Board Paper of Class 12-Science 2023 Physics Delhi(Set 1) - Solutions

Total Time: 180

Total Marks: 70.0

Section A

Solution 1

τ = Torque = pE sin30° = 8 × 10^{-3}

$\Rightarrow 2aq\ E\ \sin 30^\circ = 8 \times 10^{-3}$

$\Rightarrow q = \frac{8\times10^{-3}}{2\times10^{-2}\times2\times10^{5}\times\frac{1}{2}}$

$= 4 \times 10^{-6}$

Hence, the correct answer is option (a)

Solution 2

$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi d} = \frac{2\times10^{-7}\times3\times3}{2}$

$= 6 \times \frac{3}{2} \times 10^{-7}$

$= 9 \times 10^{-7}\ \mathrm{N/m}$

Since currents are is same direction
So, it will be attractive.
Disclaimer:- No option is correct
Correct Answer is 9 × 10^{-7} N/m, attractive

Solution 3

Copper has permeability less than that of vacuum as its diamagnetic.

Hence, the correct answer is option (a).

Solution 4

a = 0.1 m   N = 100

$\frac{dB}{dt} = 1\ \mathrm{T/s}$

$\varepsilon = \frac{NAdB}{dt} = 100 \times a^2 \times 1$

$= 100 \times 10^{-2} \times 1 = 1\ \mathrm{V}$

Hence, the correct answer is option (d).

Solution 5

Gamma rays have the least wavelength and greatest frequency.

Correct answer is option A.

Solution 6

Angular separation of fringes =
$\frac{\lambda}{d}$

Fringe width = $\frac{\lambda D}{d}$
In the question, D is increased.
∴ Angular separation won't get affected but fringe width will increase.

Hence, the correct answer is option (c).

Solution 7

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

Correct answer is option (b).

Solution 8

Nuclear density is independent of mass number.

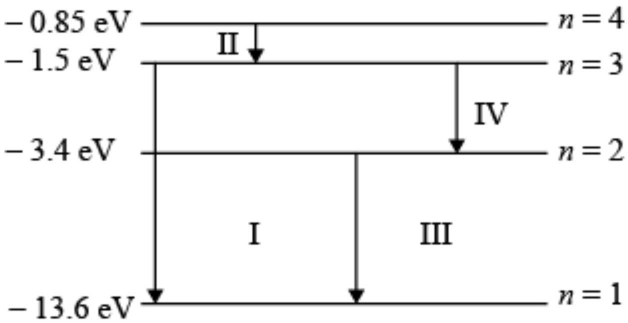
Correct answer is option D.

Solution 9

Diffusion current remains almost constant but drift current increases till both currents become equal.

Correct answer is option (d).

Solution 10



Clearly the energy difference is largest between (n = 3) and (n = 1) levels.
∴ highest energy photon is emitted in this transition.

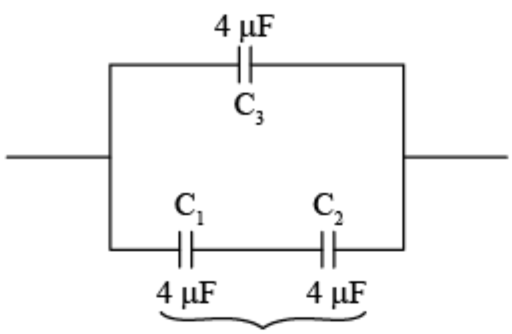
Hence, the correct answer is option (a).

Solution 11

$\lambda = \frac{h}{\mathrm{P}}$ P: momentum of the particle
λ : de-broglie wavelength
$\Rightarrow p = \frac{h}{\lambda} \Rightarrow p \propto \frac{1}{\lambda}$

Hence, the correct answer is option (d).

Solution 12

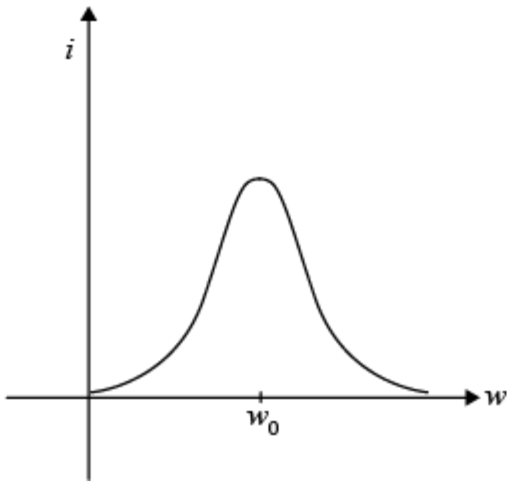


$$C_{eq} = \frac{C_1C_2}{C_1 + C_2} = \frac{4 \times 4}{4 + 4} = 2\ \mu\mathrm{F} : \text{series}$$

$$\mathrm{C_{eq}} = \mathrm{C'_{eq}} + \mathrm{C_3} = 4\ \mu\mathrm{F} + 2\ \mu\mathrm{F} = 6\ \mu\mathrm{F}\ :\ \text{parallel}$$

Hence, the correct answer is option (c).

Solution 13



$i = \frac{V}{Z}$ where Z = impedance

Current increases as ω increases to ω_0.

This mean Z reduces till ω_0.

Similarly when ω increases from ω_0. current reduces due to increase in Z.

Hence, the correct answer is option (a).

Solution 14

Huygens argued that the amplitude of the secondary wavelets is maximum in the forward direction and zero in the backward direction.

Hence, the correct answer is option (b).

Solution 15

$$\mathrm{R_n} = 0.529 \frac{\mathrm{n}^2}{\mathrm{Z}}\ \mathrm{A}^\circ \Rightarrow \mathrm{R_n} \propto \mathrm{n}^2$$

Hence, the correct answer is option (a).

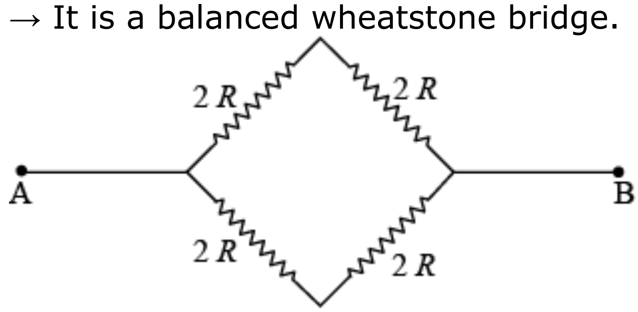
Solution 16

Resistance of intrinsic conductors decreases with rise in temperature because concentration of electrons and holes increase (charge carriers) due to increase in rate of thermal generation of e-h pairs.

Hence, the correct answer is option (a).

Solution 17

→ It is a balanced wheatstone bridge.



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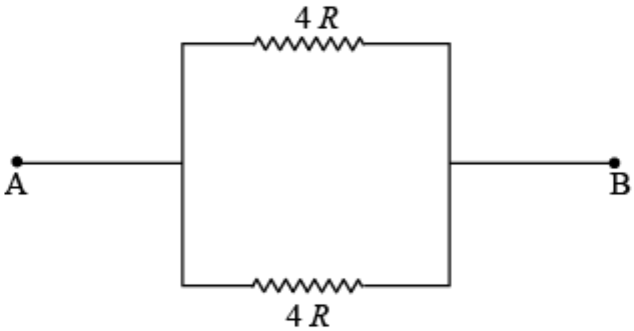

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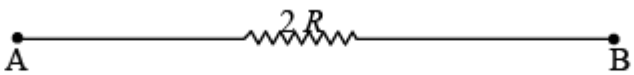


Effective resistance is 2*R*, but all are not in parallel.

Hence, the correct answer is option (c).

