5I + 4I\cos\phi$

$I = 5I - 4I$

$\boxed{I = I}$

Ans4: White light produces interference but due to different colour present in white light interference pattern overlaps the central bright fringe for all the colours is at the position, so its colour is white. The white central bright fringe is surrounded by few coloured rings.

Ans5: $\lambda = 5000 A^o = 5\times10^{-7} m$

$\beta = 0.6 cm = 0.6\times10^{-2} m$

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

$$\frac{\beta}{\lambda} = \frac{D}{d} \Rightarrow \frac{D}{d} = \frac{0.6\times10^{-2}}{5\times10^{-7}}$$

$$\frac{D}{d} = 1.2\times10^{4} ------(1)$$

New Distance $D' = \frac{D}{d}$

New fringe width $\beta' = \frac{\lambda D'}{d} = \frac{\lambda D'}{2d}$

$$\beta' = \frac{5\times10^{-7}\times1.2\times10^{4}}{2}$$

$$\boxed{\beta' = 3\times10^{-3} m}$$

Ans6: The phenomenon of restricting the vibrations of a light vector in a particular direction in a plane perpendicular to the direction of propagation of light is called polarisation of light.

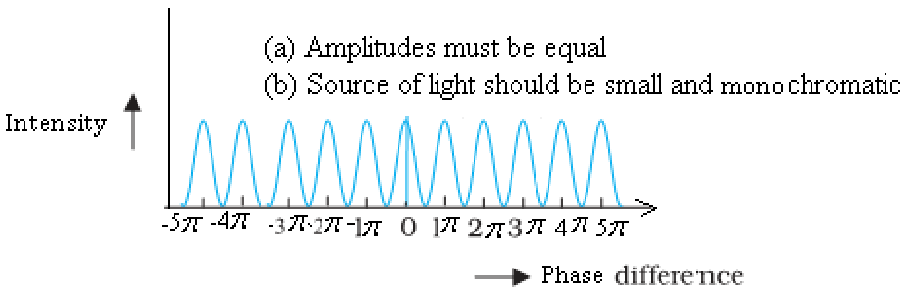
Transverse waves show the property of polarisaiton.

Two methods to produce plane polarised light

(1) Polarisation by Reflection

(2) Polarization by scattering

Ans7:



Conditions for sustained interference of light

(1) Two sources must be coherent sources of light.

(2)Two sources should exist light waves continuously. Intensity mono

Ans8: Path difference between S_1P and S_2P

$$\Delta x = S_2P - S_1P ------(A)$$

$$In\ \Delta S_2BP$$

$$(S_2P) = \left[(S^2B)^2 + (PB^2)\right]^{\frac{1}{2}}$$

$$S_2P = D\left[1+\frac{\left(y+\frac{d}{2}\right)}{D^2}\right]^{\frac{1}{2}} -----(1)$$

Using Binomial theorem expand equation. (1) and neglect higher terms

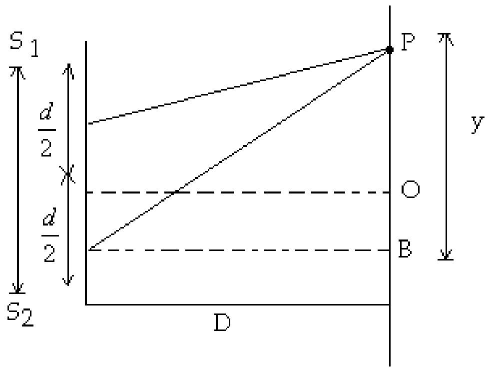
$$S_2P = D+\frac{\left(y+\frac{d}{2}\right)^2}{2D}$$

$$Similarty\ \mathrm{S_1P = D} + \frac{\left(y-\frac{d}{2}\right)^2}{2D} \quad -----(2)$$

Substituting equation (1) & (2) in equation (A)

$$\Delta\mathrm{x} = \frac{\left(y+\frac{d}{2}\right)^2-\left(y-\frac{d}{2}\right)^2}{2D}$$

$$\Delta\mathrm{x} = \frac{y^2+\frac{d^2}{4}+yd-y^2-\frac{d^2}{4}+yd}{2D}$$



$$\Delta\mathrm{x} = \frac{2yd}{2D}$$

$$\boxed{\Delta\mathrm{x} = \frac{yd}{D}}$$

For bright fringes

Path difference = $x\lambda$

$$x\lambda = \frac{yd}{D}$$

$$i.e\ y = \frac{x\lambda D}{d}$$

$$\mathrm{form =1} \quad \mathrm{y_1 = \frac{\lambda D}{d}}$$

$$\mathrm{n = 2} \quad \mathrm{y_2 = \frac{\lambda D}{d}}$$

For fringe width

$$\beta = y_2 - y_1$$

$$\boxed{\beta = \frac{\lambda d}{d}}$$

(b) $\frac{a_1^2}{a_2^2} = \frac{w_1}{w_2} = \frac{4}{1}$

$\frac{a_1}{a_2} = \frac{2}{1}$

$or\ a_1 = 2a_2$

Using $\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2}$

$\frac{I_{max}}{I_{min}} = \frac{(2a_1 + a_2)^2}{(2a_1 - a_2)^2} = \left(\frac{3a_2}{a_2}\right)^2$

$$\boxed{\frac{I_{max}}{I_{min}} = \frac{9}{1}}$$

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Dual Nature of Matter and Radiation)

1. Calculate the energy associated in eV with a photon of wavelength 4000A^o ? [1]
2. Mention one physical process for the release of electron from the surface of a metal? [1]
3. The maximum kinetic energy of photoelectron is 2.8 eV. What is the value of stopping potential? [1]
4. Derive an expression for debroglie wavelength of an electron? [2]
5. Light of wavelength 2000A^o falls on an aluminum surface. In aluminum 4.2 eV are required to remove an electron. What is the kinetic energy of (a) fastest (b) the slowest photoelectron? [2]
6. An electromagnetic wave of wavelength λ is incident on a photosensitive surface of negligible work function. If the photoelectrons emitted form this surface have de-broglie wavelength λ_1. Prove that $\lambda = \left(\frac{2mc}{h}\right)\lambda_1^2$. [2]
7. It is difficult to remove a free electron from copper than from sodium? Why? [2]
8. The following table gives the values of work functions for a few sensitive metals. [3]

S. No.	Metal	Work function(eV)
1	Na	1.92
2	K	2.15
3	Mo	4.17

If each of these metals is exposed to radiations of wavelength 3300nm, which of these will not exit photoelectrons and why?

9. Define threshold wavelength for photoelectric effect? Debroglie wavelength associated with an electron associated through a potential difference V is λ? What will be the new wavelength when the accelerating potential is increase to 4V? [3]
10. An electron has kinetic energy equal to 100eV. Calculate (1) momentum (2) speed (3) Debroglie wavelength of the electron. [3]

[ANSWERS]

Ans1: $E = \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{4000\times10^{-10}}$

$E = 4.95\times10^{-19} J$

$E = \frac{4.95\times10^{-19} J}{1.6\times10^{-19}} eV$

E = 3.09 eV

Ans2: Photoelectric emission.

Ans3: $\frac{1}{2}m\upsilon^2 = eVo = 2.8eV$

$\Rightarrow Vo = 2.8V$

Ans4: If a beam of electrons traveling through a potential difference of V volt, the electron acquires kinetic energy.

$\frac{1}{2}m\upsilon^2 = eV$

multiply by m

$m^2\upsilon^2 = 2meV$

Now $\lambda = \frac{h}{m\upsilon}$

$\Rightarrow \lambda = \frac{h}{\sqrt{2meV}}$ $(\because eV = E)$

$\Rightarrow \lambda = \frac{h}{\sqrt{2mE}}$ Since m, e, h are constant

$$\therefore \lambda = \frac{12.27}{\sqrt{V}} A^o$$

Ans5: $\lambda = 2000A^o \quad = 22\times10^{-7} m$

$\phi_o = 4.2eV$

(a) $K.E_{\max} = \frac{1}{2}mV_{\max}^2 = hv - \phi o$

$$\frac{1}{2}mV_{\max}^2 = \frac{hc}{\lambda} - \phi_o = \frac{6.6\times10^{-34}\times3\times10^8}{2\times10^{-7}} - 4.2$$

$$\frac{1}{2}mV_{\max}^2 = 6.2 - 4.2 = 2eV$$

This is the K.E of the fastest electron

(b) Zero

Ans6: $hv = \phi + K.E.$

$$\frac{hv}{\lambda} = o + K.E.$$

$$K.E. = \frac{hc}{\lambda}$$

Using $\lambda_1 = \frac{h}{\sqrt{2mK.E.}}$

$$\lambda_1 = \frac{h}{\sqrt{2m\frac{hc}{\lambda}}} = \sqrt{\frac{h\lambda}{2mc}}$$

Squaring we get

$$\lambda_1^2 = \frac{h\lambda}{2mc}$$

Or $\boxed{\lambda = \left(\frac{2mc}{n}\right)\lambda_1^2}$

Ans7: since $\phi_o = \frac{hc}{\lambda_o}$

Where λ_o is the threshold wavelength

Since $\lambda_o Na > \lambda_o Cu$

∴ Work function for copper is greater and it becomes difficult to remove a free electron from copper.

Ans8: That material will not emit photoelectrons whose work function is greater than the energy of the incident radiation.

$$E = \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^8}{33\times10^{-8}}$$

$E = 6.20\times10^{-19}$ Joules

$$\Rightarrow E = \frac{6.20\times10^{-19}}{1.6\times10^{-19}eV}$$

E = 3.76 eV

Hence work function of M_0 is (4.17eV) which is greater than the energy of the incident radiation (= 3.76 eV) so M_0 will not emit photoelectrons.

Ans9: The maximum wavelength of radiation needed to cause photoelectric emission is known as threshold wavelength.

$$\lambda = \frac{12.27}{\sqrt{V}} A^o$$

$$\lambda' = \frac{12.27}{\sqrt{4V}} A^o = \frac{12.27}{2\sqrt{V}} A^o$$

$$\frac{\lambda'}{\lambda} = \frac{1}{2}$$

Or $\boxed{\lambda' = \frac{\lambda}{2}}$

Ans10: $\frac{1}{2} m\upsilon^2 = 100eV$

$$\frac{1}{2} m\upsilon^2 = 100 \times 1.6 \times 10^{-19} J$$

$$\frac{1}{2} m\upsilon^2 = 1.6 \times 10^{-17} J ------(1)$$

Multiply by m

$$\frac{1}{2} m^2\upsilon^2 = 1.6 \times 10^{-17}$$

$$m^2\upsilon^2 = 2 \times 1.6 \times 10^{-17}$$

(1) (Momentum) $P = m\upsilon = \sqrt{2 \times 1.6 \times 10^{-7}}$

$$\boxed{P = 5.40 \times 10^{-24} Kgm/s}$$

(2) Speed $\frac{P}{m}$

$$\upsilon = \frac{5.40 \times 10^{-24}}{9.1 \times 10^{-31}}$$

$$\boxed{\upsilon = 5.93 \times 10^6 m/s}$$

(3) Debroglie wavelength $\lambda = \frac{h}{mV}$

$$= \frac{6.6 \times 10^{-34}}{5.40 \times 10^{-24}}$$

$$\Rightarrow \boxed{\lambda = 1.23 A^o}$$

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Dual Nature of Matter and Radiation)

1. Calculate the threshold frequency of photon for photoelectric emission from a metal of work function 0.1eV? [1]
2. Ultraviolet light is incident on two photosensitive materials having work function ϕ_1 and ϕ_2 ($\phi_1 > \phi_2$). In which of the case will K.E. of emitted electrons be greater? Why? [1]
3. Show graphically how the stopping potential for a given photosensitive surface varies with the frequency of incident radiations? [1]
4. Obtain the expression for the maximum kinetic energy of the electrons emitted from a metal surface in terms of the frequency of the incident radiation and the threshold frequency? [2]
5. For a given K.E. which of the following has the smallest de–broglie wavelength: electron, proton, $\alpha -$ particle? [2]
6. Photoelectrons are emitted with a maximum speed of 7×10^5m/s from a surface when light of frequency 8×10^{14}Hz is incident on it. Find the threshold frequency for this surface? [2]
7. Is photoelectric emission possible at all frequencies? Give reason for your answer? [2]
8. Assume that the frequency of the radiation incident on a metal plate is greater than its threshold frequency. How will the following change, if the incident radiation is doubled? [2]
   (1) Kinetic energy of electrons
   (2) Photoelectric current
9. Why are de – broglie waves associated with a moving football is not visible? [2]
10. (a) Define photoelectric work function? What is its unit? [2]

    (b) In a plot of photoelectric current versus anode potential, how does [3]
    (i) Saturation current varies with anode potential for incident radiations of different frequencies but same intensity?
    (ii) The stopping potential varies for incident radiations of different intensities but same frequency.
    (iii) Photoelectric current vary for different intensities but same frequency of radiations? Justify your answer in each case?

