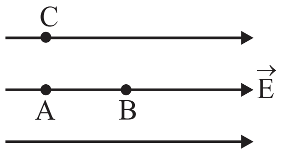
MARKING SCHEME
PHYSICS
Subject Code – 042
CLASS – XII
Academic Session 2024 – 25

Maximum Marks:70 **Time Allowed: 3hours**

[SECTION – A]

Ans.1- (B) **(1 mark)**



$V_A > V_B$ $[V_A = V_C]$

In the direction of electric field, the electric potential decreases.

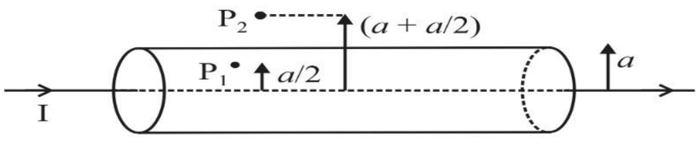
Ans.2- (B) In the state of equilibrium, **(1 mark)**

The potential on the surface of bigger sphere = the potential at the surface of the smaller sphere

$$\frac{kq_1}{r_1} = \frac{kq_2}{r_2} \Rightarrow \frac{q_1}{q_2} = \frac{r_1}{r_2}$$

$$\therefore \quad \frac{E_1}{E_2} = \frac{q_1}{q_2}\frac{r_2^2}{r_1^2} = \frac{r_1}{r_2}\cdot\frac{r_2^2}{r_1^2} = \frac{r_2}{r_1}$$

Ans.3 - (C) **(1 mark)**



AtP_2, $B_2 = \dfrac{\mu_0 I}{2\pi\left(\dfrac{3a}{2}\right)} = \dfrac{\mu_0 I}{3\pi a}$

AtP_1, $B_1 = \dfrac{\mu_0 (I/4)}{2\pi(a/2)} = \dfrac{\mu_0 I}{4\pi a}$

$$\therefore \quad \frac{B_2}{B_1} = \frac{\left(\dfrac{\mu_0 I}{3\pi a}\right)}{\left(\dfrac{\mu_0 I}{4\pi a}\right)} \Rightarrow \frac{B_2}{B_1} = \frac{4}{3}$$

Ans.4 - (D)Sound waves as well as light waves (1 mark)

Ans.5 -(A) (1 mark)

Ans.6 - (C)When all the given components are connected(1 mark)

$IR = IX_C = IX_L = 10V$

$X_C = X_L = R$

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

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

$Z = R$

$V_S = IZ = IR = 10\ V$

So, the source voltage is also 10 V

When the capacitor is short circuited then

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

$= \sqrt{R^2 + R^2} = R\sqrt{2}$

$V_L = I'\ X_L = \frac{10}{\sqrt{2}R} \times R = 5\sqrt{2}\ V$

Ans.7 - (B)(1 mark)

Ans.8 - (B) The distance of closest approach**(1 mark)**

$d = \frac{\text{const}}{V_1^2}$ ...(1)

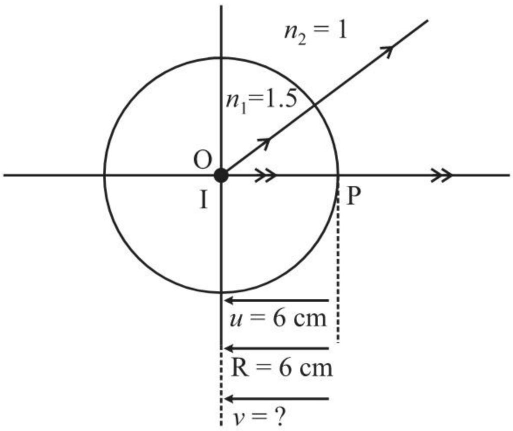
$\frac{d}{2} = \frac{\text{const}}{V_2^2}$ ...(2)

From equations (1) and (2),

$2 = \frac{V_2^2}{V_1^2} \Rightarrow V_2 = \sqrt{2}\ V_1$

$\therefore$ $V_2 = \sqrt{2}\ V$ Given, ($V_1 = V$)

Ans.9 - (C)(1 mark)



$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

$$\frac{1}{v} - \frac{3}{2[-6]} = \frac{[1 - 3/2]}{-6}$$

$$\frac{1}{v} = \frac{-3}{12} + \frac{1}{12} = \frac{-2}{12} = \frac{-1}{6}$$

v= –6 cm

Ans.10 - (B)Diffraction (1 mark)

Ans.11- (A)doping level (1 mark)

Ans.12- (C)+0.4% (1 mark)

Ans.13- (A) (1 mark)

Ans.14- (A)(1 mark)

Ans.15- (D)(1 mark)

Ans.16- (A)(1 mark)

[SECTION – B]

Ans.17–

Given $\boldsymbol{\emptyset_0 = 5.63eV = 5.63 \times 1.6 \times 10^{-19}J}$

$$\boldsymbol{\nu = 1.6 \times 10^{15}Hz}$$

$\boldsymbol{K.E. = h\nu - \emptyset_0 = \frac{hc}{\lambda}}$ ½

$\boldsymbol{\lambda = \frac{hc}{h\nu - \emptyset_0}}$ ½

$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{6.63 \times 10^{-34} \times 1.6 \times 10^{15} - 5.63 \times 1.6 \times 10^{-19}}$ ½

$$= \frac{19.89 \times 10^{-26}}{1.6 \times 10^{-19}(6.63 - 5.63)}$$

$= \frac{19.89 \times 10^{-26}}{1.6 \times 10^{15}} = \boldsymbol{12.4 \times 10^{-7}\,m}$ ½

Ans.18 - $\lambda_1 = 4 \times 10^{-7}\,m \lambda_2 = 6 \times 10^{-7}\,m$

Distance at which dark fringe is observed $x = \left(n + \frac{1}{2}\right)\frac{\lambda D}{d}$ ½

First Dark fringe for $\lambda_1 d_1 = \frac{1}{2}\frac{4 \times 10^{-7}}{10^{-2}}\,m = 2 \times 10^{-5}\,m$ ½

First Dark fringe for $\lambda_2 d_2 = \frac{1}{2}\frac{6\times10^{-7}}{10^{-2}}\ m = 3\ \times\ 10^{-5}\ m$

First dark fringe will be the distance where both dark fringes will coincide i.e LCM of $d_1 \& d_1$ ½

i.e. $2\ \times\ 10^{-5}\ m\ \times\ 3\ \times\ 10^{-5}\ m$

$=\ 6\ \times\ 10^{-5}\ m$ ½

OR

(II) $Net\ I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\Phi$ **0.5 M**

Since, $I_1 = I_2 = I$

Net I = I + I + 2 I cosΦ

= 2I (1 + cosΦ)

= 2I (2 $\cos^2\frac{\emptyset}{2}$) **0.5 M**

For path difference λ/4 , phase difference is π/2 **0.5 M**

Net I = 4 I $\cos^2\frac{\pi}{4}$

Net I = 2 I **0.5 M**

(2 Marks)

Ans.19 - (I)The direction of the magnetic field is perpendicular and inward into the plane of thepaper **0.5M**

(II) For a head-on collision to take place, the radius of the path of each ion should be equal to 0.5 m.

