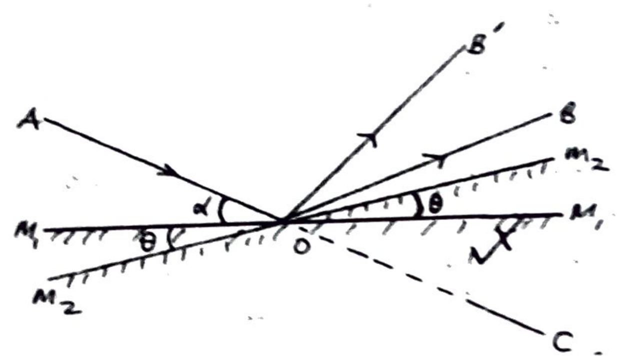
WAKISSHA JOINT MOCK EXAMINATIONS
MARKING GUIDE
Uganda Advanced Certificate of Education
PHYSICS P510/2

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

(ii)



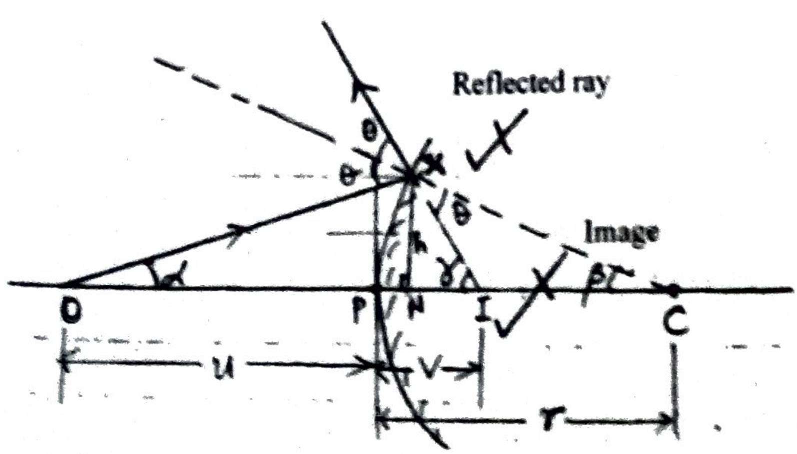
- For an incident ray AO, angle of deviation: < COB= 2α
Where α is the glancing angle.
- On rotating the mirror M_1M_1 to position M_2 M_2 through angle θ with th direction of the incident ray AO constant, the reflected ray is OB:
- The new glancing angle = $(\alpha + \theta)$ = new angle of deviation = $2(\alpha + \theta$
- The new reflected ray OB^{11} is thus rotated through angle
$BOB^1 = \angle COB^1 - \angle COB = 2(\alpha + \theta) - 2\alpha = 2\theta$

(03

(b) (i) Principal focus of a convex mirror is the point on the principal axis from which the rays originally parallel and close to the principal axis appear t diverge or come after reflection from the mirror. (01

(ii) Radius of curvature of a convex mirror is the radius of the sphere of which the mirror forms a part (or it the distance between the Centre of curvature and the pole) (01

(c)



P – Pole
O – Object
I – Image
C – Centre of curvature

- In $\triangle$ Cox, $\theta = \alpha + \beta$ ______ (i)
- In $\triangle$ CIx, $\theta = \gamma + \beta$ ______ (i)

From (i) and (ii); $\propto + \beta = \gamma - \beta$

From which $\gamma - \propto = 2\beta$ _____________ (iii)

Since angles $\propto$, β and γ are very small,

$\text{Tan} \propto \approx \propto = \frac{XN}{ON} = \frac{XN}{OP}$ Since P is very close to N.

Similarly, $\tan \beta \approx \beta = \frac{XN}{CN} = \frac{XN}{CP} = \frac{XN}{CP}$ and $\tan \gamma \approx \gamma = \frac{XN}{IN} = \frac{XN}{IP}$

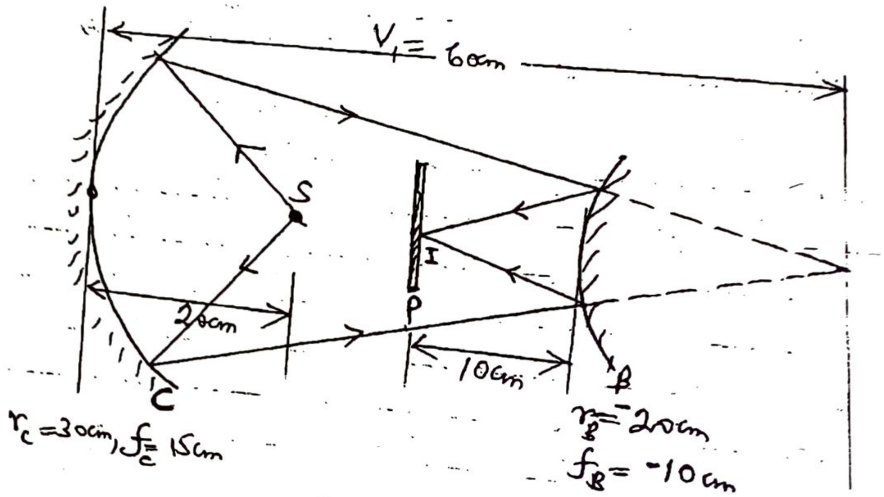
Since I is virtual, IP = - V, CP = -r, XN = h

Substituting in (iii) gives : $\frac{h}{v} - \frac{h}{u} = \frac{2h}{r} = \frac{2h}{2f}$

$\Rightarrow \frac{1}{=v} - \frac{h}{u} = \frac{h}{-f}$ 2.

Rearranging gives: $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ **(5 marks)**

(d)



(i) Action of concave mirror C:

$$f_c = 15cm$$

$$\frac{1}{v} = \frac{1}{f_c} - \frac{1}{u}, u = 20cm.$$

$$\frac{1}{15} - \frac{1}{20} = \frac{4-3}{60} = \frac{1}{60}$$

$$\therefore V_1 = 60cm$$

$$Action B = \frac{1}{u_2} = \frac{1}{f_B} - \frac{1}{V_2}, V_2 = +10cm$$

$$= \frac{^-1}{10} - \frac{1}{10} = -\frac{2}{10} = -\frac{1}{5}$$

$$\therefore u_2 = {^-5}cm.$$

$\therefore$ Distance

$$SP = 60 - (20 + 10 + 5)$$

$$= 60 - 35$$

(ii) Magnification of

$$S = m_c \times m_B$$
$$= \frac{V_1}{u_1} \times \frac{V_2}{u_2}$$
$$= \frac{60}{20} \times \frac{10}{5}$$
$$= 3 \times 2$$
$$= 6$$

