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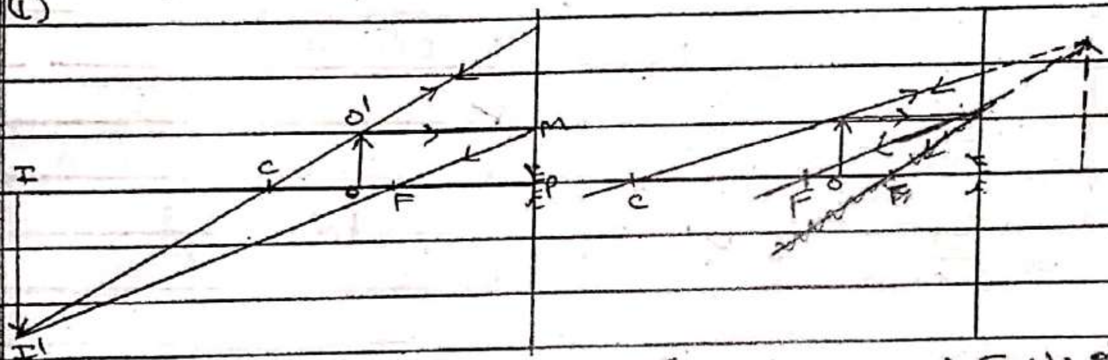
Subject: PHYSICS Paper code: P510/2

Level: ☐ PLE ☐ UCE ☑ UACE (1) Year: 2023

1.(a) - The incident ray, the reflected ray, the normal, all at the point of incidence lie in the same plane.
- The angle of incidence is equal to the angle of reflection. (02)

(b) (i)



object, image ✓✓ rays, ~~instrument~~ - Finite object (2 rays) - Point object (one ray)

- Real images are formed by intersection of real rays while virtual images are formed by apparent intersection of rays.
- Real images can be formed on the screen while virtual images cannot. (any 2)
- Real images are formed in front of the mirror while virtual images are formed behind the mirror. (04)
- ~~Real~~ image is upright, - Virtual is inverted

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(b) (ii) From Δs OCO' and CII',

$\frac{OC}{CI} = \frac{OO'}{II'}$ — (1)

From Δs FPM and FII',

$\frac{FP}{FI} = \frac{MP}{II'}$ — (2)

But $MP = OO' \Rightarrow \frac{OC}{CI} = \frac{PF}{IF}$

Also, $OC = CP - OP$

$CI = IP - CP$, $IF = IP - PF$

$\therefore \frac{CP - OP}{IP - CP} = \frac{PF}{IP - PF}$

$\Rightarrow \frac{r - u}{v - r} = \frac{f}{v - f}$, but $r = 2f$

$\therefore \frac{2f - u}{v - 2f} = \frac{f}{v - f} \Rightarrow (2f - u)(v - f) = (v - 2f)f$

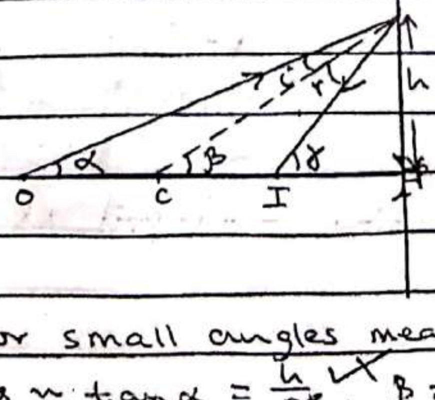
$2vf - 2f^2 - uv + uf = vf - 2f^2$

$vf - uv + uf = 0$

$vf + uf = uv$, deviding through by uvf,

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$. (04)

Method 2



$i = r$

$\alpha + i = \beta$ and $\beta + r = \gamma$

$i = \beta - \alpha$, $r = \gamma - \beta$

$\Rightarrow \beta - \alpha = \gamma - \beta$

$\therefore 2\beta = \alpha + \gamma$

For small angles measured in radians,

$\alpha \simeq \tan\alpha = \frac{h}{OP}$, $\beta \simeq \tan\beta = \frac{h}{CP}$, $\gamma = \tan\gamma = \frac{h}{IP}$

$\frac{2h}{CP} = \frac{h}{OP} + \frac{h}{IP} \Rightarrow \frac{2}{r} = \frac{1}{u} + \frac{1}{v}$. but $r = 2f$

$\frac{2}{2f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ (04)

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1. (c)

$m = \frac{v}{u} = -3$, $v = -3u$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $f = \frac{r}{2} = \frac{30}{2} = 15cm$

$\frac{1}{15} = \frac{1}{u} - \frac{1}{3u}$

$\frac{1}{15} = \frac{3-1}{3u} \Rightarrow \frac{3u}{15} = 2$ $\therefore u = 10cm.$ (03)

method 2

$r = 30cm$, $m = 3$

$m = \frac{v}{u} = 3 \Rightarrow v = 3u$

$r = 2f \Rightarrow f = 15cm$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{15} = \frac{1}{u} - \frac{1}{3u}$

$\frac{1}{15} = \frac{3-1}{3u} \Rightarrow 3u = 30$ $\therefore u = 10cm$ (03)

method 3

$\frac{1}{m} = \frac{u}{f} - 1$, $f = \frac{r}{2} = \frac{30}{2} = 15cm$

$m = \frac{v}{u} = -3$

$-\frac{1}{3} = \frac{u}{15} - 1$

$u = 10cm.$ (03)

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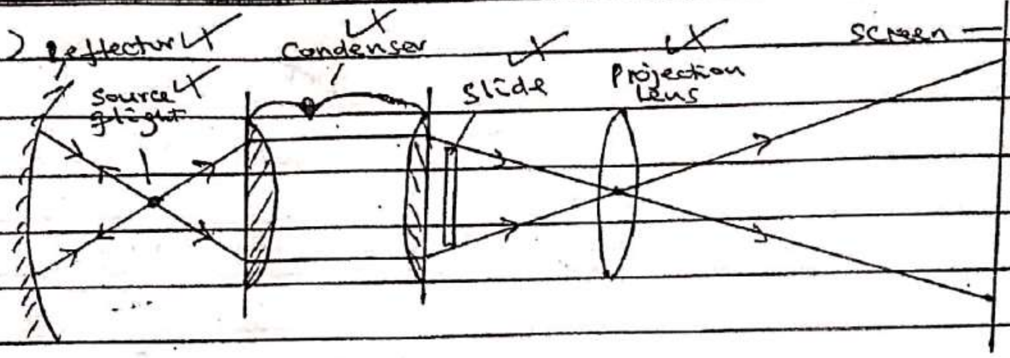
1\. (d)



(any four)