$r = \frac{mv}{qB} = 0.5$ m **0.5M**

$B = \frac{mv}{qr} = \frac{4\times10^{-26}\times2.4\times10^{5}}{4.8\times10^{-19}\times0.5}$ **0.5M**

B = 0.04 T **0.5M**

For VI Candidate

(a) As Pitch (p)=$\frac{2Лmv\ cos\theta}{qB}$ **0.5M**

Or, p= $\frac{2\ X\ 3.14\ X\ 1.7X10^{-27}X\ 2\ X10^{5}\ Cos\ 30^{0}}{1.6\ X10^{-19}X1.5}$m

Or, P=7.7X10^{-3}m **0.5M**

(b)As, done by magnetic field is always zero K.E=1/2m$v^2$0.5M

KE=3.4 X 10^{-17}J **0.5M**

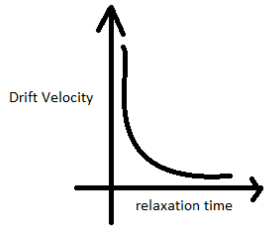
Ans.20 –(i) Nuclear fission –W 0.5M

Reason: As W has binding energy per nucleon less then Y and X and nucleus is larger in size. 0.5M

(ii) Nuclear fusion-Z 0.5M

Reason: As Z has binding energy per nucleon more then Y and X and nucleus is smaller in size. **0.5M**

Ans. 21 - **(I)** $\boldsymbol{Drift\ velocity} \propto \frac{\mathbf{1}}{\boldsymbol{Relaxation\ time}}$



1 M

(II) Alternating current changes direction every half cycle. 0.5 M

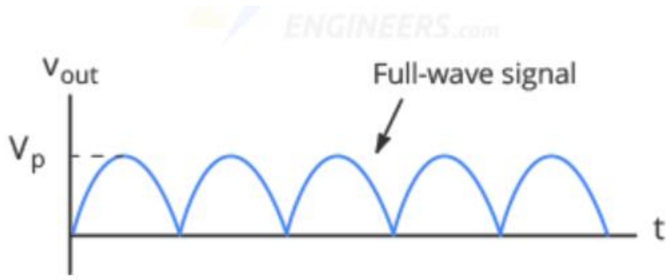
So average drift velocity is zero 0.5 M

[SECTION – C]

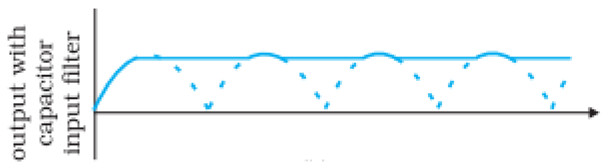
(3 Marks)

Ans.22 -(I) X = Full wave rectifier½

Y = Filter½

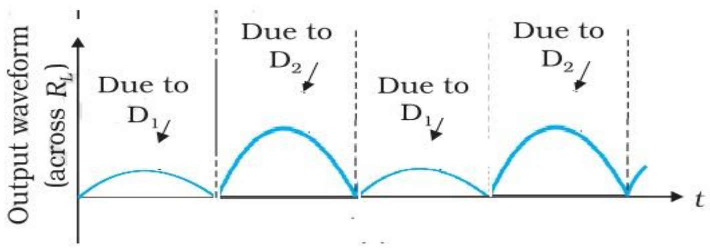


(Output Waveform for X) ½



(Output Waveform for Y) ½

(ii) 1



For VI Candidates

Rectifier 0.5M

Underlying principle of Rectifier

The basic principle of the rectifiers is the transformation of current by changing the frequency of the input signal, and diodes are used to do this.

0.5M

Working

In rectifier, one end of terminal which is connected to PN junction diode will never have negative potential, as it allows current in forward biasing only. Hence potential difference across load resistor will always be Positive or zero.

1M

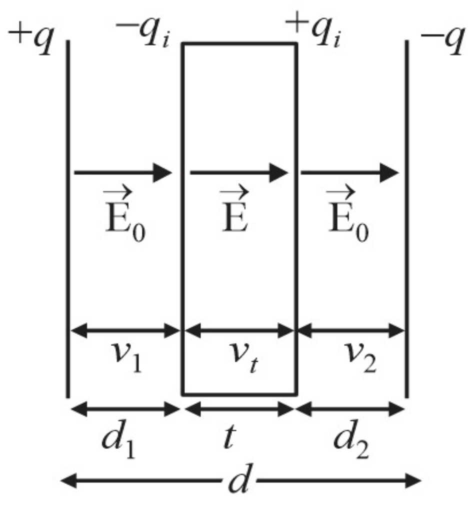
For 60 Hz input of AC, output of

Half wave rectifier will be 60Hz 0.5M

Full wave rectifier will be 120 Hz 0.5M

Ans.23 - (I)The capacitance of a parallel plate capacitor with dielectric slab (t < d)

(3 Marks)



0.5M

$+q$, $-q$ = the charges on the capacitor plates

$+q_i$, $-q_i$ = Induced charges on the faces of the dielectric slab

E_0 → electric field intensity in air between the plates

E → the reduced value of electric field intensityinside the dielectric slab.

When a dielectric slab of thickness $t<d$ is introduced between the two plates of the capacitor the electric field reduces to E due to the polarisation of the dielectric. The potential difference between the two plates is given by

$V = V_1 + V_t + V_2$

$V = E_0d_1 + Et + E_0d_2$ … (1)**0.5M**

Here E is the reduced value of electric field intensity

$\vec{E} = \vec{E}_0 + \vec{E}_i$. Here $\vec{E}_i$ is the electric field due to the induced charges [$+q_i$ and $-q_i$]

$E = \sqrt{E_0^2 + E_i^2 + 2E_0 E_i \cos 180°}$

$= \sqrt{(E_0 - E_i)^2}$

$E = E_0 - E_i$ **0.5M**

Also the dielectric constant K is given by

$$K = \frac{E_0}{E} \quad \ldots (2)$$

$$E_0 = \frac{\sigma}{\varepsilon_0} = \frac{q}{A\varepsilon_0} \quad \ldots (3)$$

From equations (1), (2) and (3)

$$V = E_0[d_1 + d_2] + \frac{E_0}{K}t$$

$$V = \frac{q}{A\varepsilon_0}\left[d - t + \frac{t}{K}\right] \quad \ldots (4)$$

The capacitance of the capacitor on the introduction of the dielectric slab is

$$C = \frac{q}{V} \quad \ldots (5)$$

From (4) and (5)

$$C = \frac{\varepsilon_0 A}{d - t + \frac{t}{K}}$$ **0.5M**

If $t = d$, then $C = K\frac{\varepsilon_0 A}{d} \Rightarrow C = KC_0$ Here $C_0 = \frac{\varepsilon_0 A}{d}$

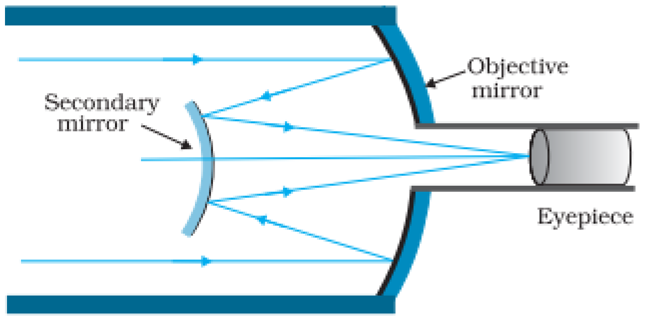
Since K >1 therefore $C > C_0$

(II) For a metallic slab K is infinitely large, therefore $C = \frac{\varepsilon_0 A}{d - t}$ **1M**

(3 Marks)

Ans.24 -(i)

2



(ii) 1

- It has mirror objective, which is free from chromatic and spherical aberrations.
- It can gather more light as objectives can be made larger, hence images can be brighter.

Any other two equivalent examples can be accepted.

