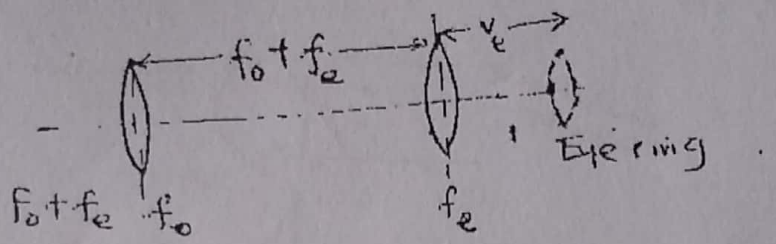
WAKISSHA
MARKING GUIDE
Uganda Advanced Certificate of Education
PHYSICS P510/2

1 (a) (i) Magnifying power is the ratio of the angle subtended by the final image of the eye using an optical instrument (a rded eye) to the angle subtended by the object at the eye without using the optical instrument (un arded eye)

(ii) Eye ring is the image of the objective as formed in the eye piece lens. **(02)**

(b) (i) Consider the astronomical telescope in normal adjustment.



Action of eye piece

$U_e = f + f_e = f_0$

$$\frac{1}{f_e} = \frac{1}{U_e} + \frac{1}{V_e}$$

$$\frac{1}{f_e} = \frac{1}{f_o + f_e} + \frac{1}{V_e}$$

$$\frac{1}{V_e} = \frac{1}{f_e} - \left(\frac{1}{f_o + f_e}\right)$$

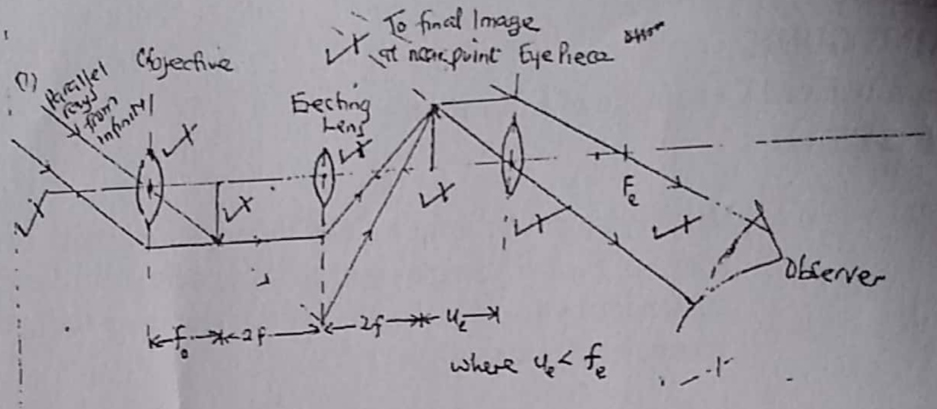
$$\frac{1}{V_e} = \frac{f_o + f_e - f_e}{f_e(f_o + f_e)}$$

$$V_e = \frac{f_e(f_o + f_e)}{f_o}$$

$$V_e = \frac{20(155 + 20)}{155}$$

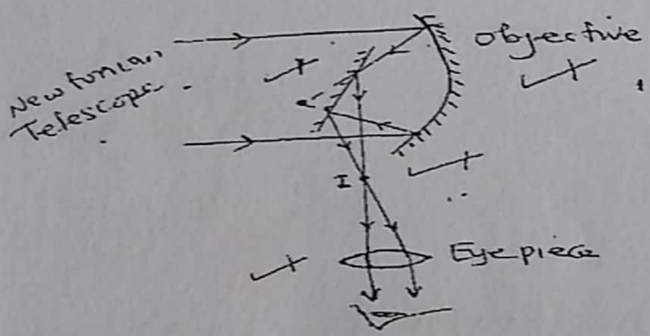
$V_e = 22.6cm$ **(04)**

- Recall for any telescope $f_0 > f_e$
- Then f_0= 155cm f_e = 20cm



(iii) - The brightness of the final image formed is reduced due to progressive reflection of some portion of light at the objective, erecting lens and finally at the eyepiece.
- The set up is very expensive due to additional lens.

(e) (i)



- Rays from a distant object are incident on the objective which is a concave mirror.
- The reflected rays from objective are directed to inclined such that the real image of the distant object is formed at the focal point of the eyepiece lens.
- The rays then emerge parallel in the eyepiece and to an observer, the final image is to infinity.

