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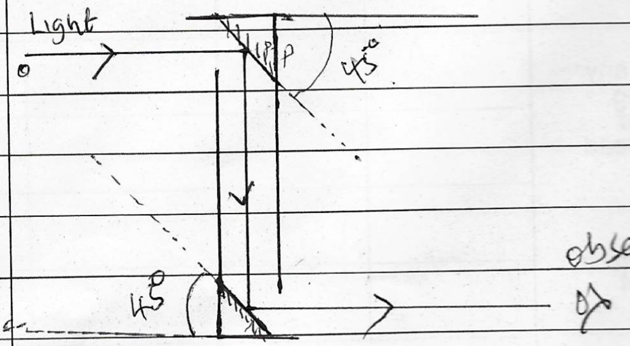
P510/2

Qn 1 (a)

The Incident ray, the reflected ray and the normal at ~~the~~ point of Incidence all lie in ~~the~~ same plane. 02

~~Or~~ The angle of Incidence is Equal to ~~the~~ angle of reflection.



- A periscope is an application of the law of reflection, the plane mirrors are placed at 45° angle as light always reflects away from a mirror at the same angle that it hits it. Light from an object O hits/strikes the top mirror at 45° and bounces off at the same angle. This sends light directly down the tube and onto the lower mirror. This mirror also at a 45° angle, reflects light directly to ~~your~~ the eye 05

b (ii)

- No significant loss of light energy in total internal reflection, hence

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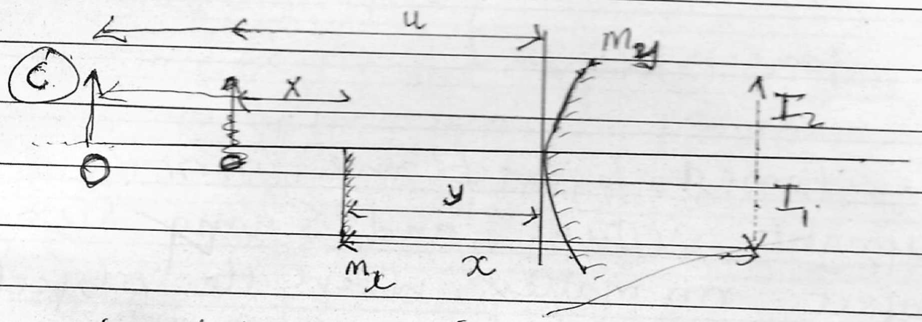
in prisms, the reflected ray has a whole of the energy incident light wave so a brighter image is formed in prisms unlike in plane mirrors.

- No need of silvering is ~~requ-~~ prisms

- Total reflecting prism can be used to invert an image, while a plane mirror cannot.

Any 2

2



- An object pin O is placed in front of convex mirror M_2 such that it forms a virtual diminished image I. The distance u of object O from convex is measured and recorded.

- A plane mirror M_x is then placed between object O and the convex mirror such that it covers half aperture of the convex mirror.

- The plane mirror M_x is adjusted until its own image I_2 of O coincides with image I_1 by no parallax method.

- Measure distances x & y.

- focal length, f of a concave mirror is got from $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$, where

$u = x+y$

$v = -(x-y)$.

05

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d(i) $y = 10cm$.

$x = 20cm$.

$u = y + x = 10 + 20 = 30cm$

$v = -(x - y) = -(20 - 10) = -10cm$.

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

$\frac{1}{30} - \frac{1}{10} = \frac{1}{f}$ $f = -15cm$.

05

The Image fome.

The image formed by a plane mirr is always upright, virtual and same size as the object no matter where the object is infront of the mirror. Images formd in Concave mirror is Inverted, real and diminished if the object is at a distance farther than ~~the~~ focal length.

01

20

UACE

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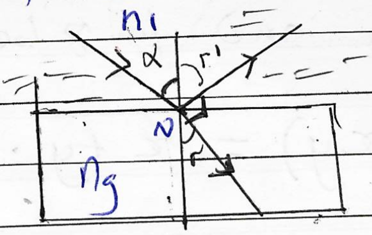
2 (a) (i).

Absolute Refractive Index of a medium is the ratio of the velocity of light in vacuum to the velocity of light in the medium. 01

a (ii).



Apply Snell's at N'

$n_1 \sin\alpha = n_g \sin r$ — ①

$\Rightarrow$ Since $r' + 90 + r = 180$, $r = 90 - r'$

but $r' = \alpha$ (laws of Reflection);

hence $r = 90 - \alpha$. — ②

Substitute ② in ①. 02

$n_1 \sin\alpha = n_g \sin(90 - \alpha)$.

$n_1 \sin\alpha = n_g \sin 90 \cos\alpha - \sin\alpha \cos 90$

$n_1 \sin\alpha = n_g \cos\alpha - 0$.

$\frac{n_1 \sin\alpha}{\cos\alpha} = n_g$

$\boxed{n_g = n_1 \tan\alpha.}$

(ii)

Before Removal; $n_g = 1.33 \tan\alpha$ — ①

After Removal $n_g = 1 \tan(\alpha + 8)$ — ②

Equating ① and ②

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Pg 5

$1.33\tan\alpha = \tan(\alpha+8).$

$1.33\tan\alpha = \dfrac{\tan\alpha + \tan 8}{1-\tan\alpha\tan 8}.$ ✓

let $\tan\alpha$ be x, and $\tan 8$ be y

$1.33x(1-xy) = x+y.$

$1.33x - 1.33x^2y = x+y.$ ✓

but $y = \tan 8 =$

$1.33x - 0.186919x^2 = x + 0.1405$

$0.33x - 0.186919x^2 = 0.1405$

$0.186919x^2 - 0.33x - 0.1405 = 0$ --- (1)