- The source provides light which is reflected by the concave reflector.
- The condenser concentrates light on the slide
- The projection lens focuses a magnified image on the screen. (04)

(e) $m = \frac{300}{5} = 60$, $\frac{v}{u} = 60$, $u = \frac{2400}{60} = 40\text{cm}$

$v = 2400\text{cm}$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{40} + \frac{1}{2400}$, $f = 39.3\text{ cm}$ (03)

$m = \sqrt{\frac{3 \times 3}{5\times10^{-2} \times 5\times10^{-2}}} = 300/5$

method 2

$m = \frac{300}{5} = 60$, $v = 24\text{m} = 2400\text{cm}$

$\frac{v}{f} = m + 1$

$\frac{2400}{f} = 60 + 1$

$f = 39.3\text{ cm}$ (03)

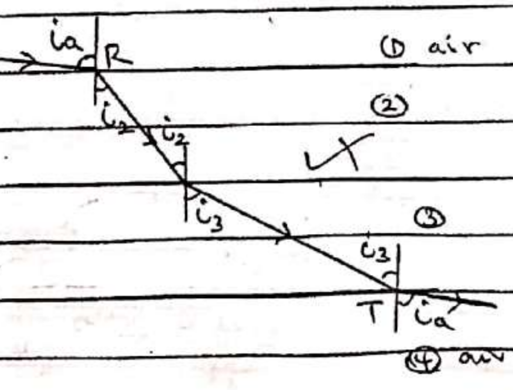
2. (a) (i) - The incident ray, the normal and the refracted ray, at the point of incidence all lie in the same plane. ✓

- The ratio of the sine of angle of incidence to the sine of angle of refraction is a constant for a given pair of media. ✓ (2)

(ii) Refractive index of a medium is the ratio of the sine of angle of incidence to the sine of angle of refraction for a ray travelling from a vacuum or air to a medium. ✓ (1)

OR it is the ratio of the speed of light in a vacuum or air to the speed of light in a medium.

(b) consider a ray travelling through different media as shown



At R, ✓

$a n_2 = \frac{\sin i_a}{\sin i_2}$, $\sin i_a = a n_2 \sin i_2$ ✓ — (1)

At T, ✓

$3 n a = \frac{\sin i_3}{\sin i_a}$, $\sin i_a = \frac{1}{3 n a} \sin i_3$

but $3 n a = \frac{1}{a n_3}$

$\therefore \sin i_a = a n_3 \sin i_3$ — (2) ✓

$\sin i_a = a n_2 \sin i_2 = a n_3 \sin i_3$. ✓ $n_a = 1$, $a n_2 = n_2$, $a n_3 = n_3$. ✓

$\therefore \sin i_a = n_2 \sin i_2 = n_3 \sin i_3$. $\therefore n \sin i = $ constant. ✓ (04)

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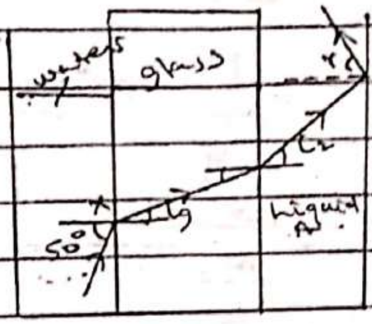
(c)



Using $n \sin i$ = constant (light only)

At point X, $n_w \sin i_w = n_g \sin i_g$

$1.33 \sin 50° = 1.50 \sin i_g$

$\sin i_g = \frac{1.33 \sin 50°}{1.5}$ $i_g = 42.28°$

At B, $1.5 \sin 42.28 = 1.25 \sin i_2$, $i_2 = 54.59°$

but $i_2 = r$, $r = 54.59°$ (05)

method 2

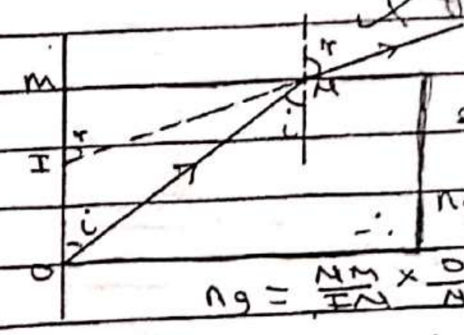
$n_w \sin i_w = n_2 \sin i_2$

$1.33 \sin 50° = 1.25 \sin i_2$, $i_2 = 54.59°$.

But $r = i_2$, $r = 54.59°$ (05)

(examples)

(d)



$n_g \sin i = n_a \sin r$

$\sin i = \frac{MN}{ON}$, $\sin r = \frac{MN}{IN}$

$n_g \frac{MN}{ON} = n_a \frac{MN}{IN} = \frac{MN}{IN}$ (since $n_a = 1$)

$n_g = \frac{MN}{IN} \times \frac{ON}{MN} = \frac{ON}{IN}$

since i and r are small angles in radians,

$ON \approx OM$ and $IN \approx IM$

$\therefore n_g = \frac{OM}{IM} = \frac{\text{Real depth}}{\text{apparent depth}}$ (04)

Scanned with CamScanner

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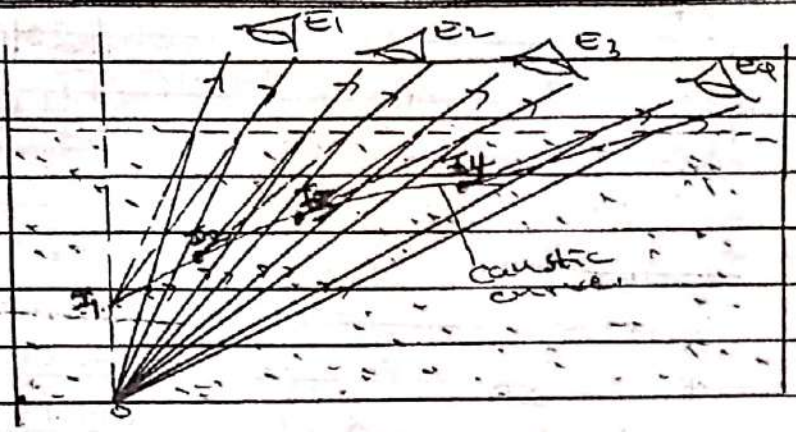

Three different positions of eye

2 pts → $\frac{1}{2}$ mk

Light from the object O, is refracted away from the normal as it emerges from the water surface, and the object appears displaced to I_1.

As the eye moves away from E_1, the angle of incidence increases hence the angle of refraction, leading to greater apparent displacement.

