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UNEB UACE 2022

PHYSICS PAPER TWO

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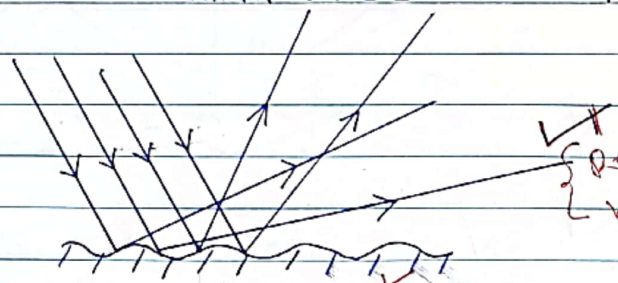
MARKING GUIDE BY: MATIGO.

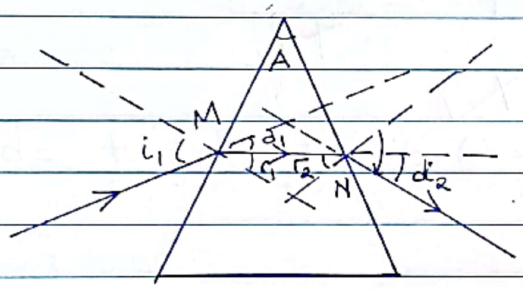
1 (a)



Regular incident beam & scattered rays

When a parallel beam of light is incident on unpolished surface, it is reflected in different directions. This reflection is refered to as diffused (02)

(b)



Ray refracted twice with angles.

Consider light incident on a prism of small refracting angle A at M at an angle of incidence, i_1 and refracted at angle r_1,

$\sin i_1 = n \sin r_1$

For small angles i_1, r_1 measured in radians

$\sin i_1 \simeq i_1$ and $\sin r_1 \simeq r_1$ $\therefore$ $i_1 \simeq n r_1$ ①

Now $A = r_1 + r_2$. Since A is small, r_2 is also small. This implies that i_2 is also small. At, N, $\sin i_2 = n \sin r_2$. Since i_2, r_2 are small when measured in radians,

$\sin i_2 \simeq i_2$, $\sin r_2 \simeq r_2$ $\Rightarrow$ $i_2 \simeq n r_2$ ②

The deviation, $d = d_1 + d_2 = (i_1 - r_1) + (i_2 - r_2)$

$\Rightarrow d = n r_1 - r_1 + n r_2 - r_2$

$= (n-1)(r_1 + r_2)$

$d = (n-1) A$ (05)

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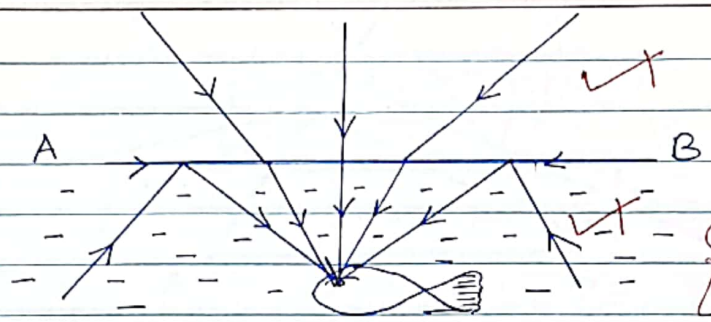
(d)



Denay arrow from eye.

{Refractions
Reflections}.

All rays from above the water surface AB incident on the water surface are refracted and recieved by the eye. Rays grazing the Interface are also refracted and received by the eye. Light from the inside water undergo total Internal reflection and recieved by the eye. Hence the fish has a wide field of view.

(e) $d = t_1\left(1-\frac{1}{n_1}\right) + t_2\left(1-\frac{1}{n_2}\right)$

But $d = 13 - 9.5$
$= 3.5$

$3.5 = 5\left(1-\frac{1}{n_1}\right) + 8\left(1-\frac{1}{1.33}\right)$

$5\left(1 - 1/n_1\right) = 3.5 - 1.98$

$1 - \frac{1}{n_1} = \frac{1.52}{5}$

$\frac{1}{n_1} = 0.696$

$n_1 = 1.44$

OR

$n_1 = \frac{t_1}{a_1}$

$1.33 = \frac{8}{a_1}$

$a_1 = 6.02$

$n_2 = \frac{t_2}{a_2}$

$n_2 = \frac{5}{9.5 - 6.02}$

$n_2 = 1.44.$

OR

$d = t\left(1-\frac{1}{n}\right)$

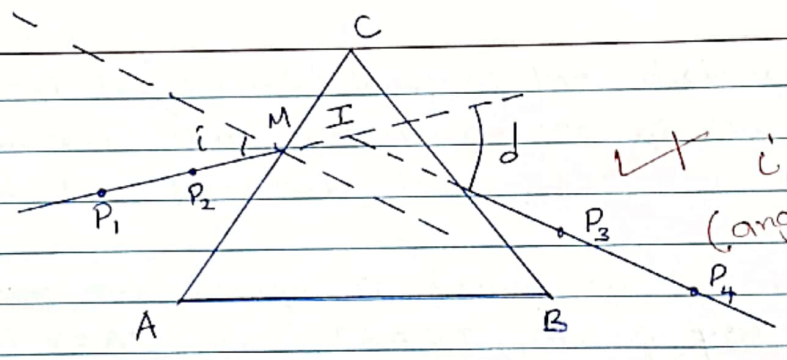
$d_1 = 8\left(1-\frac{1}{1.33}\right)$
$= 1.98$