$x_1 = -0.3546$ (not applicable). | and $x_2 = 2.12$ ✓

but $\tan\alpha = 2.12$

$\alpha = \tan^{-1}(2.12) = 64.7^0$

$n_g = 1.33\tan\alpha$

$= 1.33 \times 2.12$

$= 2.8196$

From the equation above; ---- (1)

$x_1 = 0.7172$ and $x_2 = 1.0484$

For $x_1 = \tan\alpha_1$

$\alpha_1 = \tan^{-1}(0.7172)$ $\alpha_2 = \tan^{-1}(1.0484)$

$\alpha_1 = 35.6^0$ or $\alpha_2 = 46.4^0$

$n_g = 1.33\tan\alpha_1$ or $n_g = 1.33\tan\alpha_2$

$n_g = 1.33 \times 0.7172$ or $n_g = 1.33 \times 1.0484$

$n_g = 0.95$ $n_g = 1.40$

$\therefore\ n_g = \underline{\underline{1.40}}$ and $\alpha = \underline{\underline{46.4^0}}$

04

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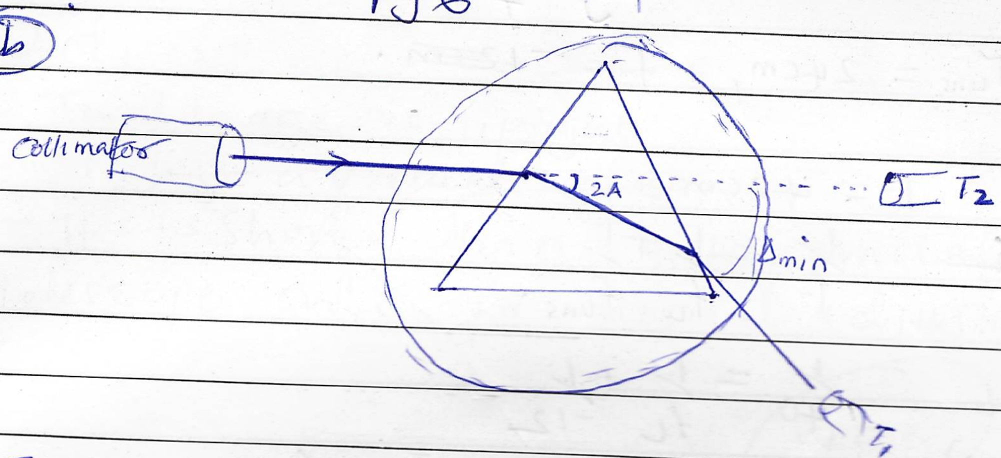
(b)



- The Collimator is adjusted to produce parallel rays of light.
- The telescope is adjusted to receive light from the Collimator on its cross wire
- The turntable is levelled.
- The prism is placed with the refracting angle facing away from the Collimator as shown above.
- The telescope is turned to receive refracted light from the opposite face of the prism.
- The table is now turned while keeping the refracted light in view until a point when the ray begins to move backwards. Mark T_1
- The prism is removed and the telescope is turned to ~~to~~ receive light directly from the collimator. The new position T_2 is now noted.
- The angle between T_1 and T_2 is determined and is the angle of minimum deviation, D_{min}.
- Since the refracting angle, A, is known, then the refractive index

$$n = \frac{\sin\left(\frac{D_m + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

06

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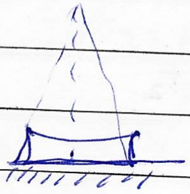
2(c). $r_{lens} = 24cm$, $f = -\cancel{12cm}$.



$F = 40cm$.

$$\frac{1}{F} = \frac{1}{f_L} + \frac{1}{f_{lens}}.$$

$$\frac{1}{40} = \frac{1}{f_L} + \frac{1}{-12}$$

For liquid lens:

$$\frac{1}{f_L} = (n_L - 1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

$$\frac{1}{f_L} = (1.4 - 1)\left(\frac{1}{24} + \frac{1}{\infty}\right)$$

$$f_L = 60cm.$$

$$\Rightarrow -\frac{1}{40} = \frac{1}{60} + \frac{1}{f_{lens}}$$

$$f_{lens} = -24cm.$$

$$\frac{1}{24} = (n_g - 1)\left(\frac{1}{-24} + \frac{1}{-24}\right).$$

$$n_g = 1.5.$$

05

05

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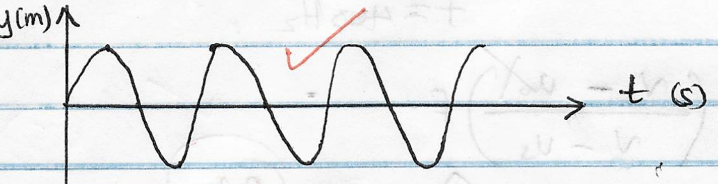
2(d).

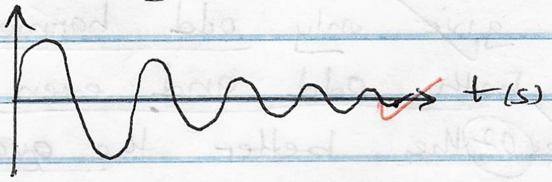
- Final Image is upright
- Jt ~~has a virtual eye ring~~. Any 2 02
- Jt is Shorter than astronomical telescope when in normal adjustment.

20

3 (a) Free oscillations are oscillations that take in absence of dissipative forces such as air resistance and the amplitude of oscillation remains the same. 02



Damped oscillations are oscillations that take place in presence of dissipative forces and the amplitude of oscillation keeps on reducing with time due to loss energy to the sorrounding.