(03 marks

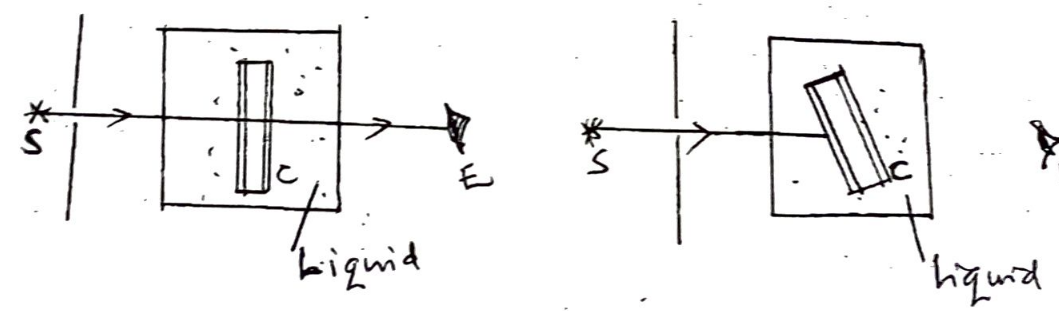
TOTAL MARK = 2(

2. (a) (i) Absolute refractive index is the ratio of velocity of light in a **vacuum** to the velocity of light in a given **medium**. (01)
(or at The ratio of the sine of angle of incidence in a **vacuum** to the sine o angle of refraction in a given medium for a ray of light travelling from a vacuum into the **medium**).

(ii) Total internal reflection is a phenomenon which occurs when the angle of incidence in the optically denser medium **exceeds the critical angle** and al the light is reflected back into the denser medium.

(01 marks

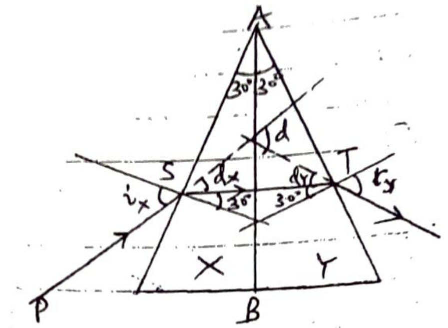
(b)



- The liquid whose refractive index is required is placed in a transparent glass vesse having thin plane – parallel sides. ***or diagram.***
- The air cell, C, is then lowered into the liquid so that it can rotate about a vertica axis.
- A bright source of **monochromatic light** S, is positioned on one side of the vesse so that its rays are incident normally on the sides of the vessel and the air cell; an light from S can be seen directly by observer E.
- The air cell C is then rotated slowly about a vertical axis until the light is suddenl cut off from E; and so no light passes through C.
- The air cell is now rotated in the opposite direction until the light is again suddenl cut off from E.
- The angle, θ, between the two positions of C for the extinction of the light i determined.
- The refractive index of the liquid is then obtained from $n = \dfrac{1}{\sin\left(\dfrac{\theta}{2}\right)}$.

(05 marks

(c)



For refraction at S:

$$n_x = \frac{\text{Sin} i_x}{\text{Sin } r_x}$$

$$\therefore 1.51 = \frac{\sin i_x}{\sin 30^0}$$

From which $i_x = 49.03^0$

$\therefore$ *deviation* at S, $dx = lx - 30^0 = 49.03^0 - 30^0$
$= 19.03^0$.

3.

For refraction at $T : n_y = \frac{\sin ry}{\sin 30^0} \Rightarrow 1.65 = \frac{\sin ry}{\sin 30^0}$

from which $ry = 55.59^0$

$\therefore$ *deviation at* $T, \; = d_y = r_y - 30^0 = 55.59^0 - 30^0 \; = 25.59^0$

$\therefore$ *Total deviation* $d = d_x + d_y$

$= 19.03^0 + 25.59^0$

$= 44.62^0$

(04 mar

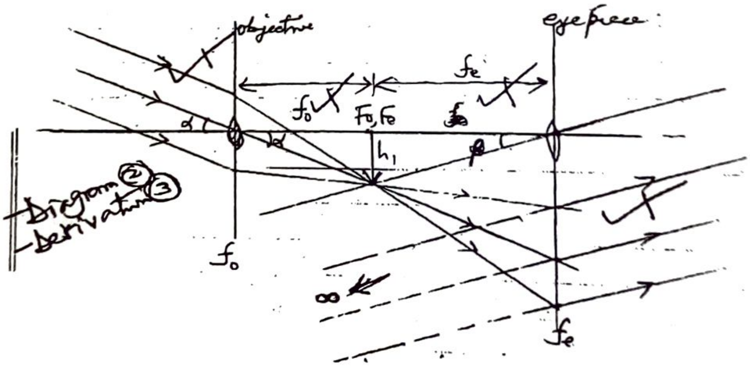
(d) (i) Magnifying power of a telescope is the ratio of the angle subtended at the eye by the final image when using the telescope to the angle subtended at the eye by object when the instrument is not being used.

(01 mar

(ii) The eye-ring is the circular image of the objective lens of the telescope formed by the eye piece.

(01 mar

(e) (i)



- Diagram (2)
- Derivation (3)

- A normal adjustment, the final image is formed at infinity. For small angle radians.
- Since angles are small $\alpha = \frac{h_1}{f_0}$ *and* $\beta = \frac{h_1}{f_e}$
- Magnifying power, $M = \frac{\beta}{\alpha} = \frac{h_1}{f_e} / \frac{h_1}{f_o}$

$$= \frac{f_o}{fe}$$

(05 mar

(ii)
- Refracting telescope have **chromatic aberration** unlike in reflecting telescopes
- Refracting telescopes have **lower resolving power** and less bright images unlike reflecting telescopes.

- More **expensive in terms of costs** to construct since two surfaces of the lenses have to be ground unlike the mirrors in reflecting telescopes.
- May experience **spherical aberration** for a point object on the axis at infinity unlike a reflecting telescope which uses parabolic mirror.

First two are correct.

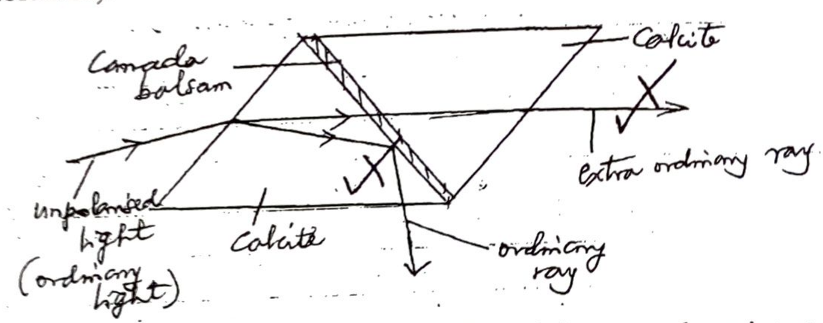
Any two @(02 marks)

TOTAL MARKS 20

SECTION B

3. (a) (i) Plane – polarized light is light whose electric field vector oscillates or electromagnetic vector in one particular plane perpendicular to the direction of propagation of the light. (Or it is light which has only one plane of vibration).