$d = 13 - 9.5$
$= 3.5$

$d_2 = 5\left(1-\frac{1}{n_1}\right)$

(04) $n_1 = 1.44.$

20



i, d"
(angles i, d, and pins)

A prism is placed on a plain sheet of paper fixed on a drawing board and it's outline traced. The prism is removed and a line drawn on side AC at M, making a measured angle i.
The prism is placed back and two pins P_1 and P_2 placed on the line. looking through the prism from side BC, two other pins P_3, P_4 are placed so that the four pins appear to be in a straight line.
The prism and the pins are removed and the lines drawn through pins marks $P_1 P_2$ and $P_3 P_4$ to meet at T.
Angle, d is measured and recorded with the corresponding angle of incidence, i.
The experiment is repeated with other angles of incidence, i and the values recorded in a table. A graph of d against i is plotted and a smooth curve is obtained. The Least value of d on the graph is read. This is the angle of minimum deviation.

Recover without a diagram if d is positioned wert.

05

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2 (a) Focal length of a lens is the distance between the optical centre of the lens and the principal focus. (01)

(b) when the Image is formed at, I, $u = OA$ and $v = AI$ But $OA = BI$ and $OI = OA + AB + BI$

$\Rightarrow OI = 2OA + AB$

$$OA = \frac{OI - AB}{2}$$

$$= \frac{l-d}{2}$$

$$AI = OI - OA$$

$$= l - \left(\frac{l-d}{2}\right)$$

$$= \frac{l+d}{2}$$

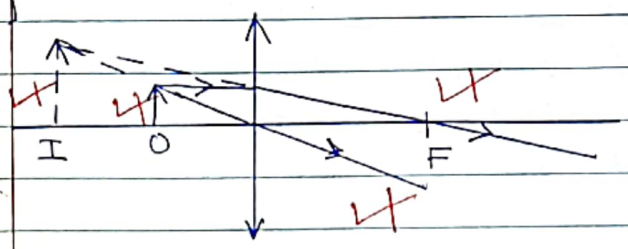
now $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

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

(04)

$$l^2 - d^2 = 4lf$$

(ii)



~ No Instrument deny ½ for object.

(02)

~ Wrong Instrument loses all.

(iii) The Image formed is virtual
upright
magnified

2 correct
x-tics @ ✓

NB: If negated, both are wrong.
eg virtual & real.

(c) $f = 20.0cm$, $u = 7.0cm$

using $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{1}{20} = \frac{1}{v} + \frac{1}{7.0}$

$v = -10.8cm$

But $v = r$, the radius of curvature, $r = 10.8cm$ (04)

Alternatively

$f = 20.0cm$, $v = 7.0cm$

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

$\frac{1}{20.0} = -\frac{1}{r} + \frac{1}{7.0}$

$r = 10.8cm$.

Deny 1/2 if $r \rightarrow -ve$.

(d) (i) The near point is the closest point / position to the eye where it can view an object clearly. (01)

Reject distance.

(ii) Accommodation is the process in which the focal length (ciliarly muscles) of the eye adjusts to enable the eye focus objects at different distances away from it

OR Ability of eye to see far and near objects.

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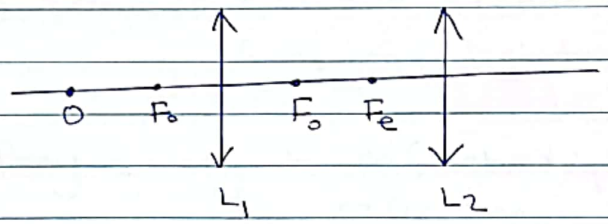
(c)



Action of L_1, $u = 1.5cm$, $f = 1.2cm$

$$\frac{1}{f_o} = \frac{1}{u_o} + \frac{1}{v_o}$$

$$\frac{1}{1.2} = \frac{1}{1.5} + \frac{1}{v_o}$$

$$v_o = 6.0cm$$

Action of L_2, $f_e = 4.0cm$ $v_e = -25cm$

$$\frac{1}{f_e} = \frac{1}{u_e} + \frac{1}{v_e}$$

$$\frac{1}{4.0} = \frac{1}{u_e} + \frac{1}{-25}$$

$$\Rightarrow u_e = 3.45cm$$

Separation of the lens $= u_o + u_e$
$= 6.0 + 3.45$
$= 9.45cm.$

— reversed
lenses gets
image
max

04

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A progressive wave is one that transmits wave energy from one point to another. (01)

They undergo :- reflection
- refraction
- Interference
- diffraction
- polarisation. (03)

$$y = 20\sin\left(300\pi t + \frac{\pi x}{15}\right)$$ (01)

$$y = y_1 + y_2$$

$$= 20\sin\left(300\pi t - \frac{\pi x}{15}\right) + \left(20\sin\left(300\pi t + \frac{\pi x}{15}\right)\right)$$

$$= 20\left(2\sin 300\pi t \cos\frac{\pi x}{15}\right)$$

$$= 20(2)\cos\frac{\pi x}{15}\sin 300\pi t$$

$$= 40\cos\frac{\pi x}{15}\sin 300\pi t$$

$$= A\sin 300\pi t$$

Where $A = 40\cos\frac{\pi x}{15}$ is the amplitude (04)