(ii) Advantages of reflecting telescope over a refracting telescope.
- No chromatic aberration in reflecting telescopes.
- Bright final image of distant object is seen
- It relatively cheap

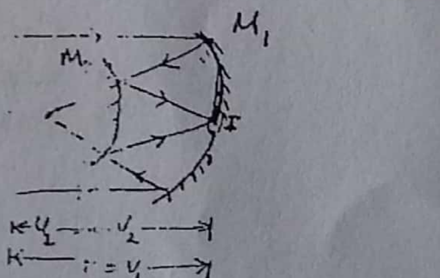
Any two @ ½

Action of concave mirror (objective)

$\frac{1}{f}=\frac{1}{\alpha}+\frac{1}{V_1}$, but $\quad V_1 = f_o = \frac{1}{2}r$

$V_1 = \frac{1}{2}x30$

$V_1 = 15cm$



Action of convex mirror

Let $U_2 = U, V_2 = d$ separation between M_1 and M_2

$U + d = f_1$

$U = 15 - d$ recall u – is virtual

f_2 " "

$$\frac{1}{^-f_2} = \frac{1}{^-(15-d)} + \frac{1}{d}$$

$$\frac{1}{^-10} = \frac{1}{d-15} + \frac{1}{d}$$

$$\frac{1}{^-10} = \frac{2d-15}{d^2-15d}$$

$$d^2 - 15d + 2od - 150 = 0$$

$$d^2 + 5d - 150 = 0$$

Solving by completing squares

a, = 1, $b = 5$, c= -150

From $d = \dfrac{-5 \pm \sqrt{5^2 - (4x1x - 150)}}{2}$

$$d = \frac{-5 \pm 25}{2}$$

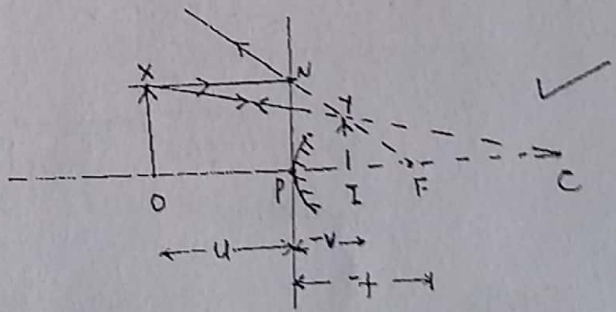
Consider $d = \dfrac{-5+25}{2}$ = 10 cm (04)

Thus d = 10cm separation of the mirrors.

2. (a) (i) Radius of curvature is the radius of the sphere from which the mirror was cut or of which the mirror forms part.

(ii) Principal focus is the point on the principal axis through which paraxial rays converge to after reflection. (02)

(b) (i)



Triangles OXC is similar to Δ FYC

$$\frac{OX}{IY} = \frac{OC}{IC} \, but OX = PN$$

$$\frac{PN}{IY} = \frac{OC}{IC} \,.....(i)$$

Triangle PNF and IYF are similar

$$\frac{PN}{IY}=\frac{PF}{IF} \text{ .... (2)}$$

Equating (1) to (2)

$$\frac{OC}{IC}=\frac{PF}{IF}$$

$$\frac{U-2f}{V-2f}=\frac{^-f}{V-f}$$

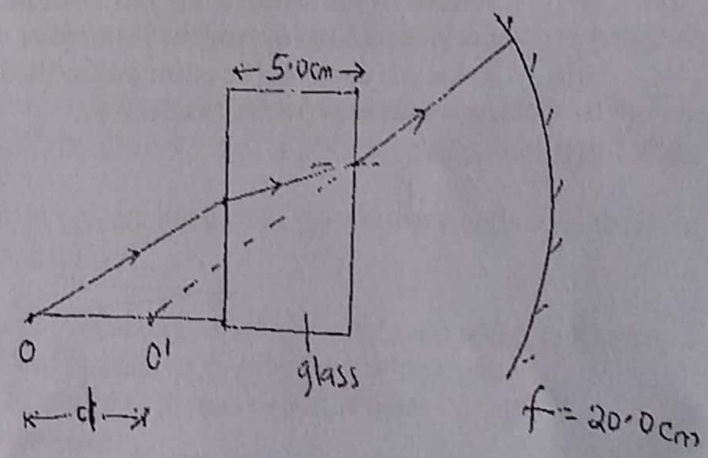
$$UV-UF-2FV+2f^2={}^-fV+2f^2$$ **(06)**

$$\frac{UV}{UVF}-\frac{UF}{UVF}-\frac{FV}{IUVF}=0$$ Dividing all through by UNF.

$$\frac{1}{f}-\frac{1}{V}-\frac{1}{U}=0$$

$$\frac{1}{f}=\frac{1}{V}+\frac{1}{U}$$

(ii) Convex mirrors
- Have a wider field of view
- Form erect / upright images **(02)**



<u>Case I</u>

$$\frac{1}{V}=\frac{1}{f}-\frac{1}{U}$$

$$\frac{1}{V}=\frac{1}{20}-\frac{1}{40}$$

$$\frac{1}{V}=\frac{1}{40}$$

V = 40cm – position of screen from the mirror

Case II

Effect if glass block – displaces initial object position O to O^1 through distance d.

