Physics 2

UACE

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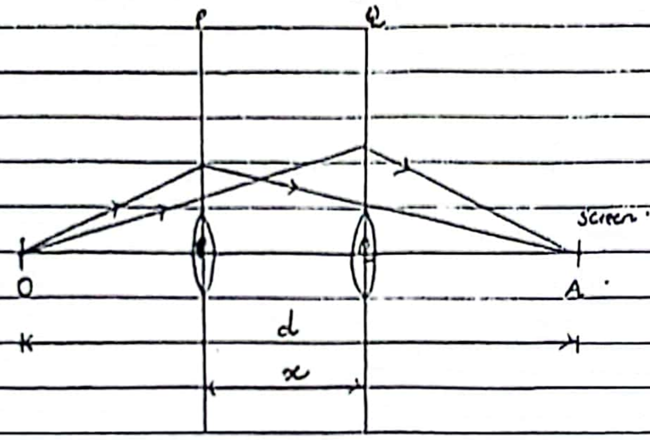
1(a)

(i) Are points on the principal axis such that when the object is placed at one, the image is formed at the other. 01

(ii) Is one formed by actual intersection of light rays and can be formed on the screen. 01

1, 2, 4.

(iii)



O and A are conjugate,

$OQ = PA$ and $OP = QA$

With the lens at P,

$$d = OP + PQ + QA$$

$$d = u + x + u$$

$$u = \frac{d-x}{2}$$

And, $PA = PQ + QA$

$$v = x + \frac{d-x}{2}$$

$$v = \frac{d+x}{2}$$

Now from, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$$= \frac{1}{\frac{d-x}{2}} + \frac{1}{\frac{d+x}{2}}$$

$$\frac{1}{f} = \frac{2}{d-x} + \frac{2}{d+x}$$

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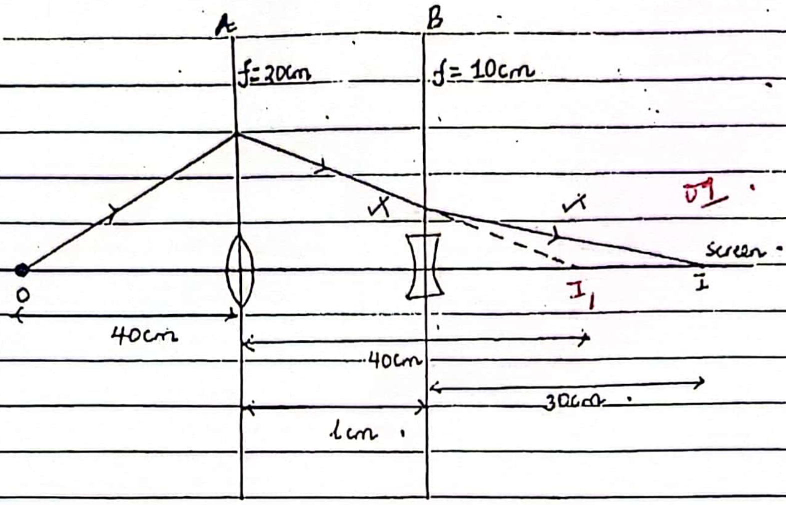
$$\frac{1}{f} = \frac{4d}{d^2 - x^2}$$

$$\therefore \quad f = \frac{d^2 - x^2}{4d} \quad 03$$

(b) (i)



Action of A;

from, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$$\frac{1}{20} = \frac{1}{40} + \frac{1}{v}$$

$$v = 40\text{cm}.$$

Action of B; $u = -(40 - l)\text{cm}$

$v = +30\text{cm}$ 05

so, $$\frac{1}{-10} = \frac{1}{-(40-l)} + \frac{1}{30}$$

$$\frac{1}{40-l} = \frac{1}{30} + \frac{1}{10}$$

$$\frac{1}{40-l} = \frac{2}{15}$$

$$\therefore \quad l = 32.5\text{cm}.$$

(ii) If the final image is virtual, $v = -30\text{cm}$,

then, $$\frac{1}{-10} = \frac{1}{-(40-l)} - \frac{1}{30}$$

$$\frac{1}{40-l} = \frac{1}{10} - \frac{1}{30}$$

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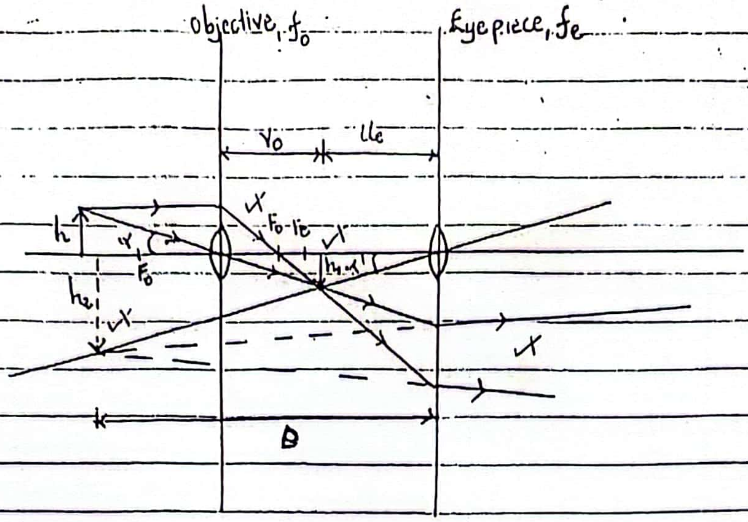
$$\frac{1}{40-l} = \frac{1}{15} ✓$$

$l = 25cm$ ✓ 03.