The position of the image therefore moves along the curve as the eye moves away from E_1. (04)

OR The object thus appears to be Moving closer to the surface

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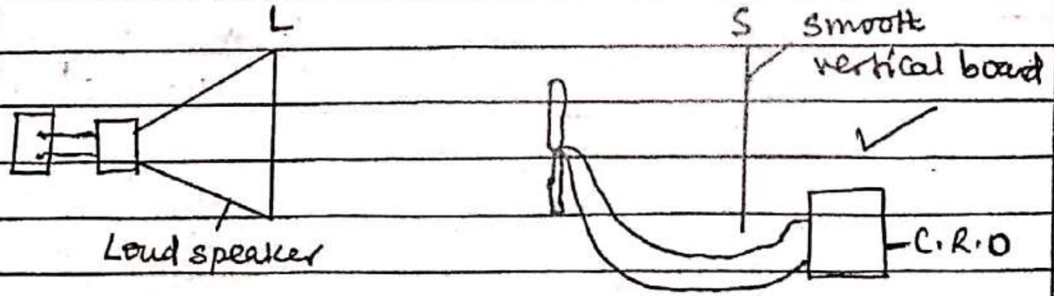
QUESTION 3

Accept identical waves

Coherent sources

3(a) (i) When two waves of equal frequency, equal wavelength and equal amplitude travelling in the same medium in opposite directions meet, they superpose. Where they arrive in phase, reinforcement takes place and maximum amplitude (intensity) is observed. This position is the antinode. Where they meet out of phase, cancellation takes ~~places~~ place and amplitude (intensity) is zero. This position is the node. (04)

(ii)



The apparatus is set up as shown above. The generator is switched on and the X-plates switched off. The length of the trace on the screen is observed. If it changes with time, the position of the board ~~bo~~ is varied until the length of the trace remains constant. The frequency f of the generator

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distance b/n speaker & Board s'ld be a s'ce to contain $\frac{1}{2}(\lambda)$ (integral no $\times \frac{1}{2}\lambda$)

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is recorded. Keeping the positions L and S of the loud speaker and the vertical board fixed, the microphone is moved until a position where the trace reduces to a dot (or reaches maximum). This position A is noted. The microphone is farther moved in one direction until the trace again reduces to a dot (or reaches maximum). The new position, B of the microphone is noted. The distance, l between A and B is measured. The velocity of sound in air is calculated from $v = 2fl$ (05)

(b) It is used in radar speed traps to measure the velocity of vehicles.
Microwaves are sent from the gun towards approaching vehicles and get reflected. The machine detects the frequency of the reflected waves, determines the beat frequency and calculates the speed of the vehicles. (03)

(c)

V – velocity of the wave
U – velocity of the train
f – frequency of the waves

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The apparent wavelength of the waves received by the observer, $\lambda' = \frac{v-u}{f}$ ✓

The apparent speed received by the observer due to echo, $v' = v+u$ ✓

The apparent frequency of the waves received, ~~$f' = v'/\lambda$~~

$$f' = \frac{v'}{\lambda'}$$ ✓

$$= \frac{(v+u)f}{v-u}$$ ✓ (04)

(c) (ii) The apparent wavelength of the waves received $\lambda' = \frac{v+u}{f}$ ✓

The apparent speed of the waves received $v' = v-u$ ✓

The apparent frequency $f' = \frac{(v-u)f}{v+u}$ ✓

$$\Rightarrow f' = \left(\frac{330-25}{330+25}\right)\times 980 = 842\,Hz$$ ✓ (04)

OR $$f' = \left(\frac{340-25}{340+25}\right)\times 980 = 845.7\,Hz$$ ✓

OR $$f' = \left(\frac{v-25}{v+25}\right)\times 980$$ ✓

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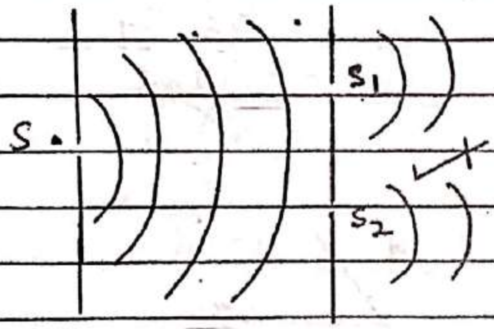
QUESTION 4

(a) Coherent sources are sources of waves of
- equal frequency and equal wavelength
- equal or nearly equal amplitude
- which superpose with constant phase relationship. — created from same source

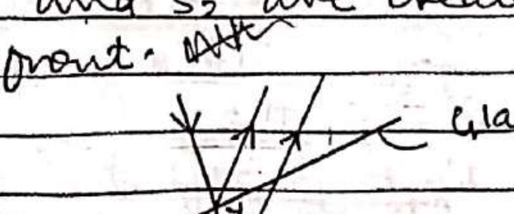
verify (03)

(b) (i)



Consider wavefronts diffracting through slit, S. Slits S_1 and S_2 are equidistant from S. The wavefronts diffracting through S_1 is from the same wavefront as that diffracting through S_2. Therefore Sources S_1 and S_2 are created by division of wavefront. (02)

(ii)



Consider a thin beam of light incident almost normally on an air wedge above.

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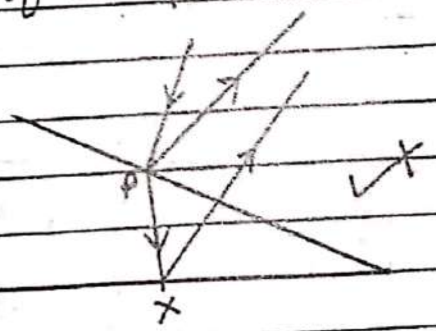
It is partly reflected by the bottom surface of the upper slide at Y and partly transmitted into the air film. The transmitted light is reflected by the top surface of the lower glass slide at X. (102)
X and Y are sources created by division of the same wave energy. Since wave energy is proportional to the square of the amplitude, the sources are formed by division of amplitude.

(c) (i)



Monochromatic light is made incident almost normally onto the upper glass slide. It is partly reflected at the bottom surface of the upper glass slide and partly ~~transm~~ transmitted through the air film. The transmitted light is reflected at the top surface of the lower ~~bottom~~ glass slide. The two wave trains meet above the air wedge and interfere. Where they meet with and path difference equal to an

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integral multiple of a full wavelength a dark band is formed. Where they meet with geometrical path difference equal to an odd multiple of half wavelength a bright band is formed. This is because reflection at the top surface of the lower plate occurs at boundary with a dense medium and hence the wave suffers a phase change of 180° equivalent to travelling an extra path length of $\lambda/2$. A series of straight alternate dark and bright fringes are formed which is an interference pattern. (05)

(ii) t - diameter of wire, x - fringe separation

from $\Delta x = \frac{\lambda s}{2t} \Rightarrow t = \frac{\lambda s}{2 \cdot \Delta x}$

But $\Delta x = \frac{5.0 \times 10^{-3}}{20}$ m

$\Rightarrow t = \frac{500 \times 10^{-9} \times 10.0 \times 10^{-2}}{2 \times \frac{5.0}{20} \times 10^{-3}}$

$\Rightarrow t = 1.0 \times 10^{-4}$ m

(d) (i) Constructive interference is said to occur when two light waves superpose in phase to form a bright band.