[ANSWERS]

Ans1: $\phi_o = h\nu_o$

$$\nu_o = \frac{\phi_o}{h} = \frac{0.1eV}{6.6\times10^{-34}Js}$$

$$\nu_o = \frac{0.1\times1.6\times10^{-19}J}{6.6\times10^{-34}Js}$$

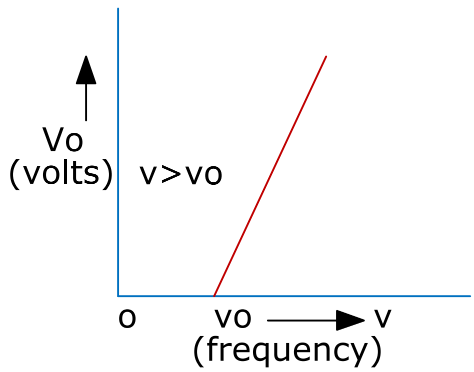
$$\boxed{\nu_o = 2.4\times10^{-13}\Delta^{-1}}$$

Ans2: $h\nu = \phi_o + K.E.$

If ϕ_1 > ϕ_2 thus K.E. will be more for second surface whose work function is less.

Ans3: ν_o - threshold of frequency

or cut off frequency



Ans4: $K.E_{\max} = h\nu - w$

W is the threshold energy or work function depends upon threshold frequency ν_o

$w = h\nu_o$

$or \frac{1}{2}mv^2{}_{\max} = h\nu - h\nu_o$

Or $\boxed{h\nu = \frac{1}{2}mv^2{}_{\max} + h\nu_o}$

Ans5: Debroglie wavelength

$$\lambda = \frac{h}{m\upsilon}$$

and m $\upsilon = \sqrt{2mE}$

When E is energy $\Rightarrow \lambda = \frac{h}{\sqrt{2mE}}$

Comparing masses we get mass of $\alpha -$particle is more; hence wavelength of alpha particle is minimum.

Ans6: $h(v - v_o) = \frac{1}{2} m\upsilon^2{}_{\max}$

$$v_o = \frac{v - m\upsilon^2{}_{\max}}{2h}$$

$$v_o = 8\times 10^{14} - \frac{9.1\times 10^{-31}\times(7\times 10^5)^2}{2\times 6.63\times 10^{-34}}$$

$$\boxed{v_o = 4.64\times 10^{14}\, Hz}$$

Ans7: No, photoelectric emission is not possible at all frequencies because it is possible only if radiation energy is greater than work function $\omega = hv_o$ of the emitter.

Ans8: (1) If the frequency of the incident radiation is doubled $hv - hv_o$ is increased, hence kinetic energy is increased.

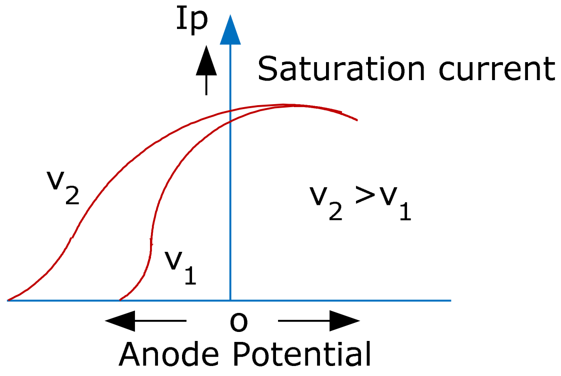
(2) If the frequency of the incident radiation is doubled there will be no change in the number of photoectrons i.e. photoelectronic current.

Ans9: The wavelength of a wave associated with a moving football is extremely small, which cannot be detected.

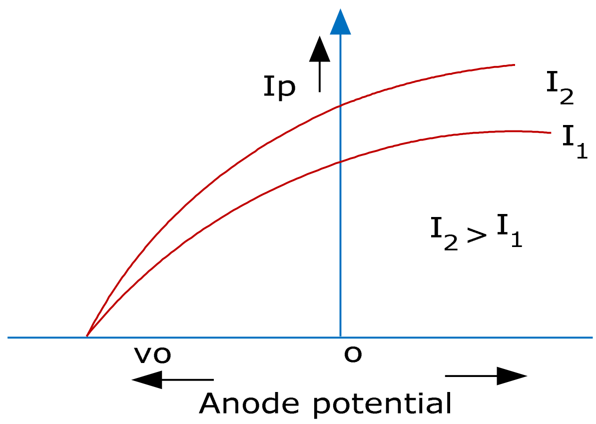
Since $\lambda = \frac{h}{m\upsilon}$

Ans10: (a) The minimum amount of energy required to take out an electron from the surface of metal. It is measured in electron volt (eV).

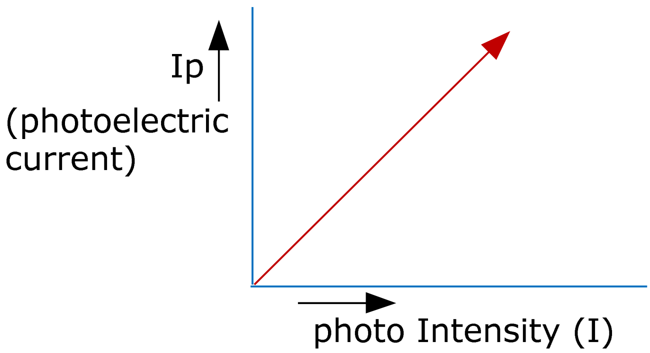
(b) (i) Saturation current depends only on the intensity of incident radiation but is independent of the frequency of incident radiation.



(ii) Stopping potential does not depend on the intensity of incident radiations.



(iii) Photoelectric current is directly proportional to the intensity of incident radiations, provided the given frequency is greater than the threshold frequency.



CBSE TEST PAPER-03

CLASS - XII PHYSICS (Dual Nature of Matter and Radiation)

1. How does the stopping potential applied to a photocell change if the distance between the light source and the cathode of the cell is doubled? [1]
2. On what factor does the retarding potential of a photocell depend? [1]
3. Electron and proton are moving with same speed, which will have more wavelength? [1]
4. By how much would the stopping potential for a given photosensitive surface go up if the frequency of the incident radiations were to be increased from 4×10^{15} Hz to 8 $\times\ 10^{15}$ Hz? $\left(h = 6.4\times10^{-3}4Js,\ e = 1.6\times10^{-19}C,\ c = 3\times10^{8}m/s\right)$ [2]
5. Work function of Na is 2.3eV. Does sodium shoe photoelectric emission for light on the velocity of photoelectrons? [2]
6. An electron and an alpha particle have the same debroglie wavelength associated with them? How are their kinetic energies related to each other? [2]
7. An $\alpha - particle$ and a proton are accelerated from rest through same potential difference V. find the ratio of de–broglie wavelength associated with them? [2]
8. Photoelectric work function of a metal is 1eV. Light of wavelength 3000A^o falls on it. What is the velocity of the effected photoelectron? [3]
9. The wavelength λ of a photon and debroglie wavelength of an electron have the same value. Show that the energy of the photon is $\frac{2\lambda mc}{h}$ times the kinetic energy of electron where m, c, and h have their usual meanings? [3]
10. Draw a graph showing the variation of stopping potential with frequency of the incident radiations. What does the slope of the line with the frequency axis indicate. Hence define threshold frequency? [3]

[ANSWERS]

Ans1: Stopping potential does not depend on the intensity of the light source which changes due to the change in distance from the light source.

Ans2: It depends upon the frequency of the incident light

Ans3: Since $\lambda \alpha \frac{1}{\sqrt{m}}$ so electron being lighter will have more wavelengths

Ans4: Stopping potential $V_o \alpha v$

$$\Rightarrow \frac{V_{o2}}{V_{01}} = \frac{v_2}{v_1} = \frac{8\times10^{15}}{4\times10^{15}} = 2$$

$$\boxed{\Rightarrow V_{o2} = 2V_{01}}$$

Ans5: Since $\frac{1}{2}m\upsilon^2 \alpha \frac{1}{\lambda}$

∴ Velocity of photoelectrons increases with the decrease in the wavelength of the incident light.

Ans6:

$$\lambda = \frac{h}{m\upsilon} \quad or \quad m\upsilon = \frac{h}{\lambda}$$

$$K.E = \frac{P^2}{2m}$$

$$\Rightarrow K.E(E') = \frac{h^2}{2m\lambda^2} -----(2)$$

$$\Rightarrow \frac{(K.E.)electron}{(K.E.)alpha} = \frac{m\alpha}{me} \begin{pmatrix} \because \lambda = \frac{h}{P} \\ \text{is same} \end{pmatrix}$$

Ans7: $\frac{1}{2}m\upsilon^2 = qV$

and $P = \sqrt{2mE} = \sqrt{2mqV}$

$$P(\alpha) = \sqrt{2\times4m_p \times 2q_p V} -----(1) \begin{pmatrix} \because m\alpha = 4mp \\ q\alpha = 2qp \end{pmatrix}$$

Dividing equation (1) and (2)

$$\frac{P}{P_{proton}} = \frac{\sqrt{2\times 4m_p \times 2q_p V}}{\sqrt{2m_p q_p V}} = \frac{\sqrt{8}}{1}$$

$$Since\ \lambda\alpha\frac{1}{P}$$

$$\Rightarrow \frac{\lambda\alpha}{\lambda P} = \frac{1}{\sqrt{8}} = \frac{1}{2\sqrt{2}}$$

$$\boxed{\lambda\alpha : \lambda P = 1 : 2\sqrt{2}}$$

Ans8: $\phi_o = leV = 1\times 1.6\times 10^{-19}\ Joules$

$$\lambda = 3000A^o = 3000\times 10^{-10}m$$

$$or\ \lambda = 3\times 10^{-7}m$$

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

$$E = \frac{6.6\times 10^{-34}\times 3\times 10^{8}}{3\times 10^{-7}}$$

$$\boxed{E = 6.625\times 10^{-19}\ Joules}$$

Now kinetic energy $(K.E.) = \frac{1}{2}m\vartheta^2 = h\nu - \phi_o$

$$\frac{1}{2}m\upsilon^2 = 6.625\times 10^{-19} - 1.6\times 10^{-19}J$$

$$\frac{1}{2}m\upsilon^2 = 5.025\times 10^{-19}$$

$$\Rightarrow \upsilon^2 = \frac{2\times 5.025\times 10^{-19}}{9.1\times 10^{-31}}$$

$$or\ \upsilon = \sqrt{\frac{2\times 5.025\times 10^{-19}}{9.1\times 10^{-31}}}$$

$$\boxed{\upsilon = 1\times 10^{6}m/s}$$

Ans9: Energy of a photon $E = h\nu = \frac{hc}{\lambda}$ ------(1)

Kinetic energy $E' = \frac{1}{2}m\upsilon^2 = \frac{m^2\upsilon^2}{2m} = \frac{(mv)^2}{2m}$ of an electron

But de-broglie wavelength of an electron is given by

$$\lambda = \frac{h}{m\upsilon} \text{ or } m\upsilon = \frac{h}{\lambda}$$

$$\Rightarrow K.E(E') = \frac{h^2}{2m\lambda^2} ------(2)$$

Dividing (1) by (2)

$$\frac{E}{E'} = \frac{hc}{\lambda} \times \frac{2m\lambda^2}{h^2} = \frac{2m\lambda c}{h}$$

$$\boxed{E = \left(\frac{2m\lambda c}{h} E'\right)}$$

Ans10: Slope of the graph $= \frac{\Delta v_o}{\Delta v}$

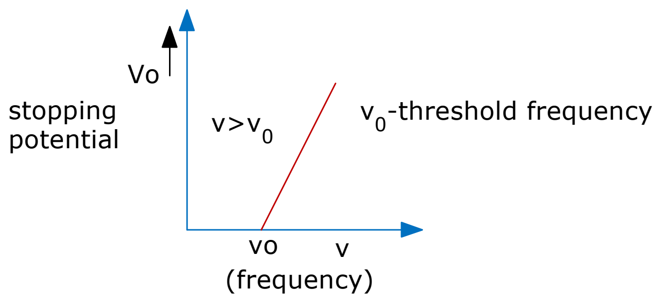
Einstein photoelectric equation

$$eV_o = hv - \phi_o ------(1)$$

Differentiating equation (1)

$$e\Delta V_o = h\Delta v$$

$$\boxed{\frac{\Delta V_o}{\Delta v} = \frac{h}{e}}$$



Thus slope is equal to the ratio of planck's constant to the charge on electron.

Threshold frequency – The minimum values of frequency of the incident light below which photoelectric emission is not possible is called as threshold frequency.

