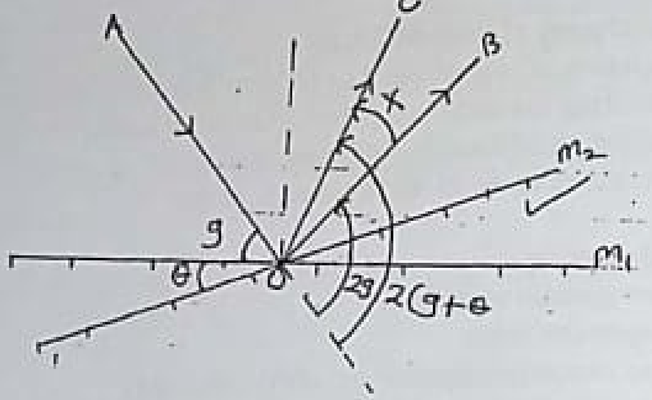
WAKISSHA JOINT MOCK EXAMINATIONS
MARKING GUIDE
Uganda Advanced Certificate of Education
UACE August 2018
PHYSICS P510/2

1. (a) (i) - The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane. (01)
- The angle of incidence is equal to the angle of reflection. (01)

(02)

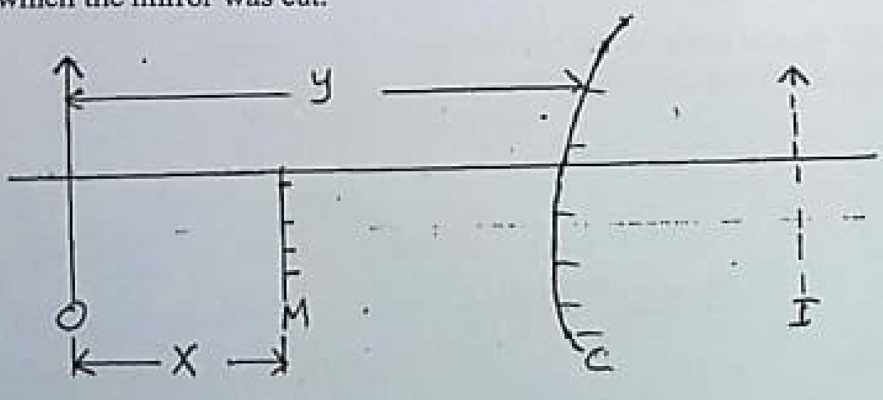
(ii)



(01)

A constant ray of light OA is incident onto a plane mirror in position M_1 and it is reflected along OB. The glancing angle = g
Deviation, d = 2g
When the mirror is turned through angle, θ to position M_2
The new glancing angle = $(g+\theta)$
The new deviation = $2(g+\theta)$ (03)
The angle through which the ray turns/ rotates is
$X = 2(g + \theta) - 2g$
$X = 2\theta$

(b) (i) Radius of curvature of a convex mirror is the radius of the sphere from which the mirror was cut. (01)



(01)

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An object, O is placed in front of the convex mirror, C
A plane mirror, M is placed between the object, O and the convex mirror to cover half the aperture of the convex mirror.

Viewing through both mirrors the position of the plane mirror is adjusted until a point is found where the image of the pin in the convex mirror coincides with one in the plane mirror without parallax. Distance OC, y and X are measured, Now u=y and v= -(2x-y).

The focal length can be calculated from $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$

The radius of curvature r =2f (03)

(c) $d=t\left(1-\frac{1}{n}\right)=15\left(1-\frac{1}{1.5}\right)=5.0\text{cm}$

$f=\frac{r}{2}=\frac{20}{2}=10\text{cm},\ U^{l}=20-5.0=15\text{cm}$

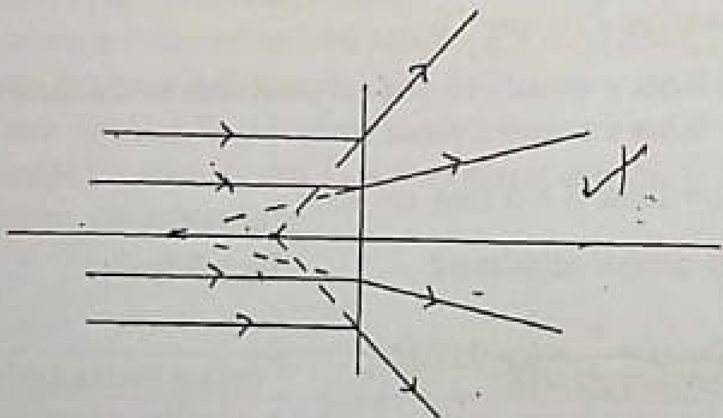
$\frac{1}{f}=\frac{1}{u^{l}}+\frac{1}{v^{l}}$

$\frac{1}{10}=\frac{1}{15}+\frac{1}{v^{l}}\Rightarrow V^{l}=30\text{cm}$

Position of image of the pin = (30+5) cm = 35cm. (04)

(d) Chromatic aberration is the colouring of the image produced by a lens. A parallel beam of white light incident on a convex lens is dispersed and each colour is brought to its own focus. This is because the different colours have different refractive indices.
(02)

(e)



½

When a wide beam of light falls on the lens marginal rays are refracted and appear to come from a point different from that of the central rays. The image formed is thus blurred. This is called spherical aberration.