Solution 18

→ Torque on a current loop in magnetic field is given by:

$\overrightarrow{\tau} = \overrightarrow{\mathrm{M}} \times \overrightarrow{\mathrm{B}}$

$\tau = \mathrm{MBsin}\theta$

Here, θ is the angle between area vetor (direction of $\overrightarrow{\mathrm{M}}$) and magnetic field $\overrightarrow{\mathrm{B}}$.
As, plane of loop is perpendicular to direction of magnetic filed, θ = 0º

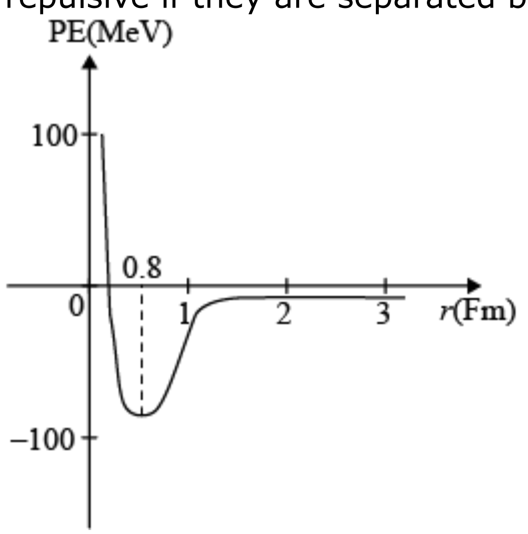
$\therefore \boxed{\tau = 0}$

∴ Assertion is correct but reason is wrong.

Section B

Solution 19

The potential energy is a minimum at a distance of about 0.8 fm.
This means that the force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm.

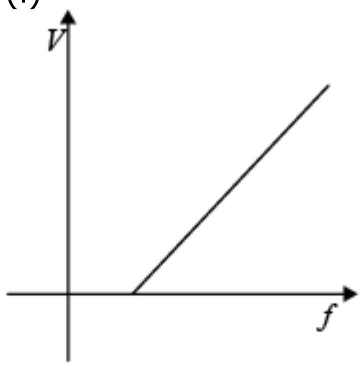


Solution 20

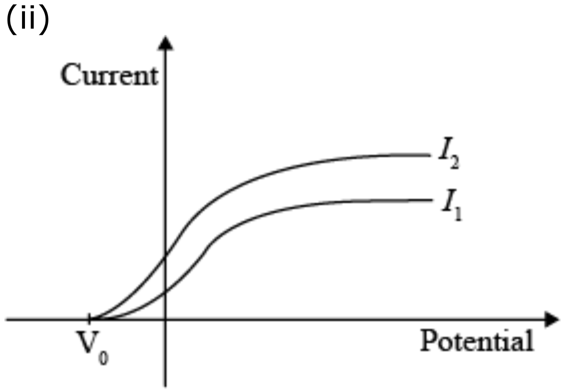
(i) De Broglie wavelength $\lambda = \frac{h}{mu} \Rightarrow \lambda \propto \frac{1}{v}$
if velocity of election decreases then wavelength of election will increase.
(ii) If V = accelerating potential then $\lambda = \frac{1.227}{\sqrt{V}} \mathrm{nm} \Rightarrow \lambda \propto \frac{1}{\sqrt{V}}$
if V increases then wavelength will decrease.

OR

(i)



Stopping Potential = $V_0 = \frac{hf}{e} - \frac{hf_0}{e}$
where f = frequency of incident Radiation.
if f increases then V_0 increases.
(ii)

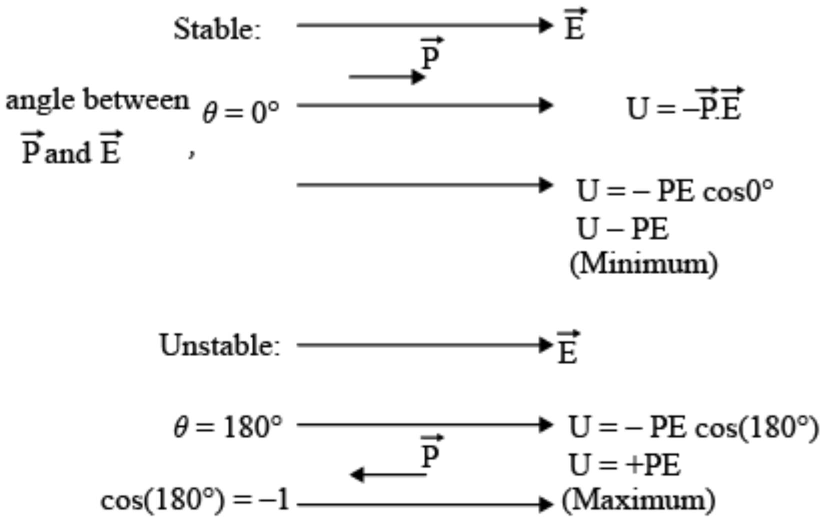


for a given frequency of the incident radiation, the stopping potential is independent of its intensity.
Intensity $I_2 > I_1$ but stopping potential V_0 is same for both intensities.

Solution 21

(a) **X - ray:** X-rays are used as a diagnostic tool in medicine and as a treatment for certain forms of cancer.
(b) **Microwave:** Due to their short wavelengths, they are suitable for the radar systems used in aircraft navigation

Solution 22



Solution 23

$$\vec{F}_m = q\left(\vec{V} \times \vec{B}\right) = qVB\sin\theta\hat{n} \ \text{(magnetic force)}$$

$$\text{Electric force} = \vec{F}_E = q\vec{E} = 0 \ (\because \text{ E is not mentioned})$$

$$\vec{F}_{\text{lorentz}} = q\left(\vec{E}\right) + q\left(\vec{V} \times \vec{B}\right)$$

$$\vec{F}_{\text{lorentz}} = q\left(\vec{V} \times \vec{B}\right)$$

For maximum force $\rightarrow \sin\theta = 1,\ \theta = 90^\circ$

So $\vec{V} \perp \vec{B}$

Work done by $\vec{F}_{\text{lorentz}} = W = \int_{\vec{r}_1}^{\vec{r}_2} \vec{F} \cdot \vec{dr}$

Now $\vec{F} \perp \vec{\nu}$, so $\vec{F} \perp \vec{dr} \Rightarrow \vec{F} \cdot \vec{dr} = 0$

So $W = 0$ J

OR

$$\vec{F} = q\left(\vec{V} \times \vec{B}\right)$$

B = magnetic field due to current I = $\frac{\mu_0 I}{2\pi d}$ $(into\ the\ plane)$

$F = qVB\sin 90^\circ$

$F = \frac{q\nu\mu_0 I}{2\pi d}$ (direction = away from current I)
(assuming q > 0)

Solution 24

(i) $\mu = \frac{\nu_\text{d}}{\text{E}} = \frac{e^\Gamma}{\text{m}} = \left(\frac{\nu_\text{d} \text{x} \, 1}{\text{v}}\right) \left(\because \text{ E} = \frac{\nu}{\text{l}}\right)$

Now if $v \to 2v$, then $E \to 2E$

So

$$\nu_d \propto E, \text{ So } \nu_d \longrightarrow 2\nu_d$$

$$\Rightarrow \mu' = \frac{2v_d}{2E} = \frac{v_d}{E} = \mu$$

So mobilty remains unchanged.

$$\left(ii\right) j = \sigma E = \frac{\sigma v}{l} \text{ so if } \nu \longrightarrow 2\nu$$

$$j \longrightarrow 2j$$

So current density is doubled.