B(i) Beats are periodic rise or fall in the intensity of sound heard when two notes of nearly the same frequency are played together. 01

(ii) A tuning fork of known frequency f_T is sounded together with a musical instrument of unknown frequency f,

The number of beats (n) per second are counted and beat frequency is noted as

$$f_b = \frac{n}{t}$$

One prong of a tuning fork is loaded with plasticine and sounded again together with the musical instrument and the new beat frequency f_b' is noted.

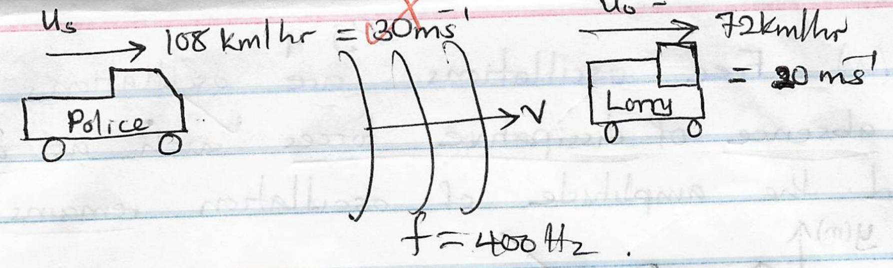
~~If $f_b' < f_b$ then frequency of the musical~~

When two notes are perfectly in tune, beats stop and the interference becomes purely constructiv 04

c (i) Doppler effect is the apparent change in the frequency of waves 01 heard due to relative motion betweeen the observer and source of signals.

(ii)

(ii)



$$f_a = \left(\frac{v - u_o}{v - u_s}\right) f$$

$$f_a = \left(\frac{340 - 20}{340 - 30}\right) \times 400$$ 03

$$f_a = \underline{\underline{412.9 \text{ Hz}}}$$

d(i) Closed pipes give only odd harmonics while open pipes give both, odd and even harmonics/tones The more overtones 02 the better the quality of sound thus open.

(ii) $f_n = \frac{nV}{4l}$ $n = 1, 3, 5, 7, 9 - - - - -$

$$860 = \frac{n \times 340}{4 \times 0.29}$$

$$n = 2.9 \simeq 3$$

The mode of vibration is the 3rd harmonic

Using

$$f_n = \frac{nV}{4(l+c)}$$

$$c = \left(\frac{3 \times 340}{4 \times 860}\right) - 0.29$$

$$c = 0.2965 - 0.29$$ 03

$$c = 0.0065 \text{ m}.$$

e

T = 20

If the path difference differ by a half number of wave-lengths, destructive Interference occurs.

For maximum brightness $n\lambda = d\sin\theta$.

minimum brightness $(n+\frac{1}{2})\lambda = d\sin\theta$

05

Where λ is Wavelength and d is the distance of separation between the two slits.

(c)(i) Equally spaced bright and dark fringes are observed and these fringes are parallel to the thin end of the wedge 02

(ii) The line of contact will still be a dark fringe but wavelength of light in water is less than in air hence the fringe separation is reduced. 02

(d) $\lambda = 5.8 \times 10^{-7}$ m.

$n = 2$ (second order).

$\theta = 27°$

Using $d\sin\theta = n\lambda$.

$$d = \frac{n\lambda}{\sin\theta}$$

$$= \cancel{2 \times 5.8 \times 10^{-7}}$$

$$\frac{1}{d} = \frac{1}{\frac{n\lambda}{\sin\theta}}$$

$$\left(\frac{1}{d}\right) = \frac{\sin\theta}{n\lambda}.$$

$\left(\frac{1}{d}\right)$ No of lines per metre $= \frac{\sin 27}{2 \times 5.8 \times 10^{-7}}$.

$= 3.91 \times 10^{3}$ lines/cm

04

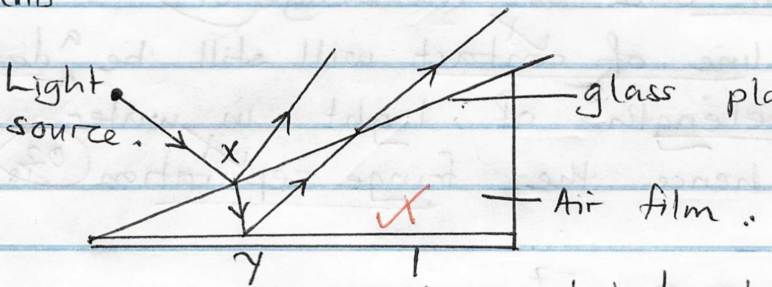
T = 20

4(a)(i) Intereference is the overlapping of waves from different two coherent sources resulting into alternate regions of maximum and minimum intensity. 02

(ii) - Coherent sources must be close to each other

- Wave trains must have nearly equal amplitudes 02 any two
- Waves sources must be coherent or have constant phase relationship.
- The screen must be as far as possible from the source.

(iii)



- The surface to be tested is placed in contact with an optical flat surface to form an air wedge as shown below.

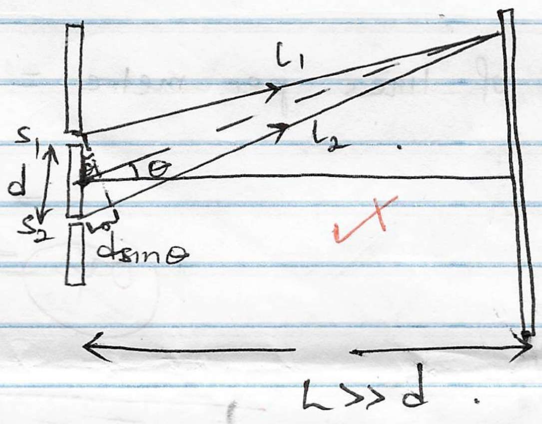
- Monochromatic light is made incident almost normally onto the upper glass slide.

It's partly reflected back at X and partly transmitted in the air film and reflected at Y.