It is minimized by use of an opaque disc with a central hole so that light is incident on the middle of the lens 2 ½

Total = 20marks

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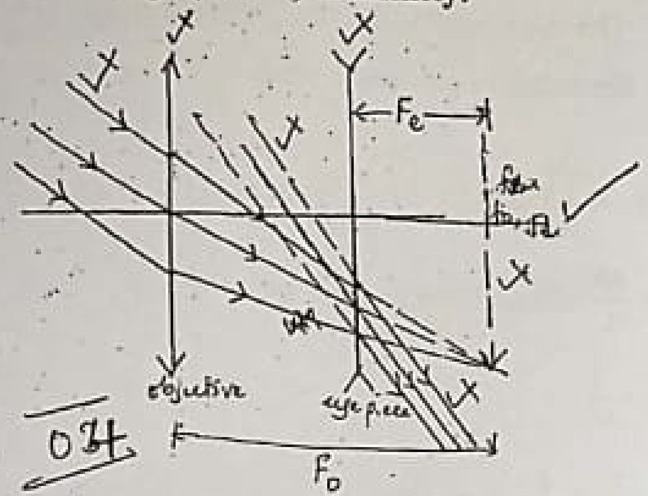
2. (a) (i) Power of the lens is the reciprocal of its focal length in metres

(ii) Exit pupil; is the best position for the eye when viewing an image through the instrument or image of the object in the eye piece (02)

(b) - A converging is lens is arranged coaxially with a diverging lens such that their focal points are at the **same point.**

- The converging lens forms a real image of a distant object at its focal point, F_0 situated exactly at the principal focus F_e of the diverging lens coinciding
- The image formed acts as a **virtual object** for the diverging lens which thus forms a final image (virtual) at **infinity.**



04

$$M = \frac{\alpha^1}{\alpha}.$$

In radians: $\alpha^1 = \tan\alpha^1 = \frac{h}{fe}$, $\alpha = \tan\alpha = \frac{h}{fo}$

$$M = \frac{\alpha^1}{\alpha} = \frac{\left(\frac{h}{fe}\right)}{\left(\frac{h}{fo}\right)} = \frac{fo}{fe}, \quad m = \frac{fo}{fe}$$

Separation of the lens = $f_0 - f_e$

(b) (ii) - It has a virtual eye ring not accessible to the observer

- It has a narrow field of view. (02)

(c) (i) $f_o = 1.0m$, $f_e = 0.10m$. $\alpha = 0.30^0$

In normal adjustment $U_E = 0.5m$

$$\text{Tan } \sigma = \frac{h}{f_o} = h = 0.00524_m$$

Where $f_0 = 1$

$$\alpha^1 = \tan^{-1}\left(\frac{0.00524}{0.1}\right)$$

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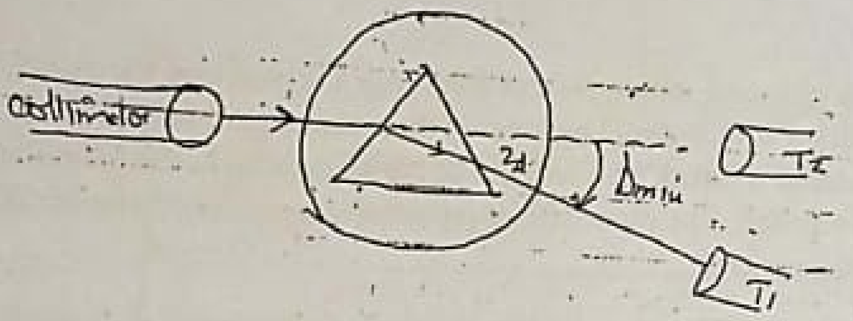
$$\tan\alpha^1 = 0.0524 = \frac{h_1}{0.5} = h_1$$

(ii) Distance between objective & screen $= f_0 - u$

$= 1.0m - 0.5$

$d = 0.5m$

(d)



- Collimator is adjusted to produce parallel rays of light.
- Telescope is adjusted to receive light from the collimator on its cross wires.
- The turn table is leveled.
- The prism is placed with the refracting angle pointing away from the collimator.
- 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 when the ray begins to move backwards.
- Position T_1 of the telescope noted
- The prism is removed and the telescope is turned to receive light directly from the collimator.
- The new position T_2 is marked.
- The angle between T_1 and T_2 is determined and this is the angle of minimum deviation dmin

09

Total - 20 marks

3.

Mechanical waves	Electromagnetic waves
- Need a material medium for their propagation	- Don't need a material medium for their propagation. (Or can propagate in vacuum).
- Propagate at relatively low speed	- Propagate at very high speed
- Have longer wave lengths	- Have shorter wave lengths
- Are due to vibrations or oscillations of particles in the transmitting medium	- Are due to variations in electric and magnetic fields (03)

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(b) (i) Overtones are notes of higher frequencies produced by an instrument above the fundamental frequency. (01)

(ii) When an instrument is played all the allowed vibrations take place producing different frequencies. The quality of the musical note is determined by the number and the strengths (or intensity) of the overtones. (03)

When a note played on an instrument has fewer overtones it sounds different from the same note played on a different instrument with more overtones.

(03)

(c) A vibrating tuning fork of frequency f is held near the mouth of a tube filled with water. The level of the water is gradually lowered until a loud sound is heard. The length l of the air column in the tube is measured and recorded. The procedure is repeated using tuning forks of different frequencies.

The results are recorded in a table including values of $\frac{1}{f}$. A gragh of l against $\frac{1}{f}$ is plotted. The intercept, C on the l-axis is noted and is equal to the end correction.

05

(d) (i) Doppler effect is the apparent change in the frequency of a wave when there is relative motion between the source and the observer.