For V.I Candidates

Objective mirror,

Radius of curvature, R_1=200mm

Focal Length, $f_1=R_1/2$=100mm **0.5M**

Secondary Mirror,

Radius of curvature, R_1=150mm

Focal Length, $f_1=R_1/2$=75mm **0.5M**

Distance between two mirror, x=20mm

For object at infinity, image is formed by objective lens will act as virtual object for secondary mirror

U_2=(100-20)mm=80mm **0.5M**

Applying, mirror formula for secondary mirror

$$\frac{1}{v_2} + \frac{1}{u_2} = \frac{1}{f_2}$$ **0.5M**

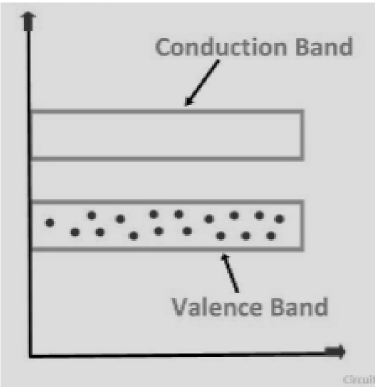
Or, $$\frac{1}{v_2} = \frac{1}{f_2} - \frac{1}{u_2}$$

$$= \frac{1}{75} - \frac{1}{80} = \frac{1}{1200}$$ **0.5M**

V_2=1200mm **0.5M**

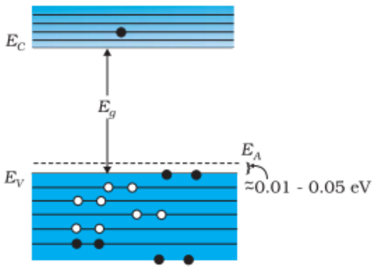
Ans.25 -

(a). T = 0 K



1M

(b) T = Room Temperature



1M

(ii) Answer will be (a) when switch is open **0.5M**

as when switch is closed diode will be forward biased and current will by-pass the bulb. **0.5M**

For V.I. Candidate

(i) A potential barrier is formed in a p-n junction due to the depletion layer, which is a layer of unmovable positive and negative charges that develops on either side of the junction. The depletion layer is created when holes move towards electrons, causing a layer of electrons on the p-type side and a layer of holes on the n-type side. The potential difference across this region is called the barrier potential **2M**

(ii)(a) In forward biasing width of depletion region decreases. **0.5M**

(b) In reverse biasing width of depletion region increases. **0.5M**

Ans.26 - (3 Marks)

Given

$B = 2\,T$, $q = 10mC$, $mass\ of\ the\ ball = 10^{-2}$kg , $g = 9.8\ {}^{m}/_{s^2}$

Magnetic force $(qvB\sin\theta) = gravitational\ force\ (mg)$

$v = \frac{mg}{qB\sin\theta}$ ½

For min. velocity $\sin\theta = 1$

$v = \frac{mg}{qB\sin\theta} = v = \frac{mg}{qB}$ ½

$= \frac{10^{-2}\times 9.8}{10^{-2}\times 2}$m/s ½

=4.9m/s

$v = 4.9\ {}^{m}/_{s^2}$ ½

As force is in upward direction so from Fleming's Left-hand rule, magnetic field will be along North to South. 1

(3 Marks)

Ans.27 - (I)Since the light ray enters perpendicular to the face AB, the angle of incidence onface AC will be45°. **0.5M**

So,

$\sin\theta_C = \frac{1}{n}$

$sin\,45^\circ = \frac{1}{n} = \frac{1}{\sqrt{2}}$ So, $n = \sqrt{2}$ **0.5M**

(II)In fig.2, the face AC of the prism is surrounded by a liquid so$n = \frac{n_g}{n_l} = \frac{\sqrt{2}}{\left(\frac{2}{\sqrt{3}}\right)} = \frac{\sqrt{3}}{\sqrt{2}}$

$\sin\theta_C = \frac{1}{n} = \frac{\sqrt{2}}{\sqrt{3}}\ \theta_C = sin^{-1}(\frac{\sqrt{2}}{\sqrt{3}}) = 54.6^\circ$

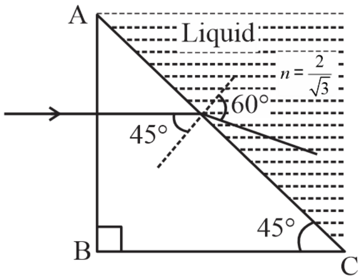
Since the angle of incidence on the surface AC is 45°, which is less than the critical angle for the pair of media (glass and the liquid), the ray neither undergoes grazing along surface AC, nor does it suffer total internal reflection **1M**

Instead it passes through the surface AC and undergoes refraction into the liquid.

For refracting interface AC, $n_1 \sin i = n_2 \sin r$

$n_1 . sin 45^\circ = \left(\frac{2}{\sqrt{3}}\right) sin\, r$

$sin\, r = \frac{\sqrt{3}}{2} \therefore\ r = 60^\circ.$



1M

(3 Marks)

For V.I. candidates

(a) Let the angle of incidence of light at prism, I = x

So, angle of emergence as per question, e = x

Angle of prism, A = $\frac{4}{3}x$

0.5M

Since prism Is equilateral

$3A=180^0$

0.5M

Or, $A= 60^0$

Or, $X=45^0$

From prism formulaeδ

δ= i+e-A

0.5M

or, $\delta=45+45-60=30^0$ **0.5M**

(b) $\mu = \frac{sin\frac{A+\delta m}{2}}{sin\frac{A}{2}}$ **0.5M**

Or, $\mu = \frac{sin\frac{60+30}{2}}{sin\frac{60}{2}}$

Or, $\mu = \sqrt{2}$ **0.5M**

Ans.28– (I)Gauss'stheorem: The flux of electric field through any closed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the closed surface.

$\phi = \frac{q}{\varepsilon_0}$ … (1)

By definition, the total electric flux through the closed surface is given by

$\phi = \oint \vec{E}.\overrightarrow{ds}$ … (2)

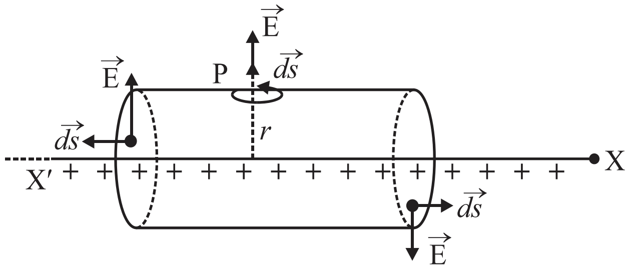
∴ From (1) and (2), Gauss's theorem may be expressed as follows

$$\phi = \oint \vec{E}.\overrightarrow{ds} = \frac{q}{\varepsilon_0}$$

∴ The surface integral of electric field over a closed surface is equal to $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface. **1M**

Application of Gauss's theorem

To find electric field due to a line charge let us consider an infinitely long line charge placed along XX' axis with linear charge density λ. Our aim is to find electric field intensity at a point P distant*r* from the line charge. We draw a cylindrical surface of radius *r* and length *l* coaxial with the line charge. The net flux through the cylindrical gaussian surface i.e.



0.5M

$$\phi = \oint \vec{E}.\overrightarrow{ds} = \int_{LCF} \vec{E}.\overrightarrow{ds} + \int_{CS} \vec{E}.\overrightarrow{ds} + \int_{RCF} \vec{E}.\overrightarrow{ds}$$ **0.5M**

$$= \int_{LCF} Eds \cos 90° + \int_{CS} Eds \cos 0° + \int_{RCF} Eds \cos 90°$$ **0.5M**

$$\phi = \int_{CS} Eds \cos 0° = E.2\pi rl \quad \ldots (1)$$

The charge enclosed by the gaussian surface is $q = \lambda l$… (2)

Using Gauss's theorem from equations(1) and (2)

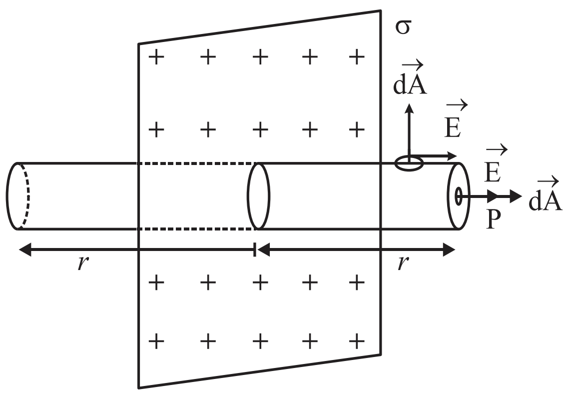
$$E(2\pi rl) = \frac{\lambda l}{\varepsilon_0} \Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0 r}$$ **0.5M**

OR

(II) (a) Definition of electric flux and its SI unit **1M**

(b)Electric field due to an infinite plane sheet of charge.