(c)



02 mks

Angular magnification, $m = \frac{\alpha'}{\alpha}$

But for small angles in radians,

$$\tan\alpha \simeq \alpha = \frac{h}{D} ✓, \text{ and}$$

$$\tan\alpha' \simeq \alpha' = \frac{h_2}{D} ✓$$

Now, $m = \frac{h_2/D}{h/D}$ ✓

03

$$m = \frac{h_2}{h}$$

$$= \frac{h_2}{h_1} \cdot \frac{h_1}{h} ✓$$

$$= m_e \cdot m_o ✓$$

$$= m_o \cdot m_e$$

$$= \left(\frac{v_0}{f_0} - 1\right)\left(\frac{D}{f_e} - 1\right) ✓$$

05

(d) When an object is viewed through a magnifying glass, various coloured images are formed at different positions. However these images subtend the same angle at the eye and therefore appear to coincide or overlap at the same point ✓ Thus the image is almost free of chromatic abberation. 02

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2. (a)

(i) Monochromatic light is light of a single wavelength. 01

(ii) Absolute refractive index is the ratio of the speed of light in a vacuum to the speed of light in the medium. 01

Snell's law with air as one medium.

(b) (i) A liquid whose refractive index, n is to be measured is poured into a parallel sided transparent vessel.

Monochromatic light is then directed normally on the vessel and observed from the opposite side.

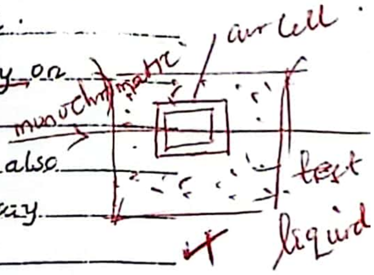
The aircell is placed in the vessel so that it is also illuminated normally on one side. The position, say, I of the aircell is noted.

The aircell is now rotated in one direction until light is just cut off from the observer. The angle θ_1 of rotation of the aircell is noted.

The aircell is restored to position, I and again rotated slowly in an opposite direction until light just cut off from the observer. The new angle, θ_2 of rotation of the aircell is also noted.

The refractive index, n of the liquid can then be calculated from, 05

$$n = \frac{1}{\sin\left(\frac{\theta_1 + \theta_2}{2}\right)} \qquad n = \frac{1}{\sin\theta}$$



(ii) Monochromatic light is essential for producing clear and undistorted images unlike white light. 01

(c)

(i) Critical angle is the angle of incidence for which the angle of refraction is 90° for a ray of light travelling from a more optically dense medium to a less optically dense. 01

Total internal reflection is a reflection within the dense medium when the angle of incidence exceeds the critical angle of the medium. 01

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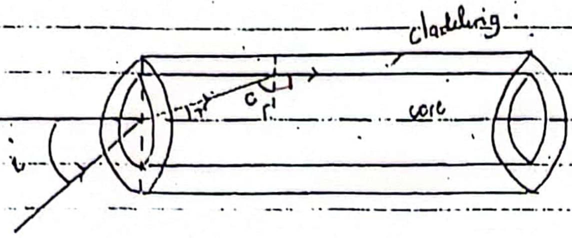
(ii)



At the core- cladding interface,

from $n \sin i = c$

$1.6 \sin c = 1.5 \sin 90°$

$c = \sin^{-1}\left(\frac{1.5}{1.6}\right)$

$c = 69.64°$

But $r + c = 90°$

$r = 90° - 69.64°$

$r = 20.36°$. 04.

Now, $n_a \sin i = n_g \sin r$

$1 \sin i = 1.6 \sin 20.36°$

$i = \sin^{-1}(1.6 \sin 20.36°)$

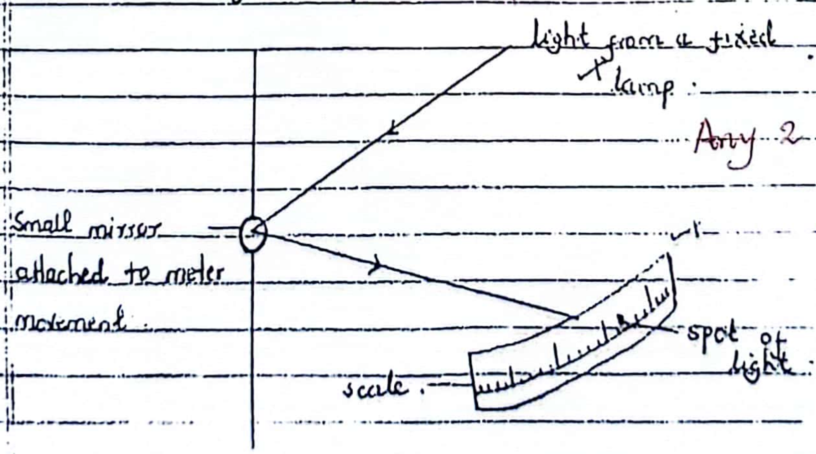
$i = 33.83°$.