01

(ii) Apparent wave length of the waves reaching the observer

$$\lambda^1 = \frac{v + u_s}{f}$$

Apparent velocity of sound received

$$v^1 = v - u_0$$

Apparent frequency $f^1 = \frac{v^1}{\lambda^1} = \frac{V - \mu_0}{v + u_s}$

$$= \left(\frac{330-15}{330+25}\right)\times 500$$

$$= \underline{443.7H_z}$$ (03)

(e) At the mouth the air is free to move and therefore the displacement of air molecules is large and pressure is low. At the closed end the molecules are less free and small and the displacement is minimal (or zero) and the pressure is high. (04)

Total - 20 marks

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

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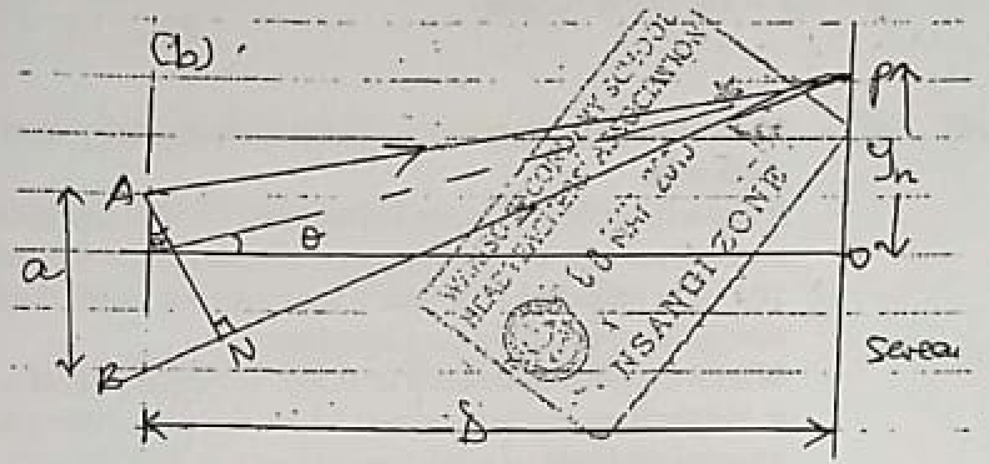
Diffraction is the spreading of wave fronts a round gaps or obstacles beyond geometrical boundaries leading to interference. (02)

(ii) - The dimension of the obstacle must be of the same order as the wave length of the light.

(01)

(b)



(01)

For bright fringe at p.

- Path difference, BN = BP = AP = a sinθ–(i), for d>>a, θ is very small in radius, sinθ = tanθ

  BN = a tanθ = $\frac{ay_n}{D}$ .... (ii)

For n^{th} bright fringe at p

Path difference, BN = nλ

$$\frac{ay_n}{D} = n\lambda$$

$$y_n = \frac{n\lambda}{a}D$$

For $(n+1)^{th}$ bright fringe

$$y_{n+1} = \left(\frac{n+1}{a}\right)\lambda D \ (5)$$

Fringe width $w = y_{n+1} - y_n$

$$= \frac{\lambda(n+1)}{a}D - \frac{n\lambda}{a}D \qquad (04)$$

$$\omega = \frac{\lambda D}{a}$$

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(c) $\lambda = 5.0 \times 10^{-7}$m $\omega = 5.0$mw D = 2.0m

$\omega = \frac{\lambda D}{a} \Rightarrow a = \frac{\lambda D}{w}$

$a = \frac{5.0 \times 10^{-7} \times 2.0}{5.0 \times 10^{-3}}$ (03)

$= \frac{5.0 \times 10^{-3} \times 2}{5}$

$\omega = 2.0 \times 10^{-4}$m or 0.2mm

(d) (i)
- Monochromatic light is incident almost normally onto the upper glass side.
- It is partly reflected at the bottom part of *the top slide and partly transmitted into the air film and reflected at the top surface of Y.
- The light reflected at X and Y are coherent, when they overlap above the upper slide they interfere.
- Where the path difference is an odd multiple of half a wavelength it, bright fringe is formed and where the path differences is an integral multiple of a full wave length, a dark fringe is formed.

(05)

Total - 20 marks

(ii) $\lambda = 600$nm $\omega = 1.8$mm

$\tan\theta = \frac{\lambda}{2y} = \frac{t}{15 \times 10^{-2}}$

$\frac{\lambda}{2y} = \frac{t}{15 \times 10^{-2}} \Rightarrow \frac{600 \times 10^{-9}}{2y} = \frac{t}{15 \times 10^{-2}}$

$t = \frac{600 \times 10^{-9} \times 15 \times 10^{-2}}{2 \times 1.8 \times 10^{-3}}$

$t = 2.5 \times 10^{-5}$m

Total - 20 marks

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

(b) (i) $w = 2\Pi f \rightarrow 160\Pi = 2\Pi \rightarrow f = 80H_z$ (01)

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(ii) $<p> = \frac{V_{rms}^2}{R} = \frac{V_0^2}{2R} = \frac{40\times40}{2\times200} = 4w$ (03)

(c) (i) $V = v_0 \sin 2\Pi ft$

Charge on the capacitor is $Q = CV$

Where C is the capacitance of the capacitor. The instantaneous current flowing through the capacitor.