Let us consider an infinite thin plane sheet of positive charge having a uniform surface charge density σ. Let P be the point where electric field E is to be found. Let us imagine a cylindrical gaussian surface of length 2*r* and containing P as shown. The net flux through the cylindrical gaussian surface.



0.5M

$\phi \quad = \oint \vec{E} \cdot \overrightarrow{dA}$

$= \int_{RCF} \vec{E} \cdot \overrightarrow{dA} + \int_{LCF} \vec{E} \cdot \overrightarrow{dA} + \int_{CS} \vec{E} \cdot \overrightarrow{dA}$ **0.5M**

$= \int_{RCF} EdA \cos 0° + \int_{LCF} EdA \cos 0° + \int_{CS} EdA \cos 90°$ **0.5M**

= E A + EA + 0

ϕ = 2 EA ...(1)

Here A is the area of cross-section of each circular face *i.e.* LCF and RCF.

The total charge enclosed by the gaussian cylinder

= σA ...(2)**0.5M**

Using Gauss's theorem, from (1) and (2),

$$2\,EA = \frac{\sigma A}{\varepsilon_0}$$

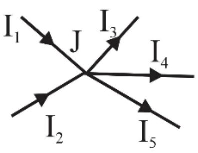
$$E = \frac{\sigma}{2\varepsilon_0}$$

Ans.29 - I(B) II(C) III(B) IV (C) 0R IV (D) **(4X1=4)**

Ans.30 - I(D) II(C) III (A) IV(B) 0R IV (A) **(4X1=4)**

(5 Marks)

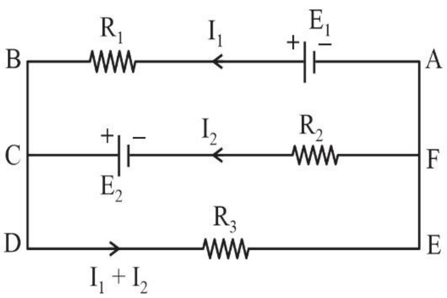
Ans.31–(I) (a) Kirchhoff's I Law :The algebraic sum of all the currents meeting at a point in an electrical circuit is always equal to zero.**1M**



$[+I_1] + [+I_2] + [-I_3] + [-I_4] + [-I_5] = 0$

Or $I_1 + I_2 = I_3 + I_4 + I_5$

Kirchhoff's II Law :The algebraic sum of the changes in potential around any closed resistor loop must be zero.**1M**



For closed mesh ABCFA

$[+E_1]\ [-I_1R_1] + [-E_2] + [+I_2R] = 0$ … (1)

For closed mesh FCDEF

$[+E_2] + [-(I_1+I_2)]R_3 + [-I_2R_2] = 0$ … (2)

(b). $I = \frac{\varepsilon}{R_0 + r}$ $Where\ R_0\ is\ resistance\ at\ room\ temperature\ 20^0$ ½

$\Rightarrow R_0 = \frac{\varepsilon}{I}$ -1

OR $R_0 = \frac{100}{10}$ -1 = $R_0 = 9\Omega$ ½

Now Final temperature is 320^0C

So, $R = R_0\,(1 + \alpha\Delta T)$ ½

= 9 ($(1 + 3.7 \times 10^{-4} \times 300)$

= 10 Ohm ½

Power Consumed by cell $(P) = i^2 r$ ½

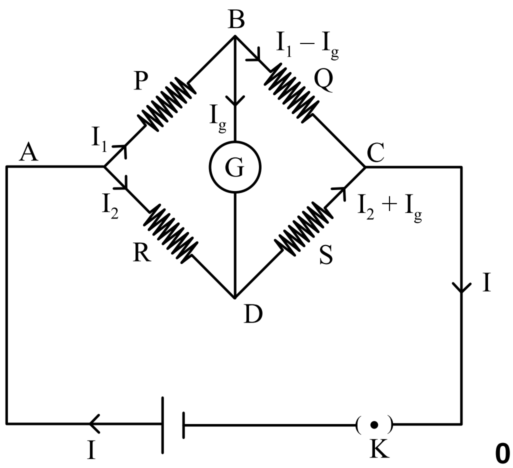
= $(\frac{\varepsilon}{R + r})^2 \times r \quad Watt$

= $(\frac{100}{11})^2$ = 82.64 W ½

OR

(II)(a) The Wheatstone bridgeis as shown in the figure

1M



0.5M

Applying Kirchhoff's II law to mesh ABDA

$I_1P + I_gG - I_2R = 0$ …..(1) **0.5M**

For the mesh BCDB

$(I_1 - I_g)Q + [-(I_2 + I_g)S] + [-I_gG] = 0$ (2) **0.5M** When the bridge is balanced, no current flows through the galvanometer i.e. $Ig = 0$ (3)

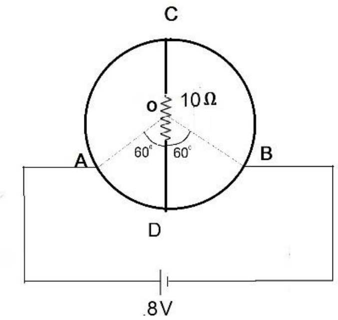
∴From equations (1) and (2) and (3)

$I_1P = I_2R$ … (4)

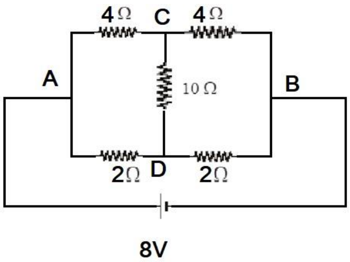
$I_1Q = I_2S$ … (5)

From equations (4)and (5), P/Q = R/S. **0.5M**

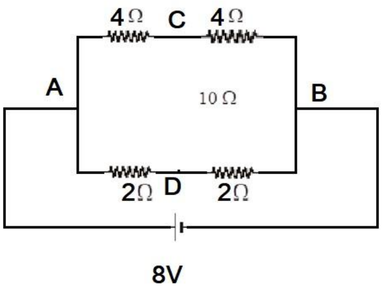
(b).



This circuit is balanced wheat stone bridge that can be drawn as below,



As it is balanced wheatston bridge ,so circuit will be as below 1



$V_{AB} = 8V\ , hence\ Current\ through\ ADB = \frac{8}{4} = 2A$ 1

(for V.I. Candidates)

(II) (a) question is same

(b) The sensitivity of a Wheatstone bridge is the amount of deflection in the attached galvanometer for every unit change in the unknown resistance **1M**

A Wheatstone bridge is most sensitive when its four arms have resistances that are of the same order of magnitude. This means that all four resistors provide the same output resistance. A Wheatstone bridge is in a balanced state when its galvanomater shows zero deflection **1M**

Ans.32 - (I) AC Generator **(5 Marks)**

It is a device used to convert mechanical energy into electrical energy

Principle: It is based on the principle of electromagnetic induction. When a closed coil is rotated rapidly in a strong magnetic field, the magnetic flux linked with the coil changes continuously. Hence an emf is induced in the coil and a current flows in it. In fact, the mechanical energy expended in rotating the coil appears as electrical energy in the coil.