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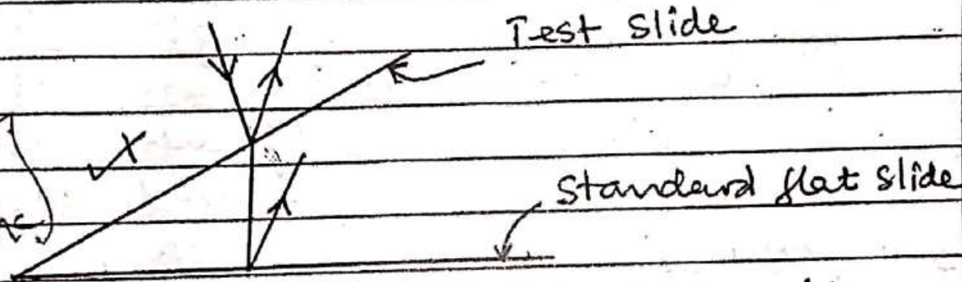
Destructive interference is said to occur when two light waves completely out of phase superpose to form a dark band. (02)

(d)(ii)



Can recover diagram marks

The test slide is placed in contact with a standard flat slide to form an air wedge. Monochromatic light is directed almost normally onto the wedge, and interference patterns formed are viewed from above. If regular fringes parallel to the line of contact is observed, the test slide is flat. Any areas showing irregular patterns correspond to the areas on the surface that are not flat. (03)

* Accept newton's ring expt/method

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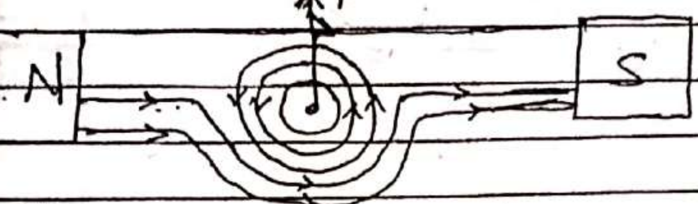
SECTION C

5a(i) Magnetic field line: Direction of the path which an isolated N-pole of a magnet would take when placed in magnetic field. ✓ 1

(ii)



field pattern
- direction

Each pattern ½ mark

Magnetic field due to current in the wire interacts with the applied field to form the resultant pattern which is stronger on the lower side ✓ and weaker on the upper side. A force therefore develops which acts (moves the wire) such a direction as to move the wire from direction of strong to weak field. ✓ 4

(b) Mechanical power = Electrical power ✓

Mechanical power $= FV$ ✓

Electrical power $= EI$ ✓ but $E = BLV$ ✓ 4

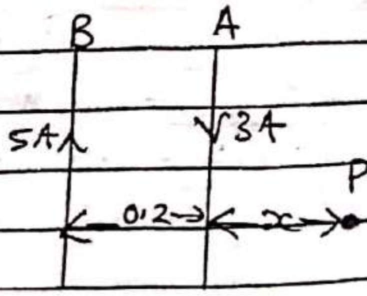
$\therefore \quad FV = BLVI$ ✓

$\Rightarrow \quad F = BIL$ ✓

1

6(i) $B = \frac{\mu_0 I}{2\pi a}$ ✓

(ii)



$B_B - B_A = 0$ ✓ path $\Rightarrow B_B = B_A$

$\frac{\mu_0 \times 5}{2\pi(x+0.2)} = \frac{\mu_0 \times 3}{2\pi x}$ ✓ substitution 3

$\Rightarrow x = 0.3\text{M}$ ✓

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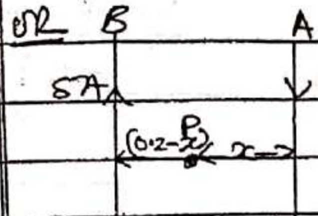
OR


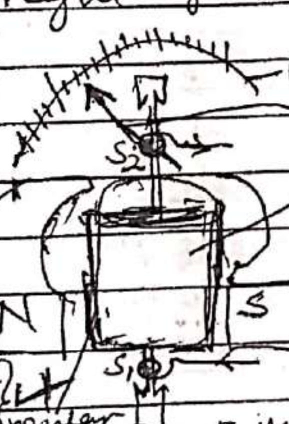
$B_1 + B_2 = 0$

$\Rightarrow B_1 = -B_2$

$\frac{5\mu_0}{2\pi(0.2-x)} = \frac{3\mu_0}{2\pi(x)}$ substitution 3

$x = 0.3M$

The neutral point is 0.3M from wire of 3A to the right of the wire

d(i)


Linear scale, pointer, Cylindrical soft iron core, N-S- pole pieces of permanent magnet, S_1S_2 - Hairsprings (any 4)

- Linear scale
- Pointer
- N S
- hairspring
- Coil
- soft iron core
- Rectangular
- Jewel bearing

- The current to be measured is let in and out by the hair springs. The coil experiences a magnetic torque $\tau = BANI$ and turns together with the pointer until they are stopped by the restoring torque of the hair spring $\tau = K\theta$. At this point $BANI = K\theta \Rightarrow \theta = \frac{BNAI}{K}$ 5

Since $\frac{NBA}{K}$ is constant, $\theta \propto I$ hence linear scale.

(ii) The coil is made heavier to increase the period of oscillation. (any 2)

- The suspension is made fine to reduce rigidity and increase sensitivity
- The coil is wound on insulating former to minimise damping due to eddy currents

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6(a)(i) - Magnitude of induced emf is proportional to the rate of change of magnetic flux linkage.
- The direction of the induced emf is such as to oppose the change causing it. 2

(ii) Let total flux linking the N turns of the coil be $N\phi$ (If -ve missing Deny ½ mk)

Induced emf $E = -N\frac{d\phi}{dt}$

Induced current $I = \frac{E}{R} = -\frac{N}{R}\frac{d\phi}{dt}$ but $I = \frac{dQ}{dt}$

$\Rightarrow dQ = -\frac{N}{R}d\phi$ 4

When the flux changes from ϕ_1 to ϕ_2.

then $Q = \int_{\phi_1}^{\phi_2} -\frac{N}{R}d\phi = -\frac{N}{R}(\phi)\Big|_{\phi_1}^{\phi_2}$

$Q = \frac{N}{R}(\phi_1 - \phi_2)$

(b) - The coil is made heavier to increase the period of oscillation.
- The suspension is made fine to reduce rigidity and increase sensitivity. 4 (any two)
- The coil is wound on insulating former. to minimize damping by eddy currents.