$\theta = \sin^{-1}\left(\frac{\sqrt{n_1^2 - n_2^2}}{n_3}\right)$

OR; $\theta = \sin^{-1}\left(\frac{\sqrt{(1.6)^2 - (1.5)^2}}{1}\right)$ 04

$\theta = 33.83°$.

(d)



Any 2 parts labelled

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A tiny mirror is attached to the part of the meter which rotates when a current flows in it
A beam of light from a fixed lamp falls on the mirror and is reflected onto a scale
For a given current, the longer the pointer, the greater the deflection observed on the scale.
Besides being almost weightless, the arrangement doubles the rotation of the moving part since the angle the reflected beam turns is twice the angle of rotation of the mirror, with direction of incident ray fixed. 04

(e) The critical angle of diamond is very small due to high ~~refractive index~~. Therefore most of the light incident on diamond is totally internally reflected repeatedly and diamond sparkles due to multiple total internal reflections at various surfaces / facets within the diamond before it comes out. 02

20

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

SECTION B

3 (a) Transverse waves are waves which propagate by vibrations perpendicular to the direction of travel of the wave. 01

Longitudinal waves are waves in which the particles vibrate in the same direction as the direction of travel of the wave. 01

(b) for, $y = a\cos 4\pi(5t - 0.2x)$

By comparison with, $y = a\cos 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$

(i) $\Rightarrow \frac{2\pi t}{T} = 20\pi t$ ✓ 02 $\frac{1}{T} = 10$

$T = 0.1s$ ✓ $T = 0.1s$

(ii) and, $\frac{2\pi x}{\lambda} = 0.8\pi x$ ✓ $\frac{1}{\lambda} = 0.4$

$\lambda = 2.5m$

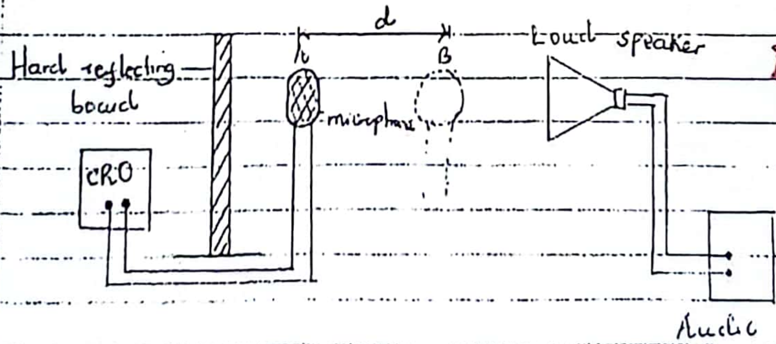
$\lambda = 2.5m$ ✓

But $v = f\lambda$ ✓ 02

$= \frac{1}{0.1} \times 2.5$ ✓

$v = 25ms^{-1}$. ✓ (with substitution seen)

(c)



Either 01½

OR

Diagram

A microphone is connected to the y-plates of a CRO to indicate the vertical movement of the signal to the screen. ✓

A loud speaker connected to an audio oscillator of known frequency, f is positioned ✓ to face the microphone.

01½

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The oscillator is then switched on and the microphone adjusted towards the speaker. While monitoring the amplitude of the signal of the CRO, the position A of the microphone where the amplitude is maximum is noted.

The microphone is again moved towards the speaker until amplitude is maximum again on the CRO. The new position, B of the microphone is also noted.

The distance, d between A and B is measured and noted.

The velocity of sound in air is obtained from, 05

$v = 2df$. $v = 2lf,$

(d) (i) Blue shift is when the apparent wavelength of the star/planet to an observer in line with it is less than the true wavelength so that the shift is towards the blue end of the visible spectrum. 01

while

Red shift is when the apparent wavelength of the star to an observer in line with it is greater than the true wavelength such that the shift is towards the red end of the visible spectrum. 01

(ii) Microwaves of frequency, f_0 from a stationary radar set are directed towards a motor vehicle moving with speed, v.

Microwaves reflected from the moving vehicle are detected at the radar set. The reflected signal mixes with the transmitted signal to produce beats.

The beat frequency, of which is equal to the difference between the frequency of the received and transmitted signal is determined. 04

The speed of the vehicle is got from, $v = c\left|\frac{\Delta f}{2f_0}\right|$.

$f - f_1 - f_2$

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(e) Given, $f = 4.56571 \times 10^{14}$ Hz and
$f' = 4.56711 \times 10^{14}$ Hz

$$\lambda = \frac{c}{f}$$

$$= \frac{3 \times 10^{8}}{4.56571 \times 10^{14}}$$

$$= 6.5707 \times 10^{-7} m$$

Also, $$\lambda' = \frac{3 \times 10^{8}}{4.56711 \times 10^{14}}$$

$$= 6.5687 \times 10^{-7} m$$

then, speed of the star relative to the earth, U_s

from, $$U_s = c\left(\frac{\lambda' - \lambda}{\lambda}\right)$$

$$\Rightarrow U_s = 3 \times 10^{8}\left(\frac{6.5687 \times 10^{-7} - 6.5707 \times 10^{-7}}{6.5707 \times 10^{-7}}\right)$$ 03.

$$= 9.1314 \times 10^{4} ms^{-1}.$$

(With units seen)

20.