1M

Construction: Main Parts **1M**

1. **Armature**: It is a rectangular coil ABCD having a large number of turns of insulated copper wire wound on a soft-iron core. The use of soft-iron core increases the magnetic flux linked with the armature.

2. **Field Magnet:** It a strong electromagnet having concave pole pieces N and S. The armature is rotated between these pole pieces about an axis perpendicular to the magnetic field.

3. **Slip Rings:** The leads from the armature coil ABCD are connected to two copper rings R_1 and R_2 called the 'slip rings'. These rings are concentric with the axis of the armature coil and rotate with it.

4. **Brushes:** These are two carbon pieces B_1 and B_2 called brushes which remain stationary pressing against the slip rings R_1 and R_2 respectively. The brushes are connected to an external circuit.

Working Theory : When the coil ABCD is rotated inside the field, an emf is induced between its two ends. Let the plane of the coil be at right angles to the magnetic field at $t = 0$ and angular speed of the rotation of the coil be ω. Then at time t, $\theta = \omega t$. The magnetic flux linked with the coil at time t is

$$\phi = n\,BA\cos\omega t$$

Induced emf $e = \frac{-d\phi}{dt} = \frac{-d}{dt}\left[nBA\cos\omega t\right]$

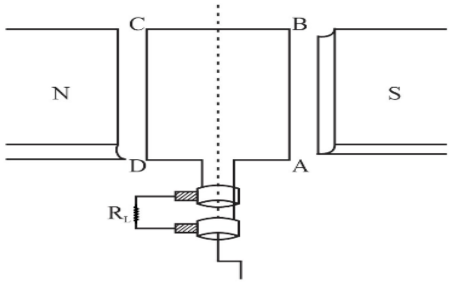
$\Rightarrow e = n\,BA\,\omega\sin\omega t$

$e = e_0\sin\omega t$ Where $e_0 = nBA\omega$ is the peak value of emf.

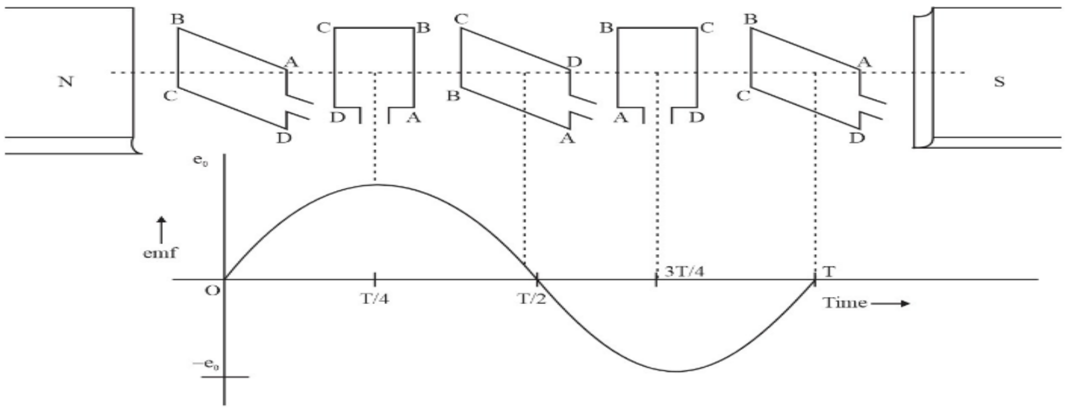
The current in the external load is given by

$$i = \frac{e_0\sin\omega t}{R_L}$$

$i = i_0\sin\omega t$ Here i_0 is the peak value of the current **1M**



1M



1M

In an ac generator the source of electrical energy is the mechanical energy.

OR

(II)

(a)TRANSFORMER

Use: It is a device which converts low ac voltage at high current into high ac voltage at low current and vice – versa.

Principle: It consists of two coils P and S wound on a closed soft iron core. The coil which is fed from the ac supply is called primary coil (P) and the other connected to the load is called secondary coil (S). The core of the transformer is made of soft -iron toreduce hysteresis loss and is laminated to reduce eddy current losses.**1M**

Working: When an alternating emf e_p is impressed on the primary winding it sends an ac current through it which sets up an alternating magnetic flux in the core. This induces an alternating emf e_s in the secondary. If N_P and N_s are the number of turns in primary and secondary coil, their linkages with the flux are

$\phi_P = N_P BA$ B → Magnetic induction

$\phi_S = N_s BA$ A → Area of cross section**0.5 M**

The magnitude of the emf induced in the secondary

$$e_s = \frac{d\phi_S}{dt} = N_S A\frac{dB}{dt} \quad \ldots (1)$$

The changing flux also induces an emf in the primary, whose magnitude

$$e_P = \frac{d\phi_P}{dt} = N_P A\frac{dB}{dt} \quad \ldots (2)$$

From equations (1) and (2)

$$\frac{\text{emf induced in secondary}}{\text{voltage applied to primary}} = \frac{e_s}{e_P} = \frac{N_s}{N_P} \quad \ldots (3)$$ **0.5 M**

$\frac{N_S}{N_P}$ = turns ratio or transformation ratio.

If $N_s > N_P$, $e_S > e_P$ → Such a transformer is called step-up transformer

If $N_S < N_P$, $e_s < e_P$ → Such a transformer is called step-down transformer

In an ideal transformer

Instantaneous output power = instantaneous input power

$e_s i_s = e_P i_P$ … (4)

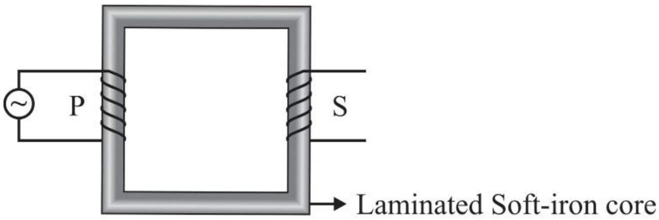
From equations (3) and (4)

$$\frac{e_s}{e_p} = \frac{i_p}{i_s} = \frac{N_s}{N_p}$$ **0.5 M**

In a step- up transformer $N_s > N_p$, $e_s > e_p$ but $i_s < i_p$

In a step-down transformer $N_s < N_p$, $e_s < e_p$ but $i_s > i_p$

At the generating station a step-up transformer is used for stepping up the voltage and at the various receiving substations a step-down transformer is used



0.5M

(b) The two sources of energy losses are eddy current losses and flux leakage losses. **1M**

(c) There is no violation of the principle of the conservation of energy in a stepup transformer. When output voltage increases the output current decreases automatically keeping the power the same.**1M**

(5 Marks)

Ans.33–(I) Givenf_0=15m, f_e=1cm=0.01m

(i) Angular magnification of the telescope M $=\frac{f_0}{f_e}=\frac{15}{0.01}$=1500 **1M**

(ii) Let d be thediameter ofmoon'simage formed by the objective lens.

Therefore, Angle subtended by the moon at the objective lens

$$\alpha=\frac{diameter\ of\ the\ moon}{Radius\ of\ lunar\ orbit}=\frac{3.48\times10^6}{3.8\times10^8} \quad (1)$$ **1.5M**

Similarly, the angle subtended by moon's image (formed by the objective) at the objective

$$\alpha=\frac{diameter\ of\ moon's\ image}{f_0}=\frac{d}{15} (2)$$ **1.5M**

Comparing equations (1) and (2) we have

$$\frac{d}{15}=\frac{3.48\times10^6}{3.8\times10^8}$$

$$d=\frac{3.48\times10^6}{3.8\times10^8}\times 15=0.137m=13.7cm$$ **1M**

OR

(II) (a) For eyepiece,v_e=-25cm,f_e=6.25cm, u_e=?