(c) B at the centre of Solenoid $= \mu_0 nI = 4\pi \times 10^{-7} \times 500 \times 5$ 3
$= 3.142 \times 10^{-3}$ T

$B = \frac{\theta R}{\alpha NA} \Rightarrow \theta = \frac{B\alpha NA}{R} = \frac{3.142\times10^{-3}\times4\times2000\times6\times10^{-4}}{10\times10^{-6}}$ 13

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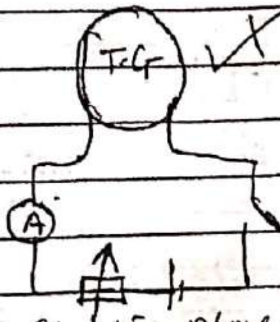
1

$\theta = 1507.97$ Divisions

(d)



A deflection magnetometer is mounted in a search coil to form a tangent galvanometer which is connected in a circuit as shown.

The coil is placed vertical and perpendicular to the horizontal component of the field intensity. Switch K is closed and the deflection θ_1 and θ_2 of the tangent galvanometer is recorded. The average deflection θ is recorded together with the ammeter reading I. ~~The~~ experiment is repeated for other values of I and the results recorded in a table including values of $\tan\theta$. 6

A graph of $\tan\theta$ against I is plotted and the slope S determined

$$H_H = \frac{N}{2RS} \quad \text{OR} \quad B_H = \frac{\mu_0 N}{2RS}$$

Where N and R are number of turns and radius of the coil respectively.

(07)

For Reverse switch method,

- $\theta_1, \theta_2, \theta_3, \theta_4$
- $B_H = \dfrac{\mu_0 N I}{2R\tan\theta}$

- the coil perp. to B_H
- K is closed, I recorded
- Deflections θ_1 & θ_2 noted
- Reverse, then note θ_3 & θ_4
- Average θ is noted.
- $H_h = \dfrac{NI}{2R\tan\theta}$

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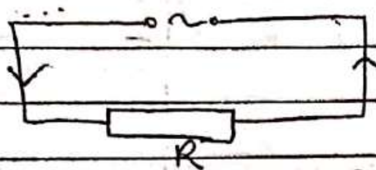
7(a) Reactance is the non resistive opposition to the flow of alternating current in a circuit [Capacitor or inductor] (1)

(ii) Frequency is the number of cycles made by the current per second. [Note: cycles not oscillations]. (1)

(b) 

$I = I_0 \sin \omega t$

Instantaneous Power dissipated $P = I^2 R$

Instantaneous Power $P = I_0^2 \sin^2 \omega t \, R$

$$\langle P \rangle = \langle I_0^2 \sin^2 \omega t \, R \rangle$$

$$= I_0^2 R \langle \sin^2 \omega t \rangle$$

but $\langle \sin^2 \omega t \rangle = \frac{1}{2}$

$$\langle P \rangle = \frac{1}{2} I_0^2 R$$

Let I_{rms} be the steady current that dissipates heats in the resistor at the same rate as the a.c then,

$$\langle P \rangle = I_{rms}^2 R$$

$$I_{rms}^2 R = \frac{1}{2} I_0^2 R$$

$$I_{rms}^2 = \frac{I_0^2}{2}$$

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$ (4)

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7(c) $I_{rms} = \frac{V_{rms}}{X_L}$

but $V_{rms} = \frac{V_0}{\sqrt{2}}$ and $X_L = 2\pi f L$.

hence $I_{rms} = \frac{V_0}{\sqrt{2} \cdot 2\pi f L}$

$I_{rms} = \frac{200}{2\pi \times 50 \times 0.5 \times \sqrt{2}}$

$I_{rms} = 0.09003A$

$X_L = 2\pi f L$

$I_0 = \frac{V_0}{X_L} = \frac{200}{157.0796}$

$= 0.1273A$

$I_{rms} = I_0/\sqrt{2}$

$= \frac{0.1273}{\sqrt{2}}$

$= 0.09003A$

(3)

(d)(i) The bulb lights continuously. This is because, when switch K is closed the capacitor charges and discharges continuously and in so doing, current flows. (2)

(ii) The brightness of the bulb increases. This is because when the capacitance increases, the reactance reduces and the current in the circuit increases. When the current increases, the brightness also increases. (2)

Accept Q ↑ses
Q=CV I ↑ses

Accept impedance see bulb R.

(iii) The brightness of the bulb reduces. This is because reducing frequency increases reactance in the circuit thus reducing current making the bulb go dim. (3)

Accept Q = CV
$\frac{I}{f} = CV \Rightarrow I \propto f$

- Average discharge I decreases
- Brightness decreases.

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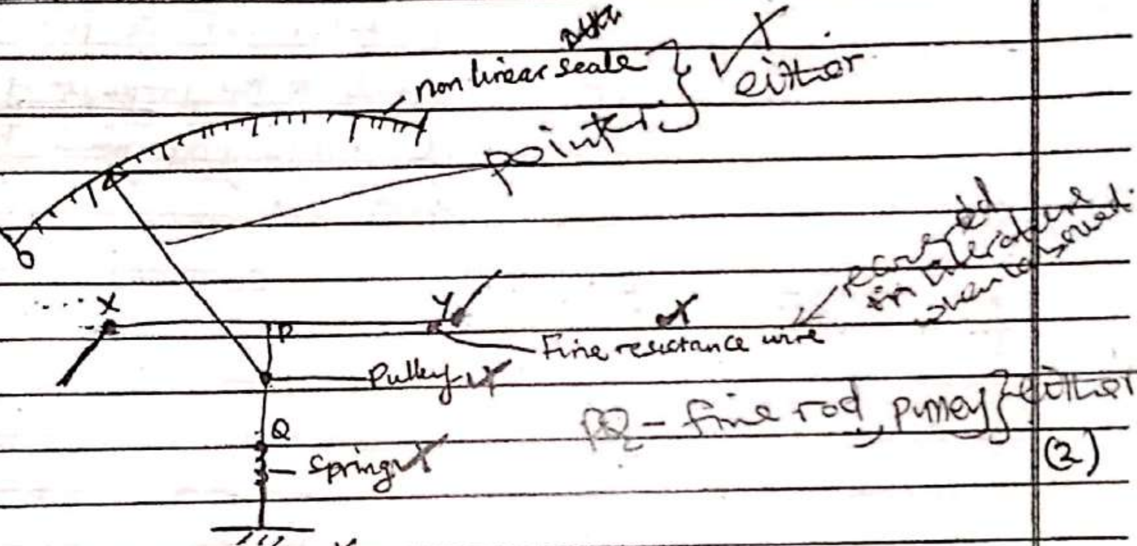
7(e)