4 (a) path length is the ~~length~~ distance in a medium that contains the same number of wavelets as a given ~~length~~ distance in a vacuum. 01

Interference is the superposition of waves from coherent sources resulting into alternate regions of maximum and minimum intensity. 01

(b)(i) The observer hears regularly spaced, alternate rises and falls in intensity of sound.

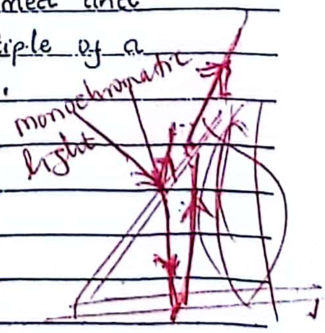
OR; Hears loud and soft sound. 02

(ii) The two speakers are coherent sources of waves. The two waves superpose and interference occurs. A loud sound is heard when the phase difference is an integral multiple of a full wavelength, thus constructive interference. Destructive interference occurs when the path difference is an odd multiple of half the wavelength implying a soft sound is heard. 04

(c) (i) When monochromatic light is made incident almost normally onto the upper glass slide of the air-wedge, it is partially reflected and partly transmitted into the air film and reflected at the top surface of the other glass slide.

The light reflected at both glass slides are coherent. When they overlap above the upper slide, interference occurs. 06

When the path difference is an odd multiple of hay a wavelength, a bright fringe is formed and when the path difference is an integral multiple of a full wavelength, a dark fringe is formed.



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(ii) Given,

Length, $l = 5.0cm$

$l = 0.05m$

Number of fringes, $n = 10$.

Distance occupied by 10 fringes, $y_{10} = 2.5mm$

$= 2.5\times10^{-3}m$.

For the n^{th} dark fringe, $y_n = \frac{n\lambda l}{2d}$

$\Rightarrow y_{10} = \frac{10\lambda l}{2d}$ ✓

$\therefore d = \frac{10\lambda l}{2y_{10}}$

$= \frac{10(500\times10^{-9})(0.05)}{2(2.5\times10^{-3})}$ 04.

$\therefore d = 5\times10^{-5} m$ ✓

OR; from, $\tan\theta = \frac{\lambda}{2y} = \frac{t}{y}$, t is the diameter of the wire.

$\frac{\lambda}{2y} = \frac{t}{5.0\times10^{-2}}$ ✓

But $y = \frac{2.5\times10^{-3}}{10}$

$y = 2.5\times10^{-4} m$ ✓

$\Rightarrow \frac{500\times10^{-9}}{2(2.5\times10^{-4})} = \frac{t}{5.0\times10^{-2}}$ 04.

$t = \frac{(500\times10^{-9})(5.0\times10^{-2})}{(5\times10^{-4})}$

$t = 5.0\times10^{-5} m$.

(d) The rings shift. This is because the water layer creates a new interference pattern, superimposed on the original newton's rings, due to the water air and water-glass 02 interfaces.

20

5 a) i) $F = BeV\sin\alpha$ ✓ 01

ii) $F_1 = BeV\sin\alpha$

Each electron takes time, t to travel a distance, l:

$\Rightarrow V = \frac{l}{t}$ ✓

$\Rightarrow F_1 = Be\frac{l}{t}\sin\alpha$ - - - (1) ✓ 03

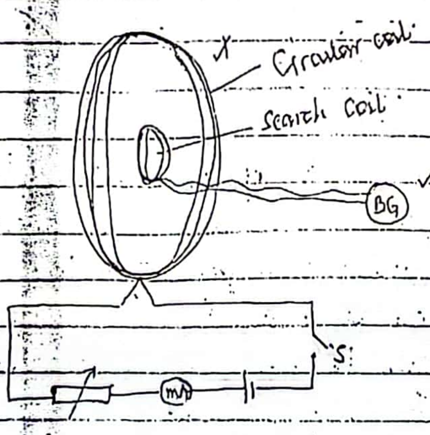
The total force on n electrons, $F = \frac{nBel\sin\alpha}{t}$ ✓ (2)

But $Q = It = ne$ ✓

$\therefore F = \frac{ItBl\sin\alpha}{t} = BIl\sin\alpha$ ✓

If $\alpha = 90^0$, $F = BIL$ ✓

b) i)



