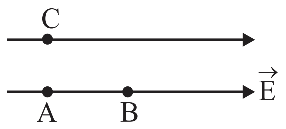
MARKING SCHEME
PHYSICS
Subject Code – 042
CLASS – XII
Academic Session 2024 – 25

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

[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.

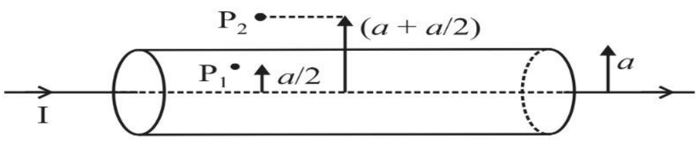
Ans.2 - (B) In the state of equilibrium, **(1 mark)**

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)**



At P_2, $B_2 = \dfrac{\mu_0 I}{2\pi\left(\dfrac{3a}{2}\right)} = \dfrac{\mu_0 I}{3\pi a}$

At P_1, $B_1 = \dfrac{\mu_0 (I/4)}{2\pi(a/2)} = \dfrac{\mu_0 I}{4\pi a}$

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

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)

$IR = IX_C = IX_L = 10$ V

$X_C = X_L = R$

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

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

$Z = R$

$V_S = IZ = IR = 10$ 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)**

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

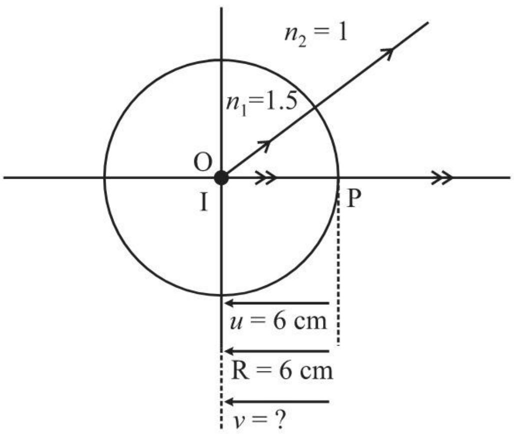
$$\frac{d}{2} = \frac{\text{const}}{V_2^2} \qquad ...(2)$$

From equations (1) and (2),

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

$\therefore \quad V_2 = \sqrt{2}$ 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 $\emptyset_0 = 5.63eV = 5.63 \times 1.6 \times 10^{-19}J$

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

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

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

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

$$= \frac{19.89 \times 10^{-26}}{1.6 \times 10^{15}} = 12.4 \times 10^{-7}\, m$$ 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) For a fringe of width β formed on the screen at distance D from the slits the angular fringe width would be

$\theta = \frac{\beta}{D} = \frac{D\lambda/d}{D} = \frac{\lambda}{d}$ **0.5 M**

or $d = \frac{\lambda}{\theta}$

Let the wavelength in water be λ' and the angular fringe width be θ' , then

$d = \frac{\lambda'}{\theta'}\quad \therefore\ \frac{\lambda}{\theta} = \frac{\lambda'}{\theta'}$ **0.5 M**

or $\theta' = \frac{\lambda'}{\lambda}\theta = \frac{\lambda/\mu}{\lambda}\theta = \frac{\theta}{\mu} = \frac{0.2^0}{4/3} = 0.15^0$ **1 M**

(2 Marks)

Ans.19 - (I) The direction of the magnetic field is perpendicular and inward into the plane of the paper **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)=$\frac{2\pi mv\cos\theta}{qB}$ **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=1/2mv^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 - $\frac{nh}{2\pi}$ = mvr (As Per Bohr's Modal) ….(i) 0.5M

As Centripetal force is provided by gravity,

$\frac{mv^2}{r}=\frac{GMm}{r^2}$ 0.5M

Or, $V^2=\frac{GM}{r}$

From equation (i)

$V=\frac{nh}{2Лmr}$

Or, $V^2=\{\frac{nh}{2Лmr}\}^2$ 0.5M

or, $\frac{GM}{r}=\{\frac{nh}{2Лmr}\}^2$

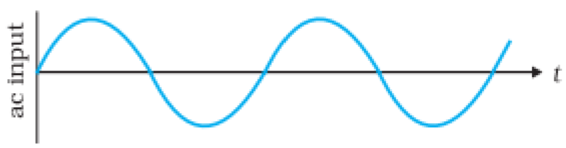
or, $r=\frac{n^2h^2}{4Л^2m^2GM}$ 0.5M

[SECTION – C]