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Atoms and Nuclei)

1. Name the series of hydrogen spectrum lying in ultraviolet and visible region? [1]

2. What is Bohr's quantisation condition for the angular momentum of an electron in the second orbit? [1]

3. Define Bohr's radius? [1]

4. State the limitations of Bohis atomic model? [2]

5. The half life period of a radioactive substance is 30 days. What is the time for $\frac{3}{4}th$ of its original mass to disintegrate? [2]

6. How many α and β-particles are emitted when $_{90}^{232}Th$ changes to $_{82}^{208}Pb$ [2]

7. Binding energies of $_{8}^{16}O$ and $_{17}^{35}Cl$ are 127.35 MeV and 289.3 MeV respectively. Which of the two nuclei are more stable? [2]

8. THE total energy of and electron in the first excited state of hydrogen atom is -34.eV. Calculate [3]
(1) K.E. of the electron in this state.
(2) P.E. of the electron in this state and
(3) Which of the answer would change of the choice .Justify your answer?

9. Prove that the speed of election in the ground sate of hydrogen atom is equal to the speed of electron in the first excited state of hydrogen like Li^{++} atom. [3]

10. Draw a graph showing variation of potential energy of a pair of nucleon as a function of their separation indicate the region in which the nuclear force is (a) Attractive (b) Repulsive. Also write two characteristics features which distinguish it from the coulomb's force. [3]

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Atoms and Nuclei)

[ANSWERS]

Ans1: Lyman series in ultraviolet region and Balmer series in visible region.

Ans2: Since $L = \frac{nh}{2\pi}$ where n = 2

$L = \frac{2h}{2\pi}$

$\Rightarrow \boxed{L = \frac{h}{\pi}}$

Ans3: The radius of the first orbit of hydrogen atom is called Bohr's radius.
It is equal to 5.29×10^{-11}m = $0.53A^o$.

Ans4: (1) It does not give any indication regarding the arrangement and distribution of electrons in on atom.
(2) It could not account for the wave nature of electrons.

Ans5: $\frac{N}{N_o} = \left(\frac{1}{2}\right)\frac{t}{T}$

Here $N = N_o - \frac{3}{4}N_o$

$N = \frac{1}{4}N_o$

$\Rightarrow \frac{1}{4} = \left(\frac{1}{2}\right)\frac{t}{30}$

Or $\left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)\frac{t}{30}$

$\frac{t}{30} = 2$ Or $\boxed{t = 60 \text{ days}}$

Ans6: $90\overset{232}{Th} \rightarrow 82\overset{208}{Pb} + 2\overset{4}{He} + y\,_{-1}\overset{o}{e}$

According to low of conservation of atomic number and mass number
90 = 82 + 2x – y
2x – y = 8 ----------- (1)
232 = 208 + 4x

$\Rightarrow \boxed{x = 6}$ ----------- (2)

From (1) & (2)
2 (6) – y = 8
12 – 8 = y

Or $\boxed{y = 4}$

Ans7: Stability of a nucleus is proportional to binding energy per nucleon

B.E / nucleon of $8\overset{16}{O} = \frac{127.35}{8} = 15.82 MeV / nucleon$

B.E / nucleon of $17\overset{35}{Cl} = \frac{289.3}{17} = 17.02 MeV / nucleon$

$\therefore$ $17\overset{35}{Cl}$ Is more stable than $8\overset{16}{O}$

Ans8: (i) K.E = -E = 3.4eV
(ii) P.E = 02 $\times$ K.E
P.E = 02 $\times$ 3.4
(iii) If the zero of the P.E is changed, K.E remains unchanged but the P.E will change, hence total energy will change.

Ans9: $\upsilon_n = \frac{2\pi Ke^2}{nh}$

For ground state of hydrogen atom x = 1 $\upsilon_1 = \frac{2\pi Ke^2}{h}$

Fro hydrogen like atom $(\upsilon_n)_\mu = \frac{Z \times 2\pi Ke^2}{nh}$ ------(1)

For Li^{++} atom z = 3 n = 2

$\Rightarrow (\upsilon_n)_{Li^{++}} = \frac{2 \times 2\pi Ke^2}{2h}$

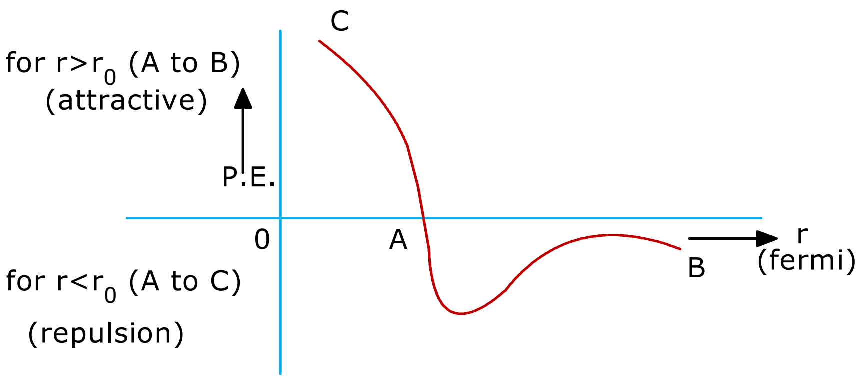
$(\upsilon_n)_{Li^{++}} = \frac{2\pi Ke^2}{h}$ ------(2)

Hence from (1) and (2)

$$\boxed{(\upsilon_n)_H = (\upsilon_n)_{Li^{++}}}$$

Ans10:

(i) Nuclear forces are charge independent.
(ii) They are non – central forces.



CBSE TEST PAPER-02
CLASS - XII PHYSICS (Atoms and Nuclei)

1. Complete the following nuclear reactions [1]
(a) $4Be^9 +_1 H^1 \rightarrow_3 Li^6 + ...$
(b) $5B^{10} + 2\overset{4}{He} \rightarrow 7N^{13} + ...$

2. What is $\theta - value$ of a nuclear reaction? [1]

3. What fraction of tritium will remain after 25 years? Given half life of tritium as 12.5 years [1]

4. Calculate the kinetic energy and potential energy of an electron in the first orbit of hydrogen atom. Given e = 1.6 $\times$ 10^{-19}C and r = 0.53 $\times 10^{-10}$m. [2]

5. A neutron is absorbed by a $3Li$ nucleus with subsequent emission of alpha particle. Write the corresponding nuclear reaction? [2]

6. If the activity of a radioactive substance drops to $\frac{1}{8}th$ of its initial value in 30 years, find its half life period? [2]

7. Show that nuclear density is in dependent of mass number A of a nucleus? [2]

8. The wavelength of the first member of Balmer series in the hydrogen spectrum is 6563A^o. Calculate the wavelength of the first member of lyman series in the same spectrum. [3]

9. A neutron is absorbed by a $3\overset{6}{Li}$ nucleus with subsequent emission of $\alpha - particle$. Write the corresponding nuclear reaction.
Calculate the energy released in this reaction. [3]
Given mass of $3\overset{6}{Li}$ = 6.015126 a.m.u.
Mass of $2\overset{4}{He}$ = 4.000 26044 a.m.u.
Mass of neutron $\left(o\overset{1}{n}\right)$ = 1.0086654 a.m.u.
Mass of tritium $\left({}_1\overset{1}{H}\right)$ = 3.016049 a.m.u.

10. Define decay constant of a radioactive sample. Which of the following radiation α-rays, β-rays and γ-rays.
(i) Are similar to X – rays? (ii) Are easily absorbed by matter? [3]

CBSE TEST PAPER-02
CLASS - XII PHYSICS (Atoms and Nuclei)

[ANSWERS]

Ans1: (a) $4Be^{9} + 1\overset{1}{H} \rightarrow 3Li^{6} + 2\overset{4}{He}$

(b) $5B^{10} + 2\overset{4}{H}e \rightarrow 7\overset{13}{N} + on^{1}$

Ans2: $\theta - value =$ (Mass of reactants – Mass of products)

Ans3: $\frac{N}{N_o} = \left(\frac{1}{2}\right)^{t/T} = \left(\frac{1}{2}\right)^{25/12.5}$

$\frac{N}{N_o} = \left(\frac{1}{2}\right)^{2} = 1/4 = 0.25$

Ans4: (i) $K.E. = \frac{e^2 K}{2a_0}$

$K.E. = \frac{(1.6\times10^{-19})^2 \times 9\times10^{9}}{2\times0.53\times10^{-10}}$

$K.E. = 21.74\times10^{-19}\, J$

$K.E. = \frac{21.74\times10^{-19}}{1.6\times10^{-19}} = 13.59eV$ K.E. = 13.59eV

(ii) $P.E. = \frac{-e^2 K}{r} = -2K.E.$

$P.E. = -2\times13.59$ P.E. = -27.18eV

Ans5: $o\overset{1}{n} + 3\overset{60}{Li} \rightarrow {}_{2}^{4}He(\alpha - particle) + z\overset{A}{Y}$

$0 + 3 = 2 + Z \Rightarrow Z = 1$

(Conservation of Atomic Number)

$1 + 6 = 4 + A$

$\Rightarrow A = 3$

(Conservation of Mass Number)

$\therefore y\overset{A}{Y} = {}_{1}^{4}Y = {}_{1}^{3}H \qquad \Rightarrow o\overset{1}{n} + 3\overset{6}{Li} \rightarrow {}_{2}^{4}He + {}_{1}\overset{3}{4}$

Ans6: $\frac{A}{A_o} = \left(\frac{1}{2}\right)^{t/T}$

$\frac{1}{8} = \left(\frac{1}{2}\right)^{30/T}$

$\left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^{30/T}$

$\Rightarrow \frac{30}{T} = 3$ Or **T = 10 years**

Ans7: Nuclear density = $\frac{\text{Mass of nucleus}}{\text{Volume of nucleus}} = \frac{(\text{Mass of P or N}) \times A}{\text{Volume of Nucleus}}$

$$P = \frac{(1.6\times10^{-27})A}{4/3\,\pi R^3} = \frac{(1.6\times10^{-27})\times A}{4/3\,\pi\left(R_o A^{\frac{1}{3}}\right)^3}$$

Here $R_o = 1.2\times10^{-15}m$

$$\Rightarrow P = \frac{(1.6\times10^{-27})\times A}{4/3\,\pi R_o^{\,3} A} = \frac{1.6\times10^{-27}}{4/3\times3.14\times(1.2\times10^{-15})^3}$$

$\Rightarrow$ **$P = 2.21 \times 10^{17}$ Kg/m^3**

Ans8: We know $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{ni^2}\right), n = 3, 4, 5 ------$

For first member ni = 3 (Balmer series)

$$\frac{1}{\lambda_1} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_1} = R\left(\frac{1}{4} - \frac{1}{9}\right)$$

$\lambda_1 = \frac{36}{5R}$ --------------- (1)

For first member of Lyman series

$$\frac{1}{\lambda_1'} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

$$\frac{1}{\lambda_1'} = R\left(1 - \frac{1}{4}\right)$$

Or $\boxed{\lambda_1' = \frac{4}{3R}}$ ---------------- (2)

From (1) and (2)

$$\frac{\lambda_1'}{\lambda_1} = \frac{4}{3R} \times \frac{5R}{36}$$

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

$$\lambda_1 = 6563A^o$$

$$\boxed{\lambda_1' = 1215.4A^o}$$

Ans9: Nuclear reaction is given by

$$\overset{1}{o}n + 3\overset{6}{Li} \rightarrow 2\overset{4}{He} +_1 \overset{3}{H}$$

Mass of reactants $= m\left(\overset{1}{o}n\right) + m\left(3\overset{6}{Li}\right)$

$= 1.0086654 + 6.015126 = 7.0237914 a.m.u$

Mass Defect, Δm = mass of reactant – mass of product.

Δm = 7.0237194 – 7.0186534

Δm = 0.005138 a.m.u.

Since1. a.m.u. = 931MeV

$\therefore$ Energy released $= \Delta m \times 931$MeV

E = 0.005138 $\times$ 931

$\boxed{\text{E = 4.783MeV}}$

Ans10: Radioactive decay constant (λ) is the reciprocal of time during which the number of atoms in the radioactive substance reduced to 36.8% of the original number of atoms in it.

(i) are similar to $X - rays$

(ii) Penetration power of α-rays is less than that of β and γ-rays so γ-rays are easily absorbed by matter.

CBSE TEST PAPER-03

CLASS - XII PHYSICS (Atoms and Nuclei)

1. The wavelengths of some of the spectral lines obtained in hydrogen spectrum are 9546A°, 6463A° and 1216A°. Which one of these wavelengths belongs to Lyman series? [1]

2. Write the empirical relation for paschen series lines of hydrogen atom? [1]

3. Why is nuclear fusion not possible in laboratory? [1]

4. Express 16mg mass into equivalent energy in electron volt? [2]

5. A radioactive nucleus undergoes a series of decay according to the scheme [2]

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta-} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

If the mass number and atomic number of A are 180 and 72 respectively, what are there number for A_4?