(ii)



- A nicol prism is used – it consists of a calcite crystal cut into two pieces and are cemented together using Canada balsam.
- The unpolarised (ordinary) light is made incident on one side of the prism and is viewed from the opposite side through an analyser.
- The angle of incidence is **gradually increased** and for each angle of incidence, the emergent light is **viewed through the analyser** while rotating it about an **axis perpendicular to its plane.**
- At some angle of incidence, the light gets extinguished completely.
- At this point, the emergent light is completely plane-polarised.

(04 marks)

(b) $n = 1.50$; From $\tan i_p = n = \tan i_p = 1.50$.

$= $ Polarising angle $i_p = 56.3^0$

From $n = \dfrac{\sin ip}{\sin r}, \Rightarrow 1.50 = \dfrac{\sin 56.3^0}{\sin r}$

$\Rightarrow r = 33.7^0$

(03 marks

(c) Principle of superposition of waves states that whenever two waves travelling in the same region meet , the total displacement at any point is equal to the vector sum of their individual displacements at that point.

(01 marks

(d) (i) Constructive interference – occurs when a crest of one wave meets a crest (trough) of a another wave and a wave of large amplitude result whereas destructive interference occurs when a crest one wave meets a trough and no wave is observed.

(02 marks

(ii) - The sources must be coherent (i.e they must have the same frequency and amplitude and be in phase with each other)

(02 marks)

- The two sources must be very close to each other.
- The distance from the source should be as far as possible from the screen.

(iii) - The oil film on water appears coloured due to interference.
- When light is incident on the oil surface it is partly reflected and refracted.
- The refracted light is then internally reflected at the oil – water interface. So the original incident ray is divided into two different rays of different amplitude that are coherent.
- When the two rays are combined by the lens of the eye, they interfere.
- The colours for which the waves meet in phase are observed in the film while those that meet out of phase are not seen.

(03 marks)

(e)

$\lambda = 5.12 \times 10^{-7} m,$

$slit\ \ seperation\ \ a = 0.45mm\ \ = 0.45 \times 10^{-3} m$

$D = 75cm = 0.75m.$

$from\ \ OP = \dfrac{m\lambda D}{a},where\ \ m = 3$

$\therefore OP\ \ = \dfrac{3 \times 5.12 \times 10^{-7} \times 0.75}{0.45 \times 10^{-3}}$

$= 2.56 \times 10^{-3} m$

(04 marks)

TOTAL MARKS

4. (a) - In progressive waves, **transfer of energy** takes place in the direction of wave motion, while in stationary waves, **no energy is transferred** from one point to another.
- In progressive waves, the wave form advances with the wave motion whereas in stationary waves, the waveform does not advance in any direction.
- In progressive waves, all particles within one wavelength have different phases while in stationary waves, the phase of all particles with two adjacent nodes are the same.
- Progressive the amplitude is the same while stationary, amplitude varies.
- Stationary have nodes and internodes while progressive have crests and troughs.

(03 marks)

(b) (i) Resonance is a phenomenon which occurs when a body is vibrating at its **natural freq.** due to impulses received from a nearby source oscillating at **the same freq.** to produce a loud sound.

(ii) - A long tube (resonance tube) with a tap at the bottom is filled with water with a short length of air column left at the top.
- A vibrating turning fork of frequency f is **sounded** and placed at the open end of the tube.
- The level of water in the tube is **gradually lowered** by opening the tap until **a loud sound is heard.**
- The length l, of the air column in the tube is **measured and recorded.**
- The procedure is repeated by using turning forks of different frequencies.

- Results are tabulated to include values of $\frac{1}{f}$
- A graph of $\frac{1}{f}$ against l, is plotted and its slope S obtained.
- The velocity V of sound is got from V= 4/s

(05 marks)

(c) At first position of resonance length of air column, $\lambda_1 = 80 - 67 = 13$ cm = 0.13m.

$\therefore \frac{\lambda}{4} = \lambda_1 + C \Rightarrow \frac{\lambda}{4} = 0.13 + C$

From which $C = \frac{\lambda}{4} - 0.13$ ______________ (i)

For third position of resonance $l_3 = 80 - 10.2$
$= 69.8$cm
$= 0.698$m.

$\Rightarrow \frac{5\lambda}{4} = l_3 + C \Rightarrow \frac{5\lambda}{4} = 0.698 + C$

from which c = $\frac{5\lambda}{4}$ - 0.698______________ (ii)

Solving equation (i) and (ii) simultaneously gives.
$\lambda = 0.568$m.
V= $f\lambda$
$= 60 \times 0.568$
V= 34.08 ms^{-1}

(04 marks)

(d) (i) - When two sound notes of neary the same freq. but similar amplitude are **sounded together,** they interfere with each other periodic rise and fall in.
- The resultant effect is a sound whose loudness or intensity **increases an[d] decreases periodically** and this **rise and fall in intensity of sound i[s]** beats.

(02 marks)

(ii) - Suppose the wave of freq f_1 makes one more cycle than the other freq f_2 i[n] Time, T

No. of cycles of freq. $f_1$made in Time T = f_1T and No. of cycles of freq f_2 made in Time T = f_2 T

$= - f_1 T - f_2 T = 1 \Rightarrow (f_1 - f_2) = 1/T$ where $\frac{1}{T}$ is frequence

$\Rightarrow$ beat freq $f = f_1 - f_2$.

(03 marks)

(e) - Tuning of a musical (stringed) instrument.
- Measurement of an unknown freq. of a note.

(02 marks)

TOTAL MARKS = 2[0]

SECTION C

5. (a) Unit of magnetic flux density is the tesla and is defined as the magnetic flux density of a field in which a force of **1N** acts on a **1m length** of a conductor which is carrying a current of **1A** and is perpendicular to the field

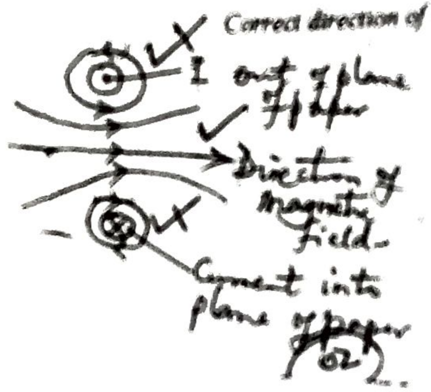
(01 mark)

(b) (i) $B = \frac{\mu_o NI}{2R}$

- μ_o = permeability of free space
- N = No of turns in the coil
- I = current flowing in the coil
- R = radius of the coil.