Solution 25

(i) We know that $\phi_2 = MI_1$

$\Rightarrow \Delta\phi_2 = M\Delta I_1$

$$\Rightarrow M = \frac{\Delta\phi_2}{\Delta I_1} = \frac{15-0}{6-0} = \frac{5}{2} = 2.5 \text{ M}$$

$$\left(ii\right) E_2 = -M\frac{dI_1}{dt} = \frac{-d\phi_2}{dt}$$

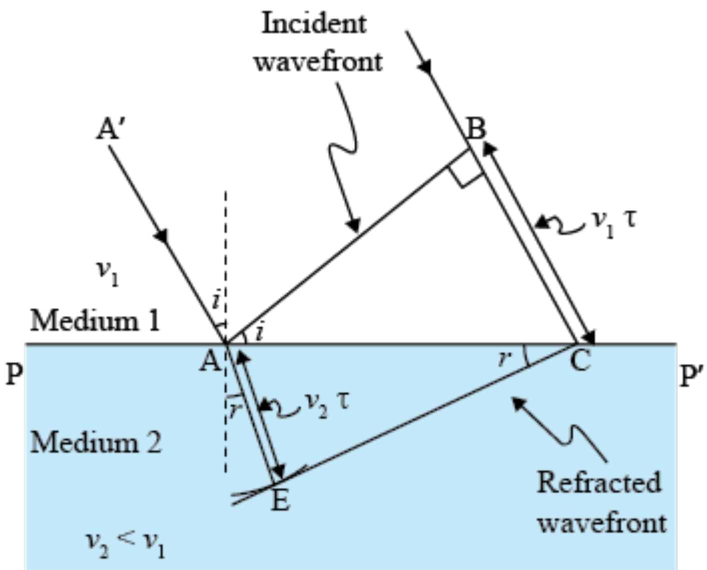
$$\Rightarrow 100 = -2.5 \times \frac{dI_1}{dt}$$

$$\Rightarrow \frac{dI_1}{dt} = \frac{-100}{2.5} = -40 \text{ A/s}$$

$$\text{So } \boxed{\frac{dI_1}{dt} = -40 \text{ A/s}}$$

Section C

Solution 26



μ_1 → Refractive index of medium 1
μ_2 → Refractive index of medium 2
In the diagram above,
BC = $\nu_1\tau$ (v_1 → speed of light in medium 1)
AE = $\nu_2\tau$ (v_2 → speed of light in medium 2)
In ΔABC:-

$$\sin i = \frac{\mathrm{BC}}{\mathrm{AC}} = \frac{\nu_1\tau}{AC} \qquad \ldots\ldots\left(1\right)$$

In ΔABC:-

$$\sin r = \frac{\mathrm{AE}}{\mathrm{AC}} = \frac{\nu_2\tau}{\mathrm{AC}} \qquad \ldots\ldots\left(2\right)$$

Using (1) and (2):- $\frac{\sin i}{\sin r} = \frac{\nu_1}{\nu_2}$

Also, $\mu_1 = \frac{C}{\nu_1}$ and $\mu_2 = \frac{C}{\nu_2}$

$$\therefore \frac{\sin i}{\sin r} = \frac{\frac{C}{\mu_1}}{\frac{C}{\mu_2}} = \frac{\mu_2}{\mu_1}$$

$$\Rightarrow \mu_1 \sin i = \mu_2 \sin r$$

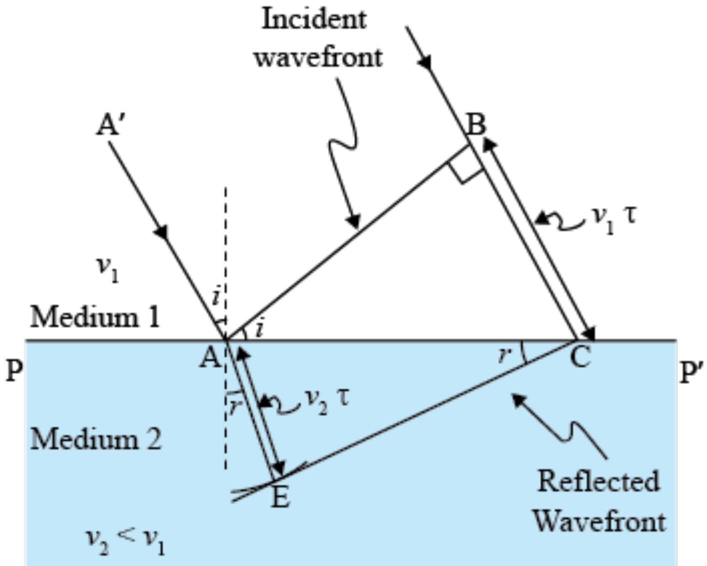
$$\Rightarrow \mu \sin i = \text{const.}$$

Hence, Snell's Law is verified.

OR

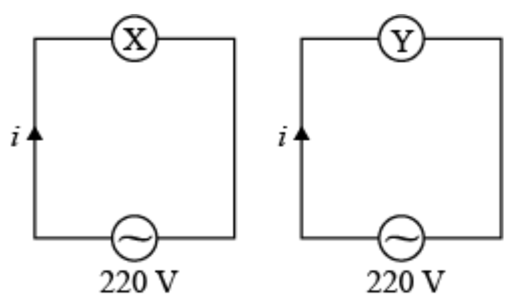
Reflection of a plane wave by a plane surface
We consider a plane wave AB incident at an angle *i* on a reflecting surface MN. If v represents the speed of the wave in the medium and if τ represents the time taken by the wavefront to advance from the point B to C then the distance BC = vτ
In order the construct the reflected wavefront we draw a sphere of radius vτ from the point A as shown in Fig. Let CE represent the tangent plane

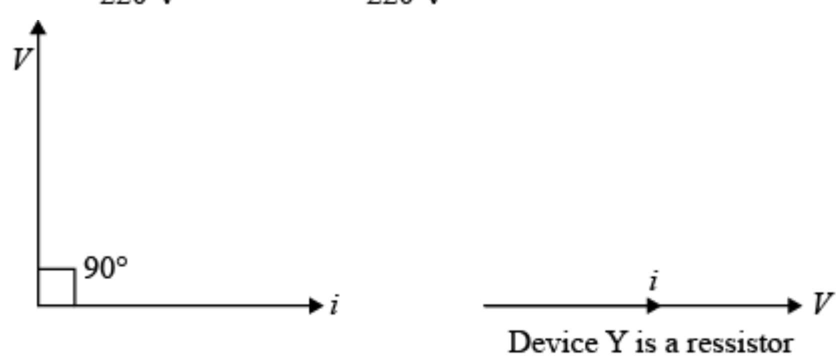
drawn from the point C to this sphere. Obviously
AE = BC = vτ



Reflection of a plane wave AB by the reflecting surface MN. AB and CE represent incident and reflected wavefronts.
If we now consider the triangles EAC and BAC we will find that they are congruent and therefore, the angles *i* and *r* (as shown in Fig.) would be equal. This is the law of reflection.

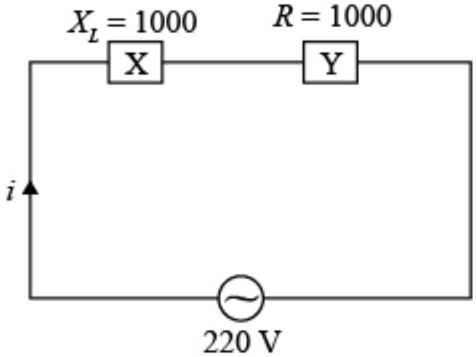
Solution 27





Device X is on Inductor
Inductive Reactance $X_L = \frac{V}{i} = \frac{220}{0.22}$ $R = \frac{V}{i} = \frac{220}{0.22} = 1000\ \Omega$
$\Rightarrow X_L = 1000\ \Omega$

(ii)



$$i = \frac{V}{Z} = \frac{220}{\sqrt{(X_L^2) + (R)^2}} = \frac{220}{\sqrt{(1000)^2 + (1000)^2}}$$