- A search coil of known area A and number of turns N is connected in series with a ballistic galvanometer, so that the total resistance is R ✓
- The search coil is then placed at the centre of a circular coil so that its plane coincides with that of the circular coil ✓ (2 planes coin
- Switch S is closed and the current I flowing through the coil is read from the milliammeter and noted ✓
- Switch S is opened and the first deflection θ of the BG is noted ✓
- A capacitor of known capacitance, C is charged to voltage, V_0 across its plates and discharged through the B.G. first deflection θ_0 of BG is noted ✓
- Magnetic flux density is calculated from: $B = \frac{CV_0R}{AN} \cdot \frac{\theta}{\theta_0}$ ✓✓
- The experiment is repeated for different values of current I and the corresponding deflection, θ of the BG is noted ✓
- A graph of B against I is plotted and a straight line through the origin is obtained meaning that Magnetic flux density at the centre of a coil is directly proportional to the current through it ✓ 02

ii) - Number of turns of the coil ✓
- Radius of the coil ✓ 02

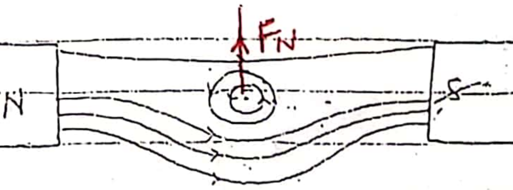
c). $\tau = BANI\cos\theta$ ✓

But $B = \mu_0 n I = 4\pi\times10^{-7}\times850\times2 = 2.1363\times10^{-3}\,T$

$\Rightarrow \tau = 2.1363\times10^{-3}\times(\pi\times0.032^2)\times20\times1.5\times\cos30^\circ$ ✓

$\tau = 1.7855\ Nm$ ✓ 05

d)



- The current in the wire sets up a magnetic field around the wire. ✓
When the field due to the wire/current interacts with the external magnetic field, the resultant magnetic field has a greater flux density below ~~above~~ the wire than above ~~below~~ it. ✓
- The wire moves from the region of greater magnetic flux density to a region of weaker magnetic field. ✓
- Hence the wire experiences a force as it moves up. ✓

03

Explanation Qtns
(put a scenario). 20

Accept flemings' left hand rule.

6(a) Faraday's law states that the magnitude of the induced emf in a circuit is directly proportional to the rate of change of the magnetic flux linked with the coil. ✓ 01

Lenz's law states that the direction of the induced emf is such as to oppose the change causing it. ✓ 01

open with either name stated or noted

(b) i) $\phi = NAB$ ✓

$= 150 \times 0.3 \times 1.2 \times 10^{-2}$ ✓ 02

$\phi_1 = 0.54\ Wb$ ✓

ii) $E = \frac{-d\phi}{dt} = \frac{-d}{dt}(\phi_2 - \phi_1)$ ✓

but $\phi_2 = NAB\cos\theta = 150 \times 0.3 \times 1.2 \times 10^{-2} \times \cos 70°$ ✓

$= 0.18469\ Wb$ ✓

$E = \frac{-(0.18469 - 0.54)}{2} = 0.17766\ V$ ✓ 03

(c) i) As the armature coil rotates in the magnetic field, the flux linking the coil/its plane changes. ✓

An emf is induced in its windings. ✓

This emf opposes the applied pd, so its known as back emf. ✓ 03

ii) From $V = E_{b_1} + IR \Rightarrow E_{b_1} = V - I_1R = 240 - (4 \times 0.75) = 237V$ ✓

Also $E_{b_2} = V - I_2R = 240 - (60 \times 0.75) = 195V$ ✓

But $E_b = NAB\omega \Rightarrow E_b \propto \omega$ ✓

$\Rightarrow \frac{E_{b_1}}{E_{b_2}} = \frac{\omega_1}{\omega_2}$ ✓

$\frac{237}{195} = \frac{400}{\omega_2}$ ✓ 05

$\omega_2 = 329.1139\ rev\ min^{-1}$ ✓

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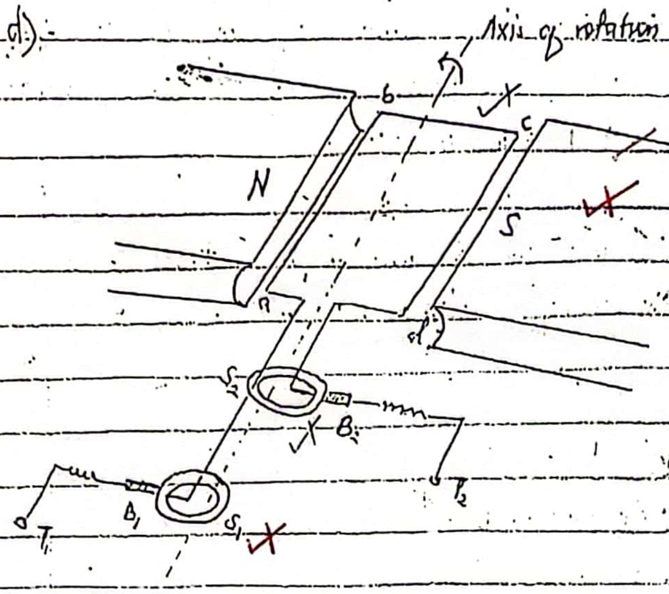
d)



Any 4 parts labelled.

02mks

abcd = Rectangular coil B_1B_2 = Carbon brushes.
S_1S_2 = Slip rings. T_1T_2 = Output terminals.