(2)

Current to be measured is passed through the fine resistance wire XY as shown above. The wire heats up, expands and sags. (Sags) The sag is taken up by the fine rod PQ which rotates the pulley as it moves, causing the pointer to turn over the scale. The deflection of the pointer is proportional to the sag. Hence the deflection is proportional to the square of the average current. (3)

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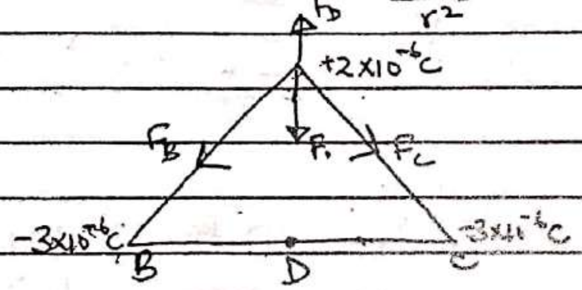
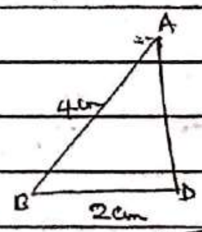
8 (a)(i) Coulomb's law of electrostatics states that the force between two point charges is directly proportional to the product of the magnitude of the charges and inversely proportional to the square of their distance apart. ✓ (1)

(ii) Electric Force $F = \frac{KQ_1Q_2}{r^2}$ ✓





$AD = \sqrt{4^2 - 2^2} = \sqrt{12}$ cm

$F_B = \frac{9\times10^9 \times 3\times10^{-6} \times 2\times10^{-6}}{(4\times10^{-2})^2} = 33.75N$. ✓

$F_C = \frac{9\times10^9 \times 3\times10^{-6} \times 2\times10^{-6}}{(4\times10^{-2})^2} = 33.75N$ ✓

Let Q be the charge at D.

$F_D = \frac{9\times10^9 \times Q \times 2\times10^{-6}}{(\sqrt{12}\times10^{-2})^2}$. ✓

Horizontally, the resultant force is zero. ✓

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Vertically,

$F_B \cos 30 + F_C \cos 30 = F_D$

but $F_B = F_C$

hence

$$\frac{9\times10^{9} \times Q \times 2\times10^{-6}}{(\sqrt{12}\times10^{-2})^{2}} = 2\times 33.75 \cos 30$$ ✓

$$Q = \frac{2\times 33.75 \cos 30 \times (\sqrt{12}\times10^{-2})^{2}}{(9\times10^{9})\times 2\times10^{-6}}$$

$$Q = 3.89\times10^{-6}\ C.$$ ✓ (5)

(b) (i) Capacitance is the ratio of the magnitude of charge on either plate of the capacitor, to the potential difference between the plates. ✓ (1)

(ii) $f = 50Hz$ $V = 25V$ $I = 10\times10^{-6}A$.

$I = Qf$.

$I = CVf$.

$C = \frac{I}{fV}$ ✓

$C = \frac{10\times10^{-6}}{50\times25}$ ✓ $= 8\times10^{-9}F$ ✓ (3)

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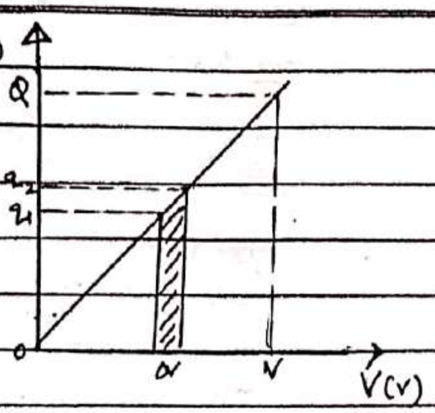
8c(i)



(1)

(ii) Energy = Area under graph

Area under graph $= \frac{1}{2} QV$

but $Q = CV$ and $C = \frac{\varepsilon A}{d}$

also $V = Ed$.

Therefore $Q = \frac{\varepsilon A E d}{d} = \varepsilon A E$

Energy $= \frac{1}{2} \varepsilon A E \cdot Ed$

$= \frac{1}{2} \varepsilon E^2 A d$

Volume $= A \times d$

Energy per unit volume $= \frac{\frac{1}{2} \varepsilon E^2 A d}{Ad}$

$= \frac{1}{2} \varepsilon E^2$

(4)

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8 d(i) A dielectric is an insulating material placed between the plates of a capacitor. ✓ (1)

d(ii) When a dielectric is placed between the plates of a charged capacitor, its molecules get polarized. ✓ Charges inside the insulator cancel each other's effect and those on the sides remain ✓. An electric field intensity develops between the two surfaces in opposition to the applied field. ✓ The resultant electric field intensity between the plates is thus reduced. ✓

From $E = \frac{V}{d}$ ✓ where V is the pd between the plates and d is the plate separation, V reduces, but $C = \frac{Q}{V}$ ✓ (4)

Therefore when V reduces, C increases ✓

OR

- polarisation ✓
- sides of dielectric acquire charges opposite to adjacent plates ✓
- positive charges lower negative potential of adjacent plate. ✓
- negative charge lowers positive potential of adjacent plate ✓
- pd between plates reduces
- $C = Q/V$ ✓
- V reduces C increases ✓

Corona discharge is apparent loss of charge at sharp points of charged conductor due to ---

A conductor loses charge
(1) leakage
(2) Corona discharge; Here only when the potential is high enough to ionise air near sharp point

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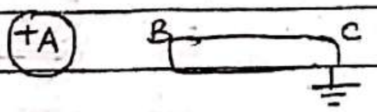
Q9a (i) The material is lowered (near) onto the cap of a neutral gold leaf electroscope using an insulating thread. The leaf of the electroscope is seen to diverge. The material is then earthed. If the leaf collapses then the material is a conductor. If it remains diverged, the material is an insulator. 03

(ii) There is always a high charge concentration on sharp points on a charged conductor. The electric field intensity around the sharp points is therefore high. Air around the sharp point is therefore ionised and charge similar to that on the conductor is repelled while that of opposite charge is attracted and neutralised. This loss of charge is reffered to as Corona discharge. 03

b



Negative charge is induced on the surface of the conductor at B. The potential at A is the sum of potential due to charge at A and charge at B (or neighbouring charges). Since the potential due to charge at B is negative, the resultant potential is lower (or reduced) 04

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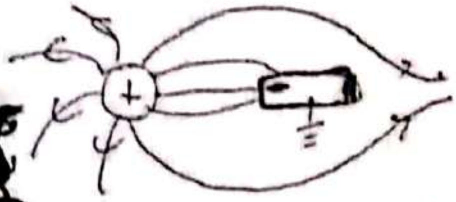