(iii) $\frac{2\pi x}{\lambda} = \frac{\pi x}{15}$

$\lambda = 30cm.$ (02)

Phase difference $\Delta\phi = \frac{2\pi}{\lambda}(x_1 - x_2)$

$= \frac{2\pi \times 25}{30}$ (02)

$= 5.23\,rad$

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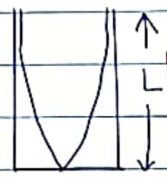
Consider a wave form produced at the fundamental frequency f_0

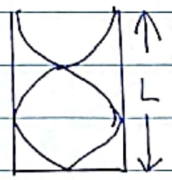


$L = \frac{\lambda_0}{4}$, $\lambda_0 = 4L$

$f_0 = \frac{v}{4L}$

$\Rightarrow v = 4Lf_0$

For the 1st overtone



$L = \frac{3}{4}\lambda_1$,

$\lambda_1 = \frac{4L}{3}$, $f_1 = \frac{v}{\lambda_1}$

$f_1 = \frac{4Lf_0}{\frac{4L}{3}}$

$f_1 = 3f_0$. (04)

The test note is sounded together with a standard note of frequency f_1. The beat frequency, f_b is determined.
The test frequency, f_b is calculated from $f_2 = f_1 + f_2$

OR

$f_2 = f_1 - f_b$

To determine which correct formula to use the frequency of the standard note is reduced a little and the new beat frequency f_b' is determined. (03)

If $f_b' < f_b$, then $f_2 = f_1 - f_b$

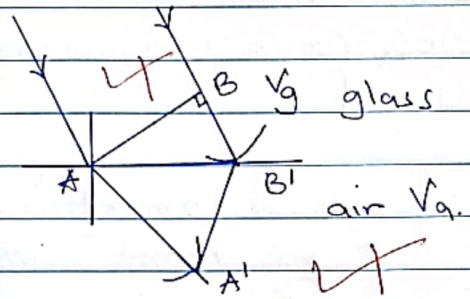
If $f_b' > f_b$, then $f_2 = f_1 + f_b$

either

20

4(a) (i) It states that every point on a wave front acts as a source of secondary wavelets which move in the forward direction with the velocity of the wave and the new wave front at any given time is the envelops which just touches the surfaces of the wave lets. (01)

(ii)



— Incident beam & wave front AB
— refracted beam & wave front A'B'

Suppose V_g and V_a are the velocities of light in glass and air respectively.
In the interval, t, when the wave let from B moves to B'. distance $BB' = V_g t$, the wavelet from A travels a distance $AA' = V_a t$ in air. By huygen's principle, the new wavefront just touches the surface of the spheres of centres A and B of radii $V_g t$ and $V_a t$ respectively.
The new wave front therefore is B'A' (03)

(iii) $\frac{n_g}{n_L} = \tan i_p \Rightarrow \frac{1.52}{4/3} = \tan i_p$

$\therefore i_p = 48.7^\circ$

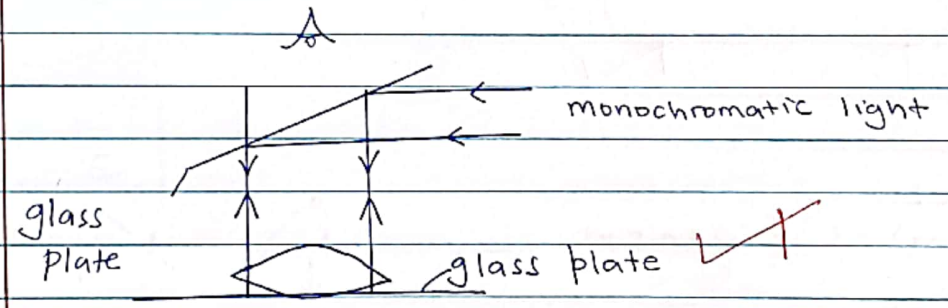
$\Rightarrow r_p = 90 - 48.7$

$= 41.3^\circ$. (04)

(b)(i) Interference is the superposition of light from two coherent sources forming permanent (alternate) dark and bright fringes. (01)

(ii) Path difference is the difference in lengths of paths taken by the wave trains from the sources to the point of overlap / Interference (01)

(iii)



- A parallel beam of monochromatic light is made incident on a slanting glass plate.
- The plate reflects the light vertically downwards onto the lens placed on a flat glass plate.
- When light reaches the lower side of the lens, it is partly reflected and partly transmitted into air.
- The refracted light is reflected at the top surface of the flat glass plate and travels to emerge from the upper surface of the lens.