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

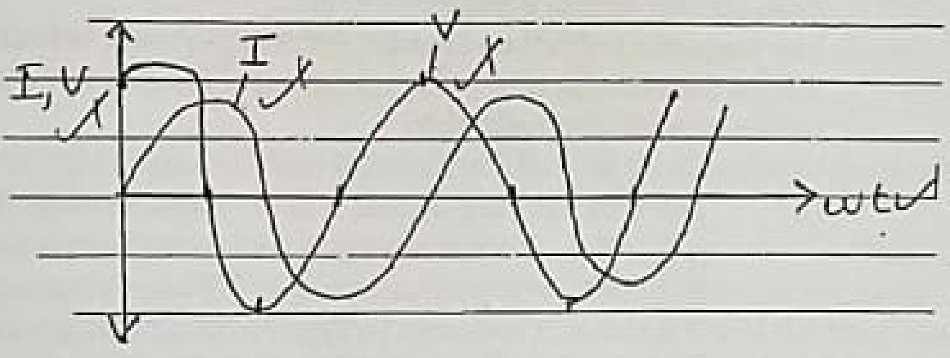
$$= \frac{d}{dt}(CV_0 \sin 2\pi ft$$

$$= 2\pi fc\ V_0 \cos 2\pi ft$$

$$= 2\pi f\ C\ V_0 \sin(2\pi f t + \frac{\pi}{2})$$

Hence current leads voltage by $\frac{\Pi}{2}$ radius or 90^0 (04)

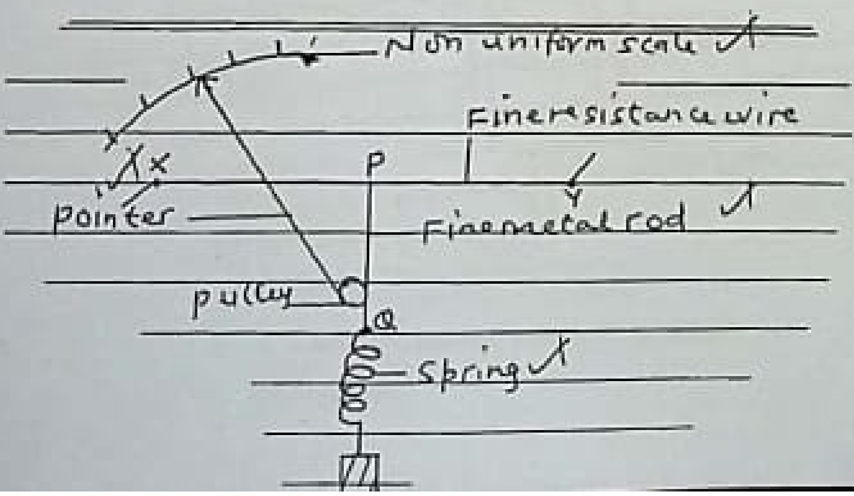
(ii)



(d) $Irms = \frac{V_{rms}}{x_L} = \frac{V_{rms}}{2\Pi fL}$

$$= \frac{80}{2\times3.14\times1.5\times1000\times0.5}$$

$= \underline{1.7\times10^{-3}A}$ (03)



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Any four correctly labelled each ½ mark (02)

Current to be measured is passed through the wire XY.

The wire heats up, expands and sags

The sag is taken up the fine wire PQ held taut by the spring. Wire PQ passes round a pulley attached to the pointer which deflects over the scale as the pulley rotates when PQ moves down.

The deflection of the pointer is proportional to the square of the average current.

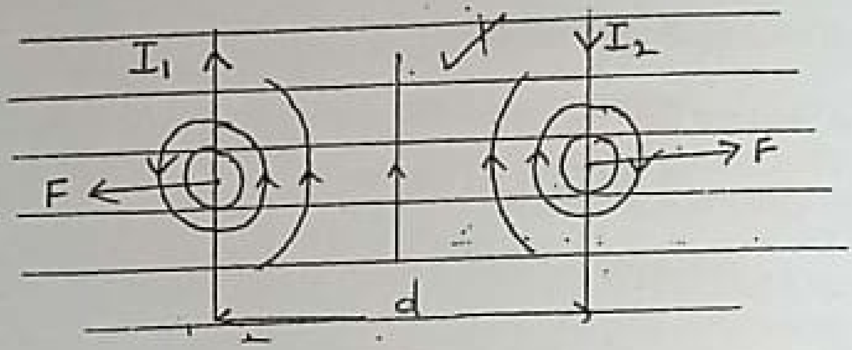
(04)

Total = 20 marks

6. (a) The ampere is the constant current which when flowing through two infinitely long conductors of negligible cross sectional area placed 1m a part in vacuum produces ~~between them a force of 2.0×10^{-7} Nm^{-1}~~

(01)

(b) (i)



½

Each current creates a magnetic field.

The magnetic fields then interact, the resultant field between the wires is then in the same direction. Each wire experiences a force towards the region of weak magnetic flux.

2 ½

(ii) The wire carrying current I_2 is the magnetic field of I_1

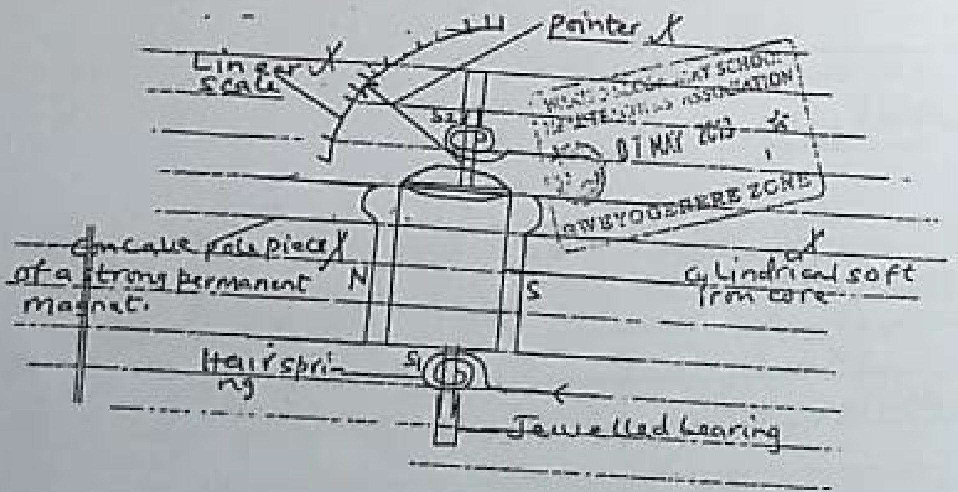
$$B_1 = \frac{M_0 I_1}{2\Pi d}$$

Force on 1m of wire carrying current I_2

$$F = B_1 I_2 = \frac{M_0 I_1 I_2}{2\Pi d}$$

(02)

(c)



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Current to be measured is allowed in through hair spring S_1. The coil experiences a magnetic torque T= BANI in a radial magnetic field. The coil turns together with the pointer until it is stopped by the restoring torque of the hair spring T= Kθ where θ is the angle turned through and K is the spring constant.