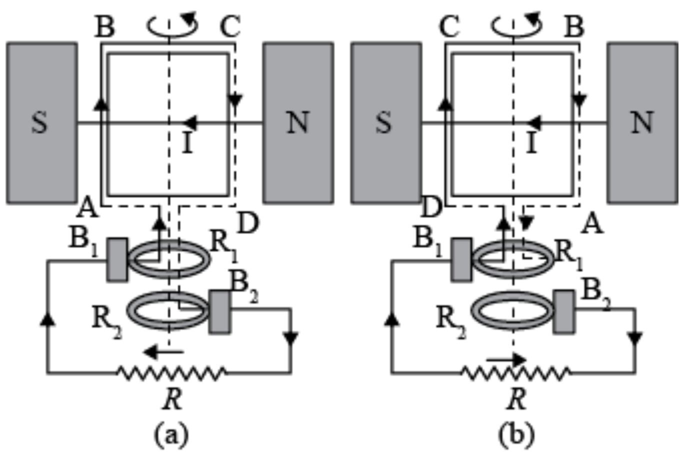
$$\Rightarrow i = \frac{220}{1000\sqrt{2}} = \frac{0.22}{\sqrt{2}} \text{ A.}$$

Solution 28

AC Generator:

Principle – Based on the phenomenon of electromagnetic induction

Construction:



Main parts of an ac generator:

- Armature – Rectangular coil ABCD
- Filed Magnets – Two pole pieces of a strong electromagnet
- Slip Rings – The ends of coil ABCD are connected to two hollow metallic rings R_1 and R_2.
- Brushes B_1 and B_2 are two flexible metal plates or carbon rods. They are fixed and are kept in tight contact with R_1 and R_2 respectively.

Theory and Working – As the armature coil is rotated in the magnetic field, angle θ between the field and normal to the coil changes continuously. Therefore, magnetic flux linked with the coil changes. An *emf* is induced in the coil. According to Fleming's right hand rule, current induced in AB is from A to B and it is from C to D in CD. In the external circuit, current flows from B_2 to B_1.

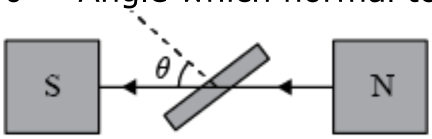
To calculate the magnitude of *emf* induced:

Suppose

A → Area of each turn of the coil

N → Number of turns in the coil

$\overrightarrow{B}$ → Strength of magnetic field
θ → Angle which normal to the coil makes with at any instant *t*



∴ Magnetic flux linked with the coil in this position:

$$\phi = N\left(\overrightarrow{B} \cdot \overrightarrow{A}\right) = NBA \cos \theta = NBA \cos \omega t \qquad \ldots(\text{i})$$

Where, 'ω' is angular velocity of the coil

As the coil rotates, angle θ changes. Therefore, magnetic flux ϕ linked with the coil changes and hence, an *emf* is induced in the coil. At this instant *t,* if *e* is the *emf* induced in the coil, then

$$e = -\frac{d\theta}{dt} = -\frac{d}{dt}(NAB \cos \omega t)$$

$$= -NAB\frac{d}{dt}(\cos \omega t)$$

$$= -NAB(-\sin \omega t)\omega$$

$$\therefore\ e = NAB\,\omega \sin \omega t$$

The generator converts the mechanical energy into electrical energy. The mechanical energy may be obtained from the rotation of the turbine associated with the generator. The turbine in turn, may be working by the kinetic energy of running water, wind or steam.

Solution 29

(a) Sensitivity, $I_S = \frac{NAB}{K}$
All symbols have usual meanings to increase I_S, N or A or B can be increased, or K can be decreased.

(b)

$R_0 = \frac{V}{I_g} - R_g$

R_0 : resistance connected in series
V : required range
I_g : full scale current

Now

$$R_1 = \frac{V}{I_g} - R_g \qquad \ldots\ldots(1)$$

$$R_2 = \frac{2V}{I_g} - R_g \qquad \ldots\ldots(2)$$

$$(1) \times 2 - (2) \Rightarrow 2R_1 - R_2 = -R_g$$

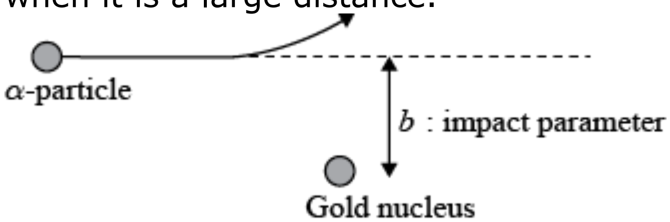
$$\Rightarrow R_g = R_2 - 2R_1$$

Solution 30

(i) The minimum distance between the centre of the nucleus and the alpha particle just before it gets reflected back through 180° is defined as the distance of closest approach r_0 (also known as contact distance).

$$r_0 = \frac{1}{4\pi\varepsilon_0}\frac{2\,Ze^2}{\frac{1}{2}mv_0^2} = \frac{1}{4\pi\varepsilon_0}\frac{2\,Ze^2}{E_k} \qquad E_k = \frac{1}{2}mv_0^2 \ : \ \text{Kinetic energy of } \alpha - \text{particle}$$

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



(ii) $E_k = 3.95\ \text{MeV} = 3.95 \times 10^6 \times 1.6 \times 10^{-19}\ \text{J}$

$$r_0 = \frac{1}{4\pi\varepsilon_0}\frac{2\,Ze^2}{E_k} = \left(9 \times 10^9\right) \times \frac{2\times79\times\left(1.6\times10^{-19}\right)^2}{3.95\times10^6\times\left(1.6\times10^{-19}\right)}$$

$$= \frac{9\times2\times79\times1.6\times10^9\times10^{-19}}{3.95\times10^6} = 576 \times 10^{-16}$$

$$r_0 = 57.6 \times 10^{-15}\ \text{m} = 57.6\ \text{fermi}$$

OR

(i)
(a) Bohr's first postulate was that an electron in *an atom could revolve in certain stable orbits without the emission of radiant energy*, contrary to the perdictions of electromagnetic theory. According to this postulate, each atom has certain definite stable states in which it can exist, and each possible state has definite total energy. These are called the stationary states of the atom.

(b) Bohr's second postulate defines these stable orbits. This postulate states that the *electron* revolves around the nucleus *only in those orbits for which the angular momentum is some integral multiple of h*/2π where *h* is the Planck's constant (= 6.6 × 10^{-34} J s). Thus the angular momentum (*L*) of the orbiting electron is quantised. That is $L = nh/2\pi$

(c) Bohr's third postulate incorporated into atomic theory the early quantum concepts that had been developed by Planck and Einstein. It states that an electron might make a transition from one of its specified non-radiating orbits to another of lower energy. When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states. The frequency of the emitted photon is then given by
$h\nu = E_i - E_f$

(ii) For, $n = 2$
$h = 6.63 \times 10^{-34}$ J s : Planck's constant

Angular momentum is given by

$$L = \frac{nh}{2\pi} = \frac{2\times6.63\times10^{-34}}{2\times3.14}$$

$$= 2.1\times10^{-34}\ \mathrm{J\ s}$$

Section D

Solution 31

(a) (i) When electron in a metal are kept in an external electric field $\vec{E}$, they experience a force $\vec{F}$ given by

$$\vec{F} = -e\vec{E} = m\vec{a},$$

$$\Rightarrow \vec{a} = -\frac{e}{m}\vec{E}$$

m = mass of electron
e = charge of electron
a = average acceleration
At a constant temperature, if we assume that electrons collide with nearby atoms or electrons, then after each collision, their average initial velocity u = O ms^{-1}, So after an average time interval 'τ' known as" relaxation time" their final average velocity (drift velocity)

$$\vec{V}_d = \vec{u} + \vec{a}\vec{\tau} = 0 - \left(\frac{e}{m}\vec{E}\right)\tau$$

$$\Rightarrow \vec{u_d} = \frac{-e}{m}\vec{E}\tau$$

(ii) We know that I = ne A v_d
where I = current = same for both wires as they are is series
⇒ $n_1 e A_1 (v_d)_1 = n_2 e A_2 (v_d)_2$
⇒ $n_1 A_1 (v_d)_1 = n_2 A_2 (v_d)_2$ where 1 and 2 represent wires A and B respectively and
$\frac{A_1}{A_2} =$ cross sectional area of A and B.