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

$$d = 5\left(1-\frac{1}{1.5}\right)$$

$$d = 1.65cm$$

New object distance $U^1 = U - 1.65$

$U^1 = 40 - 1.65$

New image distance $V^1 = \frac{U^1 f}{U^1 - f}$

$$V^1 = \frac{36.35x20}{38.25-20}$$

$V^1 = 41.8$ - New position of screen

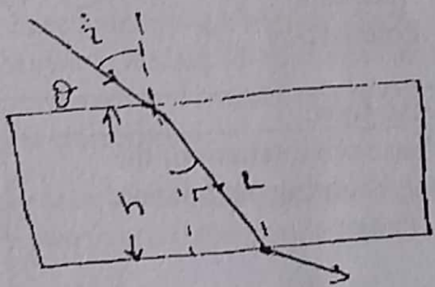
$\alpha = V^1 - V$

$= 41.8 - 40$

$\alpha = 1.8cm$ **(05)**

(d) (i) refractive index of an optical medium is the ratio of the velocity of light in air or vacuum to the velocity of light in a given medium. OR is the ratio of the sine of angle of incidence in air or vacuum to the sine of angle of refraction in a medium. **(01)**

(ii)



Time taken by light is $T = \frac{L}{V}$

But $L = \frac{h}{\cos r}$, and $r = \frac{C}{V}$, $V = \frac{c}{n}$

Then; $t = \frac{h}{\cos r} x \frac{n}{c}$

$$t = \frac{hn}{c\cos r}$$

Also $n = \frac{\sin i}{\sin r} = \frac{\cos\theta}{\sin r}, \sin r = \frac{\cos\theta}{n}$

Recall $\cos^2 r + \sin^2 r = 1$

$$\cos^2 r = 1 - \sin^2 r$$

$$\cos r = \sqrt{1 - \frac{\cos^2\theta}{n^2}}$$

$$\cos r = \frac{\sqrt{n^2 - \cos^2\theta}}{n}$$

$$t = \frac{hn}{c} x \frac{n}{\sqrt{n^2 - \cos^2\theta}}$$

$$t = \frac{hn^2}{c\sqrt{n^2 - \cos^2\theta}}$$ (05)

3. (a) (i) Path difference is the difference in the optical paths travelled by two wave trans before they superpose, superimpose, or meet or cross reach other. (01)

(ii) Wave front is a surface in an advancing wave along which all the wave particles are in phase. (01)

(iii) Wave length is the distance between two succession crests/troughs/compressions/rarefactions or wave particles in phase. (01)

(b) (i) - Diffraction
- Interference
- Reflection
- Polarisation

@ ½

(02)

Progressive wave	Standing / stationary wave
▪ Phase of vibrations of the neighbouring particles are different	▪ Phase of vibrations of points between successive nodes are in phase
▪ There is transfer of energy from one point to another	▪ Energy is localized within loops
▪ Wave profile moves along the medium at the speed of the wave	▪ Wave profile appears stationary and does not seem to move
▪ Particles vibrate with the same amplitude	▪ Points along the wave vibrate with different amplitudes.

(04)

Equation of stationary $y = y_1 + y_2$

$Y = 9 \sin\left[100\,\pi\, t - \frac{10}{9}\,\pi\, x\right]$ moving from left to right

Then (i) $y = a \sin\left[100\pi t + \frac{10}{9}\pi x\right]$ would give rise to a stationary wave

(ii) $y_1 = a \sin\left[100\pi t - \frac{10}{9}\pi x\right]$

$Y_2 = a \sin\left[100\pi t + \frac{10}{9}\pi x\right]$ **(03)**

Equation of stationary $y = y_1 + y_2$

$Y = a \sin\left[100\pi t - \frac{10}{9}\pi t\right] + a \sin\left[100\,\pi\, t + \frac{10}{9}\,\pi\, x\right]$

$Y = 29 \sin 100\pi\, t\ \cos\left(-\frac{10}{9}\,\pi\, x\right)$

$Y = 2a \cos\frac{10}{9}\,\pi\, x.\ \ \text{Sin}\ 100\,\pi\, t$

Amplitude $A = 2z \cos\frac{10}{9}\,\pi\, t\ (mm)z$

(iii) From $wt = 100\,\pi t$

$W = 100\pi$

$2\pi f = 100\pi$

$F = \frac{100}{2} H_2 = 50H_2$ **(04)**

Velocity $V = Oms^1$ since it's a stationary wave. **(01)**

4. (a) (i) Interference is the superposition of waves from coherent sources which Are traveling in the same direction to produce alternate regions of maximum and minimum intensity. **(02)**