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The two reflected waves superpose to form alternate dark and bright fringes which are observed at E

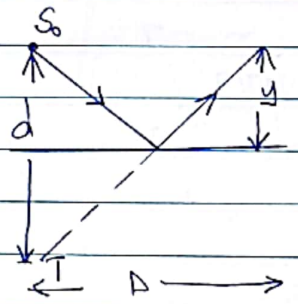
At the centre of the fringe system, a dark band is formed since there is a phase change of π radians corresponding to an extra path length of $\frac{\lambda}{2}$ when light is reflected at the top surface of the bottom glass plate.

where the geometrical path difference is an integral multiple of full wave length, a dark band is formed

Where the geometrical path difference is an odd multiple of half the wave length, a bright fringe is formed

06

(c)



$d = 2 \times 3.0 \times 10^{-3}$ $\lambda = 600nm$

$D = 36cm + 15cm = 51cm$

$y = \frac{\lambda D}{d} = \frac{600 \times 10^{-9} \times 51 \times 10^{-2}}{2 \times 3.0 \times 10^{-3}}$

$= 5.1 \times 10^{-5} m$

03

(d)
- Blooming of lenses
- Testing for optical flatness
- Determining wavelengths
- Determining speed of a wave of light

01

20

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5(a)(i) Magnetic flux density is the force experienced by a conductor of length 1m carrying a current of 1A placed perpendicular to a magnetic field. (01)

OR

Magnetic flux density is the force experienced by a charge of 1C moving with velocity $1ms^{-1}$ at right angle to the magnetic field.

(ii) The tesla is the magnetic flux density when the force on a conductor 1m long placed perpendicular to the field and carrying a current of 1A is 1N (01)

(b) (i) Let the radius of the coil be r

N X circumference of the coil = length of the wire

$$N \times 2\pi r = x$$

$$r = \frac{x}{2\pi N}$$

Magnetic flux density at the centre of the circular coil, $B = \frac{\mu_0 N I}{2r}$ (03)

$$B = \frac{\mu_0 N I}{2} \times \frac{2\pi N}{x}$$

$$B = \frac{\mu_0 \pi N^2 I}{x}$$

(ii) The magnetic field is perpendicularly into the plane containing the coil. (01)

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(c) $F = BILN$

$F = 0.2 \times 9.80 \times 1 \times 100$

$= 196.0N$

Additional force $= 196.0N$

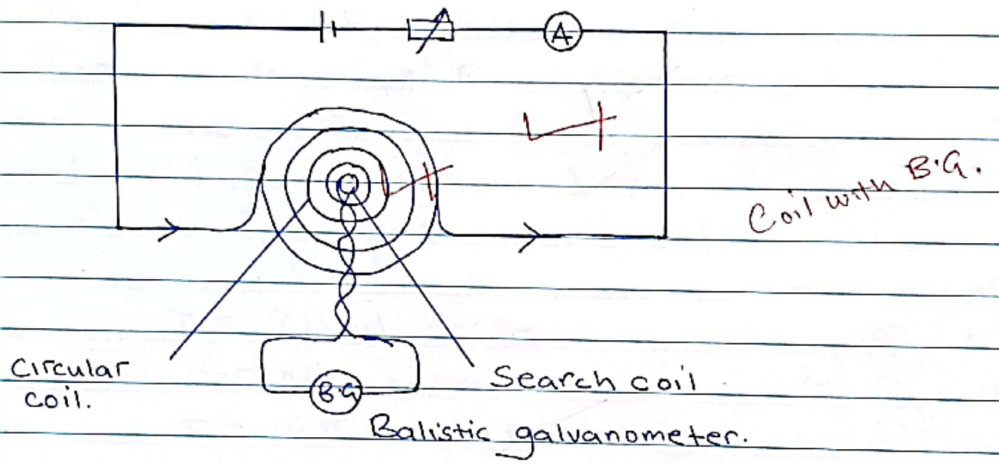
Additional weight $= mg$

$mg = 196.0$

$m \times 9.81 = 196.0$ $M = 19.98kg$ (02)

$m \simeq 20kg.$

(d)



- A Search coil is placed at the centre of a circular coil carrying current ~~with~~ its plane parallel to that of the test coil.
- The coil is then pulled completely out of the field.
- The first throw, θ of the B.G is noted together with the ammeter reading I
- The above procedures are repeated with different values of I obtained by adjusting the Rheostat and the corresponding values of θ noted
- The results are tabulated.
- A graph of θ against I is plotted and a straight line through the origin is obtained $\Rightarrow \theta \propto I$ But $B \propto \theta$

$\therefore B \propto I$

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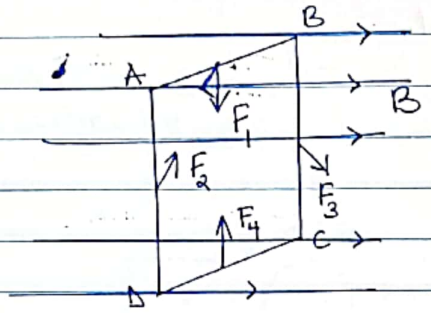
(e) (i)



Force on one turn of AB

$F_1 = BIL\sin\theta$ downwards

F_1 & F_2 = opposite.