(02 marks)

(ii)



(iii) $l = 9.81m$; $d = 3.5\ cm = 0.035m$, $R = 0.0175m$ $I = 1.5A$, $B = ?$ (02 marks)

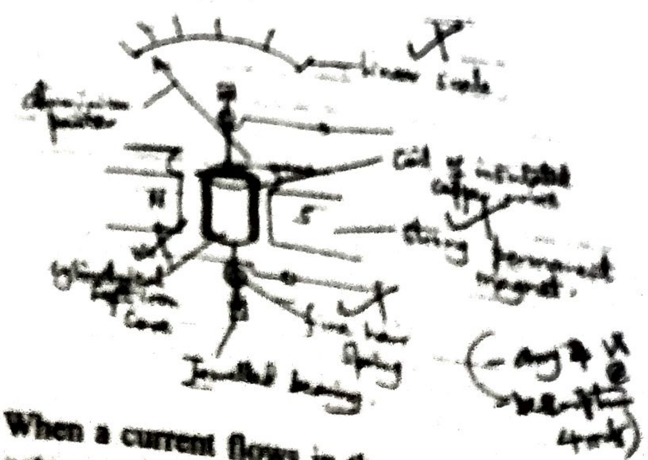
No. of turns, $N = \frac{\text{length of wire}}{\text{circumference of coil}}$

$= \frac{9.81}{3.14 \times 0.035} = 89.3$

$\therefore B = \frac{\mu_o NI}{2R} = \frac{4 \times 3.14 \times 10^{-7} \times 89.3 \times 15}{2 \times 0.0175}$

$= 4.81 \times 10^{-3}T$

(c) (i) (03 marks) 6



- When a current flows in the coils, the resultant magnetic in the annular sets up a force on each turn of the coil.
- Two forces, acting on each vertical side of the coil, having the same size opposite directions and will produce a torque
- The coil will rotate until the deflecting ... due to the hair ...

- Where N = No of turns, B = flux density of the field, I = current in the coil, A = area of the coil, C = torsional constant of the hair springs, θ = angle turned by the coil.
- It can be seen that $I \propto \theta \Rightarrow$ the scale showing current values is linear.

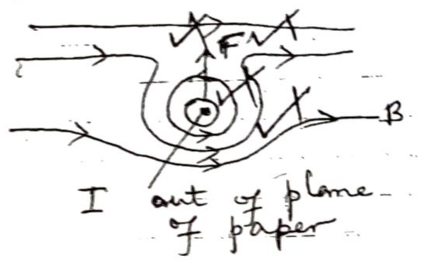
(06 marks)

(ii) - Large N would increase the resistance of the coil which is undesirable.
- This would increase the weight of the coil, this reducing damping.
- The annular space limits increase of the area.
- A current much greater than that which the meter is intended to measure will burn out its hair springs. ***Any first correct two points.***

Any 2 @ (02 marks)

(d) - A current in the conductor produces a magnetic field around the conductor.
- The external magnetic field interacts with the field due to current.
- The resulting magnetic field is stronger on one side of the conductor, than the other side producing a resultant force whose direction is in accordance with Fleming's left hand rule.

(04 marks)



field OR. - Current is constituted by flow of electrons. Each electron experiences a mechanical

force in the magnetic field.
- The force on the conductor is thus the **sum of** these individual forces.

force
- The direction of the resultant force is in accordance with Fleming's left hand rule.

TOTAL : 20 MARKS

6. (a) (i) - The magnitude of the induced emf in a conductor is directly proportional to the rate of change of magnetic flux linking the conductor.
- The induced emf is such that the current which it causes to flow oppose the change which is producing it.

(02 marks)

(ii) - A cell of known polarity is connected to a center-zero galvanometer and the direction of the deflection of the pointer is noted.
- A coil in which the sense of windings is known is then connected to the galvanometer .
- A bar magnet of known poles is then thrust into the coil and the direction of the deflection of the pointer is again noted; hence the direction of flow of current through coil is determined.
- The procedure is repeated with the bar magnet withdrawn from the coil.
- It is observed that for any movement of the bar magnet, the induced current always flows in the coil in such a direction inducing a magnetic pole of end of the coil that opposes the motion of the magnet.

(06 marks)

(b) (i) Angle of dip – Is the angle between the direction of the earth's resultant magnetic flux and the horizontal. (01

(ii) Magnetic meridian – is the vertical plane which contains the vertical and horizontal components of the earth's magnetic field. (01

(c) $N = 120$ turns, $d = 80cm = 0.80m \Rightarrow r = 0.40m$
$R = 220\Omega$, $\theta = 1$ rad; $B_H = ?$, $a = 6.0\times10^4$rad

$$Q = \frac{2NAB_H}{R} = C\theta = \frac{1}{a}\theta$$

$$\therefore B_H = \frac{R\theta}{2NAa}$$

$$= \frac{220\times1.0}{2\times120\times3.14\times(0.40)^2\times6.0\times10^4}$$

$$= 3.04\times10^{-5}T.$$

(04 ma

(d) (i) - When the armature of the motor rotates, it cuts the magnetic flux of the field magnet and an emf is induced in it. This emf is called back emf.
- If E and V represent the magnitudes of the back emf and applied respectively and I is the current in the coils, then.
- The electrical power supplied to the motor = IV the mechanical power o of the motor = IE since efficiency of the motor.

$$= \frac{\text{mechanical power output}}{\text{power supplied}}\times100\%$$

$$\Rightarrow \text{efficiency} = \frac{IE}{IV}\times100\% = \frac{E}{V}\times100\%$$

(04 ma

(ii) - It provides the mechanical energy for the motor to do work.
- It limits the armature current which would burn out the armature coil.

(02 ma

TOTAL MARKS

7. (a) (i) R.m.s of an a.c. **is the** value of the steady current which would dissipate electrical energy at the same rate in a given resistance **as the** a.c.