(ii) Conditions for interference of two light waves

- waves must have the same frequency.
- Waves must have approximately the same amplitude.
- Waves must be in phase or have a constant phase difference. **(03)**

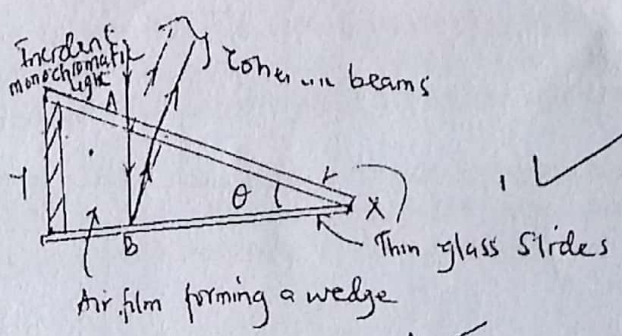
(b) (i) Constructive interference occurs when the crest of one wave meets the crest of another wave leading to reinforcement, whereas destructive interference occurs when a crest of one wave meets a trough of another wave leading to cancellation. **(01)**

In constructive interference the resultant intensity is maximum where as in destructive interference, the resultant intensity is minimum or zero. **(01)**

Constructive interference occurs when the path difference is a whole number multiple of full wavelength or zero.

$p = n\lambda$ when $n = 0, 1, 2, 3, \ldots\ldots\ldots\ldots$

(ii)



(c) (i) D...

- A thin wedge shaped film of air is formed by placing two thin glass slides separated by a foil at y. So that very smell angle θ is formed at the other end x.

- When illuminated by monochromatic light from an extended source, alternate bright and dark equally spaced fringes are seen formed by the reflected and transmitted lights and parallel to the line of transmitted lights and parallel to the line of intersection of the slide at x. (05)

- The fringes are due to the interference of the coherent beams created by partial reflection of the incident light at the lower surface of the top slide and upper surface of the lower slide. (02)

(c) (i) Diameter of wire $t = 0.04\text{mm}$
$\lambda = 5.0 \times 10^{-7}\text{m}$

Let l be distance of foil from contact or glass slide fringe spacing

Note

$y = \frac{\lambda}{2\theta}$

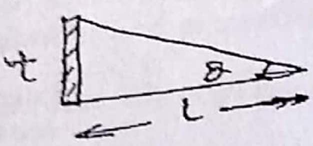
$\theta = t/l$

$\frac{\lambda l}{2t}$

$= \frac{5.0x10^{7} x(l)}{2x0.04x10^{-3}}$

$y = 6.25x10^{-3} lm$

Note



(04)

$Q = \frac{t}{l}$

$y = \frac{\lambda}{2\theta}$

$n = \frac{l}{y}$

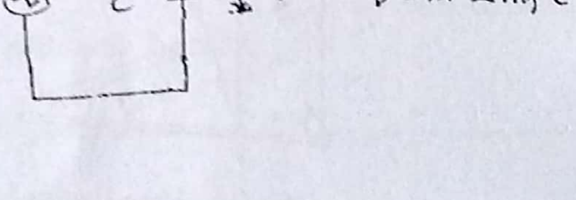
(ii) Number of fringes that can be observed.

$n = \frac{l}{6.5x10^{-3}\ l}$

$n = 160\ fringes$ (02)

5. (a) Capacitive reactance is the non resistive (dissipative) opposition to the flow of a.c (01)

(b)



At any instant the charge stored at the capacitor plates is $Q = Q_0$ sin not.
Where $Q = cv$.

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

$$I = \frac{dcv_0 \sin 2\pi ft}{dt}$$

$$I = CV_0 \frac{d}{td \sin 2\pi ft}$$

(03)

$I = CV_0, 2\pi ft$ instantaneous current trough the capacitor.

The current leads the voltage by $\pi/_2$ or 90^0 or $1/_4$ cycle.

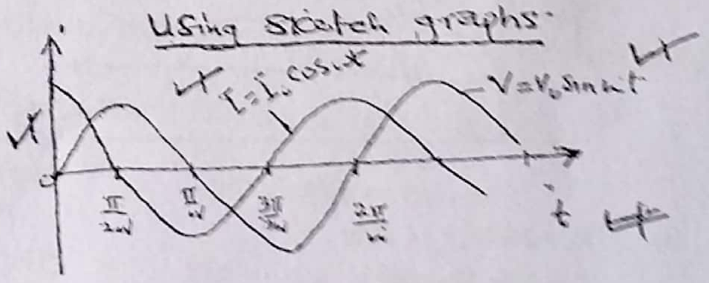
From $\cos 2\pi ft \; = \; \sin\left(2\pi ft + \pi/_2\right)$