Force on one turn of AD

$F_2 = BIL$ inwards

Force on BC, $F_3 = BIL$ outwards

Force on DC $F_4 = BIL\sin\theta$ upwards

F_1 and F_4 cancel out

F_2 and F_3 forms a couple of moment

$\tau = BIL \cdot L\cos\theta$

for N turns

$\tau = BILNL\cos\theta$

$= BIL^2N\cos\theta$

$L^2 = A$ (Square coil)

You can score direction on the diagram

04

$\tau = NBAI\cos\theta$

(ii) $F = BqV$ but $B = \frac{\mu_0 I}{2\pi d}$

$F = \frac{\mu_0 I q V}{2\pi d}$

02

$= \frac{4\pi \times 10^{-7} \times 10 \times 1.6 \times 10^{-19} \times 10^{7}}{2\pi \times 0.02}$

$= 1.6 \times 10^{-16}$ N

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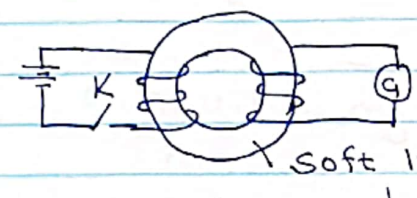
6(a)(i) Mutual induction is the production of emf in a ~~coit~~ circuit due to the change in current in a nearby circuit. (01)

(ii)



When switch, K is closed, G deflects. This shows that current has been induced in the secondary coil (02)

(b) The iron core is laminated, This reduces amount of eddy current induced

The soft iron core ~~is~~ used which is easier to magnetise and demagnetised. (02)

(c) Emf Induced $\mathcal{E} = -\frac{d\phi}{dt}$ But $\phi = BA$

$$\therefore \mathcal{E} = -B\frac{dA}{dt}$$

Since angular speed is constant

$$\frac{dA}{dt} = \frac{A}{T} = Af = \pi r^2 f$$

$$\therefore \mathcal{E} = -B\pi r^2 f$$ (03)

$$= -\tfrac{1}{2}B\omega r^2.$$

(d)(i) When the rod begins to move downwards, it cuts the magnetic field and current is induced in the circuit.

Magnetic force comes into play, which opposes the motion of the conductor. The force increases with increase in speed. When the force becomes equal to the weight of the rod, the rod begins to move with constant velocity (03)

At steady speed

$F = BIL = mg$

$I = \frac{V}{R} = \frac{BLu}{R}$

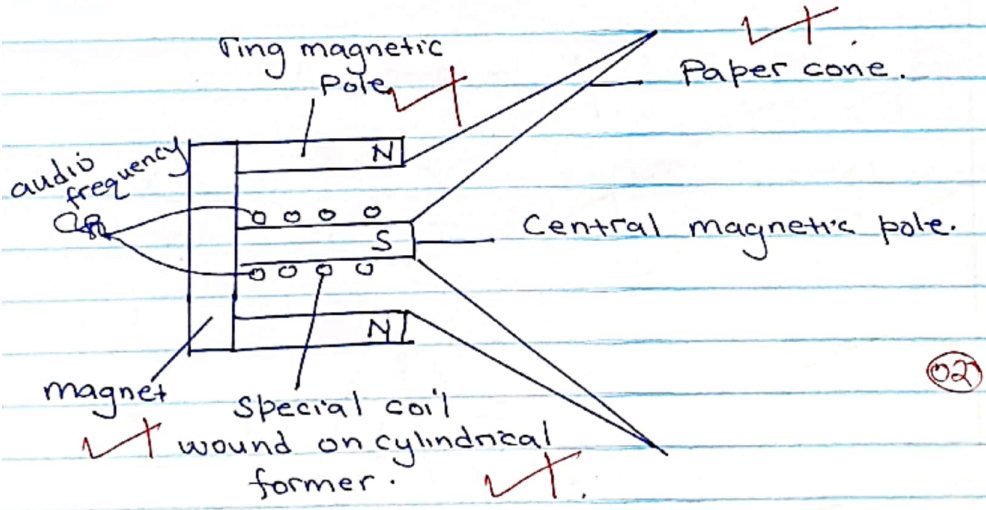
$\therefore \frac{B \cdot BLu \cdot L}{R} = mg$

$u = \frac{mgR}{B^2L^2}$

$u = \frac{0.03 \times 9.81 \times 0.04}{0.2^2 \times 0.5^2}$

$u = 1.177\ ms^{-1}$

(04)



(02)

When the audio frequency current flows in the coil, magnetic forces act on the coil causing it and the former to move in on direction.

When the current reverses, the motion is also reversed. This causes the paper cone attached to the former to move back and forth thus producing sound of the same frequency.

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7(a)(i) Alternating current is one whose magnitude and direction change periodically with time (01)

(ii) Reactance is the non-resistive opposition to flow of alternating current through a capacitor or Inductor (01)

b(i) Back e.m.f induced $E_b = -L\frac{dI}{dt}$

but $V = -E_b$ (for finite current)

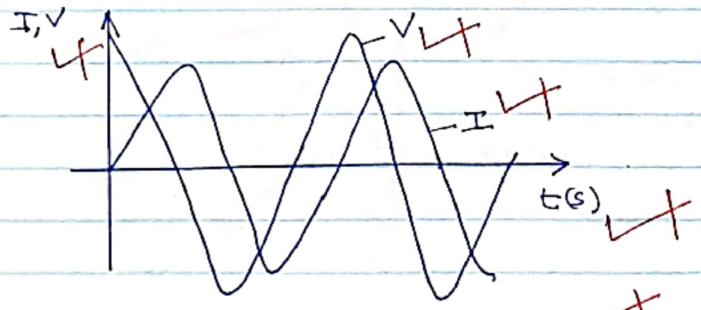
$$\therefore V = L\frac{dI}{dt} = L\frac{d}{dt}(I_0 \sin 2\pi f t)$$

$$= 2\pi f L I_0 \cos 2\pi f t$$

$$\Rightarrow V_0 = 2\pi f L I_0$$ (04)

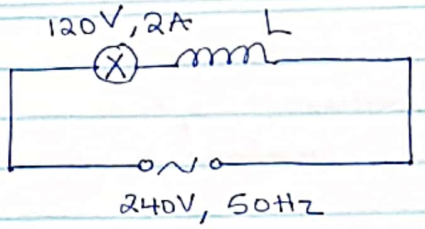
$$X_L = \frac{V_{rms}}{I_{rms}} = \frac{V_0}{I_0} = \frac{2\pi f L I_0}{I_0} = 2\pi f L$$

(ii)



(02)

(iii) Initially, current is zero, the rate of change of current is maximum, implying the back e.m.f (supply voltage) is maximum. When current increases, it's rate of change reduces hence back e.m.f reduces (02)
When current is maximum, it's rate of change is zero hence voltage is zero.