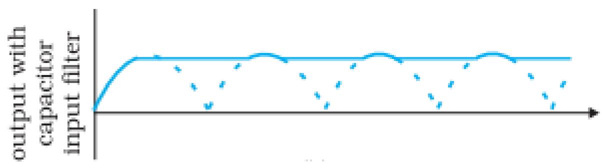
(3 Marks)

Ans.22 - (I) X = Full wave rectifier ½

Y = Filter ½

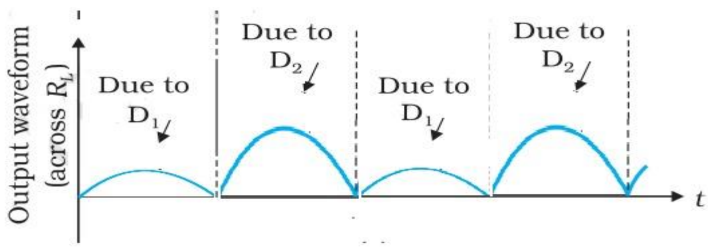


(Output Waveform for X) ½



(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

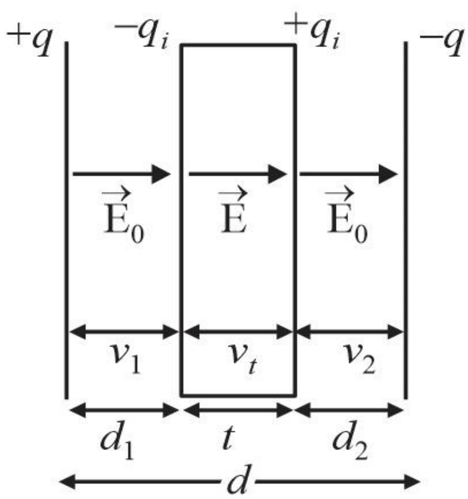
For 60 Hz input of AC, output of

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 intensity inside 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]

$E = \sqrt{E_0^2 + E_i^2 + 2E_0E_i \cos 180°}$

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

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

Also the dielectric constant K is given by

$K = \frac{E_0}{E}$ … (2)

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

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

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

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

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

$C = \frac{q}{V}$ … (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 $C_0 = \frac{\varepsilon_0 A}{d}$

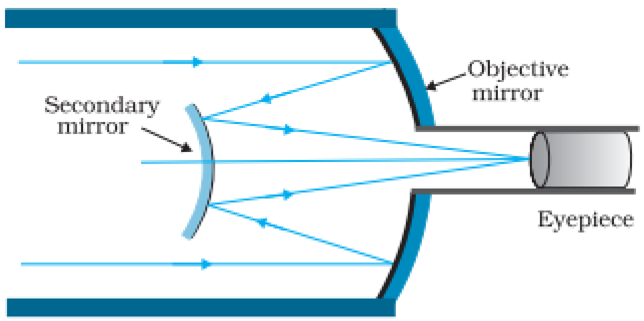
Since K > 1 therefore $C > C_0$

(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**

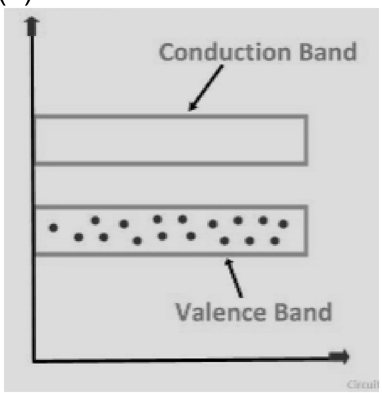
Or, $$\frac{1}{v_2} = \frac{1}{f_2} - \frac{1}{u_2}$$

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

V_{2}=1200mm **0.5M**

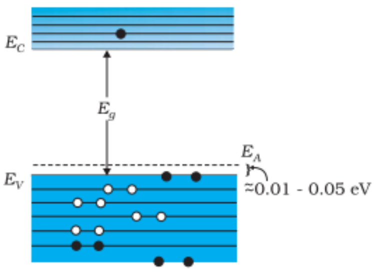
Ans.25 -

(a).