Then I $= CV_0 2\pi f \sin\left(2\pi ft + \pi/_2\right)$

But V $= V_0 \sin 2\pi ft$

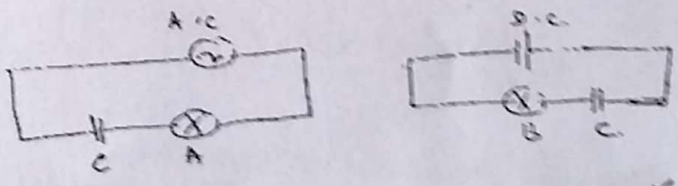
Comparing equations 1 and 2 of the same sine function, when V is at zero, I is a head by $1/_4$ cycle.

Using sketch graphs.



(02)

(b)



Bulb is connected to an a.c source which charges and discharges the capacitor at the frequency of the a.c and provides a continuous flow of current through the circuit making the bulb to light continuously.

When the capacitor is connected to a d.c it charges and current flows, and bulb B lights. When the capacitor is fully charged, the current flow in the circuit stops and bulb B equally stops lighting.

(04)

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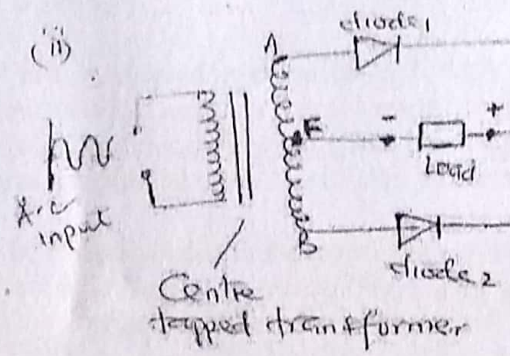
(c) (i) Rectification is the conversion of alternating current to direct current. **(01)**

(ii)

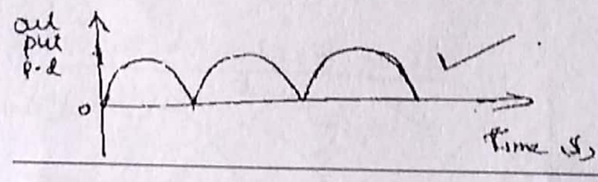


Point F is the reference position and in the first half cycle of a.c A, is positive while B is negative and rectifier 1 conducts. Current then flows in the direction

A E D F A

During the second half cycle, B is positive relative to A which is negative rectifier 2 conducts while rectifier 1 does not conduct. Current then flows in the direction B C D F B.

Its observed that current through the load (resistor) is in the same direction D F and this provides d.c which fluctuate across the load. **(05)**



(i) $V_p = 240V, V_p = 3000$

$P_{in} = bow, N_s = 200$

$\eta = 80\%$

$$\eta = \frac{I_s V_s}{I_p V_p} x100\%$$

From $\frac{N_s}{N_p} = \frac{V_s}{V_p}$

$$V_s = \frac{N_s V_p}{N_p} = \frac{200x240}{3000} = 16V$$

$$0.8 = \frac{I_s x16}{\frac{60}{240} x240}$$

(04)

$$I_s = \frac{60x0.8}{16}$$

$$I_s = 34$$

(ii) The current in the primary increases (01)

6. (a) (i) Magnetic meridian is a vertical plane containing the magnetic axis of a freely suspended magnet in the earths field.

(ii) Angle of dip is the angle between the earths horizontal component and the magnetic axis of freely suspended magnet Or the earths resultant Magnetic field. (02)

(b) A search coil of known geometry is connected in sener with a calibrated ballistic galvanometer.

The plane of search coil is made to coincide with that of the movable fame of an earth inductor and the planes are made horizontal.

The search coil is turned through 180^0 and the maximum deflection Q_1 on the ballistic galvanometer is noted.

The earths vertical component is $B_V = \frac{RKQ_1}{2NA}$....(i)

The coil is then made vertical and the turned through 180^0 and the maximum deflection Q_2 on the B.G is noted.

The earths horizontal component is $B_H = \frac{RKQ_2}{2NA}$....(ii) the angle of dip α is determined from $\alpha = \tan^{-1}\left(\frac{B_v}{Q_2}\right)$, $\alpha = \tan^{-1}\left(\frac{Q_1}{Q_2}\right)$ (06)

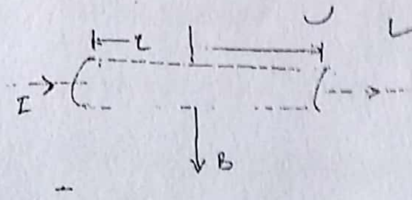
(c) Restoring torque in suspension = Tarque acting on the coil

KQ = B/AN cos θ where $Q = \frac{2\pi}{360} x40red$

$$K = \frac{4\pi x10^{-7} x3x3xnx15x10^{-4}\ x12\cos\frac{2\pi}{360}x40}{\frac{2\pi}{360}x240} \quad (04)$$

K = $nx4.82x10^{-8}\ Nm$ where n is turned per metre.