(ii) Peak value of an a.c. is the maximum value of the a.c (or the amplitude of the a.c) (01 m

(01 m

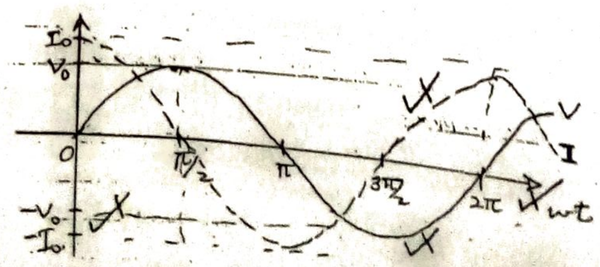
(b) (i) For a sinusoidal voltage, $V = V_o \sin wt$
But $w = 2\pi f$.
$\Rightarrow V = V_o \sin 2\pi ft$
The charge, Q on the capacitor at time t is given by $Q = CV = CV_o \sin 2\pi ft$
The current I flowing in the circuit.

$$I = \frac{dQ}{dt} = \frac{d}{dt}(CV_o \sin 2\pi ft)$$

$$\therefore I = 2\pi fCV_o \cos 2\pi ft$$

(03

(ii)



Labelling axes

(2marks)

(iii) $C = 1.0\mu f = 1.0\times10^{-6}F$, $f = 1.1kH\cancel{z} = 1.1\times10^{3}H\cancel{z}$ $I = 5mA = 5.0\times10^{-3}A$, $V = ?$

$$X_C = \frac{1}{2\pi fc} = \frac{1}{2\times3.14\times1.1\times10^3\times1.0\times10^{-6}}$$
$$=144.76\Omega$$

But $V = IX_C$
$$= 5.0\times10^{-3}\times144.76 = 0.724V$$

(03 marks)

(c) On closing K, current starts to flow from the capacitor

- This sets up a magnetic field in the coil L to **build up** and in accordance with len's law a back emf is indiced in L.
- The back emf will oppose the current flow this consequently makes the **discharge process of C slow.**
- When the discharge of C is complete, the energy that was initially in the source (ie.c) is stored in the magnetic field of the coil, L.
- The emf induced in the coil makes it to act as a generator thereby returning the energy stored in its magnetic field to the source.
- The capacitor is thus recharged to its original state.
- The process keeps on repeating.

(05 marks)

(d) (i) - Electrical power can be transmitted more economically at high p.ds. or voltages with minimum loss of energy.

- Suppose electrical power P is to be delivered at a p.d. V by supply lines of total resistance R
- The current $I = \frac{P}{V}$ and power loss $P^1 = I^2R. \Rightarrow P^1 = \left(\frac{P}{V}\right)^2.R \Rightarrow$ the greater the V, the smaller the power loss P^1.

(02 marks)

(ii)

- Energy loss due to resistance of the windings (ohmic loss) can be minimized by using thick copper wires having low resistance.
- Energy loss due to eddy currents can be minimized by laminating the core.
- Energy loss due to magnetic flux leakage can be minimized by winding the secondary on the primary.
- Hysteres's loss can be minimized by using a magnetically soft material for the core.

(03 marks)

TOTAL : 20 MARKS

SECTION D

8. (a) (i) E.m.f of a cell is the **potential difference** between the terminals of a cell when it is in an open circuit./ don't supply current.
Or it is the energy needed to convey 1C of charge round a closed circuit in which the cell is connected.

(01 mark)

... time t: $I = Q/t \Rightarrow Q = It$.

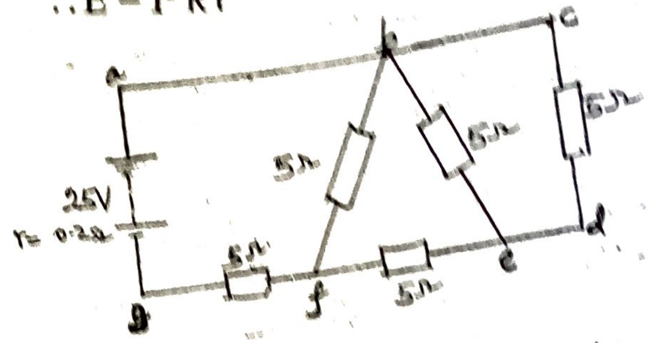
But work done is stored as electrical energy E

Thus $E = QV \Rightarrow E = It.V$

But $V = IR \Rightarrow E = It.IR$

$\therefore E = I^2 R t$

(b)



- Resistance CD and BE are in parallel; their effective resistance $R_1 = \dfrac{5\times 5}{5+5} = 2.5\Omega$
- The parallel combination of resistance R_1 is in series with fe $\Rightarrow$ Their effective resistance $R_2 = 2.5+5$

  $= 7.5\Omega$

Now R_2 is in parallel with bf and so their effective resistance $R_3 = \dfrac{5\times 7.5}{5+7.5} = 3\Omega$

$\Rightarrow$ Effective resistance $R = 5+3 = 8\Omega$

$\therefore$ Power disspated in the battery $= I^2 r = \left(\dfrac{E}{R+r}\right)^2 \times r$

$\therefore P = \left(\dfrac{25}{8+0.2}\right)^2 \times 0.2$

$P = I^2 r$

$= 1.85W$

(05 mar

(c) (i) Temp. Coefficient of resistance of a conductor is the fractional change in resistance at 0^0C for every degree celsius rise in temperature.

S.I unit is K^{-1}, or ${}^0C^{-1}$

(02 mar

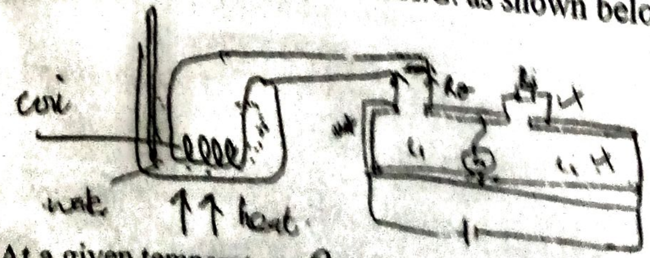
(ii)

- Semi-conductors have few electrons available for conduction at room temperature when temperature increases more electrons are set free for conduction thus increases as resistance decreases.

(02 mar

(d) (i)

- The metal wire is made into a coil and is immersed in a water bath.
- The coil is then connected in the L.H.G. of the meter bridge and a standard resistor R_s is connected in the R.H.G. as shown below.



Ant 2 labelled parts.

½ each

- At a given temperature θ of the water bath the jockey ... along the resistance wire AB until th...

- The balance length l_1 and l_2 are recorded and resistance of the coil R_θ is calculated from $R_\theta \left(\frac{l_1}{l_2}\right) R_s$.
- The procedure is repeated by varying the temperature of the bath by warming it.
- Results are tabulated to include values of R_θ and θ. A graph against θ is R_θ plotted and its slope S is obtained.
- Then t.c.r. $\propto$ is obtained from $\propto = S/R$ where R_θ axis where R_θ is the intercept on the R_θ axis.

(05 marks)

(ii) Precautions.

- R_s must be chosen such that the balance points are near the middle of resistance wire AB.
- R_s and R_θ should be interchanged when l_1 and l_2 have been determined and the average value of the balance lengths obtained.
- The slide wire AB should the jockey J scrapped by sliding the jockey J as this makes the wire non-uniform.