6. Distinguish between isotopes and isobars. Give are example for each of the species? [2]

7. A radio active nuclide decays to form a stable nuclide its half life is 3 minutes. What fractions of its 1g will remain radioactive after 9 minutes? [2]

8. State radioactive decay law and hence derive the relation $N = N_o e^{-\lambda t}$ where symbols their usual meanings. [3]

9. Define half life and decay constant of a radioactive element. Write their S.I. unit. Define expression for half life? [3]

10. Draw a curve between mass number and binding energy per nucleon. Give two salient features of the curve. Hence define binding energy? [3]

CBSE TEST PAPER-03
CLASS - XII PHYSICS (Atoms and Nuclei)

[ANSWERS]

Ans1: 1216A^o belong to Lyman series

Ans2: $\frac{1}{\lambda} = R\left(\frac{1}{3^2} - \frac{1}{ni^2}\right)$ where n = 4, 5, 6, 7 --------------------

Ans3: Nuclear fusion is not possible in laboratory as it is performed in high temperature. This cannot be attained in the laboratory.

Ans4: E = mc^2

$= 16\times10^{-6}$ Kg $\times(3\times10^8$m/s$)^2$

$= 16\times 9\times10^{10}$ Joules

$E = \frac{16\times9\times\times10^{10}}{1.6\times10^{-19}}eV$ $\boxed{E = 9\times10^{30}eV}$

Ans5: ${}^{180}_{72}A \xrightarrow{\alpha} {}^{176}_{70}A_1 \xrightarrow{\beta-} {}^{176}_{71}A_2 \xrightarrow{\alpha} {}^{172}_{69}A_3 \xrightarrow{\gamma} {}^{172}_{69}A_4$

Ans6: The elements which have same atomic number but different mass number are called Isotopes.

For eg → $6c^{10}$ $6c^{11}$ $6c^{12}$ $6c^{14}$ (Isotopes of carbon)

Thus nuclides of different elements having same mass number but different atomic number are called isobars.

For eg → ${}_1\overset{3}{H}$ and ${}_2\overset{3}{He}$

${}_3\overset{7}{Li}$ and ${}_4\overset{7}{Be}$

Ans7: Suppose no. of atoms/gram = No

t = 9 minutes

$T_{1/2} = 3 \text{ minutes}$

$$\frac{N}{No} = \left(\frac{1}{2}\right)^{t/T_{1/2}} = \left(\frac{1}{2}\right)^{9/3} = \left(\frac{1}{2}\right)^{3} = 1/8$$

$$\Rightarrow N = No/8$$

$$\Rightarrow \text{Fraction decayed } = \frac{No - N}{No} = \frac{No - No/8}{No}$$

$$= 1 - 1/8 = 7/8 = 0.875$$

$\therefore$ Fraction remain undecayed = 1 – 0.875 = 0.125

Ans8: According to radioactive decay law the rate of disintegration of a radioactive substance at an instant is directly proportional to the number of nuclei in the radioactive substance at that time i.e.

$N = N_o e^{-\lambda t}$ Where symbols have their usual meanings

Consider a radioactive substance having No atoms initially at time (t = o). After time (t) no. of atoms left undecayed be N.

If dN is the no. of atoms decayed in tine dt then according to radioactive decay law

$$\frac{-dN}{dt} \alpha N \ or \ \frac{-dN}{dt} = \lambda N ------(1)$$

Where λ is decay constant and negative sign indicates that a radioactive sample goes on decreasing with time.

Equation (1) can also be written as

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

Integrating both the sides

$$\text{loge } N = \lambda t + K ------(2)$$

Where K is constant of integration

When t = o, N = No

$\Rightarrow$ K = loge No

Substituting K in equation (2)

$^{w}\!/_{e}\ N = \text{loge}\ No = -\lambda t \left(\because \text{loge}\ m - \text{loge}\ n = \text{loge}\ ^{m}\!/_{n}\right)$

$$\text{loge}\ \frac{N}{No} = -\lambda t$$

$$\frac{N}{No} = e^{-\lambda t}$$

$$\boxed{N = Noe^{-\lambda t}}$$

Ans9: The time during which half of the atoms of the radioactive substance disintegrates is called half life of a radioactive substance.

We know $N = Noe^{-\lambda t}$

When $t = T\ ½ (Half\ \text{life})$

$$N = {}^{No}\!/_{2}$$

$$\Rightarrow \frac{No}{2} = Noe^{-\lambda T ½}$$

$$\frac{1}{2} = e^{-\lambda T ½}$$

$$or\ \ e^{\lambda T ½} = 2$$

$$\lambda T ½ = \text{loge}2$$

$$\lambda T ½ = 2.303 \times \log_{10} 2$$

$$\lambda T ½ = 2.303 \times 0.3010$$

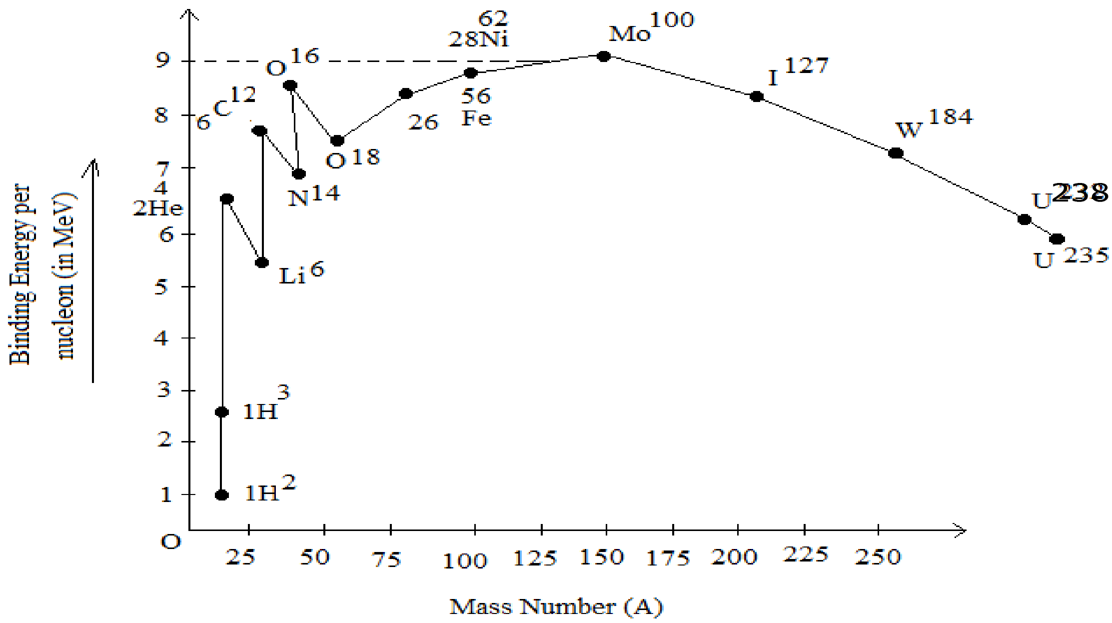
$$\boxed{T ½ = \frac{0.6931}{\lambda}}$$

S.I. unit – second (s)

Radioactive decay constant (λ) is the reciprocal of the time during which the number of atoms in the radioactive substance reduces to 36.8 % of the original number of atoms in it.

S.I. unit – s^{-1} or min^{-1}

Ans10: The total energy required to disintegrate the nucleus into its constituent particles is called binding energy of the nucleus.



Salient features of the curve

(1) The intermediate nuclei have large value of binding energy per nucleon, so they are most stable.

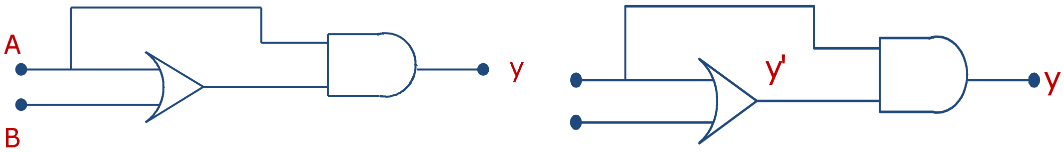
(For 30 < A > 63)

(2) The binding energy per nucleon has low value for both the light and heavy nuclei. So they are unstable nuclei.

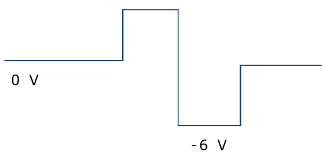
CBSE TEST PAPER-01

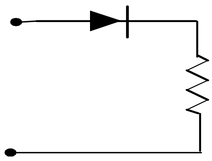
CLASS - XII PHYSICS (Solid and Semiconductor Devices)

1. Give the ratio of number of holes and the no. of conduction electrons in an intrinsic semiconductor. [1]
2. What type of impurity is added to obtain n-type semiconductor? [1]
3. Doping of silicon with indium leads to which type of semiconductor? [1]
4. Draw a pn junction with reverse bias? Which biasing will make the resistance of a p-n-junction high? [2]
5. Write the truth table for the following combination of gates? [2]



6. Draw the voltage current characteristics of a zener diode? [2]
7. What is an ideal diode? Draw the output wave form across the load resistor R, if the output waveform is as shown in the figure. [2]





8. With the help of a labeled circuit diagram, explain full wave rectification using function diode. Draw input and output wave forms? [3]
9. Distinguish between conductors, insulators and semiconductors on the basis of energy baud diagrams? [3]
10. The following truth table gives the output of a 2-input logic gate.

A	B	output
0	0	1
0	1	0
1	0	0
1	1	0

Identify the logic gate used and draw its logic symbol. If the output of this gate is fed as input to a NOT gate, name the new logic gate so formed? [3]

CBSE TEST PAPER-01
CLASS - XII PHYSICS (Solid and Semiconductor Devices)

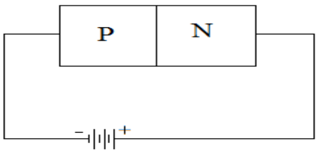
[ANSWERS]

Ans1: $\frac{nh}{ne} = 1$ (As in intrinsic semiconductor ne = nh)

Ans2: Pentavalent atoms like Arsenic (As)

Ans3: Indium is a trivalent impurity, thus doping of silicon with indium leads to p-type semiconductor.

Ans4:

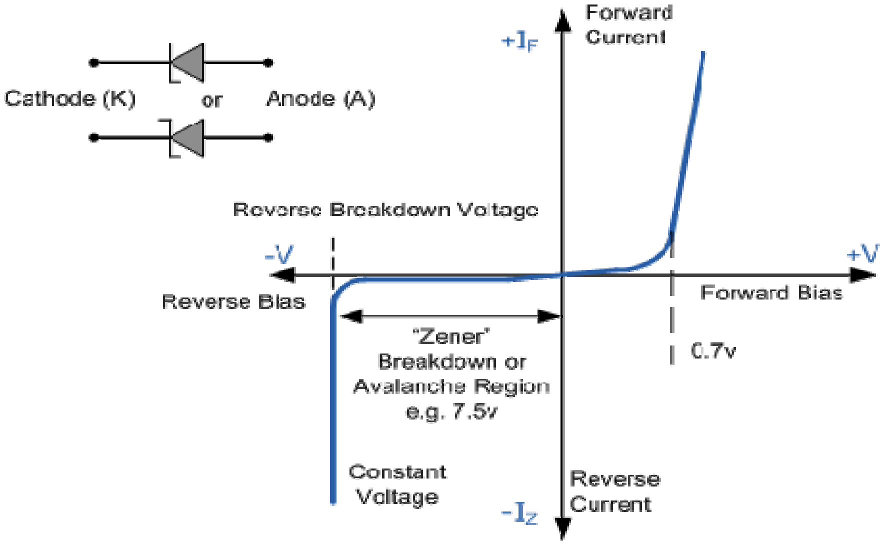


Reverser biasing will make the resistance high as it will not allow the current to pass.

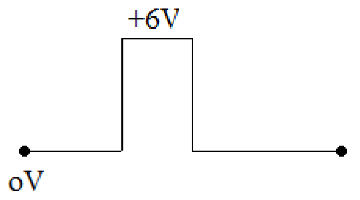
Ans5:

A	B	Y’	Y
0	0	0	0
0	1	1	0
1	0	1	1
1	1	1	1

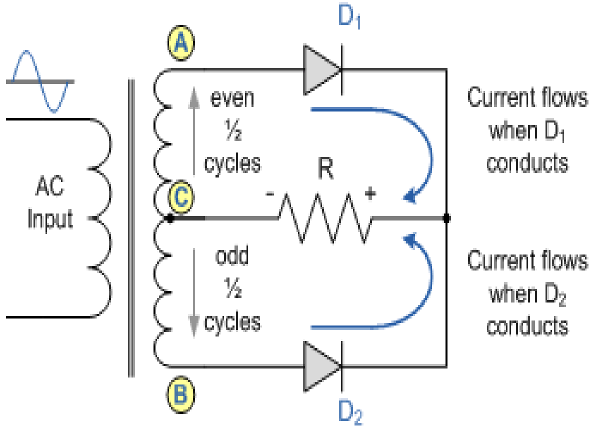
Ans6:



Ans7: An ideal diode has zero resistance when forward based and an infinite resistance when it is reverse biased. Output wave from is



Ans8: Full wave rectifier consists of two diodes and a transformer with central tap. For any half cycle of a.c. input only one diode is forward biased where as the other one is reverse biased.