Now $A_1 = \frac{\pi d_1^2}{4} = \frac{\pi d_2^2}{4} = A_2$ since diameter is same, so we get

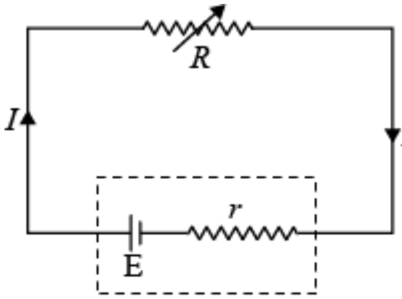
$$n_1 (v_d)_1 = n_2 (v_d)_2$$

$$\Rightarrow \frac{(v_d)_1}{(v_d)_2} = \frac{n_2}{n_1} = \frac{n_2}{1.5n_2}\ (\text{given n1} = 1.5n_2)$$

$$\Rightarrow \frac{(v_d)_1}{(v_d)_2} = \frac{2}{3}\ \text{Ratio of drift velocity of wire A to wire B is } 2:3$$

OR

(i) Given a cell of emf E and interval resistance '*r*' is connected across variable load resistance R.



New terminal potential difference across cell $= \mathrm{V} = \mathrm{E} - \mathrm{Ir} = \mathrm{IR}$

$\Rightarrow \mathrm{E} = \mathrm{I}(r + \mathrm{R})$ or $\boxed{\mathrm{I} = \frac{\mathrm{E}}{\mathrm{R}+r}}$

(i) Now $\mathrm{V} = \mathrm{IR} = \left(\frac{\mathrm{E}}{\mathrm{R}+r}\right)\mathrm{R} = \frac{\mathrm{E}}{\left(\frac{\mathrm{R}+r}{\mathrm{R}}\right)} = \frac{\mathrm{E}}{\left(1+\frac{r}{\mathrm{R}}\right)}$

As R → 0, $\frac{1}{\mathrm{R}} \to \infty, \frac{r}{\mathrm{R}} \to \infty, 1 + \frac{r}{\mathrm{R}} \to \infty$

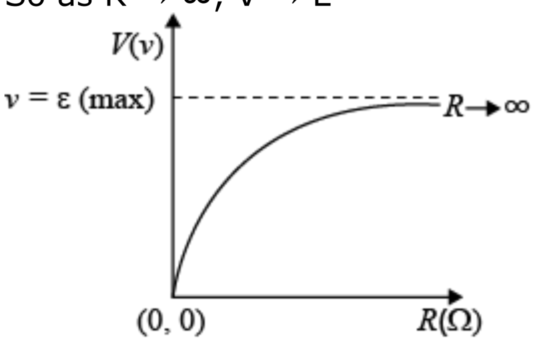
$\Rightarrow \frac{1}{1+\frac{r}{\mathrm{R}}} \to 0, \Rightarrow \frac{\mathrm{E}}{1+\frac{r}{\mathrm{R}}} \to 0, \text{ So } \mathrm{V} \to 0$

Hence as $\boxed{\mathrm{R} \to 0, \mathrm{V} \to 0}$ graph starts from (0, 0).

Now as R → $\infty, \frac{1}{\mathrm{R}} \to 0, \frac{r}{\mathrm{R}} \to 0$

$1 + \frac{r}{\mathrm{R}} \to 1 \Rightarrow \frac{1}{1+\frac{r}{\mathrm{R}}} \to 1 \Rightarrow \frac{\mathrm{E}}{1+\frac{r}{\mathrm{R}}} \to \mathrm{E} \text{ so } \mathrm{V} \to \mathrm{E} \text{ as } \mathrm{R} \to \infty$

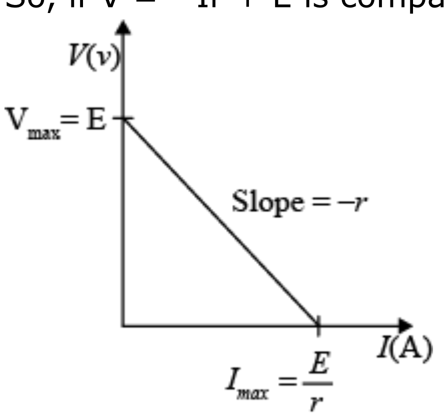
So as R → ∞, V → E



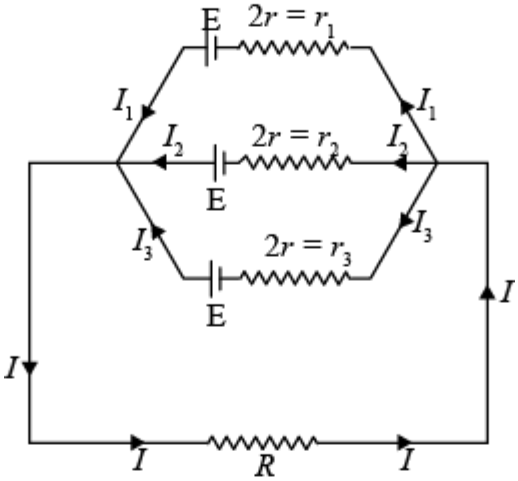
(ii) Now V = E − Ir, So as I = 0, V = E

and then if V = 0, $\mathrm{I} = \frac{\mathrm{E}}{r}$

So, if V = −Ir + E is compared with *y* = *mx* + *c*, we get $\boxed{m = -r}$ and $\boxed{\mathrm{C} = \mathrm{E}}$



(ii)



Let $E_1 = E_2 = E_3$ and $r_1 = 2r$, $3r = r_2$
and $r_3 = 6r$ be given cells emf and interval resistances respectively.
New if E_{net} = net emf and
r_{net} = net interal resistance, then

$$\frac{1}{r_{net'}} = \frac{1}{2r} + \frac{1}{3r} + \frac{1}{6r} = \frac{3+2+1}{6r} = \frac{6}{6r} = \frac{1}{r}$$

$$\boxed{r_{net} = r} \; and \; \frac{E_{net}}{r_{net}} = \frac{E_1}{r_1} + \frac{E_2}{r_2} + \frac{E_3}{r_3}$$

$$\Rightarrow \frac{E_{net}}{r} = \frac{E}{2r} + \frac{E}{3r} + \frac{E}{6r} = E\left(\frac{1}{r}\right)$$

$$\Rightarrow \boxed{E_{net} = E}$$

So total resistance of circuit = R + r_{net} = R + r

$$\Rightarrow \text{Total current} = \boxed{I = \frac{E_{net}}{R+r_{net}} = \frac{E}{R+r}}$$