Impedence, $Z = \frac{V_{rms}}{I_{rms}} = \frac{240}{2} = 120\Omega$

But $Z = \sqrt{X_L^2 + R^2}$ and $R = \frac{V}{I} = \frac{120}{2}$

$= 60\Omega$

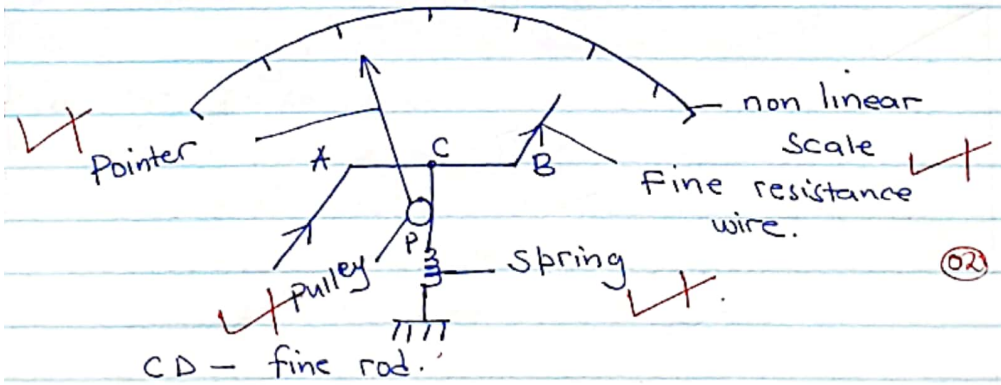
$\therefore 120 = \sqrt{X_L^2 + 60^2}$

$X_L = 103.9\Omega$ (03)

$X_L = 2\pi f L$

$L = \frac{103.9}{2\pi \times 50}$

$L = 0.33H.$ (02)



(02)

- Current to be measured is passed through a fine resistance wire AB. The wire heats up, expands and sags.
- The sag is taken up by fine rod CD passing round pulley P. Hence pulley rotates causing the pointer to deflect over the scale.
- The deflection of the pointer is proportional to the sag and therefore proportional to the average of square of current. (03)

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Resistance is the opposition to flow of current through a conductor. (01)

$$R = \rho L/A$$

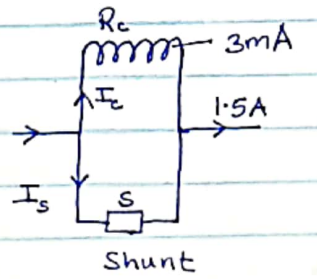
$$R = \frac{\rho_m L_m}{A_m} = \frac{\rho_n L_n}{A_n}$$

$$L_n = \frac{\rho_m L_m A_n}{\rho_n A_m}$$

$$L_n = \frac{4.6 \times 10^{-7} \times 20 \times 0.5^2}{0.54^2 \times 10}$$ (03)

$$\therefore L_n = 7.89\,m$$

Resistance is directly proportional to length of conductor and inversely proportional to cross-sectional area when connected in parallel, a larger cross-sectional area is offered for passage of charge, hence resistance is reduced. When connected in series, length is increased, which increases resistance. Hence current is larger when resistors are in parallel and smaller when in series. (03)



$$I = I_c + I_s$$

$$I_s = I - I_c$$

$$= 1.5 - 3 \times 10^{-3}$$

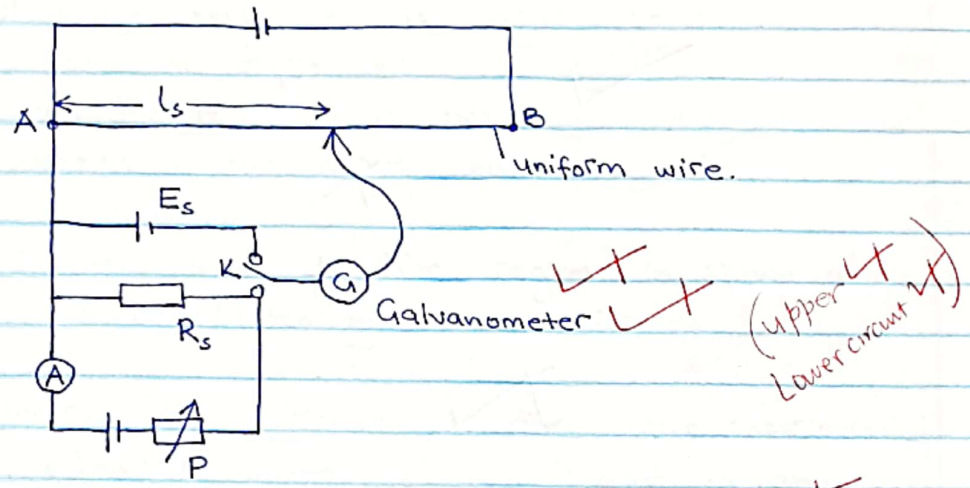
$$= 1.497\,A$$

P.d across the components (03)