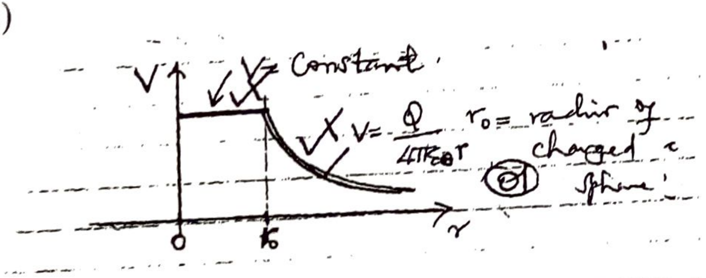
(02 marks)

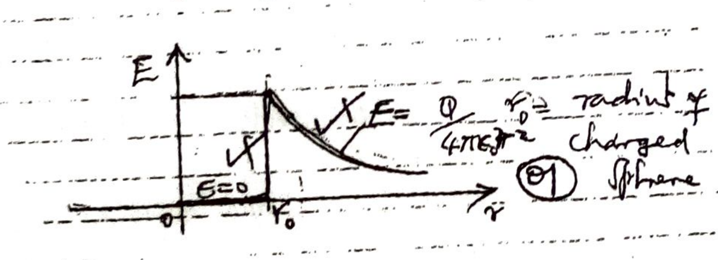
TOTAL: 20 MARKS

9. (a) (i)

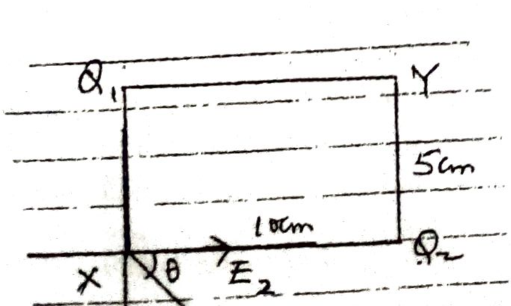
- Electric field intensity – Is the electric force exerted on a **positive charge** of 1c placed at a point in electric field.
- Electric potential – Is the work done to transfer a positive charge of 1c from **infinity** to a given point in an electric field.

(ii)





(c)



(i) Electric potential at X $= \frac{Q_1}{4\pi\varepsilon r_1} + \frac{Q_2}{4\pi\varepsilon r_2}$

$$= \frac{1}{4\pi\varepsilon}\left(\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right)$$

$$= 9.0\times10^{9}\left(\frac{+4.0\times10^{-6}}{0.05} - \frac{10\times10^{-6}}{0.10}\right)$$

$$= -1.80\times10^{5}\text{V}$$

(ii) Electri field intensity at X is given by

$$E = \sqrt{E_1^2 + E_2^2}$$

But $E_1 = \frac{Q_1}{4\varepsilon_0 r_1^2} = \frac{9.0\times10^9\times4.0\times10^{-6}}{(0.05)^2}$

$$= 1.44\times10^7\ \text{Nc}^{-1}$$

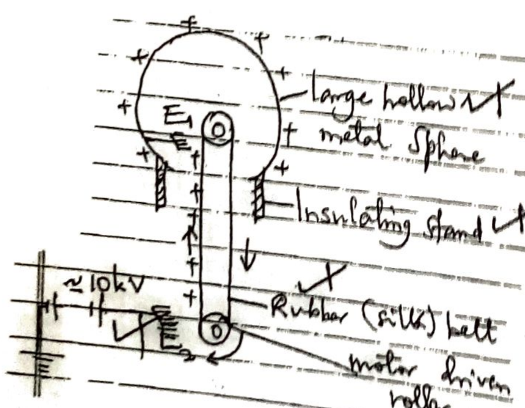
$E_2^1 = \frac{Q_1}{4\varepsilon_0 r_1^2} = \frac{9.0\times10^9\times10\times10^{-6}}{(0.10)^2}$

$$= 9.0\times10^5\text{Nc}^{-1}$$

$$\therefore E = \sqrt{(1.44\times10^7)^2 + (9.0\times10^5)^2} = 1.44\times10^7\ Nc^{-1}$$

In the direction $\theta = 86.4^{o}$ to the horizontal (04 m

(d)



- E2 is at a high positive potential with respect to the earth, and so corona disch occurs in its vicinity.
- As the belt is driven by a motor past E_1, positively charged ions are repelled **the belt** and are carried up into the hollow sphere.
- This induces negative charge (electrons) in the inner surface of the sphere an positive on the outer surface.
- The second electrode E_1 is in contact with the sphere and causes corona disc due to the high density at its points/ ends.
- Negative charges are then repelled on the belt which do **neutralize** the posi charge on the belt before going over the upper roller.
- The process is repeated and charge accumulates on the outer surface of the s

(d)

- All points on an equipotential points i

- Therefore, along any direction lying in an equipotential surface, there is no electric field since there is **no potential gradient.**
- ⇒ Electric field limes must be at right angles to an equipotential surface.

(02 marks)

TOTAL MARKS = 20

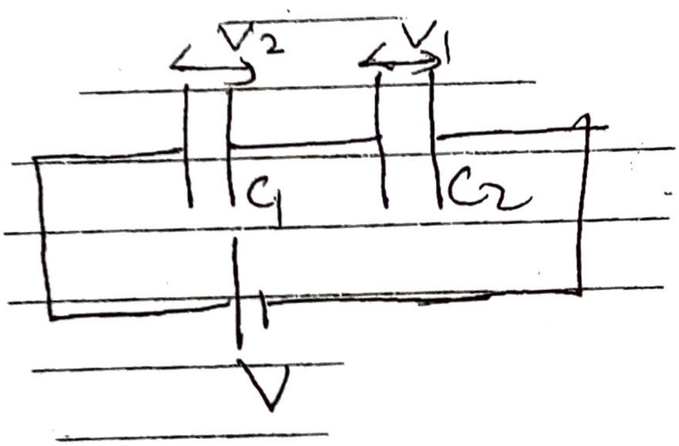
10. (a) The farad is the capacitance of a capacitor such that 1C of charge is stored when the p.d applied across its plates is IV. (01 mark)

(b) (i) Energy changes from chemical energy in the battery to electrical energy in the connection wires and then electrical potential energy in the capacitor and then later to heat in the connecting wires. (02 marks)

(ii)
- When a dielectric is in a charged capacitor, its molecules are polarized due to the electric field because of the charges on the plates.
- Therefore, at the surface of the dielectric, charges of opposite sign to the charges on the plates are induced.
- An electric field of intensity E' due to the charges on the surfaces of the dielectric is set up and it is in the opposite direction to E_o the electric field intensity due to charge on the plates.
- The resultant field intensity $E_0 - E^{|}$ is less than the initial E_o.
- This reduces the p.d between the plates leading to increase in capacitance.