At this point

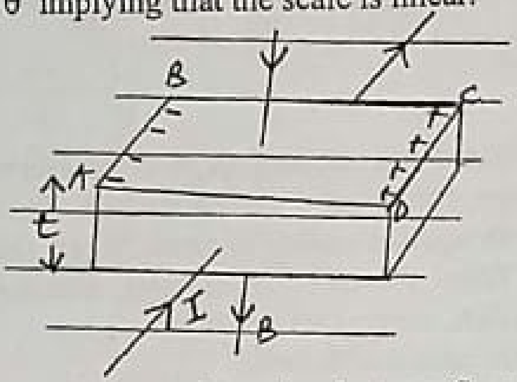
$$T = BANI = K\theta$$

$$\rightarrow I = \left(\frac{K}{BAN}\right)\theta$$

But $\frac{K}{BAN}$ = constant

hence $I \propto \theta$ implying that the scale is linear. (04)

(d)



When current begins to flow the electrons flow in the direction opposite to that of current.

The electrons experience a magnetic force F_m = BeV towards AB. Side AB is then negative and DC is positive. This creates a p.d between the faces. The p.d opposes the movement of electrons towards AB and the elections stop moving when the p.d reaches a particular value called Hall p.d.

(03)

(ii) In a semiconductors, the number of charge carriers is less than in conductors. Since hall p.d is inversely proportional to the number of charge carriers ,Hall p.d is thus large in semi-conductors.

(02)

(iii) $V_H = 8.75mV$ $B = 0.5T$, $I = 150_mA$

$e = 1.6 \times 10^{-19}c$

$V_H = \frac{BI}{Net}$

$$N = \frac{BI}{V_H et}$$

$$N = \frac{0.5x150x10^{-3}}{8.75x10^{-3}x1.6x10^{-19}x1.0x10^{-3}}$$

$= \underline{5.36 \times 10^{22}}$ (03)

<u>Total = 20 marks</u>

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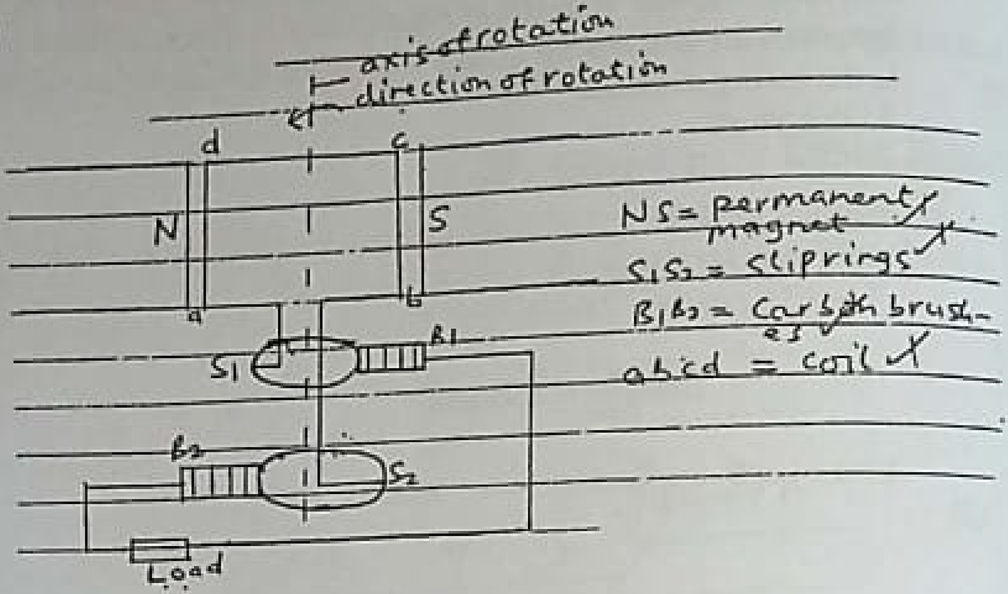
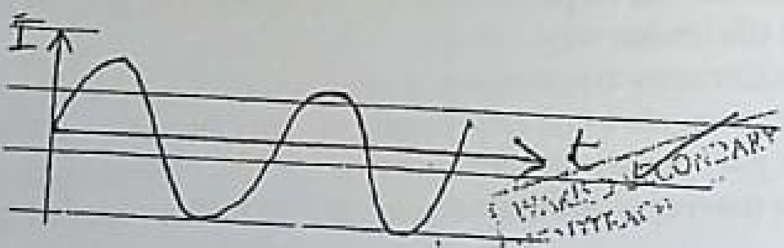
7. (a) - The magnitude of the induced e.m.f is directly proportional to the rate of change of the magnetic flux linkage.
- The direction of the induced emf / current is in such a direction as to oppose the change causing it. (02)

(b) (i)



The coil load is rotated at a constant speed in the magnetic field. An emf is induced and drivers current in a direction abcd. The current is taken by sliprings which rub against carbon brushes. When the coil is vertical, no emf is induced. When the coil is horizontal, maximum emf is induced. From vertical position, current reverses.
Variation of output current with time.