1M

(b) T = 0 K



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 on face AC will be 45°. **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 $n = \frac{ng}{n_l} = \frac{\sqrt{2}}{\left(\frac{2}{\sqrt{3}}\right)} = \frac{\sqrt{3}}{\sqrt{2}}$

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

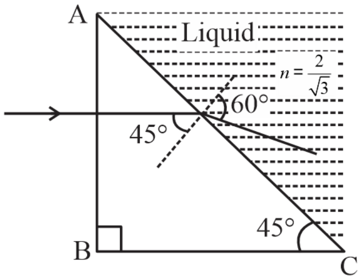
Since the angle of incidence on the surface AC is 45°, which is less than the critical angle for the pair of media (glass and the liquid), the ray neither undergoes grazing along surface AC, nor does it suffer total internal reflection **1M**

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

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

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

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



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 formulae δ

δ= i+e-A **0.5M**

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

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

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

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

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

$\phi = \frac{q}{\varepsilon_0} \qquad \ldots \quad (1)$

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

$\phi = \oint \vec{E}.\vec{ds} \qquad \ldots (2)$

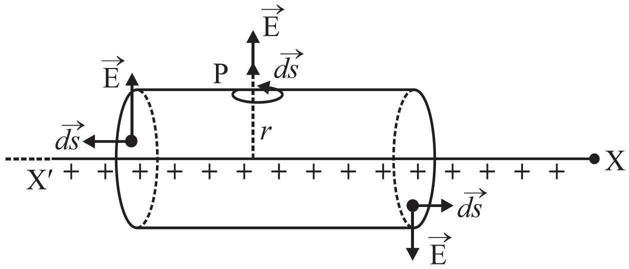
∴ From (1) and (2), Gauss's theorem may be expressed as follows

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

∴ 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**

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

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

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

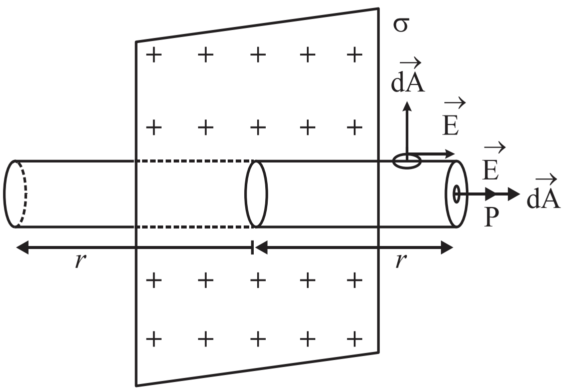
$E(2\pi rl) = \frac{\lambda l}{\varepsilon_0} \Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0 r}$ **0.5M**

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

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

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

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

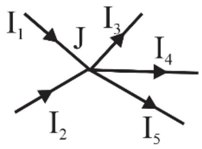
$$E = \frac{\sigma}{2\varepsilon_0}$$

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

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

(5 Marks)

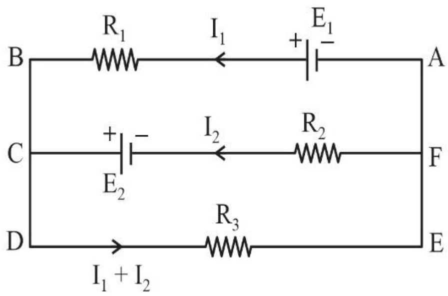
Ans.31 – (I) (a) Kirchhoff's I Law : The algebraic sum of all the currents meeting at a point in an electrical circuit is always equal to zero. **1M**



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

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). $I = \frac{\varepsilon}{R_0 + r}$ $Where\ R_0\ is\ resistor\ at\ room\ tempere\ 20^0$ 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

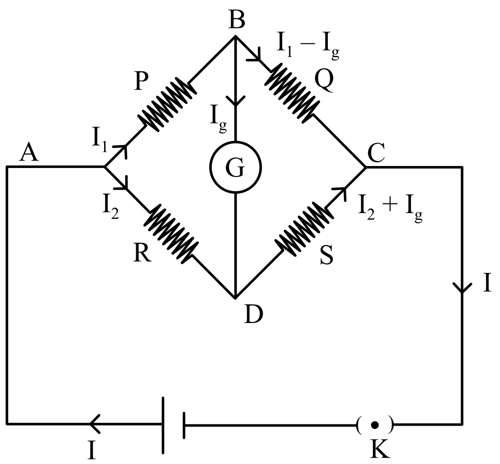
= $(\frac{\varepsilon}{R_0 + r})^2 \times r \quad Watt$

= $(\frac{100}{11})^2$ = 82.64 W ½

OR

(II) (a) The Wheatstone bridge is 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. $I_g = 0$ (3)

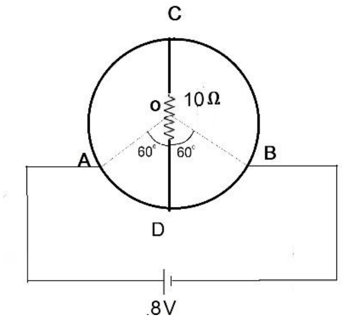
∴ From equations (1) and (2) and (3)