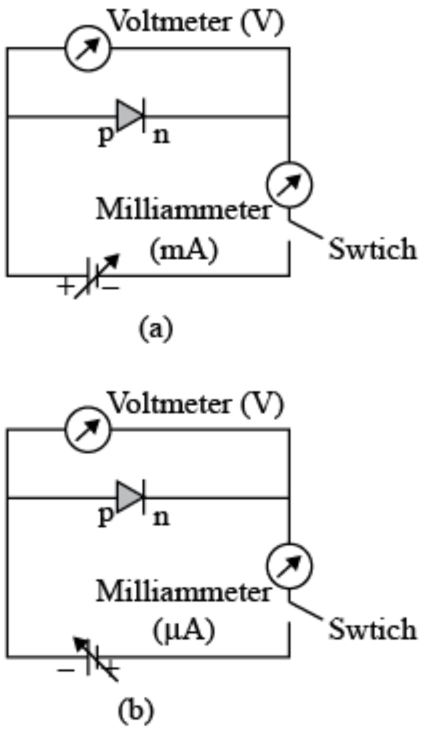
(iii) V = $E_{net} - Ir_{net}$

$$= E - \left(\frac{E}{R+r}\right)^{r}$$

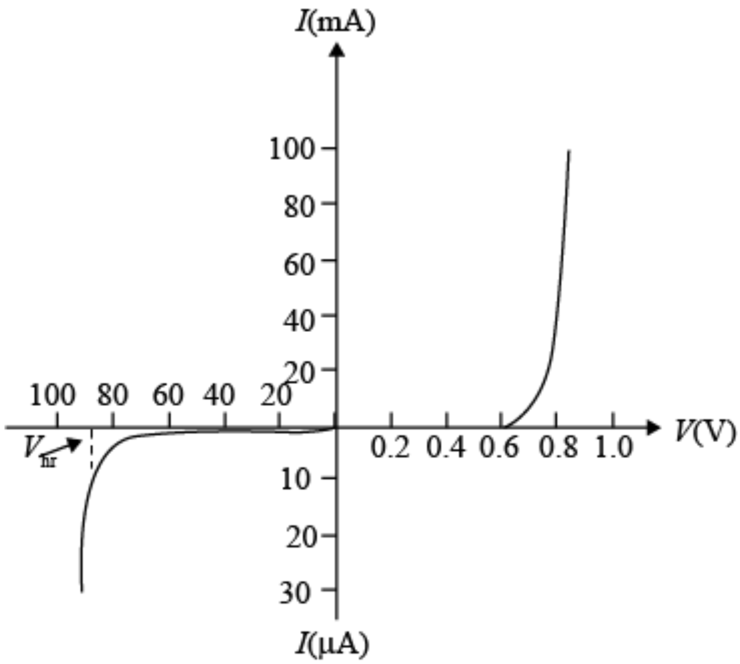
$$= E\left(1 - \frac{r}{R+r}\right) = \frac{ER}{R+r}$$

$$\boxed{V = \frac{ER}{R+r}}$$

Solution 32



Experimental circuit arrangement for studying *V-I* characteristics of a p-n junction diode (a) in forward bias, (b) in reverse bias.



Typical *V-I* characteristics of a silicon diode.

(i) Due to the applied voltage, electrons from n-side cross the depletion region and reach p-side (where they are minority carriers). Similarly, holes from p-side cross the junction and reach the n-side (where they are minority carriers). This process under forward bias is known as minority carrier injection. At the junction boundary, on each side, the minority carrier concentration increases significantly compared to the locations far from the junction.

Due to this concentration gradient, the injected electrons on p-side diffuse from the junction edge of p-side to the other end of p-side. Likewise, the injected holes on n-side diffuse from the junction edge of n-side to the other end of n-side. This motion of charged carriers on either side gives rise to current. The total diode forward current is sum of hole diffusion current and conventional current due to electron diffusion. The magnitude of this current is usually in mA.

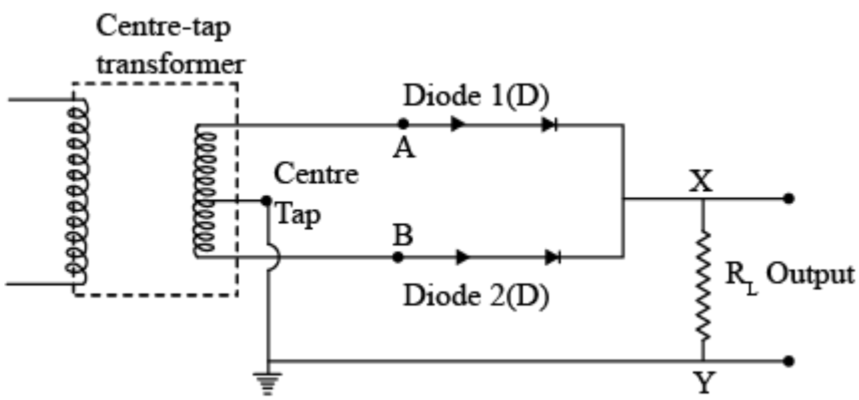
(ii) The current under reverse bias is essentially voltage independent upto a critical reverse bias voltage, known as breakdown voltage (V_{br}). When $V = V_{br}$, the diode reverse current increases sharply. Even a slight increase in the bias voltage causes large change in the current. If the reverse current is not limited by an external circuit below the rated value (specified by the manufacturer) the p-n junction will get destroyed. Once it exceeds the rated value, the diode gets destroyed due to overheating.

OR

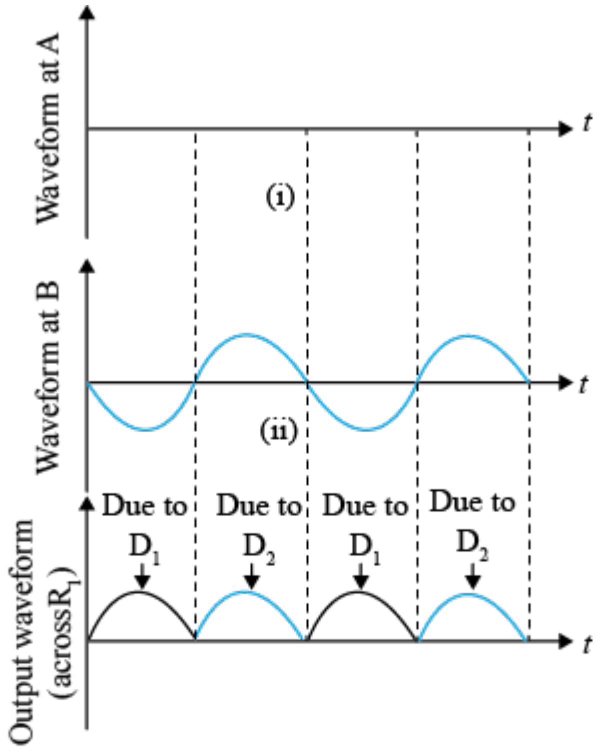
Two important processes occur during the formation of a p-n junction: *diffusion* and *drift*.

Diode as Full Wave Rectifier

To get an output voltage for both half cycles of the input signal, we use full wave rectifiers. The commonly used full wave rectifier circuits are center-tap rectifier and bridge rectifier. The figure below shows the center-tap rectifier circuit.



Now consider the circuit. The P-side of the diodes D_1 and D_2 are connected to the secondary terminals of the transformer. The N-sides of the diodes are connected together. The load is connected between this point and the midpoint of the transformer. When the input signal to diode D_1 is positive, it conducts and load current flows. During this time, the input to diode D_2 is negative with respect to the midpoint. During the negative half cycle of the input signal, the voltage at D_1 is negative and that at D_2 is positive. So D_2 conducts during this time period. Thus we get output voltage during both the half cycles. As the full wave rectifier rectifies both the half cycles, it is more efficient to then the half wave rectifier. The waveforms are given below:

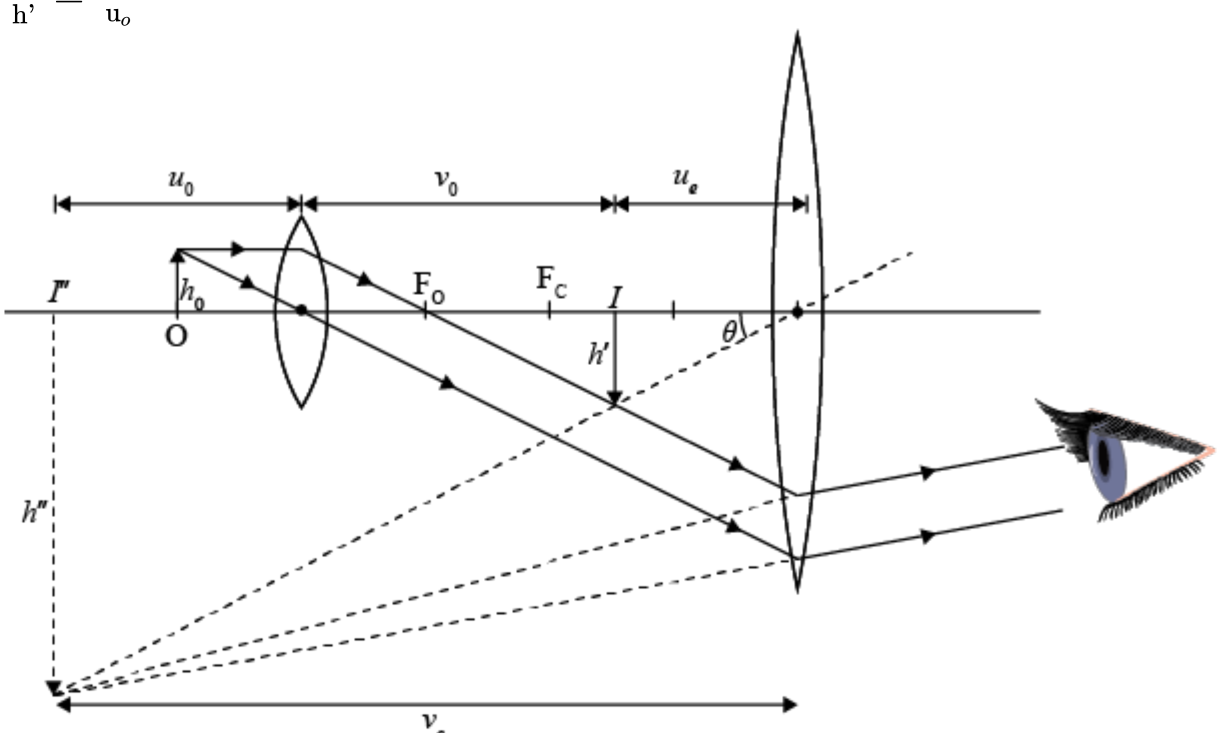


p-n junction diode is used as rectifier. Its working is based on the fact that the resistance of p-n junction becomes low when forward biased and becomes high when reverse biased. These characteristics of diode is used in rectification.

Solution 33

(i) Compound Microscope:-

$\frac{\text{h'}}{\text{h'}} = \frac{\text{V}_o}{\text{u}_o}$



$\text{u}_o \rightarrow$ distance of object from objective
$\nu_o \rightarrow$ distance of image from objective
$\text{u}_\text{e} \rightarrow$ object distance from eyepiece.

V_e → distance of final image from eyepiece.
h' → height of intermediate image
h'' → height of final image.
h_o→ height of object

$$\theta = \frac{h'}{u_e} = \frac{h''}{v_e}$$

$$m = \frac{\theta}{\theta_o} = \frac{\left(\frac{h'}{u_e}\right)}{\left(\frac{h_o}{D}\right)} = \frac{h'}{h_o} \times \frac{D}{u_e} = \left(\frac{v_o}{u_o} \times \frac{D}{u_e}\right)$$

∴ In General Setup :

$$m = \left(\frac{v_o}{u_o}\right)\left(\frac{D}{u_e}\right) \qquad \therefore\ m = m_o m_e$$

Tip : As the final image is inverted,

$$m = -\left(\frac{v_o}{u_o}\right)\left(\frac{D}{u_e}\right)$$

For final image to be formed at near point :

$$v_e = D$$

$$\Rightarrow \frac{1}{u_e} = \frac{1}{D} + \frac{1}{f_e} \Rightarrow \frac{D}{u_e} = D\left(\frac{1}{D} + \frac{1}{f_e}\right)\left(1 + \frac{D}{f_e}\right)$$

$$\therefore\ m = -\left(\frac{v_o}{u_o}\right)\left(1 + \frac{D}{f_e}\right)$$

(ii) u_o=-1.5 cm

$$f_o = 1.25 \text{ cm}$$

using lens formula :

$$\frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o} = \left(\frac{1}{1.25} - \frac{1}{1.5}\right)$$

$$\Rightarrow v_o = 7.5 \text{ cm}$$

Also, $f_e = 5$ cm, $D = 25$ cm

$$\therefore\ m = -\left(\frac{v_o}{u_o}\right)\left(1 - \frac{D}{f_e}\right)$$

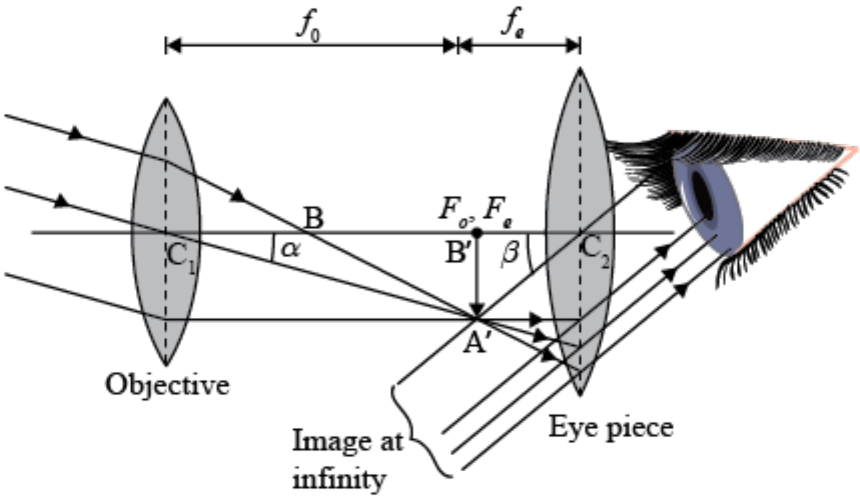
$$= -\left(\frac{7.5}{1.5}\right)\left(1 + \frac{25}{5}\right)$$

$$= -5 \times 6$$

$$m = -30$$

∴ We will get 30 times magnified image.

OR



(i)

$\propto$ → visual angle formed by object

β → visual angle formed by the final image

fo → focal length of objective

fe → focal length of eye piece

$|\propto| = \frac{\text{A'B'}}{\text{C}_1\text{B'}} = \frac{\text{A'B'}}{\text{fo}}$

$|\beta| = \frac{\text{A'B'}}{\text{C}_2\text{B'}} = \frac{\text{A'B'}}{\text{fe}}$ [As $\propto$ and β are measured in opposite senses

(clock and anti $\propto/\beta$ will be negative]

Magnifying power:-

$$\text{m} = \frac{\beta}{\propto} = -\left|\frac{\beta}{\propto}\right| = -\left(\frac{\text{A'B'}/f_e}{\text{A'B'}/f_o}\right)$$

$$\Rightarrow \boxed{\text{m} = -\frac{f_o}{f_e}}$$

(ii) According to the question:-

|m| = 2.9

$$\Rightarrow \frac{\text{f}_\text{o}}{\text{f}_\text{e}} = 2.9$$

$$\Rightarrow \boxed{\text{f}_\text{o} = 2.9 \times \text{f}_\text{e}} \longrightarrow (1)$$

Also, length of tube = 150 cm

⇒ $f_o + f_e$ = 150 cm

using (1):-

⇒ 2.9 $f_e + f_e$ = 150 cm

⇒ 3.9 f_e = 150 cm

⇒ f_e = 38.46 cm

∴ $f_o = (150 - f_e)$ cm

= 111.54 cm

∴ focal length of objective = 111.54 cm

∴ focal length of eyelens = 38.46 cm

Solution 34

(i) Focal length of upper part of lens, f_1 will be

$\frac{1}{f_1} = \left(\frac{n_1}{n_s} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ where n_S is refractive index of surroundings.