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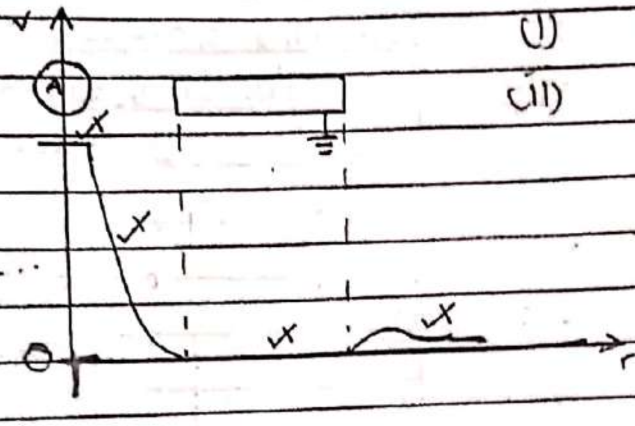
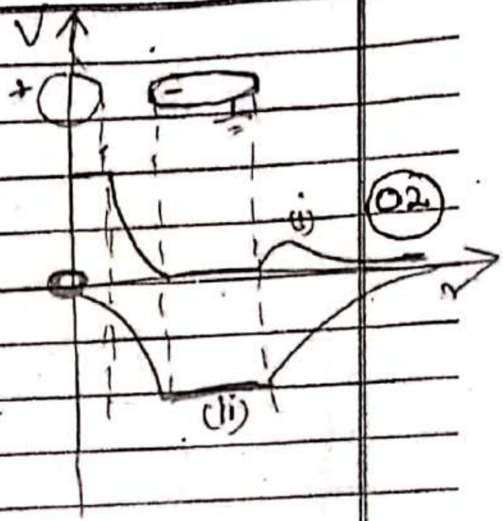
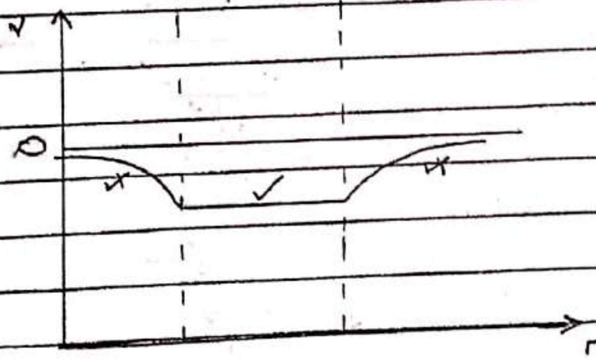
9 c (i)

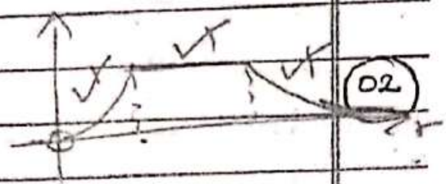




(02)

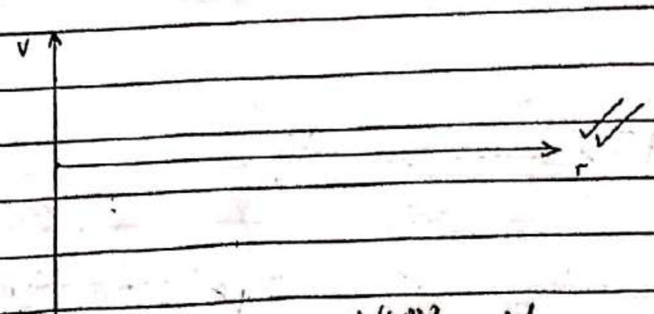
(ii)



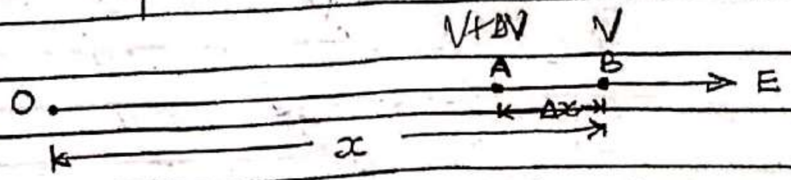


(02)

or



d (i)



Consider the Positions A and B in an electric field. The Potential at B is V and at A is V + ΔV. Work done to transfer 1C of positive

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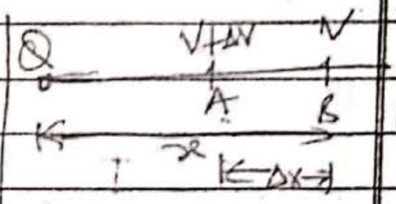
Charge from B to A is $(V+\Delta V) - V. = \Delta V$
But workdone to move the charge a small distance Δx towards O is $E \times 1 \times (-\Delta x)$
$= -E\Delta x$

$\therefore \Delta V = -E\Delta x$

$\Leftrightarrow E = -\frac{\Delta V}{\Delta x}$

$\Leftrightarrow E = -\frac{dV}{dx}$

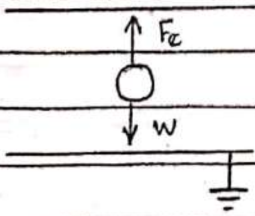
or $E = -\frac{V}{x}$



from A to B
$V_{AB} = V-(V+\Delta V)$
$= -\Delta V$
workdone $= E\Delta x$

(03)

d (ii)



$W = F_e$
$E = V/d = \frac{1800}{12\times10^{-3}}$
$= 150,000V$
$Mg = E.q$
$q = \frac{4.8\times10^{-15}\times9.8\times12\times10^{-3}}{1800}$
$= 3.14\times10^{-19}C$

When held still
$W = F_e$
but $W = mg$ & $F_e = qE = \frac{qV}{d}$

(03)

$\therefore \frac{qV}{d} = mg$

$\Rightarrow q = \frac{mgd}{V}$

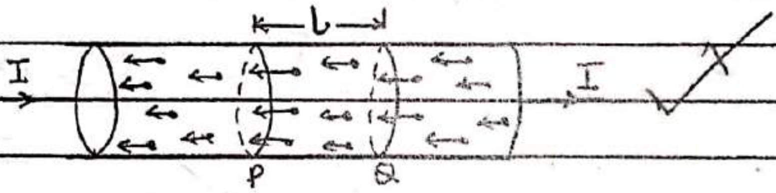
$= \frac{4.8\times10^{-15}\times9.81\times12\times10^{-3}}{1800} = 3.14\times10^{-19}C$

Q10 (a) Emf of a cell is the p.d between the terminals of a cell in an open circuit

or It is the ratio of power generated to the current it delivers. (01)

or The workdone to convey 1C of charge round in a complete circuit in which a cell is connected.

b



Volume of the section PQ of the conduct = LA

Total no of charge carriers in the section = nLA

Total charge in the section = enLA

Suppose in 1 second all charge in section PQ is swept through section Q, then

charge swept persecond is neLA (04)

But charge flow per second is current I, and distance covered persecond is velocity, v

$\therefore \quad I = nevA$

~~But distance moved per second is velocity v~~

$\Rightarrow \quad v = \dfrac{I}{neA}$

where v is the drift velocity.