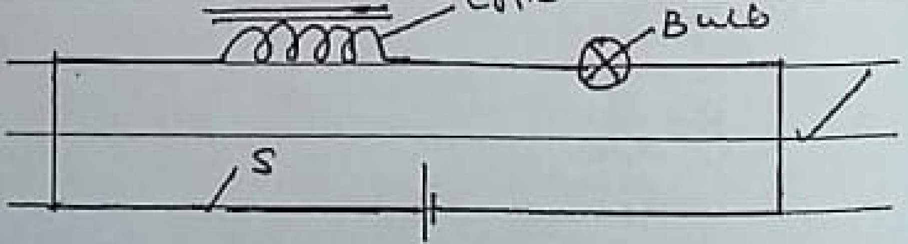


(06)

(ii) Replacing slip rings with commutators. (01)

(c) (i) Self-induction is the process in which an emf is induced in a circuit due to changing current in the same circuit.
Mutual induction is the process in which an emf is induced in a circuit due to changing current in a nearby circuit. (02)

(ii)



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An iron cored coil is connected in series with a bulb and switch, S as above. When S is closed, the bulb lights dimly then its brightness increases to maximum. Current flowing initially was small due to large back emf. As the back emf reduces current increases.

2 ½

(d) (i) - Use low resistance copper windings to reduce ohmic (I^2R) losses.
- use a laminated core to reduce eddy currents
- use a soft iron core to reduce hysteresis.
- wind the secondary coil on top of the primary coil to reduce magnetic flux leakage.

(02)

(ii) From $\frac{V_s}{V_p} = \frac{N_s}{N_p}$

$$V_s = \frac{N_s N_p}{Np} = \frac{30 \times 240}{600} = 12v$$

$$I_s = \frac{Vs}{R} = \frac{12}{3} = 4.0A$$

$$J = \frac{\text{power output}}{\text{Power in put}} \times 100\%$$

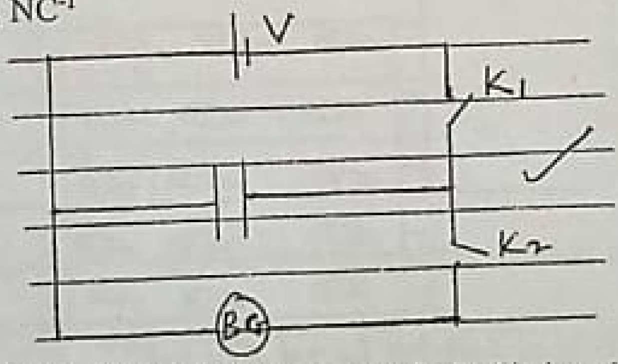
$$\frac{I_s V_S}{I_S V_P} \Rightarrow \frac{80}{100} = \frac{12 \times 4}{240 I_P}$$

$$I_P = \frac{12 \times 4 \times 100}{240 \times 80} = 0.25A$$ (04)

Total = 20 marks

8. (a) Di electric strength is the maximum potential gradient beyond which the di electric starts to conduct.
UNIT Vm^{-1}, NC^{-1} (02)

(b)



A capacitor is connected to the battery and a ballistic galvanometer as shown. Switch K_1 is closed for until when capacitor is fully charged and then opened. K_2 is then closed and the deflection θ_1 on the ballistic galvanometer noted.
A di electric is then put between the capacitor plates and the experiment repeated. The deflection θ_2 on the ballistic galvanometer is noted.
Dielectric constant is given by $\Sigma_r = \frac{\theta 2}{\theta 1}$ (04)

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(c) (i) $C_0 = \frac{\Sigma_0 A}{d} = \frac{8.85\times10^{-12}\times25\times10^{-4}}{1.0\times10^{-3}} = 2.2125\times10^{-1}$

Initial energy $E_0 = \frac{1}{2}CV^2 = \frac{1}{2}\times2.2125\times10^{-11}\times(100)^2$

$= \underline{1.10625\times10^{-7}J}$

New capacitance $C_1 = \frac{\Sigma_0 A}{2d} = 1.10625\times10^{-11}F$

Initial charge $Q_0 = C_0V = 2.2125\times10^{-11}\times100$

$= 2.2125\times10^{-9}C$

New energy $E_1 = \frac{Q_0^2}{2c_1} = \frac{2.2125x10^{-9}x2.2125x10^{-9}}{2.2125x10^{-11}}$

$\Sigma_1 = 2.2125\times10\times10^{-7}J$

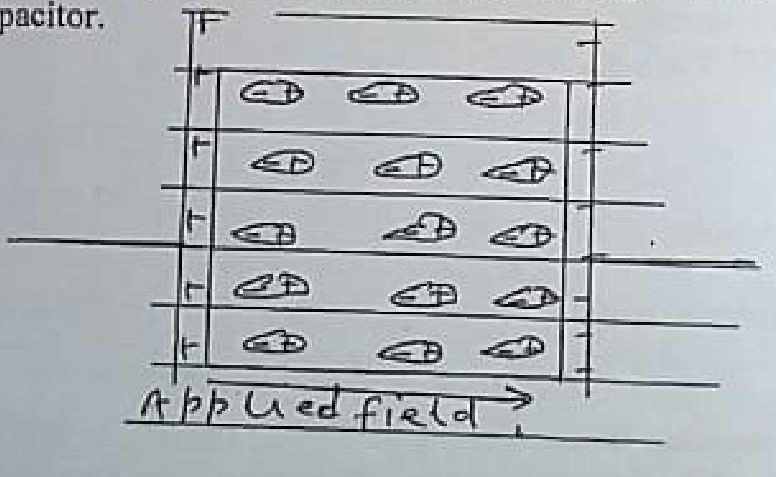
Energy change $= E_1 - E_0 = (2.2125 - 1.10625)\times10^{-7}$

$= 1.10625\times10^{-7}J$ (05)

(ii) work done in moving the plates a part against mutual attraction is converted into electrostatic energy. (02)

(d) (i) when connected in series, the charge on each capacitor is the same as the charge stored by the combination. Since the p.d across each capacitor is less than the p.d across the combination, from $C=\frac{Q}{V}$ capacitance of the combination is less than capacitance of either capacitor. (03)

(ii)



When a di electric is placed between the plates of a charged capacitor, the molecules of the di electric get polarized.