The interference patterns produced by the reflected light from the air wedge is observed.

If the surface is flat, straight parallel and equally spaced bands will be observed and for if not flat, uneven bands will be seen 03

(b).



- Consider two coherent sources of waves S_1 and S_2 at a distance of separationd, and the two waves meet at P.
- The path difference of the two waves S_1 and S_2 is

screen. $d\sin\theta = L_2 - L_1$

- If the path difference is an integral multiple of wave lengths ie $(n\lambda)$ then

SEC C

5 (a) Tesla is the magnetic flux density experienced by a current carrying conductor of length 1m carrying a current of 1A placed at right angles to uniform magnetic field.

(b). (i) When a conductor is placed at right angles in magnetic field B. and current is passed through it transversely

The electrons in the conductor experience a force on side P and drift to side Q according to Flemings left Hand Rule.

This makes side Q to gain a negative charge and side P gains a positive charge hence causing an electric field intesity between P and Q until a maximum p.d is created. 03

This p.d is called hall voltage and it accounts for the occurrence of p.d between P and Q.

(ii) Electrons experience an electric force F_E due to electric field;

At equilibrium $F_E = F_B$

$Ee = BeV\sin\theta$

$E = BV$ --① but $\sin\theta = 90°$.

But $\frac{V_H}{d} = E_H$ --② and v is velocity of electrons

substitute eqn ② in ①

$$\left(\frac{V_H}{d}\right) = BV \quad \text{and} \quad d = a.$$

$$E = B\left(\frac{I}{neA}\right)$$

$$\boxed{E = \frac{BI}{neA}}$$

Where A - cross sectional area A.

03

$V_H = BVa$ and $I = nevA$

$$V = \frac{I}{neA}.$$

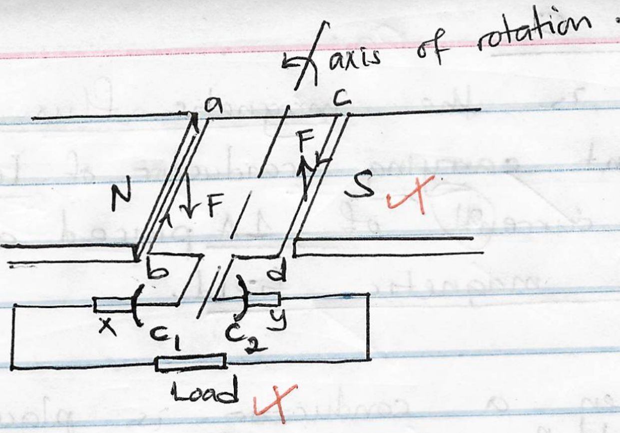
$$V_H = \frac{BIa}{neA} \quad \text{but} \quad A = a \times t$$

$$V_H = \frac{BI \times a}{ne \cdot at}$$

$$\boxed{V_H = \frac{BI}{net}}$$

Where t - thickness of conductor

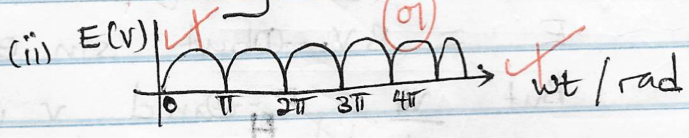
(C) (i)



When a coil is in the vertical position, a mechanical force is applied to move the coil in an anti-clockwise direction.
Side ab moves downwards and cd upwards.
As the coil rotates, the flux linking it changes, emf is induced causing a current to flow according the direction determined by Fleming's Left Hand Rule.
After the next vertical position ab & cd moves up and down respectively and this reverses the direction of current induced.
The output does not change in direction. It is because after the vertical position, the commutators change contacts from one carbon brush to another hence maintaining the direction of current at the output ie

05

(ii)



01

(iii) When the coil rotates in a magnetic field, there is a change in flux and an emf is induced. But the direction of the induced current acts in such a way to oppose the emf generated and this is referred to as back emf.

03

(d) $f = 2000 \text{ rev min}^{-1} = \left(\frac{2000}{60}\right) \text{Hz} = 33.3 \text{ Hz}$

$S = 10 \text{ cm}$

$B = 0.8\text{T}$, $N = 120$ turns ;

$E = BANw\cos\theta$

$E = 0.8 \times (0.1)^2 \times 120 \times 2\pi \times \frac{2000}{60} \times \cos 30$

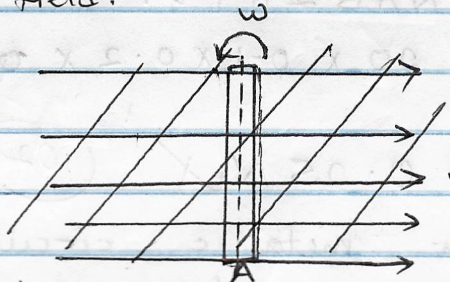
$E = 174.12 \text{ V}$

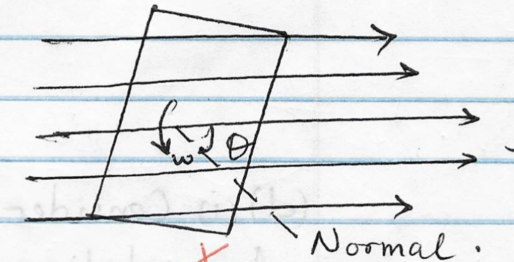
04

6(a) Faraday's law states that the rate of change of magnetic flux is proportional to emf induced in the conductor. (01)

Lenz's law states that the induced emf in a conductor acts in such a way so as to oppose the change causing it. (01)

(b)(i) Consider a coil of area A being rotated at a frequency f in a uniform magnetic field of flux density B about an axis which is perpendicular to the field.