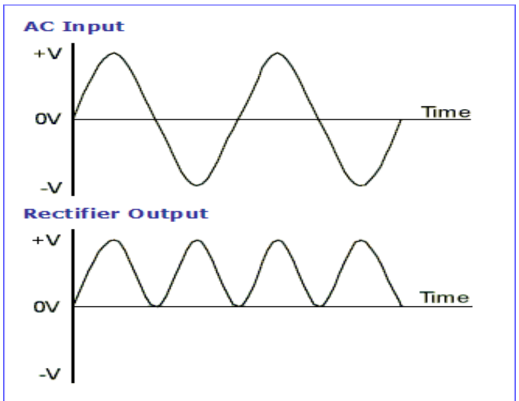
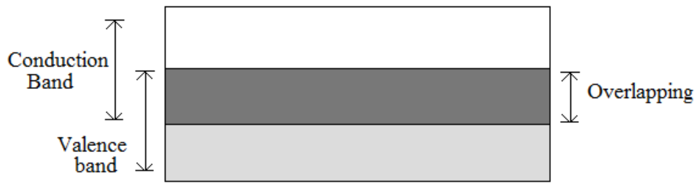


Figure 4: Full-wave rectification

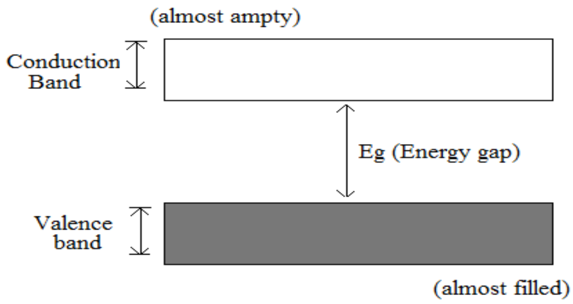
Suppose for positive half of a.c. input diode D_1 is forward biased and D_2 is reverse biased, then the current will flow across D_1 where as for negative half of a.c. input diode D_2 is forward biased and the current flows across D_2. Thus for both the halves output is obtained and current flows in the same direction across load resistance R_2 and thus a.c. is converted into d.c.

Ans9: <u>Conductor</u> – Conduction band in a conductor is either partially filled or conduction and valence band overlaps each other. There is no energy gap in a conductor.

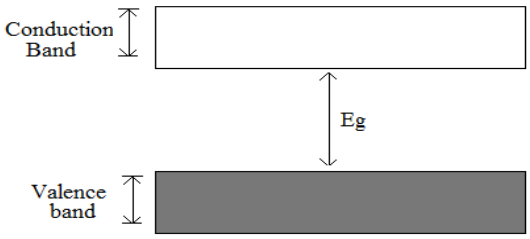


<u>Insulators</u> – conduction band and valence band of all insulator are widely separated by and energy gap of the order 6 to 9eV

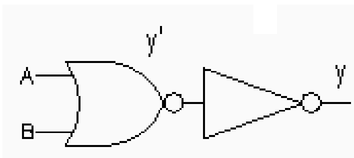
Also conduction band of an insulator is almost empty.



Semiconductor – In semiconductors the energy gap is very small i.e. about 1ev only.



Ans10: The gate is NOR gate.
If the output of NOR gate is connected to a NOT gate then the figure will be



New truth table is

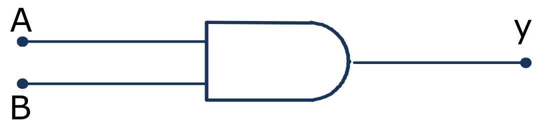
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

It is the truth table of OR gate

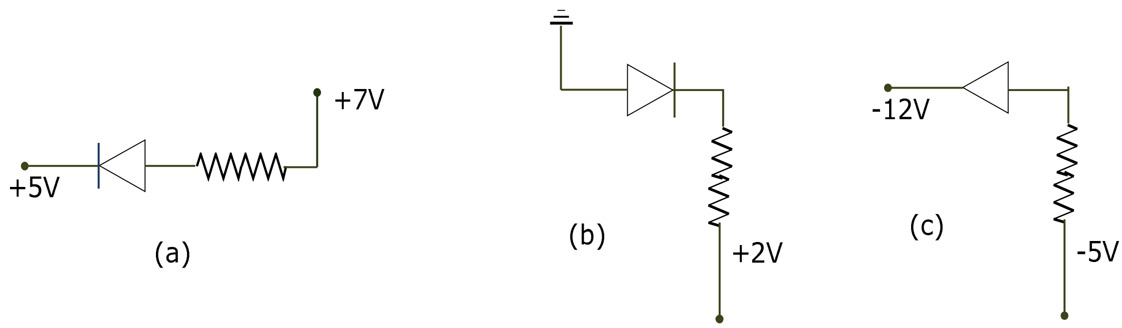
CBSE TEST PAPER-02

CLASS - XII PHYSICS (Solid and Semiconductor Devices)

1. Draw an energy level diagram for an intrinsic semiconductor? [1]
2. A semiconductor has equal electron and hole concentration of $6 \times 10^{8} m^{-3}$. On doping with a certain impurity electron concentration increases to $3 \times 10^{12} m^{-3}$. Identify the type of semiconductor after doping? [1]
3. How does the energy gap of an intrinsic semiconductor vary, when doped with a trivalent impurity? [1]
4. For a extrinsic semiconductor, indicate on the energy band diagram the donor and acceptor levels? [2]
5. What do you mean by depletion region and potential barrier in junction diode? [2]
6. A transistor has a current gain of 30. If the collector resistance is $6k\Omega$, input resistance is $1k\Omega$, calculate its voltage gain? [2]
7. Name the gate shown in the figure and write its truth table? [2]



8. In the following diagrams indicate which of the diodes are forward biased and which are reverse bias? [3]

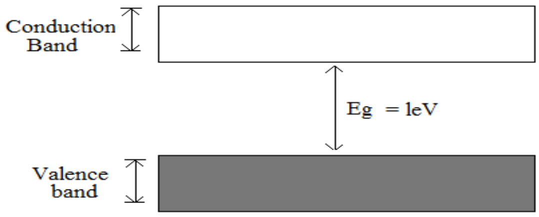


9. With the help of a diagram, show the biasing of a light emitting diode (LED). Give its two advantages over conventional incandescent lamps? [3]
10. The input resistance of a silicon transistor is $665\,\Omega$. Its base current is changed by $15\,\mu$A, which results in the change in collector current by 2mA. This transistor is used as a common emitter amplifier with a load resistance of $5k\Omega$. Calculate current gain (βac). [3]

CBSE TEST PAPER-02
CLASS - XII PHYSICS (Solid and Semiconductor Devices)

[ANSWERS]

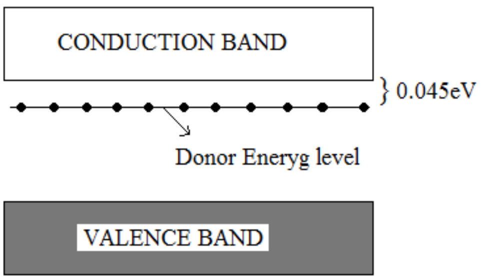
Ans1: In intrinsic semiconductor (ne = nh)



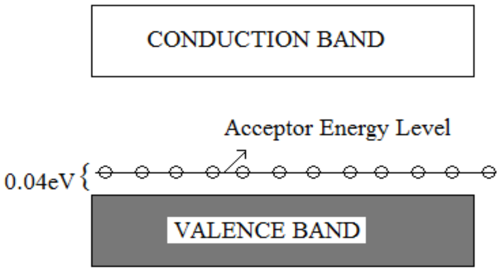
Ans2: As ne > nh, thus resulting semiconductor is of n-type.

Ans3: When a trivalent impurity is added to an intrinsic semiconductor, an acceptor energy level is created in the forbidden energy gap which lies above the valence band. Due to this electrons easily transformed to the acceptor energy level.

Ans4: N-type Extrinsic Semiconductor



P-type Extrinsic Semiconductor



Ans5: A layer around the junction between p and n-sections of a junction diode where charge carriers electrons and holes are less in number is called depletion region.

The potential difference created across the junction due to the diffusion of charge carriers across the junction is called potential barrier.

Ans6: Given $Rin = 1k\Omega$

$Rout = 6k\Omega$

$\therefore Rgain = \frac{6}{1} = 6$

$\therefore$ Voltage gain = current gain $\times$ Rgain

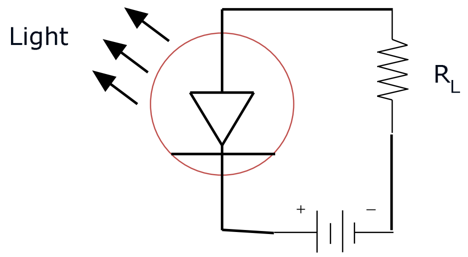
Voltage gain = $30 \times 6 = 180$

Ans7: It is AND gate and its truth table is

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Ans8: (a) Forward Biased (b) Reverse Biased (c) forward Biased

Ans9: Light emitting diode is forward biased i.e. energy is released at the junction.



Advantages of LED

(1) They are used in numerical displays as compact in size.
(2) It works at low voltage and has longer life than incandescent bulbs.

Ans10: (1) Trans conductance (gm) (2) voltage gain (Av) of the amplifier.

Here $\Delta I_B = 15\mu A = 15\times10^{-6} A$

$\Delta I_C = 2mA = 2\times10^{-3} A$

$Rin = 665\Omega, R_2 = 5k\Omega = 5\times10^{3}\Omega$

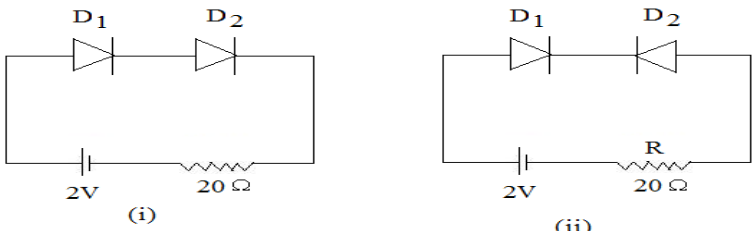
$$\beta ac = \frac{\Delta I_C}{\Delta I_B} = \frac{2\times10^{-3}}{15\times10^{-6}} = 133.3$$

(1) Trans conductance, gm = $\frac{\beta ac}{Rin} = \frac{133.3}{665} = 0.2\Omega^{-1}$

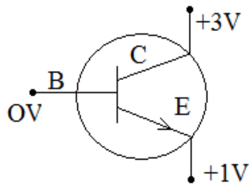
(2) Voltage gain (Av) = $gmR_L = 0.2\times5\times10^{3} = 1000$

CBSE TEST PAPER-03
CLASS - XII PHYSICS (Solid and Semiconductor Devices)

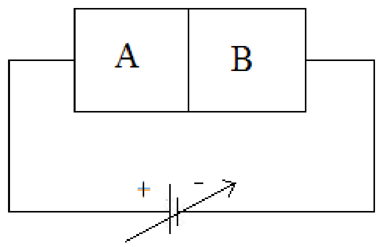
1. How does width of depletion layer of p.n junction diode change with decrease in reverse bias? [1]
2. Under what condition does a junction diode work as open switch? [1]
3. Which type of biasing gives a semiconductor diode very high resistance? [1]
4. What are the advantages and disadvantages of semiconductor devices over vacuum tubes? [2]
5. The base of a transistor is lightly doped. Explain why? [2]
6. Determine the currents through resistance R of the circuits (i) and (ii) when similar diodes D_1 and D_2 are connected as shown in the figure. [2]



7. In the given figure, is (i) The emitter (ii) collector forward or reverse biased? Justify. [2]



8. Two semiconductor materials A and B shown in the figure are made by doping germanium crystal with arsenic and indium respectively. The two are joined end to end and connected to a battery as shown. [3]



   (a) Will the junction be forward biased or reverse biased? Justify
   (b) Sketch a V-I graph for this arrangement

9. Draw the symbol for zener diode? Zener diodes have higher dopant densities as compared to ordinary p-n junction diodes. How dos it affect the (i) width of the depletion layer (i) function field? [3]

10. A P-N-P transistor is used in common – emitter mode in an amplifier circuit. A change of $4o\mu A$ in the base current brings a change of 2mA in collector current and 0.04V in base – emitter voltage. Find (i) input resistance (ii) current amplification factor (β). If a load resistance of $6k\Omega$ is used, then find voltage gain? [3]

CBSE TEST PAPER-03
CLASS - XII PHYSICS (Solid and Semiconductor Devices)

[ANSWERS]

Ans1: Decrease in reverse bias will decrease in width of the depletion layer.

Ans2: A junction diode works an open switch when it is reverse biased.

Ans3: Reverse biasing

Ans4: Advantages – Semiconductor devices are very small in size as compared to the vacuum tubes. It requires low voltage for their operation

Disadvantage – Due to the rise in temperature and by applying high voltage it can be damaged.