$I_1P = I_2R$ … (4)

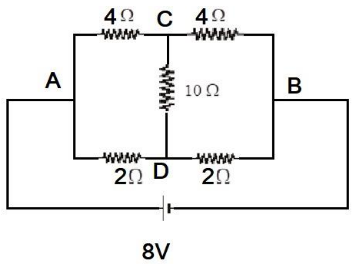
$I_1Q = I_2S$ … (5)

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

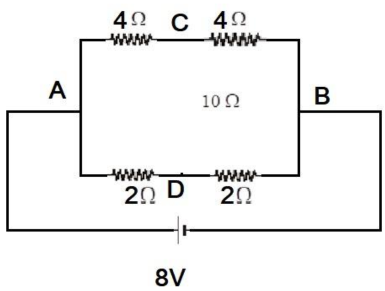
(b).



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 voltmeter shows zero deflection **1M**

Ans.32 - (I) AC Generat **(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 $e = \frac{-d\phi}{dt} = \frac{-d}{dt}[nBA\cos\omega t]$

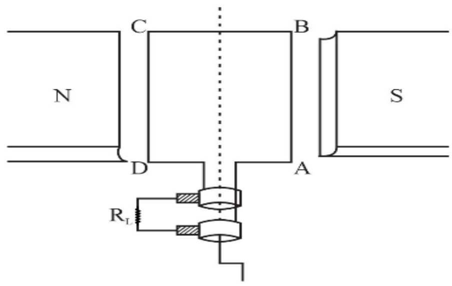
$\Rightarrow e = n\,BA\,\omega\,\sin\omega t$

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

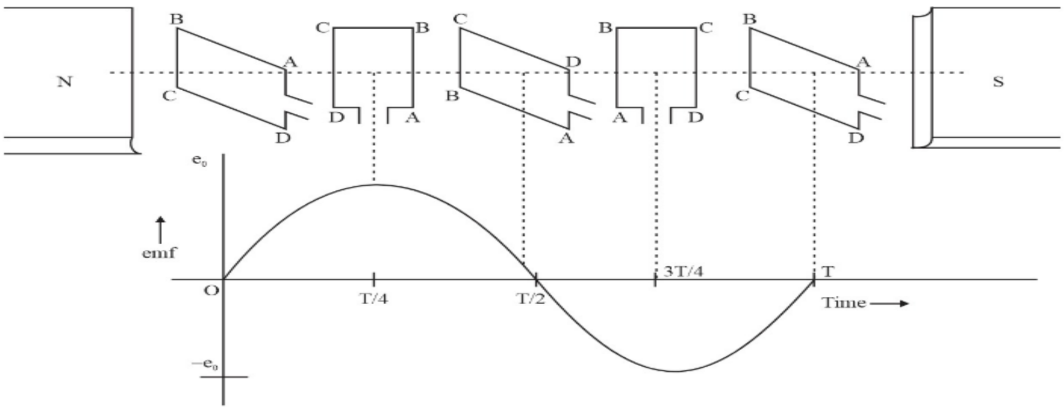
The current in the external load is given by

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

$i = i_0\sin\omega t$ 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 to reduce 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

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

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

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

From equations (1) and (2)

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

$$e_s i_s = e_P i_P \quad \dots (4)$$

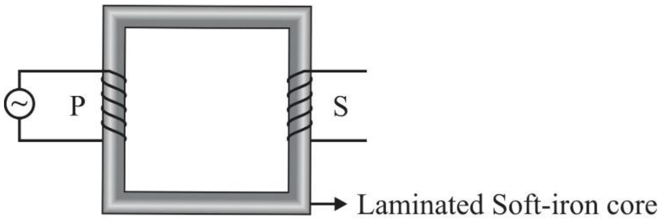
From equations (3) and (4)

$$\frac{e_s}{e_p} = \frac{i_p}{i_s} = \frac{N_s}{N_p}$$ **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 step up transformer. When output voltage increases the output current decreases automatically keeping the power the same. **1M**

(5 Marks)

Ans.33 – (I) Given f_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 the diameter of moon's image 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

$$\alpha = \frac{diameter\ of\ moon's\ image}{f_0} = \frac{d}{15} \quad (2)$$ **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= 2 cm, v_0= ?

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

u_0 = - 2.5 cm **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. Therefore the distance of the image formed by the objective from its optical center,

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

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