- The coil is rotated with uniform angular frequency, ω in a magnetic field provided by a strong permanent magnet.
- As it rotates, the magnetic flux linkage changes and an emf is induced hence current flows which is lead away by means of the slip rings.
- If V is the induced emf, B is the magnetic flux density, A is the area of the coil and N is the number of turns
Then $V = NAB\omega \sin \omega t$.

03

- After each vertical position of the plane abcd, the direction of the current flowing through the coil changes.
- Since there is no change in contact between the slip rings and carbon brushes, the current at the output also changes in direction hence producing an alternating current.

05

T.T 20

7(a)

(i) Root mean square value of an alternating current is the steady current which dissipates ~~electrical~~ heat energy in a given resistor at the same rate as the alternating current. 01

while

Peak value is the maximum value of an alternating current ~~from~~ its ~~equilibrium position~~. 01

(ii) from,

$$V_{rms} = \frac{V_0\sqrt{2}}{2}$$

$$220 = \frac{V_0\sqrt{2}}{2}$$

$$V_0 = 311 \cdot 127\ V$$

02 7/ 1 dps

(b)(i) When S is closed, current flows and produces a magnetic field which is generally perpendicular to the plane of the coin. Therefore, as current grows, the coin experiences a fluctuating magnetic field and therefore the eddy currents circulates the coin.
The eddy currents produces a magnetic field in a direction that opposes the growing field. The result is a repulsion between the coin and the solenoid which causes the coin to jump.
And when the current through the solenoid becomes steady, eddy currents stop circulating and therefore the coin settles back. 03

(ii) The magnetic field induced in the solenoid continuously fluctuates. Therefore, eddy currents continue to flow which is quite high and also alternates as the current in the solenoid. Because of continuous circulation of eddy currents, the coin heats up. 03

03

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(c)

(i) Is the opposition to the flow of alternating current in a purely capacitive circuit. 01

OR; non-resistive opposition

(ii) Considering a sinusoidally varying voltage,

$V = V_0 \sin \omega t$

The charge, Q on the plates of the capacitor,

$Q = CV$

$Q = CV_0 \sin \omega t$

For current through the capacitor,

$I = \frac{dQ}{dt}$

$I = \frac{d}{dt}(CV_0 \sin \omega t)$

$I = CV_0 \omega \cos \omega t$

Now, $I_0 = CV_0 \omega$

$\frac{V_0}{I_0} = \frac{1}{C\omega}$

But capacitive reactance, $X_c = \frac{V_0}{I_0}$ 05

$X_c = \frac{1}{C\omega}$

$X_c = \frac{1}{2\pi f C}$

(d) for $V = 10 \sin 20t$, $L = 0.5H$

from $X_L = 2\pi f L$

$X_L = 20(0.5)$

$X_L = 10\Omega$

Now, $I_{rms} = \frac{V_{rms}}{X_L}$ 03

$= \frac{10/\sqrt{2}}{10}$

20

$I_{rms} = 0.70711 A$

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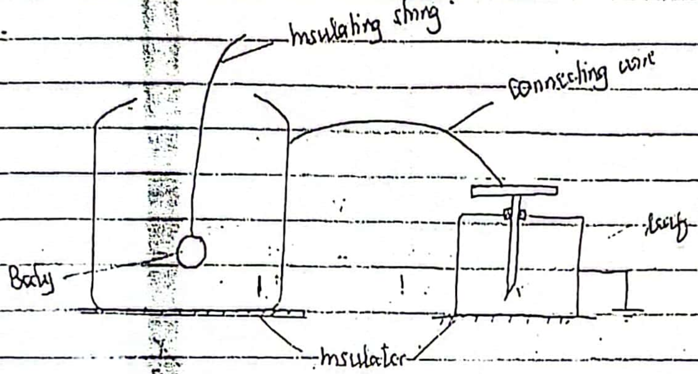
8. a) i. - The point of the pin is sharp and hence has great charge density.
- A high electric field intensity arises near the sharp point of the pin.
- This leads to ionisation of air molecules producing ion pairs.
- Ions with charge similar to the conductor are repelled while those with opposite charge are ~~repelle~~ attracted to it which leads to neutralisation. In this way, the conductor loses charge.

03

ii).



- A hollow can is connected to the cap of ~~the~~ a neutral gold leaf electroscope using a connecting wire.
- One of the bodies is suspended without touching the sides into the can and the divergence, θ_1 of the electroscope noted.
- The body is removed ~~and the electroscope is discharged~~.
- The other body is also suspended into the can and the new divergence, θ_2 of the leaf is noted. it is noted that $\theta_1 = \theta_2$
- The body is removed and the electroscope discharged.
- Now the two bodies are both suspended into the can and leaf is seen to not diverge.
- This shows that the two bodies neutralize each other hence they have equal but opposite charges.