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

$\frac{1}{u_e}=\frac{1}{v_e}-\frac{1}{f_e}=\frac{1}{-25}-\frac{1}{6.25}=\frac{-1}{5}$ **0.5M**

u_e=-5cm **0.5M**

Therefore the image formed by the objective is formed at a distance of 10 cm towards the eyepiece.

Hence for the objective, v_0=+10 cm, f_0=2cm, v_0=?

$\frac{1}{u_0}=\frac{1}{v_0}-\frac{1}{f_0}=\frac{1}{10}-\frac{1}{2}$ **0.5M**

u_0=-2.5cm **0.5M**

Therefore the magnifying power M=$\frac{v_0}{|u_0|}(1+\frac{D}{f_e})=\frac{10}{2.5}(1+\frac{25}{6.25})$=20 **0.5M**

(b) When the final image is formed at infinity the object for the eyepiece must lie at its principal focus.Thereforethe distance of the image formed by the objective from its optical center,

v_0=15-6.25=8.75cm **0.5M**

$\frac{1}{u_0}=\frac{1}{v_0}-\frac{1}{f_0}=\frac{1}{8.75}-\frac{1}{2}=\frac{6.75}{17.50}$ **0.5M**

$u_0=\frac{-17.5}{6.75}$=-2.6cm **0.5M**

M=$\frac{v_0}{|u_0|}.\frac{D}{f_e}=\frac{8.75}{2.6}\times\frac{25}{6.25}$=13.5 **1M**

SAMPLE QUESTION PAPER

PHYSICS

Subject Code – 042

CLASS – XII

Academic Session 2024 – 25

Maximum Marks: 70 **Time Allowed: 3 hours**

General Instructions

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) **Section A** contains **sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each**, **Section B** contains **five questions of two marks each**, **Section C** contains seven questions of three marks each, **Section D** contains **two case study-based questions of four marks each** and **Section E** contains **three long answer questions of five marks each**.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s

ii. $m_e = 9.1 \times 10^{-31}$ kg

iii. $m_p = 1.7 \times 10^{-27}$ kg

iv. $e = 1.6 \times 10^{-19}$ C

v. $\mu_0 = 4\pi \times 10^{-7}$ T m $\boldsymbol{A^{-1}}$

vi. $h = 6.63 \times 10^{-34}$ J s

vii. $\varepsilon_0 = 8.854 \times 10^{-12}$ $\boldsymbol{C^2 N^{-1} m^{-2}}$

viii. Avogadro’s number = 6.023 X $\mathbf{10^{23}}$ per gram mole

[SECTION – A] **(16x1=16 marks)**

Q1. A uniform electric field pointing in positive X-direction exists in a region. Let A be the origin, B be the point on the X-axis at x = +1 cm and C be the point on the Y-axis at y = +1 cm. Then the potential at points A, B and C satisfy.

(A) $V_A < V_B$ (B) $V_A > V_B$. (C) $V_A < V_C$ (D) $V_A > V_C$

Q2. A conducting wire connects two charged conducting spheres of radii r_1 and r_2 such that they attain equilibrium with respect to each other. The distance of separation between the two spheres is very large as compared to either of their radii.

The ratio of the magnitudes of the electric fields at the surfaces of the spheres of radii r_1 and r_2 is

(A) $\frac{r_1}{r_2}$ (B) $\frac{r_2}{r_1}$ (C) $\frac{{r_2}^2}{{r_1}^2}$ (D) $\frac{{r_1}^2}{{r_2}^2}$

Q3. A long straight wire of circular cross section of radius 'a' carries a steady current I. The current is uniformly distributed across its cross section. The ratio of magnitudes of the magnetic field at a point a/2 above the surface of wire to that of a point a/2 below its surface is

(A) 4:1 (B) 1:1 (C) 4: 3 (D) 3 :4

Q4. The diffraction effect can be observed in

(A) sound waves only (B) light waves only

(C) ultrasonic waves only (D) sound waves as well as light waves

Q5. A capacitor consists of two parallel plates, with an area of cross-section of 0.001 m^2, separated by a distance of 0.0001 m. If the voltage across the plates varies at the rate of 10^8 V/s, then the value of displacement current through the capacitor is

(A) $8.85 \times 10^{-3} A$ (B) $8.85 \times 10^{-4} A$ (C) $7.85 \times 10^{-3} A$ (D) $9.85 \times 10^{-3} A$

Q6. In a series LCR circuit, the voltage across the resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited the voltage across the inductance will be

(A) 10 V (B) $10\sqrt{2}$ V (C) $10/\sqrt{2}$ V (D) 20 V

Q7. Correct match of column I with column II is

C-l (waves)	C-ll (Production)
(1) Infra-red	P . Rapid vibration of electrons in aerials
(2) Radio	Q . Electrons in atoms emit light when they move from higher to lower energy level.
(3) Light	R . Klystron valve
(4) Microwave	S . Vibration of atoms and molecules

(A) 1-P, 2-R, 3-S, 4-Q (B) 1-S, 2-P, 3-O, 4-R

(C) 1-Q, 2-P, 3-S, 4-R (D) 1-S. 2-R, 3-P, 4-Q

Q8. The distance of closest approach of an alpha particle is *d* when it moves with a speed V towards a nucleus.

Another alpha particle is projected with higher energy such that the new distance of the closest approach is *d*/2. What is the speed of projection of the alpha particle in this case?

(A) V /2 (B) $\sqrt{2}$ V (C) 2 V (D) 4 V

Q9. A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of virtual image from the surface of the sphere is

(A) 2 cm (B) 4 cm (C) 6 cm (D) 12 cm

Q10. Colours observed on a CD (Compact Disk) is due to

(A) Reflection (B) Diffraction (C) Dispersion (D) Absorption

Q11. The number of electrons made available for conduction by dopant atoms depends strongly upon

(A) doping level (B) increase in ambient temperature

(C) energy gap (D) options (A) and (B) both

Q12. If copper wire is stretched to make its radius decrease by 0.1%, then the percentage change in its resistance is approximately

(A) –0.4%   (B) +0.8%   (C) +0.4%   (D) +0.2%

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
C. If Assertion is true but Reason is false.
D. If both Assertion and Reason are false.

Q13. Assertion (A): On increasing the current sensitivity of a galvanometer by increasing the number of turns may not necessarily increase its voltage sensitivity.

Reason(R) : The resistance of the coil of the galvanometer increases on increasing the number of turns.

Q14. Assertion (A): In a hydrogen atom there is only one electron but its emission spectrum shows many lines.

Reason (R): In a given sample of hydrogen there are many atoms each containing one electron; hence many electrons in different atoms may be in different orbits so many transitions from higher to lower orbits are possible.

Q15. Assertion (A): Nuclei having mass number about 60 are least stable**.**.

Reason (R): When two or more light nuclei are combined into a heavier nucleus then the binding energy per nucleon will decrease.

Q16. Assertion (A): de Broglie's wavelength of a freely falling body keeps decreasing with time.

Reason (R): The momentum of the freely falling body increases with time.

[SECTION – B]   **(05x2=10 marks)**

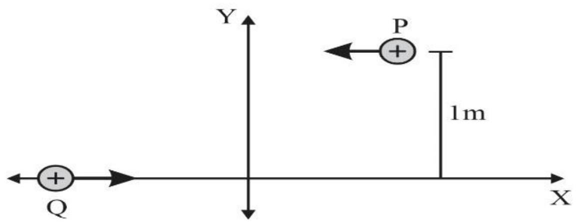
Q17. A platinum surface having work function 5.63 eV is illuminated by a monochromatic source of 1.6 x 10^{15} Hz. What will be the minimum wavelength associated with the ejected electron.