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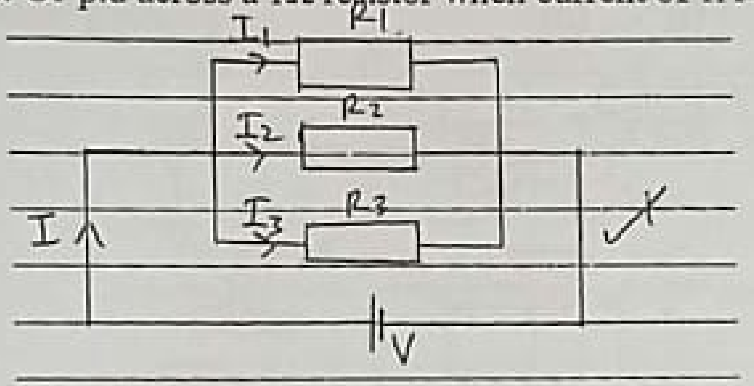
Negative charges appear near the positive plate and positive charges appear near the negative plates. An electric field intensity develops between the faces of the dielectric in a direction opposite that of the applied field. The electric field intensity between the plates is thus reduced. But $E=\frac{v}{d}$, thus the p.d is also reduced. From $C=\frac{Q}{V}$ the capacitance of the capacitor is therefore increased.

(03)

Total = 20 marks

9. (a) (i) A volt is the potential difference between two points if the work done to transfer IC of charge from one of the points to the other is 1joule. **Or** p.d across a 1Ω resistor when current of 1A flows

(ii)



The p.d across all the resistors is the same and equal to V

By conservation of current at a junction,

$I = I_1 + I_2 + I_3$

By ohm's law $I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2}$ and $I_3 = \frac{V}{R_3}$

$$\therefore I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{I}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

But $\frac{I}{V} = \frac{1}{R}$ where R is the equivalent resistance of the circuit.

$$\therefore \frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$$ (04)

(b) The driver cell connected a cross the slide wire maintains a **steady current** through the slide wire. The slide wire is **uniform** and its **resistance per centimeter is constant.** Knowing the p.d per unit length of the slide wire any p.d can be determined by balancing it against a known length of the wire. If the p.d per unit length is K and balance length is L then the required p.d,

V= KL. (03)

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(c) (i) $V_{AB} = \left(\frac{50}{50+10}\right) \times 2 = \frac{100}{60} = \frac{10}{6}$

p.d /cm $= \frac{10}{6}/100 = \frac{1}{6}Vcm^{-1}$

Emf of D = p.d across 90cm of AB

$= \frac{1}{60} \times 90 = 1.5V$ (02)

(ii) When K_2 is, closed, p.d,v across 5Ω resistor
= p.d across 75cm length
$= \frac{1}{60} \times 75$
$= E = I(R + r) = 1.5$............................ (i)
$= V = IR = \frac{1}{60} \times 75$ .... (ii)
(i) ÷ (ii)

$$\frac{R + r}{R} = \frac{1.5 \times 60}{75}$$

$$\frac{5 + r}{5} = \frac{1.5 \times 60}{75}$$

$$5 + r = \frac{1.5 \times 60 \times 5}{75} = 6$$

$r = 6 - 5 = 1\Omega$ (03)

(iii) When K_2 is closed, the cell D supplies current, I through the circuit of 5Ω and internal resistance of 1Ω.
From $E = I(R + r)$
$1.5 = I(5+1) = 6I \rightarrow I = 1.5/6 = 0.25A$
Let l be the balance length
$5I = Kl \Rightarrow 5 \times 0.25 = 2/100 \times l$
$l = \frac{0.25 \times 5 \times 100}{2} = 62.5cm$ (03)

(d) At room temperature the resistance of the thermistor is high. Current flowing is thus small and the bulb lights dimly. As current flows, the thermistor heats up (or temperature increases) the resistance decreases leading to increase in current and hence increase in brightness of the bulb. (04)

Total = 20 marks

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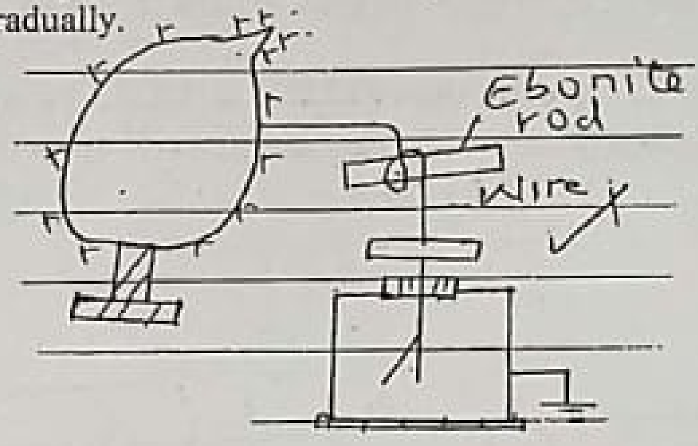
10. (a) (i) The force between two point charges is directly proportional to the product of the magnitude of the charges and inversely proportional to the square of the distance between the charges. (01)