Ans5: In a transistor, the majority carries form emitter region moves towards the collector region through base. If base is made thick and highly doped, majority carriers will combine with the other carriers within the base and only few is collected by the collector which leads to small output collector current. Thus in order to have large output collector current, base is made thin and lightly doped.

Ans6: In figure (i) D_1 and D_2 are forward biased

$$\Rightarrow I = V/R = 2/20 = 0.1A$$

In figure (ii) D_1 is forward biased but D_2 is reverse biased due to which D_1 & D_2 offers infinite resistance

$\therefore I = 0$

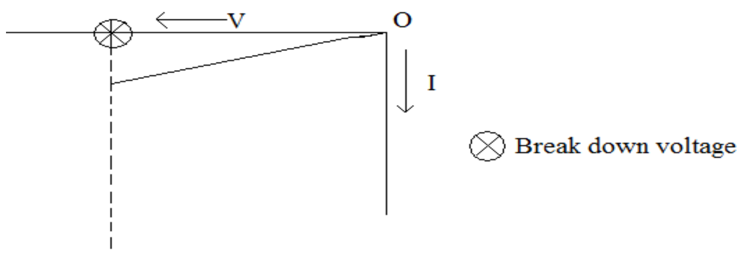
Ans7: Figure shows n-p-n transistor

(i) Emitter is reversed biased because n-region is connected to higher potential.

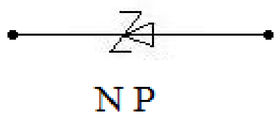
(ii) Collector is also reversed biased because n-region of p-n junction is at higher potential than p-region.

Ans8: Material A is n-type as it is doped with pentavalent impurity and material B is p-type as it is doped with trivalent impurity. As a result the junction becomes reverse biased because positive terminal of the battery is connected to n-type and negative terminal to the p-type hence it is reversed biased.

V-I graph for the given circuit



Ans9: Symbol for zener diode



(i) Width of the depletion layer of zener diode becomes very small due to heavy doping of p and n-regions
(ii) Function field will be high.

Ans10: $\Delta I_B = 40\mu A = 40\times10^{-6} A$

$\Delta I_C = 2mA = 2\times10^{-3} A$

$\Delta V_{BE} = 0.04V$

$R_L = 6k\Omega = 6\times10^3\Omega$

$$Rin = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{0.04}{40\times10^{-6}} = 1\times10^3\Omega = 1k\Omega$$

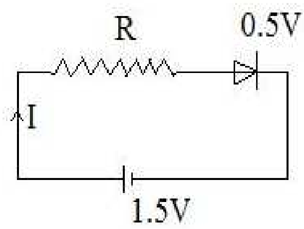
$$\beta = \frac{\Delta v_C}{\Delta I_B} = \frac{2\times10^{-3}}{40\times10^{-6}} = 50$$

Voltage gain $= \beta\, {}^{RL}\!/_{Ri} = \dfrac{50\times6\times10^3}{1\times10^3} = 300$

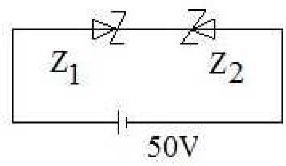
CBSE TEST PAPER-04

CLASS - XII PHYSICS (Solid and Semiconductor Devices)

1. If The output of a 2-input NAND gate is fed as the input to a NOT gate
   (i) name the new logic gate obtained and (ii) write down its truth table? [1]
2. Define current amplification factor in a common – emitter mode of transistor? [1]
3. Why is a semiconductor damaged by a strong current? [1]
4. What do you mean by hole in a circuit? Write its two characteristics? [2]
5. Diode used in the figure has a constant voltages drop at 0.5V at all currents and a maximum power rating of 100mW. What should be the value of the resistance R, connected in series for maximum current? [2]



6. Zener diode Z_1 has saturation current of 20A and reverse breakdown voltage of 100V where as the corresponding value of Z_2 are 40 μ A and 40. Find the current through the circuit? [2]



7. Calculate emitter current for which $\beta = 100$ and $I_\beta = 20\mu A$? [2]
8. Draw the circuit diagram for common – emitter transistor characteristics using N-P-N transistor? Draw the input and output characteristic curve ? [3]
9. A semiconductor has equal electron and whole concentration of $6\times10^8 / m^3$.
   On doping with certain impurity, electron concentration increases to $8\times10^{12} / m^3$.
   (i) Identify the new semiconductor
   (ii) Calculate the new whole concentration.
   (iii) How does the energy gap vary with doping? [3]
10. Draw a labeled circuit diagram of a common emitter transistor amplifier. Draw the input and the output wave forms and also state the relation between input and output signal? [3]

[ANSWERS]

Ans1: Logic gate obtained is AND gate.

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Ans2: Ratio of small change in collection current to the small change in base current at constant collector emitter junction voltage is called current amplification factor.

Ans3: When a strong current passes through a semiconductor large amount of heat is produced which breaks the covalent bonds in the semiconductor due to which it gets damaged.

Ans4: A vacancy created in a covalent bond in a semiconductor due to the release of electron is known as hole in a semiconductor.

Characteristics of hole

(i) Hole is equivalent to a positive electronic charge.
(ii) Mobility of hole is less than that of an electron

Ans5: $P = 100mW = 100\times10^{-3}$
$V = 0.5V$
$P = VI$
$\Rightarrow I = P/V = \dfrac{100\times10^{-3}}{0.5}$ 　 I = 0.2A

For the given circuit
IR = + 0.5 – 1.5 = 0
I R = 0.5
IR=0.5-1.5
IR-1=0
0.2 x R=1
$R = \dfrac{1}{0.2} = 5\Omega$ 　 $R = 5\Omega$

Ans6: Here Z_1 is forward biased where as Z_2 reverse biased hence Z_1 behaves as a conductor and reverse saturation current will flow from Z_2

Thus $R_{Z_2} = \frac{40}{40 \times 10^{-6}}$

$R_{Z_2} = 10^6 \Omega$

Now 50V will appear across Z_2 so

$I = \frac{50}{10^6}$

$$\boxed{I = 50 \times 10^{-6} A}$$

Ans7: $\beta = 100,$

$I_B = 20\mu A = 20 \times 10^{-6} A$

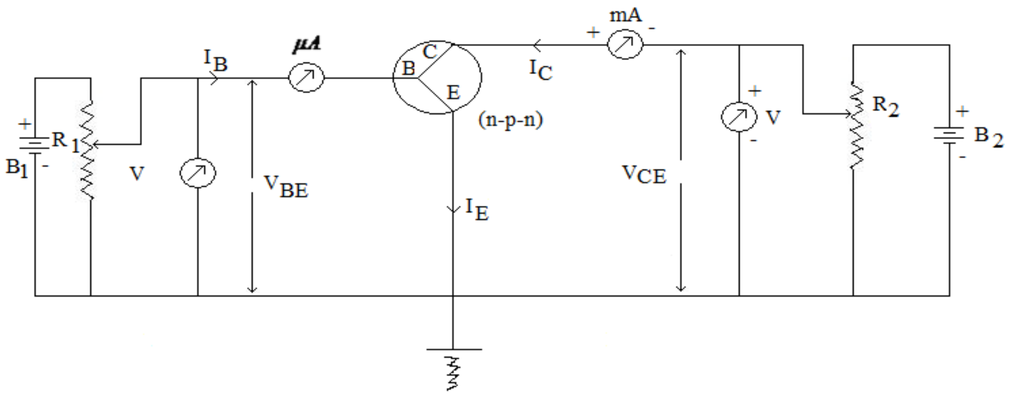
$B = I_C / I_B$

$I_C = BI_B = 100 \times 20 = 2000\mu A$

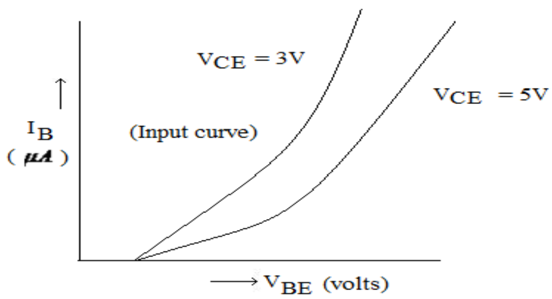
Using $I_E = I_B + I_C$

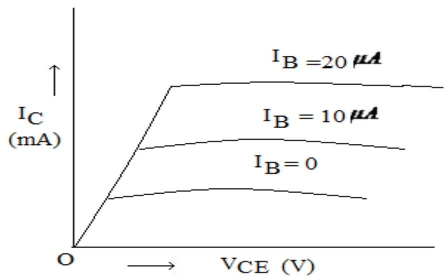
$I_E = 20 \times 10^{-6} + 2000\mu A$ $\boxed{I_E = 2020\mu A}$

Ans8:



Input characteristic curve is the variation of base current I_B (Input) with base – emitter voltage (VEB) at constant collector emitter voltage (V_{CE}).





Output characteristics is the variation of the collector current (I_C) with collector emitter voltage (V_{CE}) at constant base current (I_B) is called output characteristics.

Ans9: (i) New semiconductor obtained is N-type because

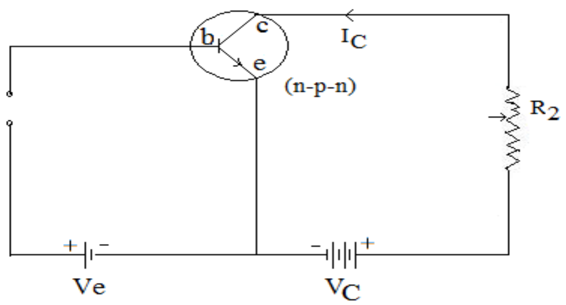
(ii) $nenh = ne^2$

$$nh = \frac{ni^2}{ne} = \frac{36\times10^{16}}{8\times10^{12}}$$

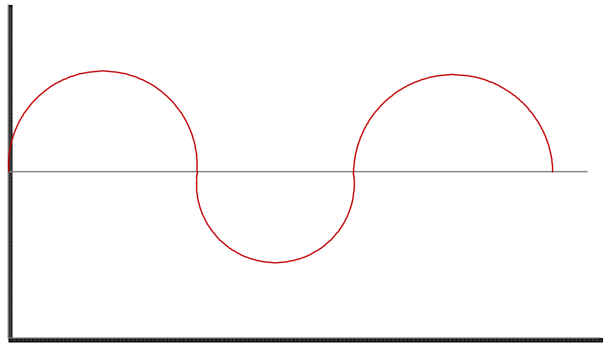
$$\boxed{nh = 4.5\times10^4 / m^3}$$

(iii) Energy gap decreases due to creation of donor level in between the valence band and the conduction band.

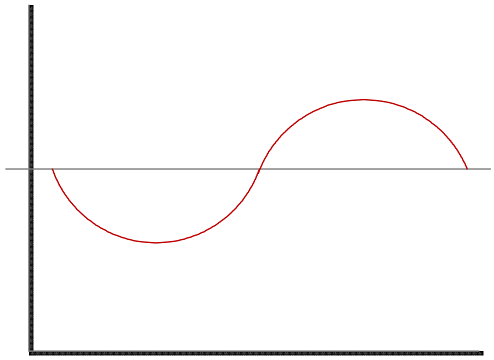
Ans10:



Input wave from



Output wave form



Relation – output waveform has 180° phase reversal as compared to input and also the output is being amplified.

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Communication System)

1. Name the type of the communication system in which the signal is discrete and binary coded version of message or information? [1]
2. What is the purpose of modulating a signal in transmission? [1]
3. What is the requirement of transmitting microwaves form one position to another on the earth? [1]
4. A signal jumps from one level to another instantaneously. [2]
   What will be its frequency?
5. Sky has no limit but sky wave propagation has its limit. Explain why? [2]
6. A transmitting antenna has a height of 50m. If radius of the earth is taken as 6250 km. find the area covered by it? [2]
7. Define the term modulation index for A.M. wave. What would be the modulation index for an A.M. wave for which the maximum amplitude is ‘a’ white the minimum amplitude is ‘b’? [3]
8. A T.V. tower has a height of 80m. By how much the height of tower be increased to triple its coverage? [3]
9. An audio signal of amplitude one half of the carries amplitude is employed in amplitude modulation. What is the modulation index? Hence define amplitude modulation? [3]
10. An audio signal of 32kHz modulates a carrier of frequency 84MHz and produces a frequency deviation of 96kHz. [3]
    Find (a) frequency modulation index
    (b) frequency range of the frequency modulated wave?

CBSE TEST PAPER-01

CLASS - XII PHYSICS (Communication System)

[ANSWERS]

Ans1: Digital communication.

Ans2: Modulation is done because low frequency signal cannot be transmitted to a longer distance so in order to increase the range of transmission modulation is done.

Ans3: The transmitting and receiving antenna must be in the line of sight.

Ans4: It means that signal jumps form one level to another in no time so its frequency will be infinite.

Ans5: Sky wave propagation is due to the reflection of radio waves by the ionosphere but high frequency waves gets absorbed by the ionosphere and cannot be reflected by the ionosphere.