(04 marks)

(c)



Effective capacitance

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

Total charge $Q = CV = \left(\frac{C_1C_2}{C_1+C_2}\right)V$

But $Q = C_1 V_1 = Q = CV = \left(\frac{C_1C_2}{C_1+C_2}\right)V$

$$\Rightarrow V_1 = \left(\frac{C_2}{C_1+C_2}\right)V$$

$C_1 = 4\,\mu F = 4\times10^{-6}F$, $C_2 = 2.0\,\mu F = 2.0\times10^{-6}$ (04 marks

$= 1.33\times10^{-6}$ F

$\therefore$ Charge on each capacitor

$Q = CV = 1.33\times10^{-6}\times120$

$= 1.60\times10^{-4}C$

On joining like terminal together total

Total initial charge $= 1.60\times10^{-4} + 1.60\times10^{-4}$

$= 3.2\times10^{-4}$ C

Total final charge, $Q = CV = (C_1+C_2)V$

$\Rightarrow 3.2\times10^{-4} = (4.0\times10^{-6} + 2.0\times10^{-6})V$

From which V= 53.33V

$\therefore$ Charge on $C_1 = C_1V = 4.0\times10^{-6}\times53.33$

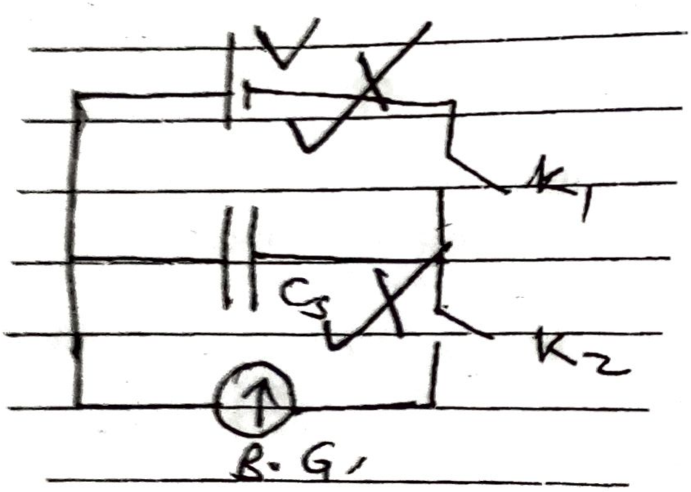
$= 2.133\times10^{-4}C$

Charge on $C_2 = C_2V = 2.0\times10^{-6}\times53.33$

$= 1.067\times10^{-4}C$

(05 ma

(e)



- The circuit is set up as shown above, with C_s being a capacitor of known capacita (standard capacitor).
- Switch K_1 is closed and after a short time, it is opened.
- Switch K_2 is then closed and the first deflection θ_s of the ballistic galvanometer is noted.
- The standard capacitor is then replaced by the capacitor whose capacitance C is to measured.
- The procedure is repeated and the corresponding deflection θ is noted.
- The capacitance C of the capacitor is then obtained from;

$$C = \frac{\theta}{\theta_s}\times C_s$$

(04 m

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Marks

uestion One

Value of x_0 = (0.485 – 0.515) 3d.p; units: m (*Correct symbols*) = 1+ ½.

Value of a_1 = (22.0 – 28.0) 1d.p; units: cm (*Correct symbols*) = 1+ ½.

Value of a_2 = (14.0 – 20.0) 1d.p; units: cm (*Correct symbols*) = 1+ ½.

Correctly calculated, M_1 = **(0.070 – 0.150); 4dp for $M_1 < 0.100$ or 3dp for $M_1 \geq 0.100$,**

units: kg; provided correct substitution; S.I. units in $M_1 = \frac{1}{2}\left(\frac{m_1 a_1}{(x_0 - a_1)} + \frac{m_2 a_2}{(x_0 - a_2)}\right)$;

(*Correct symbols*) = 2+ ½.

07

Marks

NB: *-pencil work zero marks*

Initial position of the pointer recorded to 1dp or 3dp, unit: cm = 1+ ½.

(*If symbol is used; must be defined otherwise loses the mark for the value*)

Columnar table labeled: x, p_n, d, $\frac{x}{y}$ @ ½ = 2

(*If symbol is used; must be defined otherwise loses the mark for the label and the unit of the column*)

(Correct symbols)

Indication of units; in brackets: **(m), (cm), (m), -** @½ = 2

(Correct symbols)

Values of new position of pointer recorded to 1dp; following correct unit as in the label, decreasing . @ 1 = 6

(*Difference between consecutive values:* **0.5 – 1.5) or 0.005 – 0.015**

(If all the five differences are constant mark only 1st 3values)

Correctly calculated values of, d = **(0.005 – 0.078)**, 3dp @ ½ = 3

Correctly calculated values of, $\frac{x}{y}$ = **(0.105, 0.211, 0.316, 0.421, 0.526, 0.632)** @ ½ = $\frac{3}{17\frac{1}{2}}$

NB: *-pencil work zero marks*

Marks

Title: A graph of **d** against $\frac{x}{y}$. = ½

(Accept variation of, versus, not v/s, no units, correct symbols)

Perpendicular axes drawn, with arrows, correctly labeled; vertical axis: d (m); horizontal

C3: Uniform scales (convenient) covers ½ or more, starting value indicated each, axis marked at least @ ½ = 1

HA: uniform scale; starting value zero.

C4: Correctly plotted points using ×, + or ⊙ (not •) ,with error limit of half a small square, accept shaded dots within this error limit/margin. For multiple scales consider 1st uniform scale only, if axes are not labeled do not check, for reversed axes no mark) @1 = 6

C5: Line of best fit drawn, provided at least 4 points are correctly plotted = ½

C6: Indication for slope, S covers ½ a page on at least one of the sides if D, used. (Provided line of best fit touches it) = ½

C7: Correctly calculated slope, S = **(0.0500 – 0.0650), 4dp or 3d.p**, provided coordinates are correctly read; not table values; units: **m, (correct symbols)** = 1+½

C8: Correctly read intercept, C = **(0.010 – 0.021)** 3dp; provided HA starts from zero; unit: m (correct symbols). = 1 + ½

C9: Correctly calculated value of M_2 = **(0.0700 – 0.150)**, 4dp if **M_2 < 0.100** or 3dp if **M_2** ≥ 0.100; provided correct substitution in, **$M_2 = \frac{myC}{Sx_0}$** unit: **kg** [*Correct symbols*] = 1 + ½

C10: Correctly calculated value of, M = (**0.0700 – 0.150**), 3dp if **M<0.100** or 4dp if **M≥ 0.100**; provided correct substitution in, M = $0.500(M_1 + M_2)$ unit: kg **(correct symbols)** = 1 + ½

Total Marks $15\frac{1}{2}$

NB: - *C7 to C10; pencil work is zero marks* = 40

Question Two

A1: Breadth b measured at least 3times

A2: Value of b = **(5.50 – 7.00)** 2dp; units: **cm, [*Correct symbols*]**

A3: Columnar table labeled: ***e, x, y, e^2, x^2***, $\frac{1}{e^2}$, $\frac{y^2}{x^2}$, y^2 (Correct symbols)