Q18. (I) A beam of light consisting of two wavelengths, 4000 Å and 6000 Å, is used to obtain interference fringes in a Young's double-slit experiment. What is the least distance from the central maximum where the dark fringe is obtained?

OR

(II) In Young's double-slit experiment using monochromatic light of wavelength λ, the intensities of two sources are I. What is the intensity of light at a point where path difference between wavefronts is $\lambda/4$?

Q19. P and Q are two identical charged particles each of mass 4×10^{-26} kg and charge 4.8×10^{-19} C, each moving with the same speed of 2.4×10^{5} m/s as shown in the figure. The two particles are equidistant (0.5 m) from the vertical Y -axis. At some instant, a magnetic field B is switched on so that the two particles undergo head-on collision.



Find –

(I) the direction of the magnetic field and

(II) the magnitude of the magnetic field applied in the region.

(for VI candidates)

A proton is moving with speed of 2×10^{5} m s^{-1} enters a uniform magnetic field B = 1.5 T. At the entry velocity vector makes an angle of 30° to the direction of the magnetic field. Calculate

(a) the pitch of helical path described by the charge

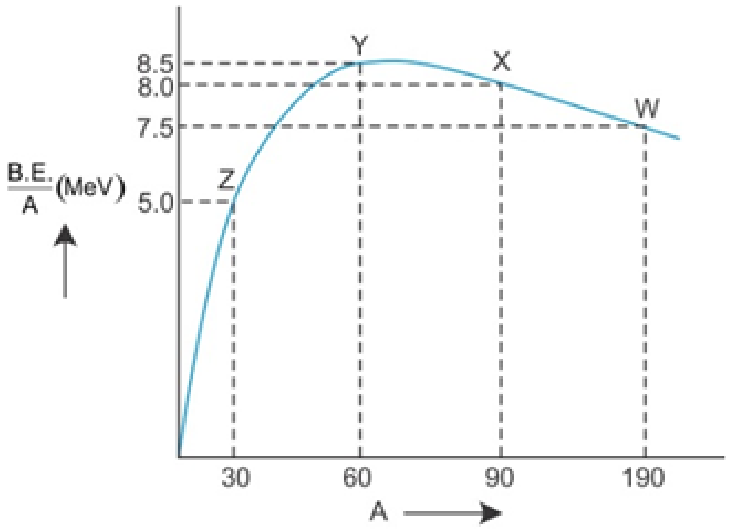
(b) Kinetic energy after completing half of the circle.

Q.20. Binding energy per nucleon vs mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. Identify which of the following nuclei is most likely to undergo

(i) Nuclear Fission

(ii) Nuclear Fusion.

Justify your answer.



(for V.I. Candidates)

Binding energy per nucleon and mass number of the following nuclei are given in the below table

Nuclei	Binding energy per nucleon (MeV)	Mass number
W	7.5	190
X	8.0	90
Y	8.5	60
Z	5.0	30

Identify which of the following nuclei is most likely to undergo

(i) Nuclear Fission

(ii) Nuclear Fusion.

Justify your answer.

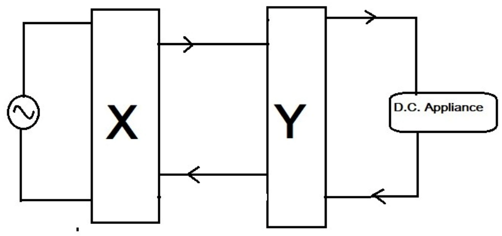
Q21. A cylindrical conductor of length l and cross-section area A is connected to a DC source. Under the influence of electric field set up due to source, the free electrons begin to drift in the opposite direction of the electric field.

(I) Draw the curve showing the dependency of drift velocity on relaxation time.

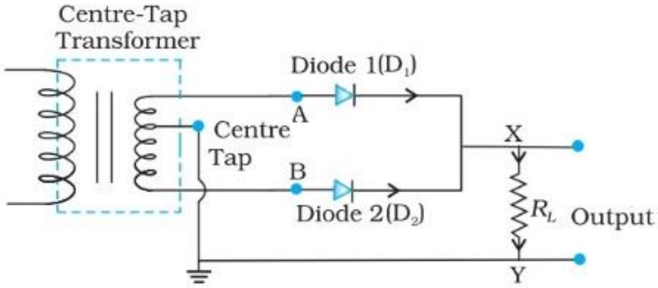
(II) If the DC source is replaced by a source whose current changes its magnitude with time such that $I = I_o \sin 2\pi\nu t$, where ν is the frequency of variation of current, then determine the average drift velocity of the free electrons over one complete cycle.

[SECTION – C] **(07x3=21 marks)**

Q22. (I) Identify the circuit elements X and Y as shown in the given block diagram and draw the output waveforms of X and Y.



(II) If the centre tapping is shifted towards Diode D1 as shown in the diagram, draw the output waveform of the given circuit.



(for V.I. candidates)

Which device is used to convert AC into DC. State it's underlying principle and explain its working. If the frequency of input AC to this device is 60 Hz, then what will be frequency of the output of this device.

Q23. Find the expression for the capacitance of a parallel plate capacitor of plate area A and plate separation d when (I) a dielectric slab of thickness t and (II) a metallic slab of thickness t, where ($t < d$) are introduced one by one between the plates of the capacitor. In which case would the capacitance be more and why?

Q24. (I) Draw a ray diagram for the formation of image by a Cassegrain telescope.

(II)Why these types of telescopes are preferred over refracting type telescopes. (Write 2 points)

(for V.I. Candidates)

A Cassegrain telescope is built with an arrangement of two mirrors placing them 20 mm apart. If the radius of curvature of the large mirror is 200mm and the small mirror is 150mm, where will the final image of an object at infinity be?

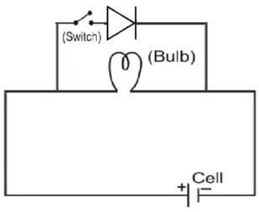
Q25. (I) Draw the energy band diagram for P-type semiconductor at (i) T=0K and (ii) room temperature.

(II)In the given diagram considering an ideal diode, in which condition will the bulb glow

(a) when the switch is open

(b) when the switch is closed

Justify your answer.



(for V.I. Candidates)

Explain briefly how

(i) barrier potential is formed in p-n junction diode.

(ii) Width of depletion region of the diode is affected when it is (a) forward biased, (b) reverse biased.

Q26. A boy is holding a smooth, hollow and non-conducting pipe vertically with charged spherical ball of mass 10 g carrying a charge of +10 mC inside it which is free to move along the axis of the pipe. The boy is moving the pipe from East to West direction in the presence of magnetic field of 2T. With what minimum velocity, should the boy move the pipe such that the ball does not move along the axis. Also determine the direction of the magnetic field.

Q27. A light ray entering a right-angled prism undergoes refraction at the face AC as shown in Fig. 1.

(I) What is the refractive index of the material of the prism in Fig. 1?

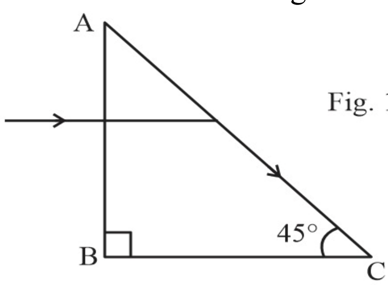


Fig. 1

(II) (a) If the side AC of the above prism is now surrounded by a liquid of refractive index $\frac{2}{\sqrt{3}}$, as shown in Fig. 2, determine if the light ray continues to graze along the interface AC or undergoes total internal reflection or undergoes refraction into the liquid.