From $\frac{d\Phi}{dt} \propto E$.

for N - turns

$$E = -N\frac{d\Phi}{dt}$$ but $\Phi = BA\cos\theta$

$\theta = \omega t$, for time t that has elapsed

$$E = -N\frac{d}{dt}(BA)\cos\omega t$$

$\theta = 90°$

$$E = -NB\left(\frac{dA}{dt}\right)\cos\omega t$$

$\omega t = 90°$

$$E = -NAB\frac{d}{dt}(\cos\omega t)$$

$$E = -NAB(-\omega\sin\omega t).$$

$$E = BAN\omega(\sin\omega t)$$ but $\omega = 2\pi f$ and

$$E = BAN(2\pi f)$$ $\omega t = 90°$

$$\boxed{E = 2BAN\pi f}$$

04

(ii) Number of turns of the coil

Cross sectional area of the coil

Speed of rotation of the coil

Strength of magnetic field.

02

(iii) - Energy losses in form of heat due to eddy currents. 02

- I^2R losses.

(c) $N = 20$

$L = 10.0$ cm

$w = 20.0$ cm

$f = 300$ rev min $= \left(\frac{300}{60}\right)$ Hz

$\theta = 90°$

$B = 0.02$ T

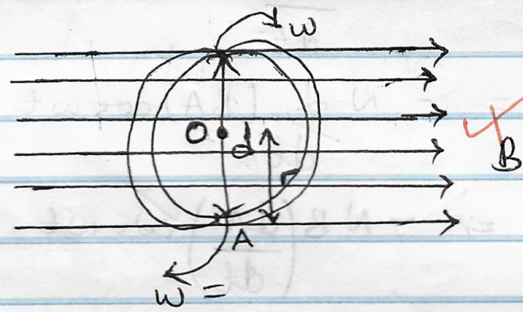
$E_{max} = NABw$

$= NAB2\pi f$

$= 20 \times 0.1 \times 0.2 \times 0.02 \times 2\pi \times \frac{300}{60}$

$= 0.25$ V 02

(d) (i) Consider a metallic circular disc of diameter d rotating in a uniform magnetic field of flux density B at frequency f with its plane perpendicular to the field.



where r - radius.

$d = 2r$.

OA cuts the cuts the magnetic field continously; Average velocity of OA $= \frac{0 + rw}{2}$

$v = \frac{rw}{2}$

Induced emf $E = BLV$

$E = BrV = Br.\frac{rw}{2} = \frac{Br^2w}{2}$

$E = \frac{Br^2 \times 2\pi f}{2}$ since $w = 2\pi f$.

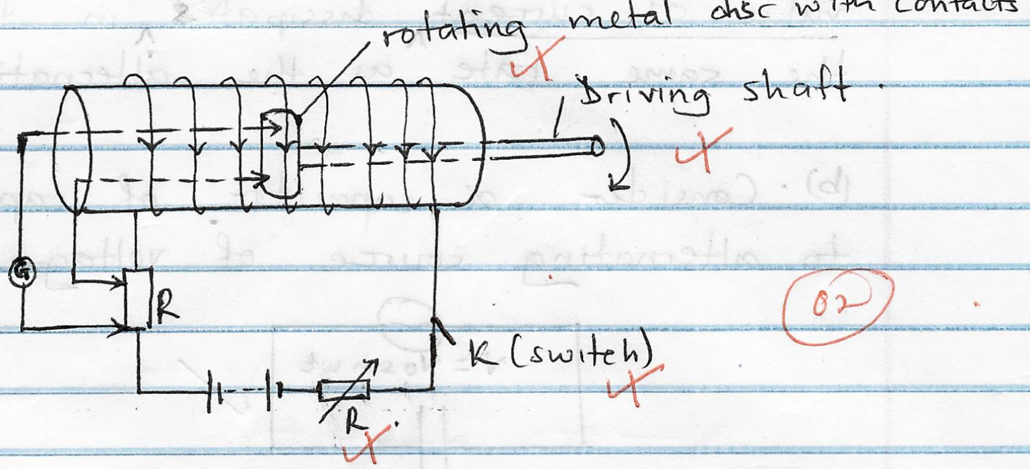
$E = B(\pi r^2)f$.

$|E| = BAf$ where $A = \pi\left(\frac{d^2}{4}\right)$

04

d = diameter of the rim.

(ii) Using a solenoid.



02

The metal disc is placed at the centre of the solenoid and attached to the ciruit carrying current through the solenoid when switch K is closed.

The plane of the disc is made perdendicular to the magnetic field.

The disc is rotated by the driving shaft and the speed of rotation is adjusted ~~by~~ until the galvanometer gives no deflection.

The number of rotations / revolutions of the disc in a given time t is counted and frequency f is determined.

The resistance ~~of~~ is calculated from;

$E = B\pi r^2 f$ but $E = IR$ and $B = \mu_0 n I$

$\Rightarrow R = \dfrac{B\pi r^2 f}{I}$

05

$R = \mu_0 n \pi r^2 f$ where n is the number of turns per metre of the solenoid.

T = 20

Qn. 7(a) Root mean square value of a.c is the steady value of current that dissipates heat in the resistor at the same rate as the alternating current.

(b). Consider a capacitor of capacitance C connected to alternating source of voltage $V = V_0 \sin wt$.

$V = V_0 \sin wt$

C

Instantaneous charge on the capacitor is given:

$Q = CV$ and

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

$I = \frac{d}{dt} CV_0 \sin wt$

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

$I = CV_0 w \cos wt$ but $I = I_0 \cos wt$.