(d) Magnetic flux is the product of the normal magnetic flux density and projection area unit – weber (wb) whilst magnetic flux density is the force acting on a 1 metre length conductor carrying current normal to the magnetic field, testa or T (03)



$I = \frac{Q}{t}$

but $t = \frac{L}{V}$, $I = \frac{QV}{l}$

F = BIL Sin Q, Q = 90⁰

$F = B\frac{QV}{l}.L \sin 90^0$

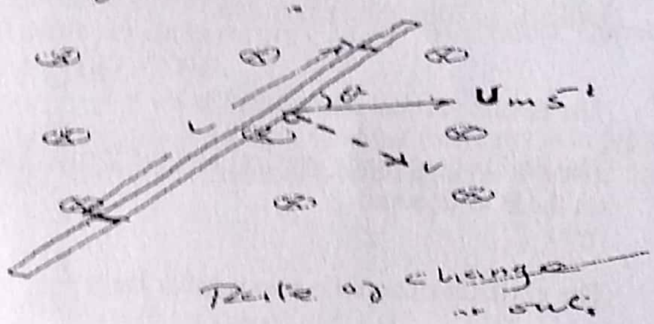
F = BQV

(ii) The force F = BQV increases the potential of the conductor where the electron shift from and lowers the potential on which the electrons accumulate on the conductor.

7. (a) (i) The magnitude of induced emf is directly proportional to the rate of Magnetic flux cutting or linkage.

The direction of the induced emf flows such as to oppose the flux change causing it

(ii)



OR rate of .....oric done by external agent = Rate of energy conversion in the conduct

F.U = E I

But F = BIL sin 0

BIL U sin 0 = E I

BIL U sin 0

(iii) From E = BLU sin 0

$1.2x10^{-3} = B_E x15x200x5\sin 30^0$

$B_E = \frac{1.2x10^{-3}}{15x200\sin 30^0}$

$B_E = 2x10^{-7}T$

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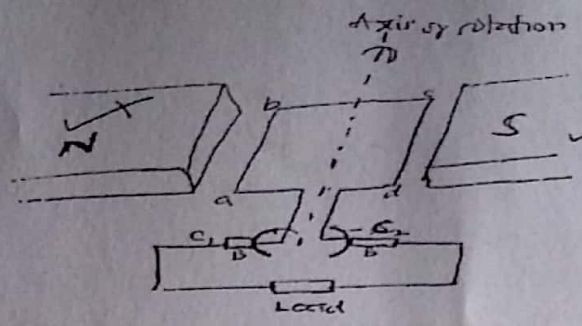
(b) (i)



C and C2 - Commutator or copper splitring

B = Carbon brushes

When the coil a b c d is rotated in a uniform magnetic field, it cuts the magnetic field and an emf is induced in the coil.

The commutators change contact with the carbon brush when the coil is in the vertical position but the direction of the current through the coil is maintained. **(05)**

The induced emf is tapped off using carbon brush and appears across a load connected in sener with the brushes.

(ii) – The number of turns of coil should be many.
- The coil should be wound on a laminated core to reduce on eddy currents.
- Increasing on the plane area of the coil.
- Using very strong poles of magnet to provide a strong magnetic field. **(02)**

Note, Increasing the speed of rotation of coil is NOT a structural modification.

(01)

(iii) Applications of electric motors
- Driving windscreen wipers.
- Driving electric funs used in homes and other devices
- Driving certain devices in computer, Radio cassetles.

Any one

(c) (i) When a metal conductor is linked with a changing magnetic flux, there will be an induced crrent that circulates in low resist once parts of the conductor.

(ii) Eddy currents cause heating of the cores leading to power loss in trans fores, motors

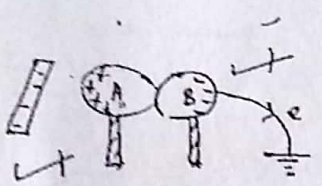
Any one

OR Reduce the efficiency of transformers/ electric motors.

8. (a) (i) The magnitude of the force between two point charges is directly proportional to the product of their charges and inversely proportional to the square of their distance of separation. **(01)**

(ii) Two insulated metal spheres A and B are brought together so that they are in contact.

A negatively charged ebonite rod is then brought near sphere A, sphere B is then earthed.



The earth connection is then broken and the ebonite rod is removed.