Ans6: $d = \sqrt{2rh}$

$d = \sqrt{2\times 6250\times 50\times 10^3}$

$d = 2.5\times 10^4 m$

Area covered $= \pi d^2 = 3.14\times(2.5\times 10^4)^2$

Area covered = 1963km^2

Ans7: Modulation index is the ratio of amplitude E_m of caries wave to the amplitude E_c of carries (original) wave.

i.e. $\mu = \frac{E_m}{E_c}$

Here Maximum Amplitude $a = E_c + E_m$

Minimum Amplitude $b = E_c - E_m$

$\Rightarrow E_c = \frac{a+b}{2}$ and $E_m = \frac{a-b}{2}$

$$\Rightarrow \boxed{\mu = \frac{a-b}{a+b}}$$

Ans8: Here $h_1 = 80m$

$$d_1 = \sqrt{2h_1R} = \sqrt{2\times 80\times R} = \sqrt{160R}$$

$$d_2 = \sqrt{2h_2R} = 3d_1$$

$$\sqrt{2h_2R} = 3\sqrt{160R}$$

$\Rightarrow$ $\boxed{h_2 = 720m}$

Ans9: $E_m = 0.5\ E_c$

$E_{max} = E_m + 0.5\ E_c = 1.5\ E_c$

$E_{min} = E_m - 0.5\ E_c = 0.5\ E_c$

$$\mu = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} = \frac{1.5\ E_c - 0.5\ E_c}{1.5\ E_c + 0.5\ E_c}$$

$\boxed{\mu = 0.5}$

Ans10: $fm = 3.2KHz$

$fc = 34MHz$

$\delta = 96KHz$

(a) Frequency modulated index

$$mf = \frac{\delta}{fm} = \frac{96}{3.2} = 30$$

(b) Frequency range of the modulated wave

$= fc \pm fm$

$= 84\times 10^3 \pm 3.2KHz$

=83.997MHz to 84.003MHz

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Communication System)

1. A T.V. tower has a height of 300m. What is the maximum distance upto which the T.V transmission can be received? [1]
2. Why ground wave propagation is not suitable for high frequencies? [1]
3. What type of modulation is used for commercial broadcast of voice signal? [1]
4. What is the role of F_2 layer in communication? [2]
5. A carrier wave of peak voltage 12V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 75%? [2]
6. Give the set up of a basic communication system? [2]
7. Distinguish between analog and digital communication? [2]
8. Define the following terms [3]
   (a) Ground wave propagation
   (b) Space wave propagation
   (c) Sky wave propagation

9. Which two communication methods make use of space wave propagation method? If the sum of the heights of transmitting and receiving antenna is line of sight communication is fixed at h, show that the range is maximum when the two antenna have a height $h/2$ each? [3]
10. A frequency modulated wave is represented by an equation. [3]
    Find (1) carrier frequency
    (2) modulating signal frequency
    (3) Power dissipated if load resistor is of $100\,\Omega$?

CBSE TEST PAPER-02

CLASS - XII PHYSICS (Communication System)

[ANSWERS]

Ans1: $d = \sqrt{2Rh} = \sqrt{2 \times 6400 \times 1000 \times 300}$

$d = 62km.$

Ans2: Ground waves are not suitable for propagation high frequencies because signals having frequency more than 1500 KHz are greatly absorbed by the surface of the earth and cannot be transmitted.

Ans3: Amplitude Modulation.

Ans4: F_2 is the topmost layer of ionosphere. Its height is upto 400km and is called as a reflecting layer for high frequency radio wave.

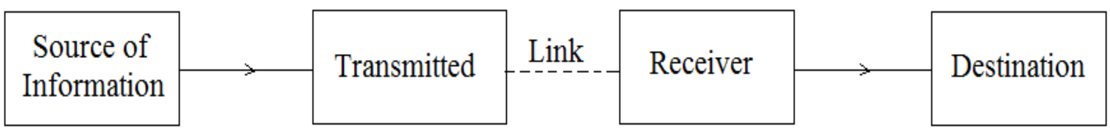
Ans5: $\mu = \frac{A_m}{A_c}$

$A_m = \mu \times A_c$

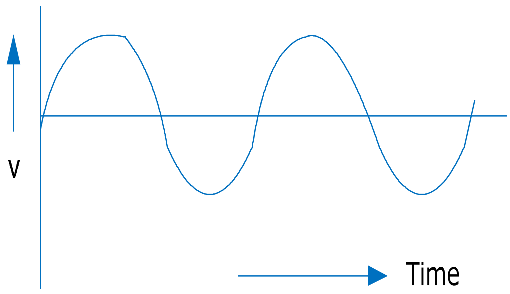
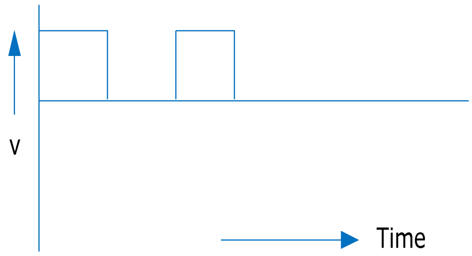
$A_m = \frac{75}{100} \times 12$

$$\boxed{A_m = 9V}$$

Ans6: Basic communication system consist of an information source, a transmitter, a link and a receiver.



Ans7:

Analog communication	**Digital communication**
(1) In analog communication analog signal is used which continuous varies with time.	(1) In digital communication digital signal is used which has only two levels i.e. high and low.
(2) 	(2) 

Ans8: (a) **Ground wave propagation** – Radio travel along the surface of the earth and are called ground waves and the propagation along the surface of the earth is called ground wave propagation. It is limited to a frequency below 1.5 MHz

(b) **Space wave propagation** – The radio waves which are reflected back to the earth by ionosphere are known as sky waves and this mode of propagation of sky waves is known as sky wave propagation.

(c) **Space wave propagation** – High frequency waves which cannot be reflected back to the earth by transmitting antenna to receiving antenna by the mode called line of sight communication. It is also called as space wave propagation.

Ans9: Satellite communication and line of sight (LOS) communication make use of space waves.

Now $d_1 = \sqrt{2Rh_1}$

$d_2 = \sqrt{2Rh_2}$

For maximum range

$d_m = \sqrt{2Rh_1} + \sqrt{2Rh_2}$

$d_m = d_1 + d_2 = d$

Given $h_1 + h_2 = h$

Let $h_1 = x$ then $h_2 = h - x$

$d_m = \sqrt{2Rx} + \sqrt{2R(h-x)}$

Differentiating wr.t x

$$\frac{dd_m}{d_x} - \sqrt{\frac{R}{2x}} = \sqrt{\frac{R}{2(h-x)}} = 0 i.e. \frac{1}{2x} = \frac{1}{2(h-x)}$$

$\Rightarrow x = h/2 \Rightarrow h_1 = h_2 = h/2$

Ans10: Given e = 10 sin $\left(5\times10^8 + +6\sin 1000t\right)$

Compare if with general equation

e = E sin (w_ct + m_f sin w_mt)

Carries frequency $\nu_c = \frac{w_c}{2\pi} = \frac{5\times10^8}{2\times3.14}$

$\nu_c = 79.62 MHz$

Modulating signal frequency

$$\nu_m = \frac{Wm}{2\pi} = \frac{100}{2 \times 3.14} = 15.92 Hz$$

Power dissipated $P = \frac{(Erms)^2}{R} = \frac{\left(10/\sqrt{2}\right)^2}{100} = 0.5\ Watts$

CBSE UNIT TEST PAPER-01

CLASS - XII (PHYSICS)

FIRST TERM UNIT TEST

Time :1.5 Hours **M.M.40**

Q.1 What does $q_1q_2 > O$, signify? (1)

Q.2 State the direction of 'electric dipole moment'. (Use suitable figures) (1)

Q.3 On what factors does the electrical capacitance of a conductor depend? (1)

Q.4 Two electric bulb are rated at 220V – 100W and 220V – 60W. Which one of these has greater resistance and why? (1)

Q.5 Deduce dimensional formula for the magnetic field. (1)

Q.6 Deduce a formula for magnetic field at the centre of a circular loop of radiua 'R' carrying a steady current l. (2)

Q.7 State and prove Gauss's Theorem. (2)

Q.8 Radius of uranium nucleus (Z 92) is 6.8×10^{-15} m. If the positive charge of the nucleus is distributed uniformly, find the electric field intensity at the surface of the uranium nucleus. (2)

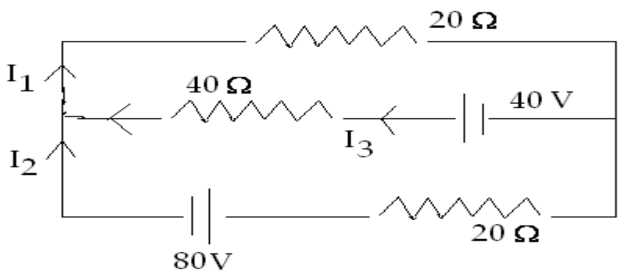
Q.9 Define internal resistance of a cell. How can you measure internal resistance of cell On what factors does it depend? (2)

Q.10 Explain Potentiometer. How can a potentiometer be made more sensitive? (2)

Q.11 Give two points of similarities & differences between Biot-Savart law for the magnetic field and coulomb's law for the electrostatic field. (3)

Q.12 Two cells of e.m.f E_1 & E_2 have internal resistances r_1 & r_2. Deduce an expression for equivalent e. m.f of their parallel combination. (3)

Q.13 Using 'Kirchhoff's rules'; determine the value of current I, in the electrical circuit give below - (3)



Q.14 Find the expression for energy stored in a charged capacitor. Explain, why energy stored in a parallel plate capacitor decreases when dielectric slab is introduced in the capacitor after disconnecting it from the battery. (3)

Q.15 An electric dipole of dipole moments in p is held in a uniform electric field E. (3)

(i) Prove that no translatory force acts on the dipole.

(ii) Hence prove that torque acting on the dipole is given by t=pESinQ, indicating direction along with it acts.

(iii) How much work is required in turning the electric dipole from the position of most stable equilibrium to the position of most unstable equilibrium?

Q.16 Explain principle, construction & working of Van-de-Graff generator using a neat labeled diagram. (5)

Q.17 (a) stat & prove 'Wheatstone Bridge principal. (5)

(b) Explain how a 'Potentiometer' can be used to find the internal resistance of a cell.

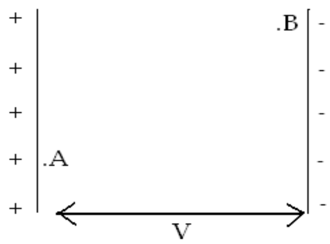
CBSE UNIT TEST PAPER-02

CLASS - XII (PHYSICS)

Time : 1.5 Hours **M.M.40**

All questions are compulsory. Marks to each question and indicated against it.

1. Two protons A and B are placed between two parallel plates having a potential difference V as shown in the figure. Will these protons experience equal or Unequal force. [1]



2. In an electric field on electron is kept freely. If the electron is replaced by a proton, what will be the relationship between the forces experienced by them? [1]

3. The distance of the field point on the equatorial plane of a small electric dipole is halved. By what factor will the electric field due to the dipole, change? [1]

4. A carbon resister is marked in coloured bands of the red, black, orange and silver. What is the resistance and tolerance and tolerance value of the resister, [1]

5. What is the effect of heating of a conductor on the drift velocity of free electrons? [1]

6. Define the term 'temperature coefficient of resistivity'. Write its s.i. unit. Plot a graph showing the variation of resistivity of copper with temperature. [2]

7. State the principle of potentiometer. Draw a circuit diagram used to compare the e.m.f of two primary cells. Write the formula used. How can the sensitivity of a potentiometer be increased? [2]

8. A potential difference of V volts is applied to a conductor of length L and diameter D. How will the drift velocity of electrons and the resistance of the [2]

conductor change when:

i. V is doubled

ii. L is halved and

iii. D is halved, where, in each case, the other factors remain same. Give reason in each case.

9. Derive the expression for the energy stored in a parallel plate capacitor with air between the plates. How does the stored energy change if air is replaced by medium of dielectric constant K? [2]

10. Calculate the electric potential at the centre of a square of side $\sqrt{2m}$, having charges 100 μ c, -50 μc, 20μc, and -60μc at the four corners of the square. [2]

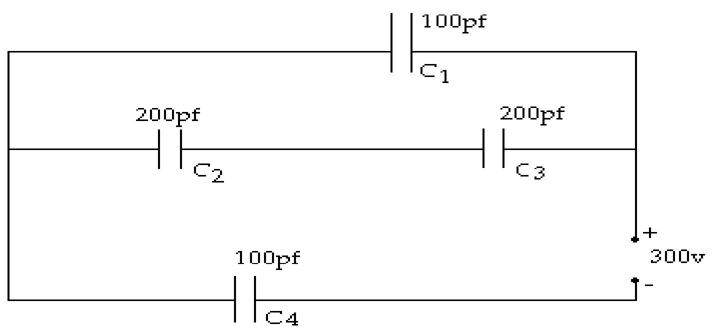
11. What is electric flux? Write its S. l. units. Using Gauss' theorem, deduce an expression fee the electric field at a point due to a uniformly charged infinite plane sheet. [3]

12. A parallel plate capacitor is charged to a potential differenc 'V' by a d. c. source. The capacitance of || plates is doubled, state with reason how the following will change: [3]

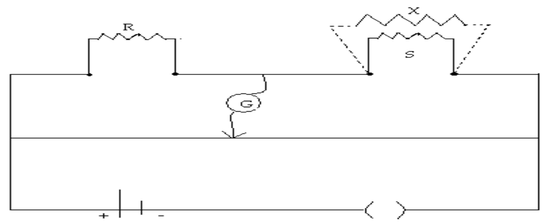
i. electric field between the plates, ii. capacitance

iii. energy stored in the capacitor.