$$I_c R_c = I_s \times S$$

$$10 \times 0.003 = 1.497 \times S$$

$$S = \frac{0.03}{1.497} = 0.02\,\Omega$$



. The circuit is connected as above; E_s is standard e.m.f and R_s is standard resistance. Switch K is connected to position 1 and the lockey is tapped along the uniform wire until where G shows no deflection. The balance length l_s is measured and recorded. K is connected to position 2 and P adjusted to a suitable reading I_r of the ammeter. The balance point is again located and the balance length l is measured. The experiment is repeated for other settings of I_r and the results recorded in a table including values of

$$I_a = \frac{E_s}{l_s} \times \frac{l}{R_s}$$

(06)

A graph of I_a against I_r is plotted and it constitutes the calibration graph

- Non uniformity of the slide wire. Resistance per cm will not be constant and hence the calculations aren't accurate.
- End errors. when there is poor contact at the ends of the wire, the resistance is not accounted for, hence causing errors (02)

(iii) – when the test cell is larger compared to that of the driver cell.

– When the test cell is not connected in opposition to the driver cell

20

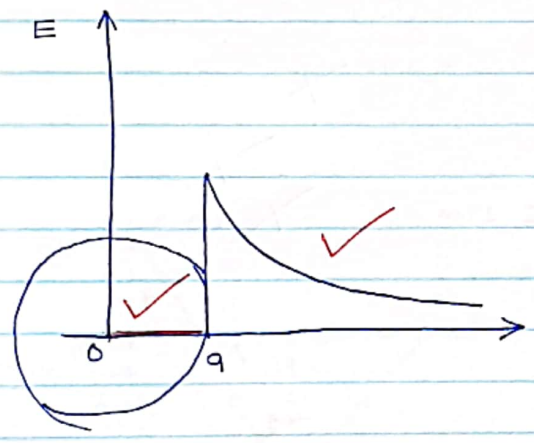
02

9(a)(i) Electric field is the region in space where electric force/intensity is experienced.

Electric field strength is the force experienced by a positive charge of 1C placed in an electric field

02

(b)



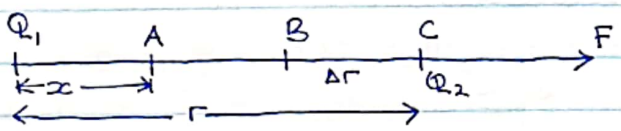
Deduct $\frac{1}{2}$ if radius of sphere not indicated.

02

(c)(i) Electic potential energy is the workdone to move a positive charge from infinity to a point in an electric field

01

(ii)



Small workdone to move Q_2 from C through distance Δr, $\Delta W = -F\Delta r$

Force acting on Q_2, $F = \frac{KQ_1Q_2}{r^2}$

$$\therefore \Delta W = \frac{-KQ_1Q_2\Delta r}{r^2}$$

Total work done to move Q_2 from infinity to point A

$$W = \int_{\infty}^{x} \frac{-KQ_1Q_2}{r^2}\,dr$$

{Check Variables & limits.}

$$= -KQ_1Q_2\left[\frac{1}{-r}\right]_{\infty}^{x}$$

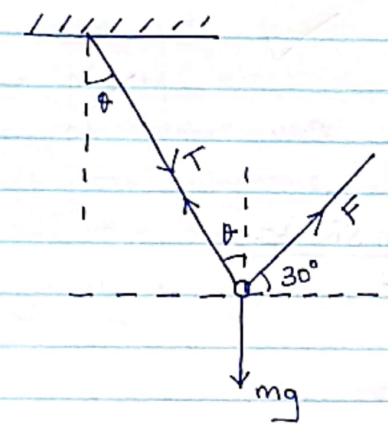
$$= \frac{KQ_1Q_2}{x}$$

(04)

$$= \frac{Q_1Q_2}{4\pi\varepsilon_0 x}$$

{for $V = \frac{KQ}{x}$} maxm 3mks.

d



MTD I

$\sin\theta = \frac{5}{20}$.

Resolving vertically.

$T\cos\theta + F\sin 30 = mg$ - - - - - - (i)

Resolving Horizontally

$T\sin\theta = F\cos 30$ - - - - - - - (ii)

from (i) and (ii)

$$\frac{mg - T\cos\theta}{T\sin\theta} = \tan 30^\circ$$

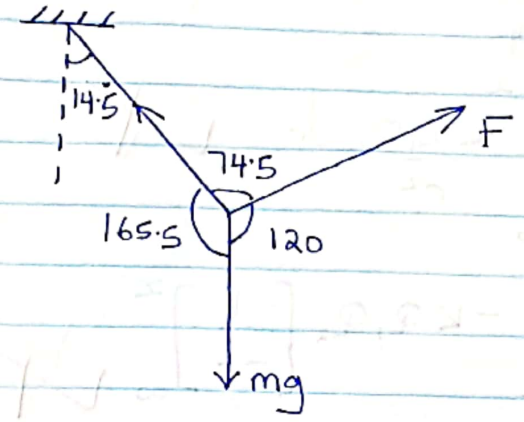
$$T = \frac{mg}{\sin\theta\tan 30 + \cos\theta} = \frac{80 \times 9.81 \times 10^{-3}}{\tan 30 \sin 14.5 + \cos 14.5}$$

$$= 0.7053\ N.$$

(02)