The two metal spheres are finally separated and are found to have acquired each positive charges. **(04)**

(b) (i) An equipotential surface is one where;

- All points on the surface are at the same potential.
- The work done to move a charge between any two points on the surface is zero.
- Electric field lines due to the charge is perpendicular to the surface.

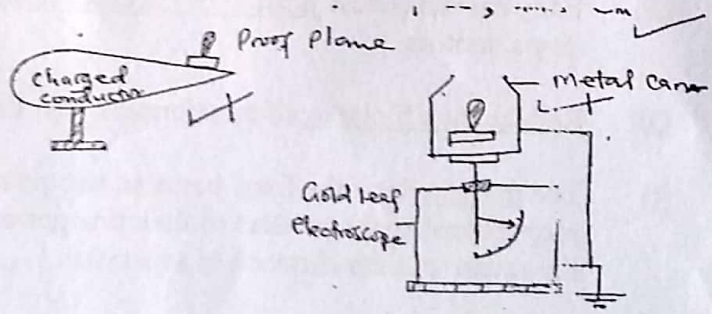
(ii) Since all points on an equinoctial surface are at the same potential, the potential gradient between any two points on the surface is zero.

$$\frac{dv}{dx}=0$$

A long the direction parallel to the surface E = O, there is no electric field, since $\frac{dv}{dx}=E$ and $\frac{dv}{dx}=O.$

Thus the electric field lines must be perpendicular to the surface so that there is no horizontal component along the surface. **(03)**

(c) (i) Charge density is the ratio of the magnitude of charge per unit area of surface, units cm^{-2} **(01)**



(01)

- Proof planes or different shape but same area that fit on the conductor are taken and fitted on different parts of an insulated pear shaped conductor previously charged using an electrophorus.

- Each proof plane is removed in turn and lowered into a metal can placed on a gold leaf electroscope.

- The divergence of the cold leaf electroscope is noted for each proof plane and the G.L.E is recharged before introducing a new proof plane.

- Its found out that the divergence of the G.L.E is proportional to the charge density of the part where the proof plane touched.

(d) $Q = 1.60x10^{-19} c$

$V = 150v$

$x = 3x10^{-3} m$

(i) $E = \frac{v}{x} = \frac{150}{30x10^{-3}} = 50KVm^{-1}$

(ii) Energy acquired by electron = work done

= QV

= 1.6= x 10^{-19} x 150

= 2.40 x 10^{-17} J

9. (a) (i) An Ohm is the resistance of a conductor through which a current of 1A is flowing when the p.d a cross its ends is 1V. (01)

(ii) Temperature; An increase in temperature increases the resistance because the amplitude of vibration of the ion increases. This increases the frequency of collisions with free electrons, low current flows hence higher resistance. (02)

(iv) Area of cross-section; when the area of cross-section of a conductor is increased, more electrons drift a long the conductor, this results in a higher current flow hence low resistance.

(iv) Length of conductor, Increase in length of a conductor leads to a larger path for electrons, this results in more collisions leading to reduced drift velocity hence high resistance. (02)

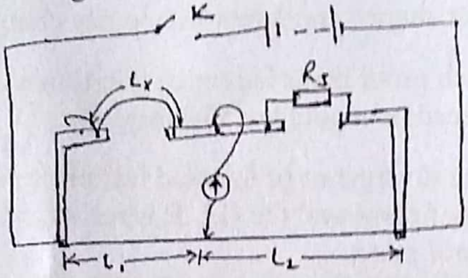
(v) Electrical resistivity; materials with higher resistivity have higher resistance.

(b) (i) The sum of all currents entering any junction in a circuit is equal to the sum of currents leaving the junction.

OR The algebraic sum of currents at a junction is zero. (01)

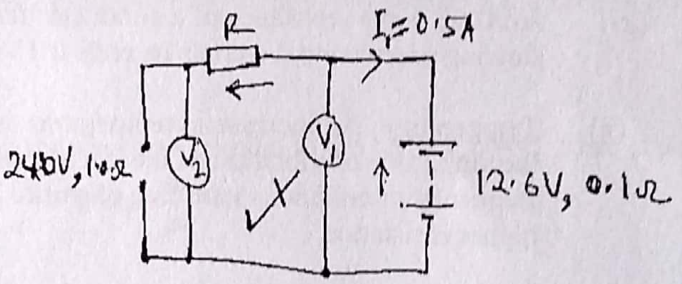
- In any closed loop, the algebraic sum of all emfs is equal to the algebraic sum of all the potential drops. (01)

(ii)