(ii) Electric field intensity is the force experienced by IC of positive charge at a point in an electric field.
Electric potential is the work done in moving IC of positive charge from infinity to a point in the electric field. (02)

(b) (i) The divergence of the gold leaf electroscope gradually reduces.
At the tip of the pin, there is high charge density, thus high electric field intensity. The air around the pin gets ionized, ions of opposite charge to that on the pin are attracted and neutralize some of the charge on the pin and the electroscope. The electroscope thus discharges gradually. (03)

(ii)



One end of the wire is connected to the cap of a neutral gold leaf electroscope and the other end is placed on the surface of a charged pear shaped conductor.
The divergence of the gold leaf electroscope is noted. The free end of the wire is then moved over the surface of the conductor and the divergence of the gold leaf electro-scope remains the same. Thus the p.d over the surface of a pear shaped charged conductor is constant.
(3½)

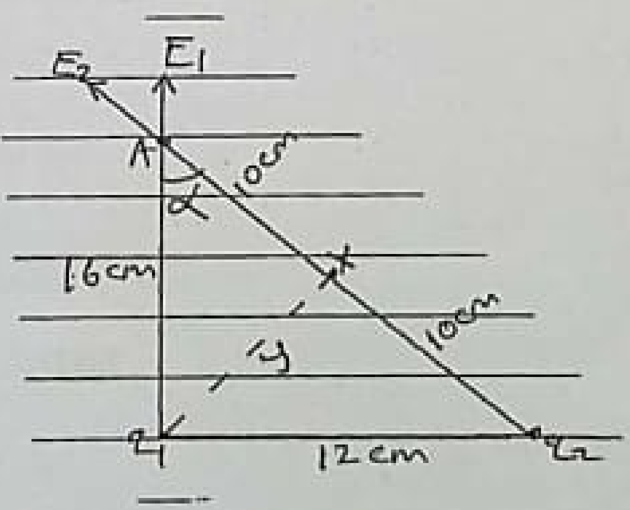
(c) $\sin\alpha = \frac{12}{20} = \frac{3}{15}$

$\cos\alpha = \frac{16}{20} = \frac{4}{5}$

$E = \frac{KQ}{r^2}$

$E_1 = \frac{4\times10^{-6}\times9\times10^{9}}{(16\times10^{-2})^2}$

$=1.406\times10^{6}\,\mathrm{Vm^{-1}}$



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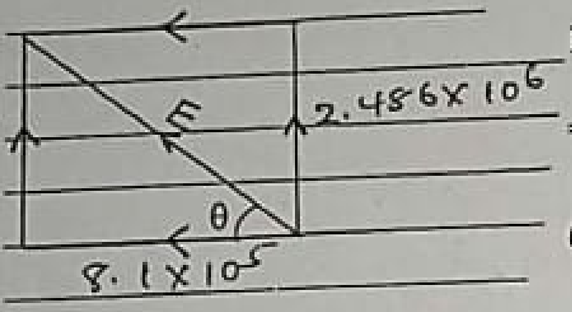
$$E_2 = \frac{6\times10^{-6}\times9\times10^{9}}{(20\times10^{-2})^2} = 1.35\times10^{6}\text{Vm}^{-1}$$

$E_X = -1.35\times10^{6}\times3/5 = -8.1\times10^{5}\text{vm}^{-1}$

$E_Y = 1.406\times10^{6} + 1.35\times10^{6}\times\frac{4}{5} = 2.486\times10^{6}\text{Vm}^{-1}$



$E = \sqrt{(2.486\times10^{6})^2 + (8.1\times10^{5})^2}$

$= 2.615\times10^{6}Vm^{-1}$

$\theta = \tan^{-1}\left(\frac{2.486\times10^{6}}{8.1\times10^{5}}\right)$

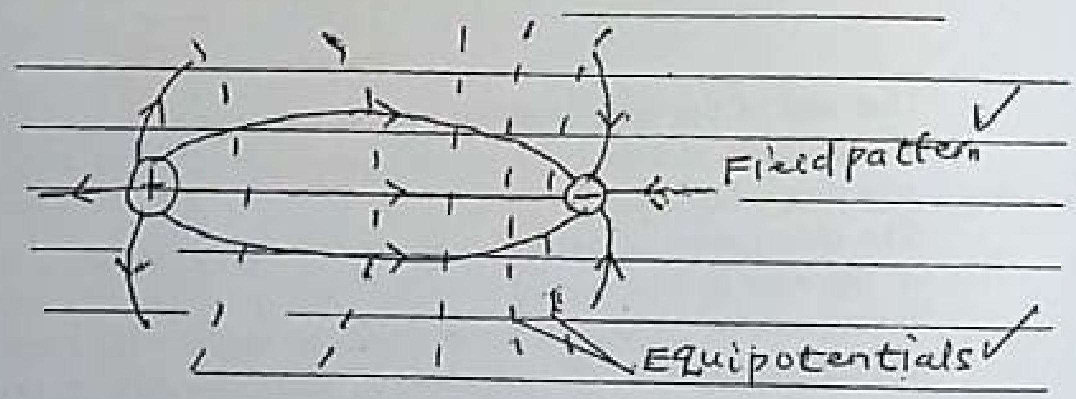
$= 72^0$ (04)

(ii) $y^2 = (16^2 + 10^2) - (2\times10\times16\times4/5)$, $y = 10\text{cm}$

$V = \frac{KQ}{r}$, $Vx = \left(\frac{4\times10^{-6}}{0.1} + \frac{6\times10^{-6}}{0.1}\right)\times9.0\times10^{9}$

$V_x = 9.0\times10^{5}\text{V}$ (04)

(d)



(02)

Total = 20 marks

END

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