05

b) i) From: $\phi = E \cdot A$ ✓

$$\phi = \frac{Q}{4\pi\varepsilon_0 r^2} \cdot 4\pi r^2$$ ✓

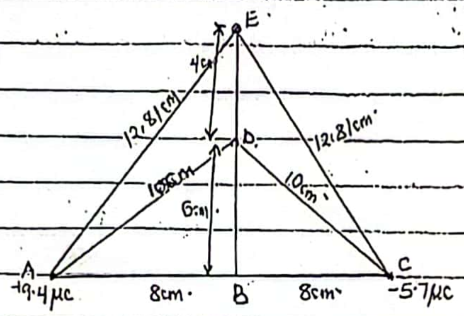
$$\phi = \frac{Q}{\varepsilon_0}$$ ✓

03

(ii) $E = \frac{\sigma}{\varepsilon_0} = \frac{39\times10^{-6}}{8.85\times10^{-12}}$ ✓ 02

$= 4.407\ NC^{-1}$ or Vm^{-1}.

c)



Potential at D:

$$V_D = 9\times10^9\left[\frac{9.4\times10^{-6}}{0.1} - \frac{5.7\times10^{-6}}{0.1}\right] = 3.33\times10^5 V$$ ✓

Potential at E.

$$V_E = 9\times10^9\left\{\frac{9.4\times10^{-6}}{0.1281} - \frac{5.7\times10^{-6}}{0.1281}\right\} = 2.59\times10^5 V$$ ✓

$W = QV_{ED}$

$= 3.5\times10^{-6}\left[2.59\times10^{5} - 3.33\times10^{5}\right]$ 03

$= 0.259\ J$ ✓

b) ii) $\sigma = 39.0\times10^{-2}\ cm^{-2} = 39\times10^{-6}\ m^2$

$$E = \frac{\sigma}{\varepsilon_0} = \frac{39\times10^{-6}}{8.85\times10^{-12}}$$ ✓ 02

$E = 4.407\ Vm^{-1}$ ✓

c) - All points on the surface are at the same potential.
- Work done to move a charge from one point to another on the eq surface is zero. 02
- Electric field lines are mutually perpendicular to the equipotential surface.

20

9 a) i) Is the ratio of the magnitude of charge on either plates of the capacitor to the potential difference across the plates. 01

or btn

ii)

$C_R = \varepsilon_r C$ and $C_P = \varepsilon_r C$

Q and R are in series

$$C_S = \frac{\varepsilon_r C \cdot C}{\varepsilon_r C + C} = \frac{\varepsilon_r C}{\varepsilon_r + 1}$$

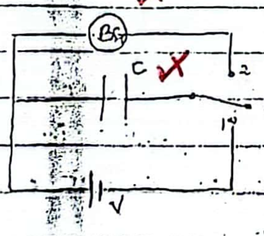
C_S and P are in parallel

$$C_T = \frac{\varepsilon_r C}{\varepsilon_r + 1} + \varepsilon_r C = \frac{\varepsilon_r C + \varepsilon_r C(\varepsilon_r + 1)}{\varepsilon_r + 1}$$

$$C_T = \frac{\varepsilon_r C(1 + \varepsilon_r + 1)}{\varepsilon_r + 1} = \frac{(2 + \varepsilon_r)(\varepsilon_r C)}{(1 + \varepsilon_r)}$$

03

b) i) Using a ballistic galvanometer.

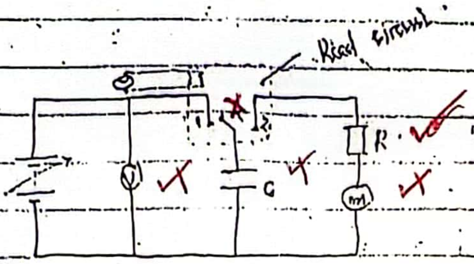


- The test capacitor C is connected as shown.
- Switch K is connected to position 1 to charge the capacitor.
- After a short time, K is connected to 2 to discharge the capacitor through the ballistic galvanometer.
- The first deflection θ_1 of the BG is noted.
- The test capacitor is replaced by a standard capacitor, C_s.
- The procedure is repeated and the first deflection θ_2 of the BG is noted.
- The capacitance of the test capacitor C is calculated from:

$$C = \left(\frac{\theta_1}{\theta_2} \times C_s\right)$$

04

OR: Using a vibrating reed circuit:



- The capacitor of unknown capacitance C is charged when X is connected to 1 and discharges when X is connected to 2 through the milliammeter
- The capacitor is rapidly charged and discharged by the vibrating reed switch at mains frequency, f.
- A steady current I is read from the milliammeter and noted
- The voltage V is also read from the voltmeter and noted
- The capacitance is calculated from:

$$C = \frac{I}{fV}$$

04

ii) - To increase the capacitance of a capacitor
- Provides a mechanical means of separating the two metal plates. Any 2
- To increase the dielectric strength so that a larger pd can be applied before it breaks down.

02

c) i) By Conserving charge:

Charge before = charge after.