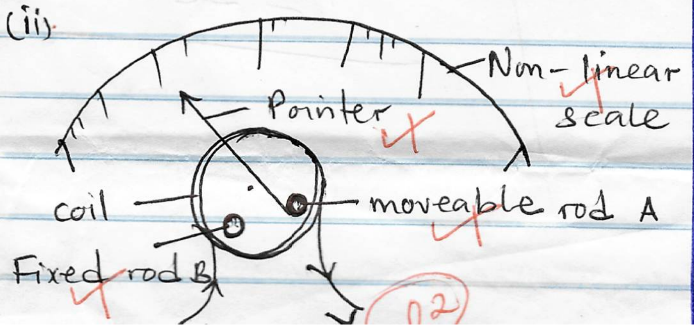
$I_0 \cos wt = CV_0 \cos wt$.

$I_0 = CV_0 w$ (peak value of current)

$\Rightarrow \boxed{I = CV_0 w \cos wt.}$

c(i) From capacitative reactance $X_c = \frac{1}{2\pi f c}$ to direct current is too much (infinity) since the frequency of d.c is zero while for a.c current, frequency is not zero hence the opposition by capacitor is smaller than that of direct current hence a capacitor allows a.c to flow but not D.C.

(ii).



(OR) c(i)

> When a capacitor is connected to a d.c source, it charges to a maximum value of p.d and current stops flowing through the capacitor

> When a capacitor is connected to a.c source, it charges and discharges repeatedly

The a·c current to be measured is passed through terminals X and Y.

Iron rods A and B are magnetised in the same sense and so they repel.

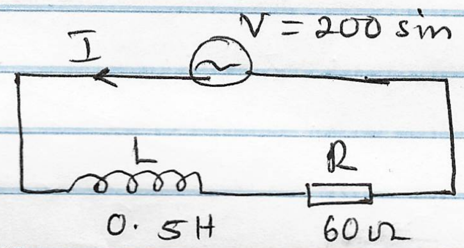
Rods A and B repel each other with the a force proportional to the square of the current I.

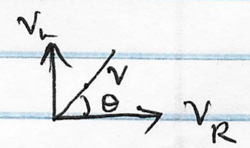
The moveable rod moves with the pointer connected to the hair spring to provide the restoring torque to balance the repulsive force. (03)

The deflection θ is proportional to the average value of square of current I ie

$\theta \propto I^2$. 05

(d) (i)





$$\theta = \tan^{-1}\left[\left(\frac{V_L}{V_R}\right) = \left(\frac{IX_L}{IR}\right) = \frac{X_L}{R}\right]$$ but $X_L = \omega L$

$X_L = 160 \times 0.5$

$$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right)$$

$$\theta = \tan^{-1}\left(\frac{160 \times 0.5}{60}\right)$$ (02) $X_L = 80\,\Omega$

$$\theta = \underline{53.1^\circ}$$

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

$$Z = \sqrt{80^2 + 60^2}$$

$$Z = 100\,\Omega$$

but From $V_0 = I_0 R$.

$$I_0 = \frac{V_0}{Z} = \frac{200}{100}$$ (03)

$$I_0 = \underline{2.0\,A}$$

(iii) $P = I_0 V_0 = 2.0 \times 200$ (02) $=$ 400 W

8(a) Temperature coefficient of resistance is the fractional change in resistance of a conductor at 0°C per degree celsius rise in temperature.

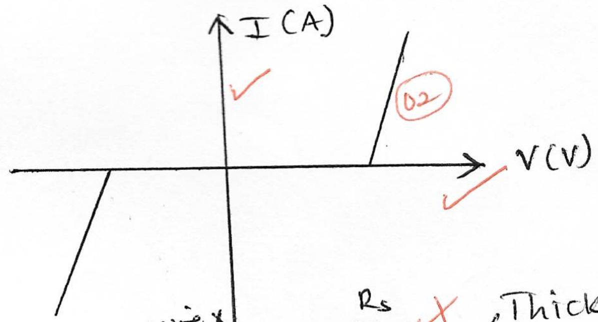
Resistivity is resistance ~~of ace~~ across opposite faces of a cubical conductor of length of 1m.

b(i) When a current is applied to pass across the conductor, conduction electrons gain kinetic energy and they drift in a direction opposite the applied current.

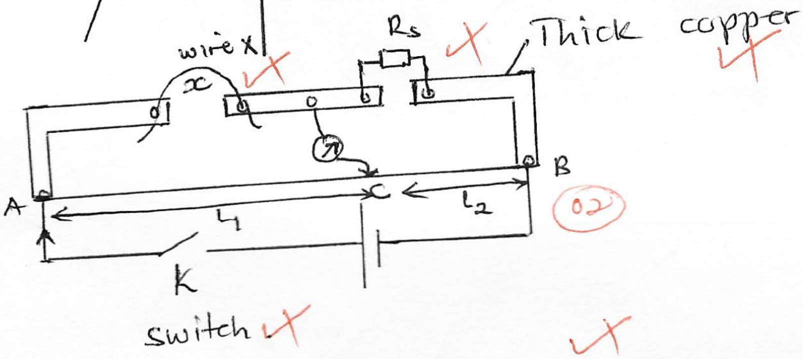
They collide with ions and lose their kinetic energy to them.

The ions vibrate with increased amplitude as a result temperature of the wire rises due to multiple collisions.

(ii)



(c)



Using a micrometer screw gauge, diameter of wire d, is measured and it's cross sectional area A is determined from $A = \frac{\pi d^2}{4}$

Connect a length x of the wire across the left hand gap and a standard resistance Rs in the right hand gap as shown above.

Close switch K and tap the jockey along AB until a suitable balance length l_1 is obtained when the galvanometer shows no deflection.

l_2 is also noted

Determine the resistance of the wire, R from

$$R_x = \frac{R_s l_1}{l_2}$$

Repeat the procedure for different values of x and tabulate your results in a suitable table.

x	L_1	L_2	R_x
⋮	⋮	⋮	⋮

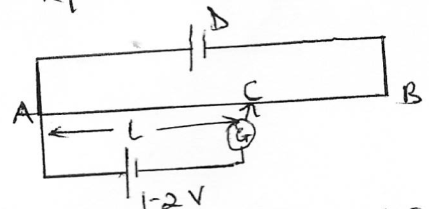
Plot a graph of R_x against x and determine the slope s of the graph.