MTD II

(i)



$\sin\theta = \frac{5}{20}$

$\theta = 14.5°.$

$$\frac{T}{\sin 120} = \frac{mg}{\sin 74.5}$$

$$T = \frac{80\times10^{-3}\times 9.81\times \sin 120}{\sin 74.5}$$

$$= 0.705N$$

(ii) $$F = \frac{mg \sin 165.5}{\sin 74.5}$$

$$= \frac{80\times10^{-3}\times 9.81 \sin 165.5}{\sin 74.5}$$

$$= 0.204N.$$

$$Q = \frac{F}{E} = \frac{0.204}{1.5\times10^{-6}}$$

$$= 1.36\times10^{-7}C$$

CamScanner

(ii) from (ii) $F = \frac{T\sin\theta}{\cos 30}$

$= \frac{0.7053 \sin 14.5}{\cos 30}$

$F = 0.2039$

$Q = \frac{F}{E}$

$= \frac{0.2039}{1.5 \times 10^{6}}$

$= 1.36 \times 10^{-7} C$

03

(e) When two dissimilar insulators are rubbed together, heat is produced due to friction. Soon the heat becomes adequate for the insulator of low work function, it releases some of it's electrons that are gained by the one of higher work function. The insulator that lost electrons becomes positively charged while the one that gained electrons becomes negatively charged.

03

(f) The divergence of the leaf reduces the increases As the body approaches the cap, it repels electrons from the cap to the plate and the leaf. This reduces the charge on the plate and the leaf. Thus divergence of the leaf reduces until they are neutralised.
On approaching the cap further more electrons are repelled to the plate and the leaf, making the leaf to diverge

03

20

10 (a) (i) A farad is the capacitance of a capacitor when a charge of 1C is on it's plate and a p.d of 1V is across it's plate. (01)

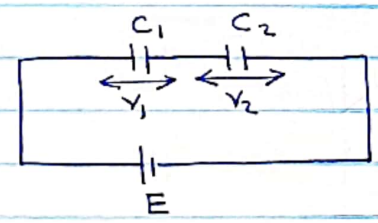
(ii) Dielectric strength is the maximum potential gradient / Electric field Intensity which the dielectric material can with stand without it's Insulator breaking down. (01)

(b)(i) - To seperate the capacitor plates.
- To reduce on chances of dielectric break down when Large p.d is applied. any two
OR
- To Increase dielectric strength.

(ii)

Chemical energy → Electrical energy → Heat energy / Electric potential energy.

(c)



$E = V_1 + V_2$ $\quad V_1 = \frac{Q}{C_1}$ & $V_2 = \frac{Q}{C_2}$

$$E = \frac{Q}{C_1} + \frac{Q}{C_2} = Q\left(\frac{C_1 + C_2}{C_1 C_2}\right)$$

$$\Rightarrow \quad Q = \frac{E C_1 C_2}{C_1 + C_2}$$

But $Q = V_1 C_1$ $\quad V_1 C_1 = \frac{E C_1 C_2}{C_1 + C_2}$ (03)

$$\therefore \quad V_1 = \left(\frac{C_2}{C_1 + C_2}\right) E.$$

OR

(d) (i) $C_0 = 16\mu F$ (ii) $C_0 = \frac{C}{4} = \frac{16}{4} = 4\mu F$ (02)

(ii) $C_d = \varepsilon_r C_0$
$= 16 \times 4$
$= 16 \times 10^{-6} F$

(ii) $E_1 = \frac{1}{2}CV^2$
$\Delta E = E_1 - E_2$
$= \frac{1}{2}(C_1 - C_2)V^2$
$\therefore \Delta E = \frac{1}{2}(16-4) \times 10^{-6} \times 6000^2$
$= 216 J$

$\Delta E = E_d - E_0$
$= \frac{1}{2}(C_d - C_1)V^2$

$= \frac{1}{2}(64-16) \times 10^{-6} \times 6000^2$ (04)

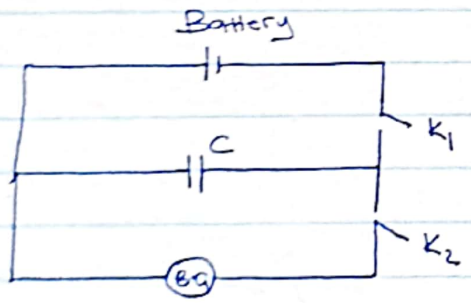
$= 864 J$

(iii) When dielectric is removed, capacitance reduces (charge reduces) hence energy reduces. (01)

OR

Some energy is returned to sources, part of it dissipated as heat in wires.

(e)



- A standard capacitor of capacitance C_s is connected at position C.
- Leaving switch K_2 open, switch K_1 is closed. K_1 is opened and K_2 closed. The maximum deflection θ_1 is noted (01)
- The standard capacitor is replaced with test capacitor of capacitance, C. The procedure is repeated and new maximum deflection θ_2 of B.G is noted.

20

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