$C_1V_1 = (C_1 + C_2)V$

$\left(\frac{16\times20}{16+20}\right)\times10^{-6}\times \cancel{40}\ 10 = \left\{\left(\frac{16\times20}{16+20}\right) + 1.5\times8\right\}\times10^{-6}V$

$\frac{3200}{36} = \frac{\cancel{332}}{36}V$

$= \frac{320}{36} + 12$

$= \frac{752}{36}V$

$\frac{3200}{36}$

$3.56\times10^{-4} = 2.09\times10^{-5}V$

$\therefore V = \cancel{17.02V}$ 4.26 V

4.3 V

04

ii) $E = \frac{1}{2}CV^2$

$= \frac{1}{2}\times\left\{\left(\frac{16\times20}{16+20}\right) + 1.5\times8\right\}\times10^{-6}\times(17.02)^2$ $(4.3)^2$

$E = \cancel{3.03\times10^{-3}}J$

$1.895\times10^{-4}J$

03

isolated

d) When a dielectric is placed between the plates of an charged capacitor its molecules become polarised.

- The charges inside the dielectric cancel each other's influence, while those at the ends acquire a charge opposite to the plate adjacent. These are bound charges or they don't neutralise.

- An electric field Ed develops with in the dielectric in opposition to the field due to the plates of the capacitor Eo.

The resultant electric field reduces ie $E_R = E_0 - E_d$

- From $E = \frac{V}{d}$, $\Rightarrow E \propto V$, so V also reduces.

From $C = \frac{Q}{V} \Rightarrow C \propto \frac{1}{V}$, so the capacitance increases

V - pd b/n plates,

C - Capacitance, Q = charge stored, d = plate separation.

04

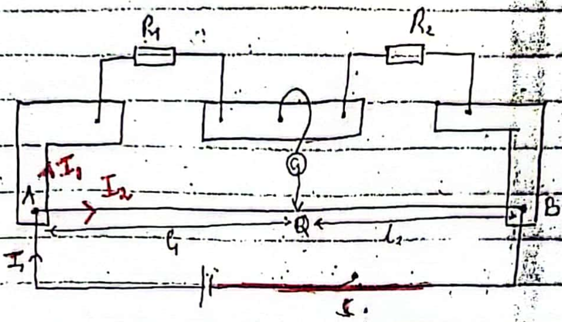
20

10. a) i) Is the opposition to flow of electric current. 01

ii) When the length of the conductor increases, there is a larger mean free path for the conduction electrons.
This lead to more collisions per second between the electrons and the atoms vibrating over their mean positions.
This decreases the drift velocity implying that the less current flows through the conductor.
Hence increasing length of a conductor increases its ~~length~~ resistance

03

b)



01

At balance, P.d across R_1 = P.d across AQ

$I_1R_1 = I_2 r l_1$ ... (1)

P.d across R_2 = P.d across QB

$I_1R_2 = I_2 r l_2$ ... (2)

where r = p.d per cm

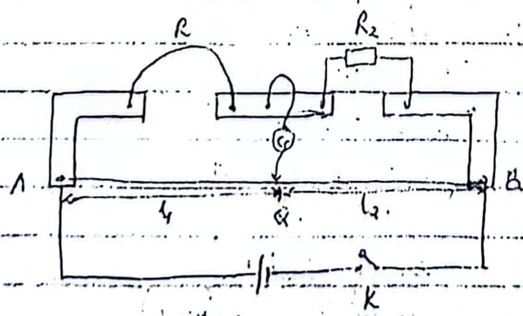
03

(1) ÷ (2)

$$\frac{I_1R_1}{I_1R_2} = \frac{I_2 r l_1}{I_2 r l_2}$$

$$\therefore R_1/R_2 = l_1/l_2$$

b) ii)



R –
R_2 – standard Resistor of resistance, R_2

- A wire of known length L, area A_x and resistivity ρ is connected in the left hand gap of a metre bridge and a standard resistor of resistance R_s in the right hand gap.
- Switch K is closed and the jockey tapped at different points along the uniform wire AB until a point is found where the galvanometer shows no deflection.
- The balance lengths l_1 and l_2 are measured and recorded.
- The resistance R_x is calculated from $R_x = \frac{l_1}{l_2} R_s$

- The procedure is repeated using the same wire of the same resistivity and length but different areas of cross section.
- The results are tabulated including values of A_x
- A graph of R_x against A_x is plotted
- The graph has a negative slope which means that resistance is inversely proportional to the cross section area of the wire.

c)(i) The p.d across the wire, AB,

$$V_{AB} = \left(\frac{4}{4+1}\right)(2)$$

$$= 1.6\ V$$

The p.d per cm, $K = \frac{1.6}{100}$

$$= 0.016\ V/cm$$

When K_1 is closed, the p.d across the 4Ω is equal to the p.d across the wire

$$IR = Kl$$

$$I(4) = 0.016(57.7)$$

$$I = 0.2308\ A$$

then,

$$E_2 = I(R+r)$$

$$1.5 = 0.2308(4+r)$$

$$\therefore r = 2.499\ \Omega$$

03

CamScanner

(ii) When K_1 and K_2 are closed, then the effective resistance,

$$R = \frac{4 \times 2}{4+2}$$

$$R = \frac{4}{3}\Omega$$

But $E = I(R+r)$

$$1.5 = I\left(\frac{4}{3} + 2.499\right)$$

$$I = 0.3914 A$$

such that, $0.3914\left(\frac{4}{3}\right) = 0.016 l$

$$l = 32.62 cm$$

03

20

λ

IBG