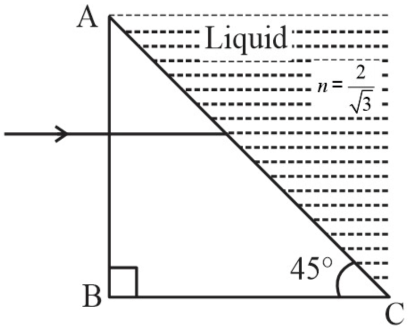


Fig. 2

(b) Draw the ray diagram to represent the path followed by the incident ray with the corresponding angle values.

(Given, $sin^{-1}(\frac{\sqrt{2}}{\sqrt{3}}) = 54.6^{\circ}$)

(for V.I. candidates)

A ray of light is incident on an equilateral prism at an angle 3/4 th of the angle of the prism. If the ray passes symmetrically through the prism, find the (a) angle of minimum deviation, and (b) refractive index of the material of the prism.

Q28. (I) State Gauss's theorem in electrostatics. Using this theorem, derive an expression for the electric field due to an infinitely long straight wire of linear charge density λ.

OR

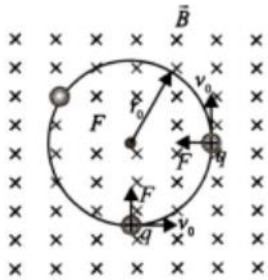
(II) (a) Define electric flux and write its SI unit.

(b) Use Gauss's law to obtain the expression for the electric field due to a uniformly charged infinite plane sheet of charge.

[SECTION D] **(02x4=08 marks)**

Q29. **Case Study Based Question**: **<u>Motion of Charge in Magnetic Field</u>**

An electron with speed $v_o << c$ moves in a circle of radius r_o in a uniform magnetic field. This electron is able to traverse a circular path as the magnetic force acting on the electron is perpendicular to both v_o and B ,as shown in the figure. This force continuously deflects the particle sideways without changing its speed and the particle will move along a circle perpendicular to the field. The time required for one revolution of the electron is T_o



(i) If the speed of the electron is now doubled to $2v_o$. The radius of the circle will change to

(A) $4r_o$ (B) 2 r_o (C) r_o (D) $r_o/2$

(ii) If v = $2v_o$, then the time required for one revolution of the electron (T_o) will change to

(A) 4 T_o (B) 2 T_o (C) T_o (D) $T_o/2$

(iii) A charged particle is projected in a magnetic field **B** = (2 **i** + 4 **j**) X 10^2 T . The acceleration of the particle is found to be **a** = (x **i** + 2 **j**) m/s^2 . Find the value of x.

(A) 4 ms^{-2} (B) -4 ms^{-2} (C) -2 ms^{-2} (D) 2 ms^{-2}

(iv) If the given electron has a velocity not perpendicular to B, then trajectory of the electron is

(A) straight line (B) circular (C) helical (D) zig-zag

OR

If this electron of charge (e) is moving parallel to uniform magnetic field with constant velocity v, the force acting on the electron is

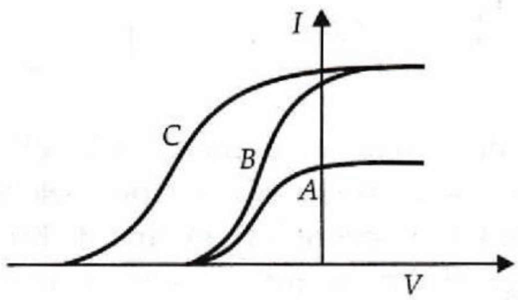
(A) Bev (B) Be/v (C) B/ev (D) Zero

Q30. **Case Study Based Question**: **Photoelectric effect**

It is the phenomenon of emission of electrons from a metallic surface when light of a suitable frequency is incident on it. The emitted electrons are called photoelectrons.

Nearly all metals exhibit this effect with ultraviolet light but alkali metals like lithium, sodium, potassium, cesium etc. show this effect even with visible light. It is an instantaneous process i.e. photoelectrons are emitted as soon as the light is incident on the metal surface. The number of photoelectrons emitted per second is directly proportional to the intensity of the incident radiation. The maximum kinetic energy of the photoelectrons emitted from a given metal surface is independent of the intensity of the incident light and depends only on the frequency of the incident light. For a given metal surface there is a certain minimum value of the frequency of the incident light below which emission of photoelectrons does not occur.

(I) In a photoelectric experiment plate current is plotted against anode potential.



(A) A and B will have same intensities while B and C will have different frequencies

(B) B and C will have different intensities while A and B will have different frequencies

(C) A and B will have different intensities while B and C will have equal frequencies

(D) B and C will have equal intensities while A and B will have same frequencies.

(II) Photoelectrons are emitted when a zinc plate is

(A) Heated (B) hammered

(C) Irradiated by ultraviolet light (D) subjected to a high pressure

(III) The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 500 nm. Its work function is about

(A) $4 \text{x} 10^{-19}$ J (B) 1 J (C) $2 \text{x} 10^{-19}$ J (D) $3 \text{x} 10^{-19}$ J

(IV) The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential is

(A) 2 V (B) 4 V (C) 6 V (D) 10 V

OR

The minimum energy required to remove an electron from a substance is called its

(A) work function (B) kinetic energy (C) stopping potential (D) potential energy

[SECTION E] **(03X5=15)**

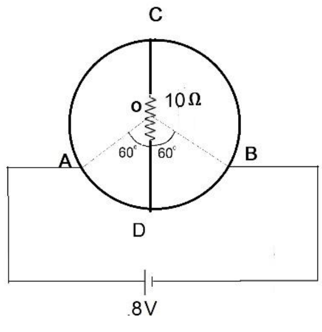
Q31. (I) a) Write two limitations of ohm’s law. Plot their I-V characteristics.

b) A heating element connected across a battery of 100 V having an internal resistance of 1 Ω draws an initial current of 10 A at room temperature 20.0 °C which settles after a few seconds to a steady value. What is the power consumed by battery itself after the steady temperature of 320.0 °C is attained? Temperature coefficient of resistance averaged over the temperature range involved is $3.70 \times 10^{-4}\ °C^{-1}$.

OR

(II) a) Using Kirchhoff’s laws obtain the equation of the balanced state in Wheatstone bridge.

b) A wire of uniform cross-section and resistance of 12 ohm is bent in the shape of circle as shown in the figure. A resistance of 10 ohms is connected to diametrically opposite ends C and D. A battery of emf 8V is connected between A and B. Determine the current flowing through arm AD.



(for V.I. Candidates)

(II) a) Using Kirchhoff’s laws obtain the equation of the balanced state in Wheatstone bridge.

b) What do you understand by 'sensitivity of Wheatstone bridge' ? How the sensitivity of wheatstone bridge can be increased?

Q32. (I) Explain briefly, with the help of a labelled diagram, the basic principle of the working of an a.c. generator. In an a.c. generator, coil of N turns and area A is rotated at an angular velocity ω in a uniform magnetic field B. Derive an expression for the instantaneous value of the emf induced in coil. What is the source of energy generation in this device?

OR

(II) a) With the help of a diagram, explain the principle of a device which changes a low ac voltage into a high voltage . Deduce the expression for the ratio of secondary voltage to the primary voltage in terms of the ratio of the number of turns of primary and secondary winding. For an ideal transformer, obtain the ratio of primary and secondary currents in terms of the ratio of the voltages in the secondary and primary coils.

b) Write any two sources of the energy losses which occur in actual transformers.

c) A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain.

Q33. (I) a) A giant refracting telescope at an observatory has an objective lens of focal length 15 m. If an eyepiece of focal length 1.0 cm is used, what is angular magnification of the telescope in normal adjustment?

b) If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens? The diameter of the moon is 3.48×10^6 m, and the radius of lunar orbit is 3.8×10^8 m.

OR

(II) A compound microscope consists of an objective lens of focal length 2.0 cm and an eyepiece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at

a) the least distance of distinct vision (25 cm) and

b) infinity? What is the magnifying power of the microscope in each case?