- The circuit is arranged as shown above, a suitable length l_x of a specimen wire x is connected in the left hand gap with a standard resistor R, in the R.H.U.
- Switch K is closed and the jockey J is placed at different places along wire AB until the galvanometer shows no deflection.
- the balance length L, and L_2 are noted
- the procedure is repeated for different values of L_x and the results tabulated including values of $R_x = \left(\frac{l_1}{L_2}\right) R_s$
- A graph of R_x against L_x is plotted and the slopes determined.
- The diameter of the specimen wire X is measured at three different positions and the average diameter at determined.
- Electrical resistivity of the wire is then calculated from $\vartheta = \frac{\pi d^2 s}{4}$

(c)



(i) $I_1 = \frac{Netpd}{\text{Re}\,ft}$

$$0.5 = \frac{240 - 12.6}{R + 1.0 + 1.0}$$ (03)

$R = 21.7\Omega$

(ii) $I_2 = \frac{11.4}{0.9 + 1.1}$ sine R = 0.9Ω $V_2 = V_1 + 0.9 \times 5.7$

$I_2 = 5.7A$ $V_2 = 18.3V$ (03)

$I_1 = 12.6 + 5.7 \times 0.1$

$V_1 = 13.17v$

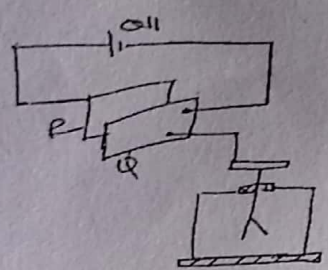
10. (a) (i) A farad is the capacitance of a capacitor such that one coulomb of charge is stored on its plates when the applied p.d is one volt. (01)

(ii) Dielectric constant is ratio of a capacitor when there is a dielectric material between its plates to the capacitance of the same capacitor when there is a vacuum between its plates. (01)

(iii) Dielectric strength is the potential gradient at which the insulation of the dielectric material breaks down and a spark passes through it. (01)

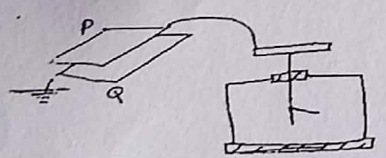
(b) Plate separation.
- Area of overlap of the plate.
- Permittivity of the dielectric material. (03)

(c) Method I (variable charge, constant p.d)



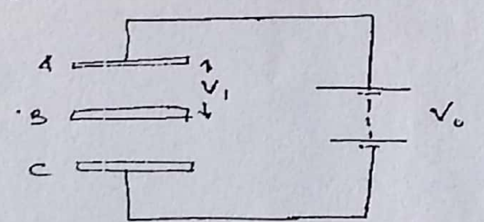
- A constant p.d is set up across capacitor plates p and Q by connecting a cell across it.
- Plate Q is connected to the cap of the electroscope and the divergence noted .
- plate p is the slid relative to Q, keeping the separation constant, but reducing the common area of overlap,
- the divergence is observed to decrease and since divergence is proportional to charge which is proportional to capacitance c, hence C α A.

Method II (constant charge, variable p.d)



P and Q are capacitor plates initially with air between them.

The divergence of the leaf is noted, when plate P displaced sideways relative to Q so that the common area of overlap is reduced, the divergence is noted to increase. This indicates an increase in p.d and since p.d is inversely proportional to capacitance, there results a decrease in capacitance thus C α A.



Capacitors AB and BC are in series (constant charge on each capacitor)

$$\ell_{AB} = \frac{\Sigma A}{d} \text{ and } \ell_{BC} = \frac{\Sigma A}{d}$$

$$\frac{1}{C_{eff}} = \frac{1}{C_{AB}} = \frac{2d}{\Sigma A}$$

$$C_{eff} = \frac{\Sigma A}{2d}, \text{ Total charge } \quad Q = C_{eff}V_0$$

$$Q = \frac{\Sigma A V_0}{2d}$$

Where plate B is displaced a distance x downwards

$$\ell^1_{AB} = \frac{\Sigma A}{d+x}$$

New p.d between A and B

$$V_1 = \frac{Q}{C^1_{AB}} = \frac{\Sigma A V_0}{2d} x \frac{d+x}{\Sigma A}$$

$$V_1 = \left(\frac{d+x}{2d}\right)V^0$$

(05)

(ii) p.d between B and C

$$\ell^1_{BC} = \frac{\Sigma A}{d-x}$$

$$V_2 = \frac{Q}{C^1_{BC}} = \left(\frac{\Sigma A V_0}{2d}\right)\left(\frac{d-x}{\Sigma A}\right)$$

$$V_2 = \left(\frac{d-x}{2d}\right)V_0$$

$$V_2 = \left(\frac{3x10^{-3} - 0.8x10^{-3}}{(2)(3x10^{-3})}\right)(12)$$

$$V_2 = 4.4v$$

(04)

END