OR

- volume of conductor = Al, where l - length of conductor.
- Total no. of charge carriers in conductor = nAl
- Total charge, $Q = neAl$.
Suppose all charge flows out of conductor in time t,
- The charge flowing per second,

$I = \frac{Q}{t} = \frac{neAl}{t} = neAv$, since $v = l/t$

$\Rightarrow v = I/neA$

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c. - when e.m.f of the driver cell is less than the test p.d. In this case, the test p.d drives current through the slide wire for all points. (04)

- when the cells are not connected in opposition to each other. In this case, the test cell only supports the driver cell

d. $I_d(R_Q + r \times 32.0) = 1.018$

$r = 4/100$

$I_d \times r \times 68.5 = E_x$

$I_d\left(40 + \frac{4}{100} \times 32.0\right) = 1.018$ —— (i)

$I_d \times \frac{4}{100} \times 68.5 = E_x$ —— (ii)

(ii)/(i) gives $\frac{0.04 \times 68.5}{40 + 0.04 \times 32.0} = \frac{E_x}{1.018}$

$E_x = \frac{0.04 \times 68.5 \times 1.018}{40 + 0.04 \times 32.0}$

$= 0.06757\ V$ (06)

$V_Q + Kl = 1.018$

$I \cdot 40 + I \cdot \frac{4}{100} \cdot 32 = 1.018$

$I = 0.02466A$

$E_x = Kl$

$= \frac{4}{100} \times 0.02466 \times 68.5$

$= 0.06757V$

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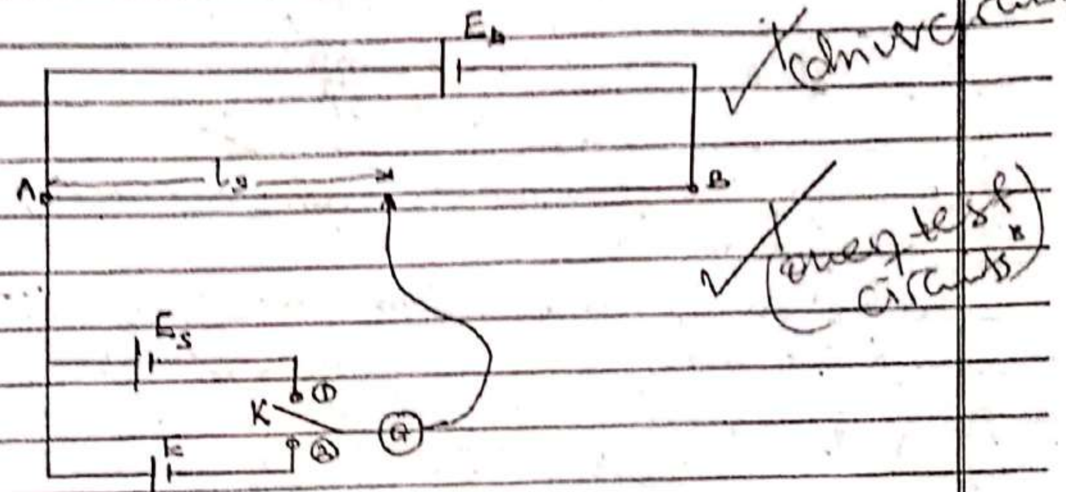
10e



The circuit is set up as above. where AB is a uniform wire, E_s and E are em.fs of standard and test cells respectively. Switch K is connected to position ① and the Jockey tapped at different Points along the uniform wire until where the galvanometer G shows no deflection. The balance length l_s is measured and recorded. K is now connected to position ② and the balance Position located. The balance length l is measured and recorded.

Em.f E is then Calculated from

$$E = \frac{E_s}{l_s} \cdot l$$

(05)

3(b) • Determining plasma temp

- spectral photograph from gas molecules known to be close to plasma (sun) is taken and one of them is ~~···~~ identified.
- The width $|\lambda_2-\lambda_1|$ of the spectral line is measured.
- spectral photograph of light emitted by the element in laboratory is taken and the position (wavelength) λ is recorded.
- speed of gas molecules, $u = \left|\frac{\lambda_2-\lambda_1}{\lambda}\right| c$
- Temperature of plasma, $T = \frac{Mu^2}{3R}$

where M is molar mass of the gas
R is molar gas constant

• determining whether the star moving away or towards earth

- spectral photograph of light from star is taken.
- for a given element present in star, the spectrum is compared with that taken from laboratory
- If there is a red shift, $(\lambda'>\lambda)$ the star is moving away.
- If there is a blue shift, $(\lambda'<\lambda)$ the star is approaching.

• Determining speed of star

- spectral photograph of light from star is taken.
- ~~For given element present in star,~~
- The wavelength λ' (position) is noted
- For same element, the wavelength λ (position) on laboratory spectrum is noted.
- wavelength shift, $= |\lambda'-\lambda|$
- Speed of star, $u = \left|\frac{\lambda'-\lambda}{\lambda}\right| c$

where c is speed of light in air

Risen to use script to generate guids . -0772231107 Otello
- Lenient -0783455448 Ndeg
0759848475
Busambe

- I doesn't flow from capacitor Same energy Same point -0752138777

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Optical path difference - integral multiple of λ (bright)
Path difference - " " " " (bright)
Geometrical path difference - " " " λ (dark)

$2t = (2n-1)\frac{\lambda}{2}$ - bright or $2t = (n-\frac{1}{2})\lambda$

$2t = n\lambda$ - dark

- intersection of rays on screen.
- m is magnitude but when used in $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$ sign convention.
- optical flatness/smoothness - produces regular pattern
- fringe spacing is same.
- general equal freq, λ/v
~~For light - freq~~
~~- λ~~
~~- equal A.~~
- constant phase relation (sources created from same source)
- virtual o cant give virtual I.

(i) - Brightness of the bulb rises. Since I in current is $\propto$ to capacitance, I rises.
OR increase in capacitance rise Q, hence I increases.

(ii) Brightness of bulb reduces since $I \propto f$, current reduces

LIES: ATTRACTION ATTRACTION WILL FAIL 4 ABUTE
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