06

Determine the resistivity of the wire $\rho = sA$

$$\rho = \left(\frac{s\pi d^2}{4}\right)$$ where s - slope, d - diameter of wire.

(d) If K_1 is closed and K_2 open.



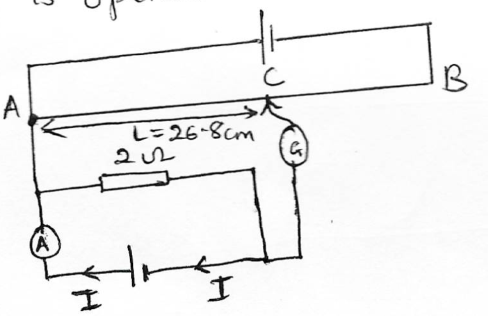
At balance p.d across $AC = 1.2$.

$$30.2 \times K = 1.2$$

$$K = \frac{1.2}{30.2}$$

$$K = 0.0397\ \mathrm{V\,cm^{-1}}$$

If K_1 is opened and K_2 closed.



At balance p.d across AC = p.d across 2Ω.

$$K \times L = I_a R$$

$$0.0397 \times 26.8 = I_a \times 2.$$

$$\Rightarrow I_a = 0.532\ \mathrm{A}$$

Error in ammeter reading $e = I_a - I_r$

$$e = 0.532 - 4.0$$

$$e = 0.132\ \mathrm{A}$$

04

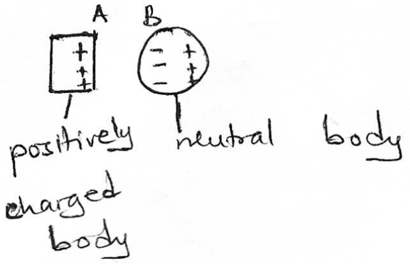
$$\text{percentage error} = \left(\frac{e}{I_a} \times 100\right)\%$$

$$= \left(\frac{0.132}{0.532} \times 100\right)\% = 24.8\%$$

T = 20

9(a) (i) When a positively charged body is brought near a neutral body, electrons in the neutral body gets re-distributed within the neutral body such that they are attracted towards the positavely charged body since unlike charges attract each other ie.

03



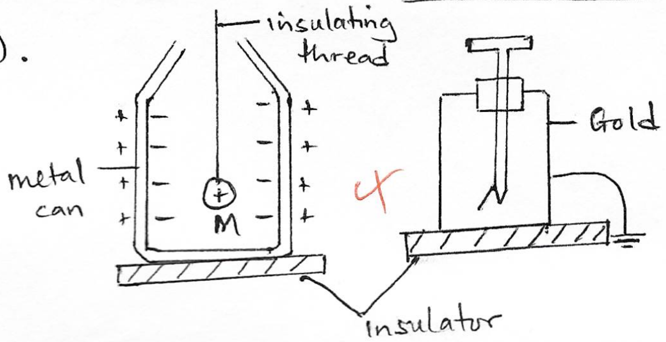
(ii) At sharp points, there is high electric field intensity which ionizes air around the charged conductor at sharp points.

The ions of opposite charge are attracted to the sharp point to neutralize the charge there.

03

This leads to loss of charge by the conductor which is known as corona discharge.

(B).



A positively charged metal sphere M is lowered into a metal can without touching it which is connected to a G-L-E and the leaf diverges.

M is withdrawn and the leaf of G-L-E collapses

Again M is lowered into the metal can (without touching it) and the leaf diverges to the same extent as before.

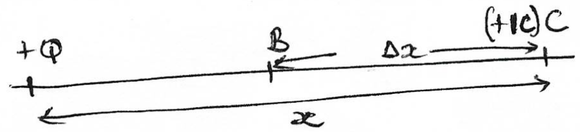
M is allowed to touch the can and the divergence remains unchanged.

M is withdrawn and on testing, it's found to have no charge.

04

Since M remains with no charge and the leaf of G-L-E remains diverged, there must have been charge inside the can equal and opposite to the charge on M, and the charge on the can must be residing outside and it is equal to the charge which was originally on M.

(c) Consider +1C charge, x metres away from $+Q$ moved from C to B through a small displacement Δx.



Force on +1C $F = \frac{Q}{4\varepsilon\pi x^2}$

Work-done to move the charge through Δx against the field is;

$\Delta W = -F\Delta x$

Total work done to bring the charge from infinity to a point at a distance d from the charge is;

$$W = \int_{\infty}^{d} -F\,dx$$

$$= \int_{\infty}^{d} -\frac{Q}{4\pi\varepsilon x^2}\,dx$$

$$= -\frac{Q}{4\pi\varepsilon}\left[-\frac{1}{x}\right]_{\infty}^{d}$$

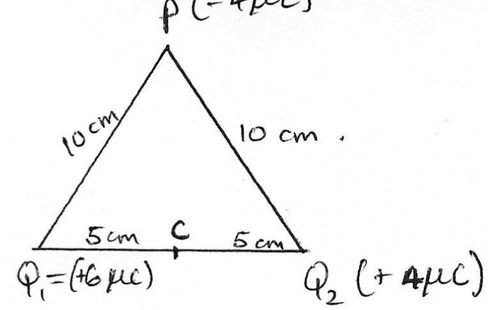
$$= -\frac{Q}{4\pi\varepsilon}\left(-\frac{1}{d} - -\frac{1}{\infty}\right)$$

$$W = \frac{Q}{4\pi\varepsilon d}$$

05

Hence $V = \frac{Q}{4\pi\varepsilon d}$

(d)



Using $V = \frac{Q}{4\pi\varepsilon_0 r}$

$V_{Q_1} = \frac{6 \times 10^{-6} \times 9.0 \times 10^{9}}{0.05} = 1.08 \times 10^{6}$ V

$V_{Q_2} = \frac{4 \times 10^{-6} \times 9.0 \times 10^{9}}{0.05} = 7.2 \times 10^{5}$ V

$02\frac{1}{2}$

potential at C $= V_{Q_1} + V_{Q_2}$.