13. Obtain the equivalent capacitance of the network inadjoining figure. For a 300V supply, determine the charge and voltage across each capacitor. [3]



14. [3]



When two know resistances R and S are connected in the left and right gaps of a meterbridge, the balance point is found at a distance l_1 from the zero end' of the meterbridge wire. An unknown resistance X is now connected in parallel to the resistance S and the balance point is now found at a distance $l_2$from the zero end of the meterbridge wire. Obtain a formula for X in term of l_1, l_2 and S.

15. Define the term resistivity of a conductor. Give its S. l. unit. Sow tat the resistance R of a conductor is given by $\frac{ml}{ne2\tau A}$ where symbols have their usual meanings. [3]

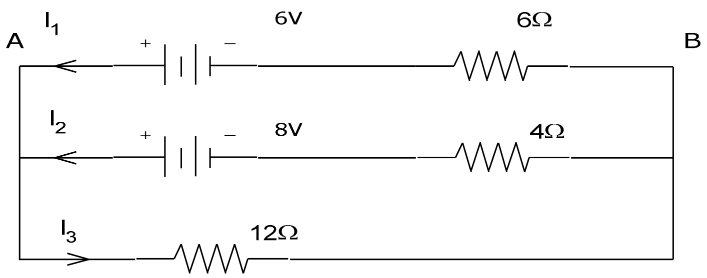
16. State Kirchhoff's laws of electrical network. [5]

In the network shown here, find the following:

a. currents l_1 , l_2 and l_3

b. Terminal potential difference of each battery

c. Consider 6 Ω to the internal resistance of 6V battery and 4 Ω to be the internal resistance of 8V battery.



17. An electric dipole is help in a uniform electric field. [5]

i. Show that no translatery force acts on it.

ii. Derive an expression for the torque acting on it.

The dipole is aligned parallel to the field, calculate the work done in rotating it through 180^0.

CBSE UNIT TEST PAPER 03

CLASS XII (PHYSICS)

Time 3 Hrs. **M. M. 70**

General Instructions

1. All questions are compulsory.
2. There are 30 questions in total. Question1 to 8 carry one mark each, Question 9 to 18 carry two narks each. Questions 19 to 27 carry three marks each and questions 28 to 30 carry five marks each.
3. There is no overall choice. However an internal choice has been provided in one question of two marks, one question of three marks and all questions of five marks each.

1. An electric dipole of dipole moment 20 x 10^6 cm is enclosed by a closed surface. What is the net flux coming out of the surface? [1]

2. Can you have at a point zero potential but having electric field? Suggest one example. [1]

3. What happens to the power dissipation if the value of electric current passing through a conductor of constant resistance is halved. [1]

4. A carbon resistor have a value of 100 Ω with a tolerance of 5%. Calculate the colour code for this resistor. [1]

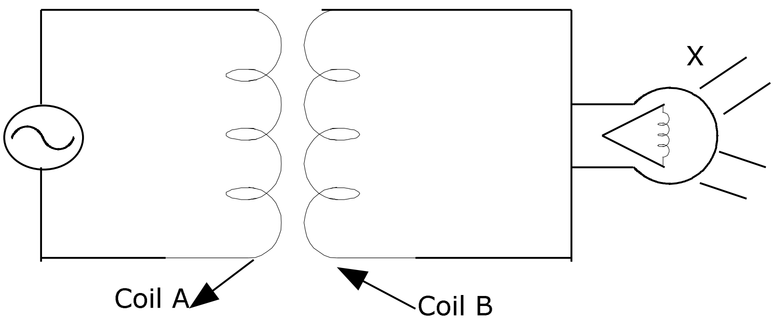
5. The instantaneous current and voltage of an a. c. circuit are given by -,l = (10 Sin 300t) A and V = 200 Sin (300t) V. What is the power dissipation in the circuit? [1]

6. How can you obtain wattles current in the circuit? [1]

7. What is the angle of dip at a place where the horizontal and vertical components of the earth's magnetic field are equal? [1]

8. In a magnetic field, a charge moves normal to the field. Will its speed increases or decreases. [1]

9. The figure given below shows an arrangement by which current flows though the bulb (X) connected with coil B, when a. c. is passed though the coil A [2]



a Name the phenomenon involved

b If a copper sheet is inserted in the gap between the coils, how the brightness of the bulb would change.

10. Define self inductance and write its unit. Write the expression for the self inductance of a long solenoid. Write the factors on which self inductance of a solenoid depends. [2]

11. A stream of electrons traveling with speed VMs^{-1} at right angles to a uniform magnetic 'B' is deflected in a circular path of radius 'r'. Prove that $\frac{e}{m} = \frac{V}{rB}$ [2]

12. A spherical Gaussian surface encloses a charge of 17.7×10^{-8} C. [2]

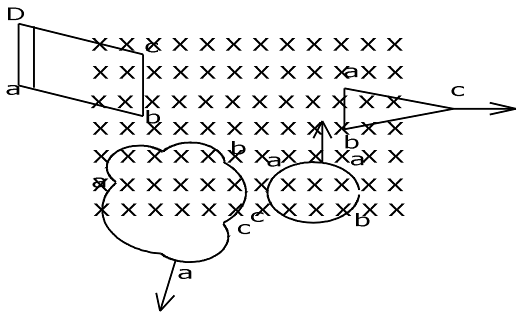
1. Calculate the electric flux passing through the Gaussian surface.
2. If the radius of the Gaussian surface is doubled, how much flux would pass through the surface.

13. Define the term electrical resistivity of a material. Write its Sl units. Derive an expression for the resistivity of a metal in terms of numbers density and mass of free electrons present. [2]

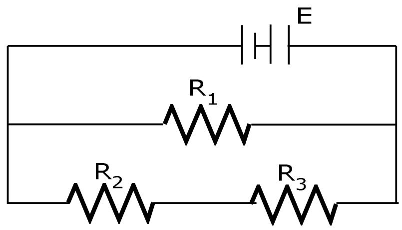
14. A long straight wire in the horizontal plane carries a current of 50 A in North to South direction. Give the magnitude and direction of B at a point 2.5 m east of the wire. [2]

15. The frequency of a.c. is doubled. How do R, X_L and X_C get affected? [2]

16. Fig below shows planar loops of different shapes moving out or into a region of a magnetic field. Determine the direction of induced current in each loop. Give the reason also. [2]



17. Three identical resistors R_1, R_2 and R_3 are connected to a battery as shown in fig what will be the ratio of voltages across R_1 and R_2. [2]



18. Two identical specimens of magnetic materials Nickel, Aluminum are kept in a non uniform magnetic field. Draw the modification in thefield lines in each case. Justify your answer. [2]

19. A short bar magnet placed with its axis inclined at 30^0 to the external magnetic find of 800 G acting horizontally experiences a torque of0.016 N-m. Calculate (1) magnetic moment of the magnet (2) Work done in moving the dipole upto 90^0 [3]

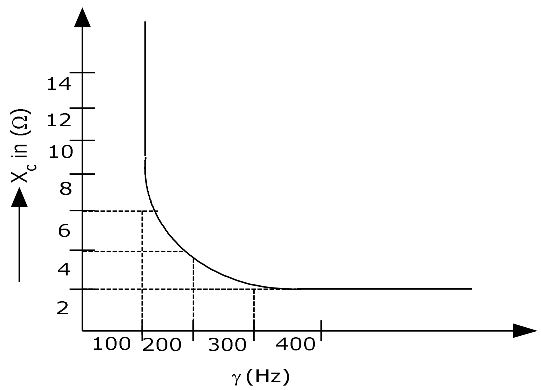
20. An a.c. circuit consists of series combination of circuit elements X and Y. the current is ahead of the voltage in phase by $\pi/4$. If element 'X' is a pure resistor of 100 Ω (1) Name the circuit element 'Y' and (2) Calculate the rms value of current, if rms value of voltage is 141 volt. [3]

21. Figure given below shows how the reactance the capacitor varies with frequency [3]

1. Use the information on the graph to calculate the capacitance of the capacitor.

2. If this capacitor is connected in series to a resistor of 10 Ω What would be

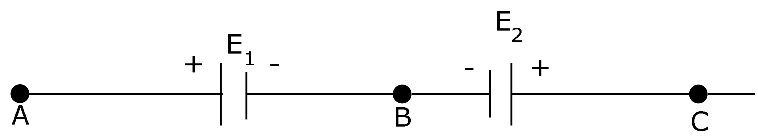
the importance of the combination.



22. Write the expression for Biot savart law for the magnetic field due to a small current carrying the conductor. Using this expression calculate the magnetic field at the centre of current carrying circular coil of radius 'r' having 'n' number of turns. [3]

23. Derive an expression for electric potential at any point due to an electric dipole. [3]

24. Two cells of e.m.f E_1 and E_2 ($E_1 > E_2$) are connected as shown below. When a potentiometer is connected between A and B the balancing length of the potentiometer is 300 c.m. on connecting the same Potentiometer between A and C, the balancing length is 100 c.m. Calculate the ratio of E_1 and E_2. [3]



25. A proton and an α - particle of the same velocity enter in a region of uniform magnetic field moving in a plane perpendicular to the magnetic field. Deduce the ratio of the radii of the circular paths described by the particles. Explain why the kinetic energy of the particle after emerging from the magnetic field remains unalterered. [3]

26. Draw a neat labelled diagram of a cyclotron. State the underlying principle and explain how a positively charge particle get accelerated in this machine. [3]

27. A transformer of 100% efficiency has 200 turns in the primary and 40,000 turns in the secondary. It is connected to a 220 V main supply and the secondary [3]

feeds to a 100K Ω resistance. Calculate (1) the output potential difference per turn (2) total output potential difference (3) power delivered to load.

28. An a.c source generating a voltage $V = V_m \sin\omega t$ is connected to a capacitor of capacitance c. Find the expression for the curren i, flowing through it. Plot a graph of V and I versus (ωt) to show that the current is $\pi/2$ ahead of the voltage. A resistor of 200 Ω and a capacitor of 15.0 μF are connected in series to a 220 V, 50 Hz a.c source. Calculate the current in the circuit and the rms voltage across the resistor and the capacitor. [5]

OR

a Explain briefly with the help of a labelled diagram; the basic principle of an a.c generator. Write the expression of the e.m.f produced.

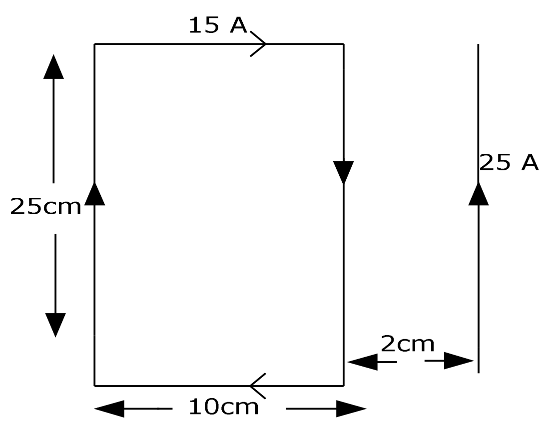
b A 100- turn coil of area 0.1 m^2 rotates at half a revolution per second. It is placed in a magnetic field 0.01 T perpendicular to the axis of rotation of the coil. Calculate the maximum voltage generated in the coil.

29. Prove that two parallel conductors of infinite lengths, carrying currents in the same direct to each other. Deduce the expression for the force per unite length, experienced by each conductor. Define 1 ampere also. [5]

OR

a Derive an expression for magnetic field inside a solenoid.

b Figure shows a rectangular current carrying loop placed 2 c.m. away from a long, straight current carrying conductor. What is the direction and the magnitude of the net force acting on the loop?



30. State Gauss's theorem in electrostatics and express it mathematically. Using it, derive an expression for electric field at a point near a thin infinite plane sheet of electric charge. How does this electric field change for a uniformly thick sheet of charge?

OR

Derive an expression for the energy stored in a parallel plate capacitor. A parallel plate capacitor with air is charged by a d.c. source to a potential 'V'. Without disconnecting the capacitor, air is replaced by a dielectric of dielectric constant 10. State with reason, how does

1 Electric field between the plates and

2 Energy stored in the capacitor change