8- 7: **2**, 6 – 5: **1½**, 4-3: **1**, 2-1: **½**

A4: Indication of units; in **brackets**: (cm), (cm), (cm²), (cm²), (cm⁻²), - (correct symbol)

8- 7: **2**, 6 – 5: **1½**, 4-3: **1**, 2-1: **½**

A5: Values of *x* = *(3.0 – 10.5)*,1dp; increasing difference between consecutive values (0.8 – 2.0), **(If all the five differences are constant mark only 1st 3values) @ 1**

A6: Values of *y* = *(7.5 – 12.5)* ,1dp; increasing difference between consecutive values

= 6

(0.8 – 2.0). (If all the five differences are constant mark only 1st 3values) @ 1

Correctly calculated values of e^2 = (4, 6, 9, 12, 16, 20),0dp

= 2

6 – 5: **02**, 4-3: **1 ½** , 2-1:1

Correctly calculated values of x^2 , 0dp @½

= 2

6 – 5: **02**, 4-3: **1**, 2 ½ -1: ½

Correctly calculated values of y^2 , 0dp @½

= 2

6 – 5: **02**, 4-3: **1 ½** , 2-1: **01**

Correctly calculated values of $\frac{1}{e^2}$ = **(0.250, 0.167, 0.111, 0.083, 0.063, 0.050)**, 3dp 02

6-5 : 02, 4-3: 01 ½ , 2-1:01

$= \frac{02}{28}$

Correctly calculated values of $\frac{y^2}{x^2}$, 1dp @½

6-5 : 02, 4-3: 01 ½ , 2-1:01

NB: ***-pencil work zero marks***

A_5 and A_6 -For values of x and y, used tracing paper must be available

= ½

Title: A graph of $\frac{y^2}{x^2}$ against $\frac{1}{e^2}$

(Accept variation with, versus, not vs, no units, correct symbols)

Perpendicular axes drawn, with arrows, correctly labeled; vertical axis: $\frac{y^2}{x^2}$;

=1

horizontal axis: $\frac{1}{e^2}(cm^{-2})$ *(Correct symbols)*

Uniform scale (convenient) cover ½ or more, starting values indicated, each axis marked at least 3 times. @ ½ = 1

HA: Starting value zero.

Correctly plotted points using ×, + ⊙ or (not •) ,with error limit of half a small square, accept shaded dots within this error limit/margin. For multiple scales consider 1st uniform scale only, if axes are not labeled do not check, for reversed axes no mark) @½ =3

= ½

Line of best fit drawn, provided at least 4 points are correctly plotted

= ½

Indication for slope, S covers ½ a page on at least one of the sides

Marks

B7: Correctly calculated slope, S = **(11.8 – 25.0), 1dp**, provided coordinates are correctly read; not table values; units: **cm²**; **(correct symbols)** =1+½

B8: Correctly read intercept, C = **(0.39 – 0.5)** 1or 2dp; provided HA starts from zero; (correct symbols). *No unit* = ½

B9: Correctly calculated value of, n_1 = **(1.40 – 1.60)**, 1or 2dp ; no units; provided correct substitution into; $b^2 = n^2S$; **(correct symbols)** = ½ + ½

B10: Correctly calculated value of, n_2 = **(1.40 – 1.60)**, 1or 2dp ; no units; provided correct substitution into; $n_2 = \sqrt{\frac{1}{C}}$; **(correct symbols)** = ½ + ½

B11: Correctly calculated value of, n = **(1.40 – 1.60)**, 1or 2dp ; no units; provided correct substitution into; $n = \frac{1}{2}(n_1 + n_2)$; **(correct symbols)** = ½ + ½

12

Total Marks = 40

NB: - ***B7 and B11; pencil work is zero marks***

Question Three.

Marks

A1: Value of **V0** = **(1.40 – 1.60)**, 1 or 2dp; units: V, (correct symbols) =½+½.

A2: Value of ***l0*** = **(60.0 - 95.0)**, 1dp or **(0.600 – 0.950)**,3dp; unit: cm; (correct symbols) =1+½.

A3: Value of **I** = **(0.16 – 0.20)**, 2dp; unit: A, (correct symbols) =½+½.

A4: Value of ***l*** = **(0.550 – 0.800)**, 3dp; unit: m (correct symbols) =1+½.

A5: Correctly calculated value of R_1 = **(7.0 - 12)**, 0dp if R1 ≥10 and 1dp if R1< 10, unit: **Ω**, provided correct SI substitution in $\boldsymbol{R_1} = \frac{l}{Il_0}V_0$, (Correct symbols) = $\frac{1+\frac{1}{2}}{06\frac{1}{2}}$

NB: -*pencil work zero marks*

Marks

B1: Columnar table labeled: R, l, $\frac{1}{l}$ (correct symbols@ 1 = 3

B2: Indication of units using brackets: (Ω), (m), (m⁻¹), correct symbols@ 1 = 3

B3: Values of ***l*** = (0.550 - 0.200) 3dp, decreasing; difference between consecutive values in the range (0.010 – 0.100) ; **(If all the five differences are constant mark only 1st 3values) @ 2** = 12

B4: Correctly calculated values of $\frac{1}{l}$, 2dp @ ½ = $\frac{3}{21}$

NB: -*pencil work zero marks*

Marks

1: Title: A graph of R against $\frac{1}{l}$ = ½
(*Accept variation with, versus, not vs, no units, correct symbols*)

2: Perpendicular axes drawn, with arrows, correctly labeled; vertical axis: R(Ω);
horizontal axis: $\frac{1}{l}$ (m^{-1}) (*Correct symbols*) @ ½ =1

3: Uniform scales (convenient) covers ½ or more, starting value indicated each, axis marked at least 3 times.
HA: starting value zero.@ ½ = 1

4: Correctly plotted points using +,× ⊙ (not •) ,with error limit of half a small square, accept shaded dots within this error limit/margin. For multiple scales consider 1st uniform scale only, if axes are not labeled do not check, for reversed axes no mark) @1 = 6

5: Line of best fit drawn, provided at least 4 points are correctly plotted = ½

6: Correctly read intercept, C = (**- 7.0 – -12.0**) 1dp; provided HA starts from zero;
unit: Ω (correct symbols). = 1+½

7: Value of $\boldsymbol{R_2}$ = (**7.0 – 12.0**), 1dp; unit: Ω (correct symbols) =1

8: Correctly calculated value of, $\mathbf{R_0}$ = (**7.0 – 12**), 0dp if $R_1 \geq 10$ and 1dp if $R1 < 10$,
provided correct substitution in $R_0 = 0.50\ (R_1 + R_2)$, (Correct symbols) $= \frac{\mathbf{1}}{\mathbf{12\frac{1}{2}}}$

Total Marks **= 40**

NB: - ***C_6 and C_8; pencil work is zero marks***

END