$= (1{\cdot}08 \times 10^{6} + 7{\cdot}2 \times 10^{5})$

$= 1{\cdot}8 \times 10^{6}$ V

Workdone, $W = QV$

$= (-4 \times 10^{-6} \times 1{\cdot}8 \times 10^{6})$ 05

$= -7{\cdot}2$ J (negative sign means that work is done by the charge to overcame forces of attraction or repulsion) or against electrostatic forces of attraction and repulsion.

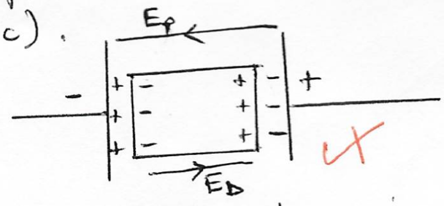
T = 20

Qn. 10 (a) (i) Dielectric field strength is the maximum p.d a dielectric material/insulator can withstand without conducting

OR Is the maximum electric field intensity an insulator can withstand without conducting. 01

A dielectric constant is the ratio of capacitance of a capacitor when the insulating material (dielectric) is placed between it's plates to the capacitance of the same capacitor with a vacuum between it's plates (without a dielectric). 01

(ii)



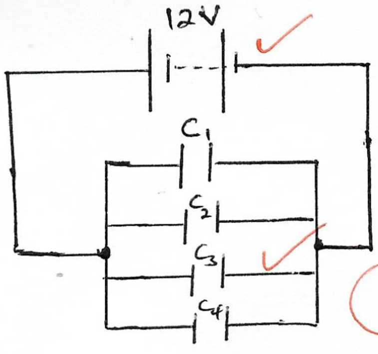
When a dielectric is placed between two parallel plates of a charged capacitor, it's molecules get polarized and it's surfaces adjacent to the plates develop charge opposite to that on the plate of the capacitor.

This results into developed of electric field intensity E_D between the polarized molecules of the dielectric and it opposes electric field intensity E_P due to the plates of the capacitor.

The resultant electric field intensity, E_R between E_P and E_D is given by; $E_R = E_P - E_D$ (E_R reduces) ie ($E \propto V$) 04

Thus $E = \frac{V}{d}$ implying that p.d between the plates reduces and Capacitance $C = \frac{Q}{V}$ hence capacitance increases.

10 B : (i)



02

Where $C_1 = C_2 = C_3 = C_4 = 6\mu F$

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

But $C_E = C_1 + C_2 + C_3 + C_4$

$= 6 + 6 + 6 + 6$

$= 24\mu F$

Energy, $E = \frac{1}{2} \times 24 \times 10^{-6} \times 12 \times 12$

$E = (0.000144 \times 12)\ J$ 03

$E = 0.0017J$ or $1.7 \times 10^{-3}\ J$

10(c) Initially energy stored by the capacitor is given by $E = \frac{1}{2}CV^2$ but $V = \frac{Q}{C}$ and

$C = \frac{\varepsilon_0 A}{d}$ (initial capacitance)

$$E = \frac{1}{2}C\left(\frac{Q}{\varepsilon_0 A/d}\right)^2$$

$$E = \frac{1}{2}\frac{dQ^2}{\varepsilon_0 A} \quad \text{--- (1)}$$

Therefore doubling the distance between the plates of the capacitor when disconneted from the source;

distance $= 2d$

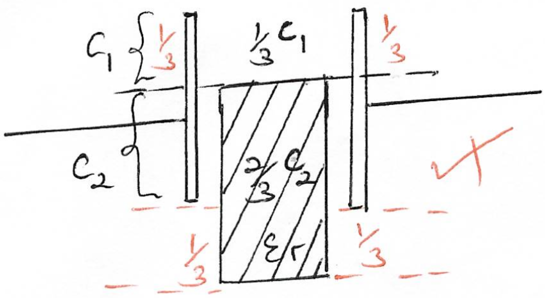
$$E' = \frac{1}{2}\cdot\frac{(2d)Q^2}{\varepsilon_0 A} = 2\left(\frac{1}{2}\frac{dQ^2}{\varepsilon_0 A}\right)$$

$E' = 2E$ (from equation (1)).

03

Thus energy will be doubled if the separation between the plates is doubled after it's disconnected from the battery (source).

(d).



$$C_1 = \frac{\varepsilon_0 A}{d}$$

$$\frac{\varepsilon_0 \varepsilon_r A}{d} = C_2.$$

Now C_1 ~~ared~~ and C_2 are in parallel connection.

The resultant capacitance $C = C_1 + C_2$.

$$C = \frac{C_1}{3} + \frac{2C_2}{3}$$

$$C = \frac{\varepsilon_0 A}{3d} + \frac{2\varepsilon_0 A \varepsilon_r}{3d}$$

$$C = \left(\frac{\varepsilon_0 A + 2\varepsilon_0 A \varepsilon_r}{3d}\right)$$

$$C = \varepsilon_0 A \left(\frac{1 + 2\varepsilon_r}{3d}\right)$$ as required. 03

(e) - storing energy
- Sensors.
- Tuning circuits any 02
- Radios, and other electronic devices.
- Timing components
- Power conditioning systems

T = 20

END.