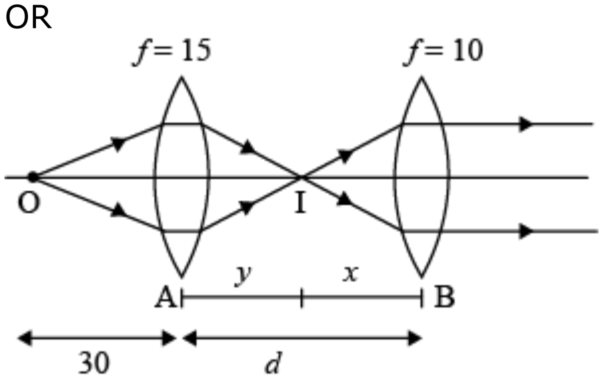
Similarly, focal length of lower part of lens, f_2 will be

$\frac{1}{f_2} = \left(\frac{n_2}{n_s} - 1\right)\ \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

So upper part of lens will make an image separate from lower part.
So composite lens will make two images of the object AB.
(ii) Real image is formed when light rays actually meet after Refraction.
So, if the screen is removed imaged will still be formed.
(iii) n = 1.55, $R_1 = R_2 = R$ = ?, f = 20 cm

$\frac{1}{f} = \left(\frac{1.55}{1} - 1\right)\ \left(\frac{1}{R} - \frac{1}{-R}\right) \Rightarrow \frac{1}{20} = \left(0.55\right)\frac{2}{R} \Rightarrow 1.1 \times 20 = 22\ \text{cm}$

OR



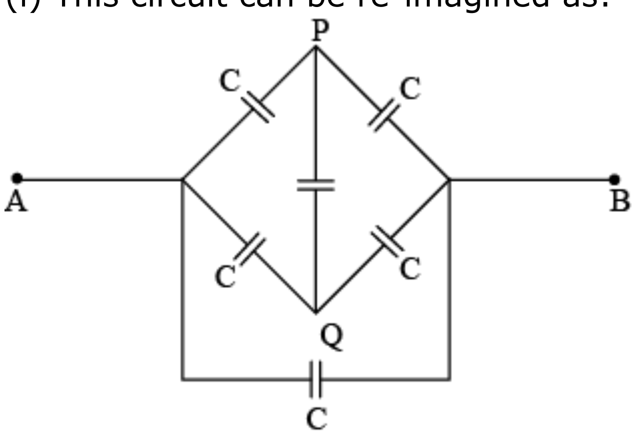
(iii) Image I should be formed at focus of B ⇒ x = 10 cm
for A, using thin lens formula

$y = v = \frac{uf}{u+f} = \frac{-30\times15}{-30+15} = \frac{-30\times15}{-15} = 30\ \text{cm}$

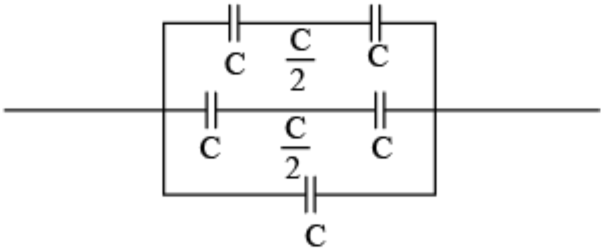
$\Rightarrow d = x + y = 30 + 10 = 40\ \text{cm}$

Solution 35

(i) This circuit can be re-imagined as:



By symmetry potential of point P and Q will be same, hence the capacitor in that branch can't be charged
Hence equivalent circuit will be



$\Rightarrow \mathrm{C}$ and C in series

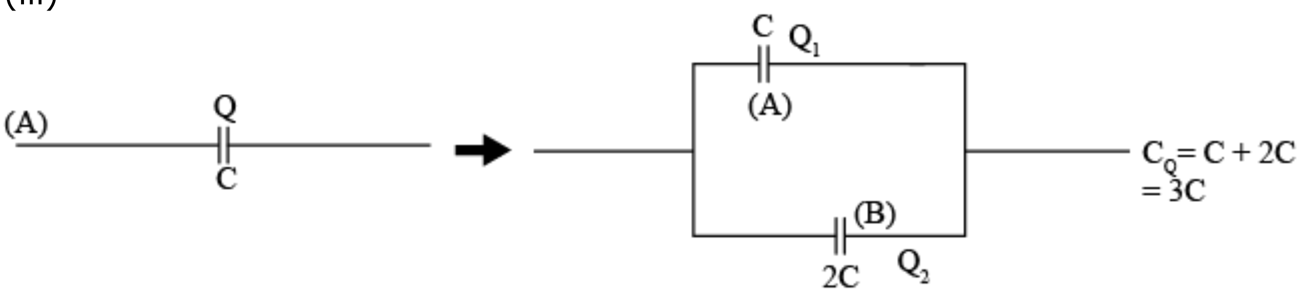
$\mathrm{C}'_{\mathrm{eq}} = \frac{\mathrm{C}\times\mathrm{C}}{\mathrm{C}+\mathrm{C}} = \frac{\mathrm{C}}{2}$

$\mathrm{C}, \frac{\mathrm{C}}{2}, \frac{\mathrm{C}}{2}$ in parallel

$\Rightarrow \mathrm{C}_{\mathrm{eq}} = \mathrm{C} + \frac{\mathrm{C}}{2} + \frac{\mathrm{C}}{2} = 2\mathrm{C}$

(ii) When a dielectric is placed between the charged plates, the polarization of the medium produces an internal electric field opposing the external field of the charges on the plate. The dielectric constant K is defined to reflect the amount of reduction in the electric field.

(iii)



Same across the two

$\Rightarrow \mathrm{V} = \frac{\mathrm{Q}_1+\mathrm{Q}_2}{\mathrm{C}_{\mathrm{eq}}} = \frac{\mathrm{Q}}{3\mathrm{C}}$

$\mathrm{Q}_1 = \mathrm{C}\times\mathrm{V} = \frac{\mathrm{Q}}{3}$

$\mathrm{Q}_2 = 2\mathrm{C}\times\mathrm{V} = \frac{2\mathrm{Q}}{3}$

$\Rightarrow \left(\mathrm{A}\right)$ has lost $\left(\mathrm{Q} - \frac{\mathrm{Q}}{3}\right) = \frac{2\mathrm{Q}}{3}$

Charge to (B)

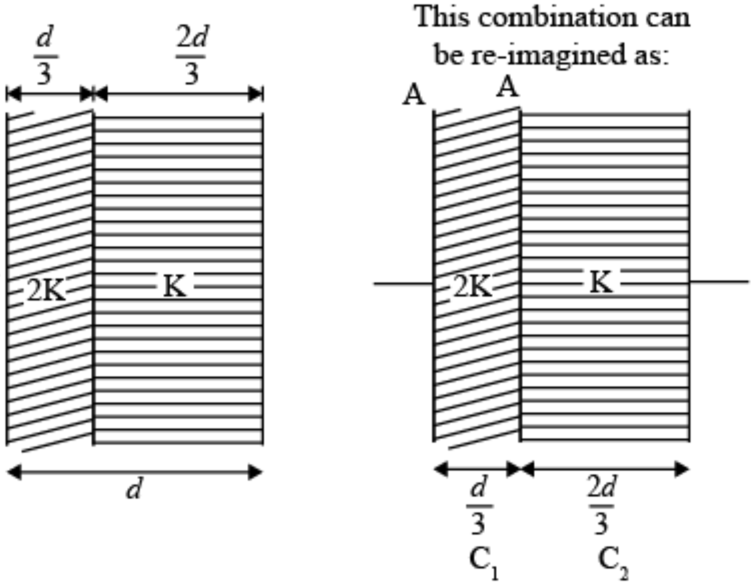
OR

(iii) If, $\mathrm{C} = \frac{\mathrm{K}\varepsilon_0 A}{d}$

This combination can be re-imagined as:

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

This combination can be re-imagined as:



$$C_1 = \frac{2K\varepsilon_0 A}{\frac{d}{3}} = \frac{6K\varepsilon_0 A}{d}, \quad C_2 = \frac{K\varepsilon_0 A}{\frac{2d}{3}} = \frac{3K\varepsilon_0 A}{2d}$$

$$\Rightarrow C_1 = 6\ C \text{ and } C_2 = \frac{3}{2}C$$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{6C \times \frac{3}{2}C}{6C + \frac{3}{2}C} = \frac{9}{\frac{15}{2}}C = \frac{6}{5}\frac{K\varepsilon_0 A}{d}$$