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UACE 2022 PHYSICS PAPER TWO (P510/2)

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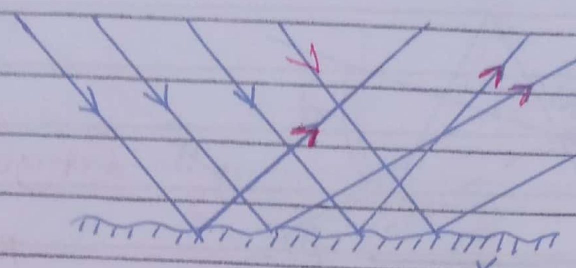
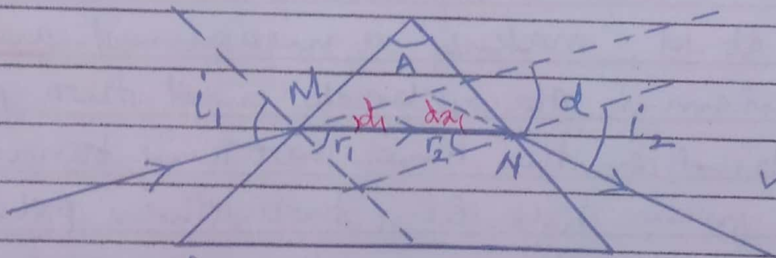
1(a)



✓ [regular ~~incident beam~~ & scattered reflected irregular]

When a parallel beam of ✓ light is incident on (rough) unpolished ✓ surface, ✓ it is reflected in different directions. This reflection is refered to as diffused. (2)

(b)



✓ (ray refracted twice) & angles

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

$\sin i_1 = n\sin r_1$ ✓. For small angles i_1, r_1 measured in radians ✓, $\sin i_1 \simeq i_1$ and $\sin r_1 \simeq r_1$ ✓

$\therefore\ i_1 \simeq nr_1$ ✓ — (1)

Now $A = r_1 + r_2$ ✓. Since A is small, r_2 is also small. This implies that i_2 is also small. (5)

At N, $\sin i_2 = n\sin r_2$. Since i_2, r_2 are small, when measured in radians, $\sin i_2 \simeq i_2$, $\sin r_2 \simeq r_2 \Rightarrow i_2 \simeq nr_2$ ✓ — (2)

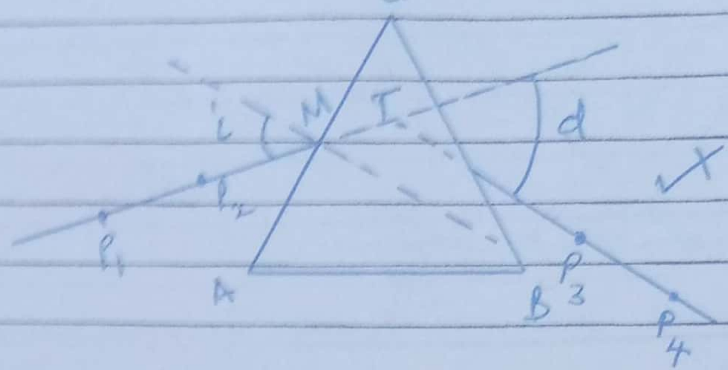
The deviation $d = d_1 + d_2 = (i_1 - r_1) + (i_2 - r_2)$ ✓

$\Rightarrow d = (nr_1 - r_1) + (nr_2 - r_2) = (n-1)(r_1 + r_2)$

$\Rightarrow d = (n-1)A$ ✓

2

(c)



(angles i, d & pins)

~~Recover~~ without a diagram if d is positioned well.

A prism is placed on a plain sheet of paper fixed on a drawing board, and its outline traced. The prism is removed, and a line drawn on side AC at M, making a measured angle i. The prism is placed back and two pins P_1 and P_2 placed on the line. Looking through the prism from side BC, two other pins P_3, P_4 are placed so that the four pins appear to be in a straight line. The prism and the pins are removed and the lines drawn through pin marks P_1, P_2 and P_3, P_4 to meet at I. Angle d is measured and recorded with the corresponding angle of incidence, i. The experiment is repeated with other angles of incidence, i and the values recorded in a table. A graph of d against i is plotted and a smooth curve is obtained. The least value of d on the graph is ~~ob~~ read. This is the angle of minimum deviation. (05)

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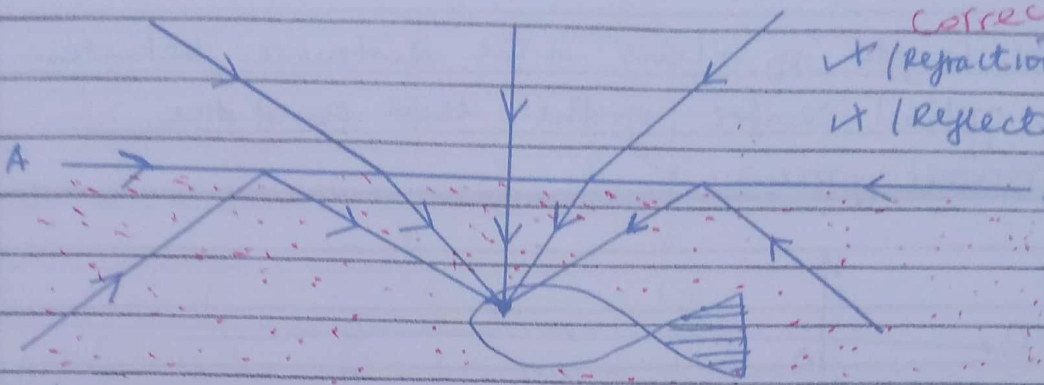
(d)



Correct
✓ (Refractions)
✓ (Reflections)
Can be rewarded in description

Arrows from eye deny 1

All rays from above the water surface AB incident on the water surface are refracted and received by the eye. ✓ Rays grazing the interface are also refracted and received by the eye. ✓ Light from the inside water undergo total internal reflection and received by the eye. ✓ Hence the fish has a wide field of view. (04)

Deny ½ if total int missed

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

But $d = 13 - 9.5 = 3.5$ ✓

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

$\Rightarrow 5\left(1 - \frac{1}{n_1}\right) = 3.5 - 1.98$ (4)

$1 - \frac{1}{n_1} = \frac{1.52}{5} = 0.304$

$\frac{1}{n_1} = 0.696 \Rightarrow n_1 = 1.44$ ✓

OR
$d = t(1-\frac{1}{n})$ ✓
$d_1 = 8(1-\frac{1}{1.33}) = 1.98$ ✓
$d = 13-9.5 = 3.5$ ✓
$d_2 = 5(1-\frac{1}{n_1}) = 3.5 - 1.98$ ✓
$n_1 = 1.44$ ✓

OR
$n_1 = \frac{t_1}{a_1}$ ✓
$\Rightarrow 1.33 = \frac{8}{a_1}$
$\therefore a_1 = 6.02$ ✓
$n_2 = \frac{t_2}{a_2}$ $\Rightarrow n_2 = \frac{5}{9.5-6.02}$ ✓
$n_2 = 1.44$ ✓

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(4)

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

(b)(i)

When the image is formed at I, $u = OA$ and $v = AI$. But $OA = BI$ and $OI = OA + AB + BI$

$\Rightarrow OI = 2OA + AB$

$\Rightarrow OA = \frac{OI - AB}{2} = \frac{l-d}{2}$

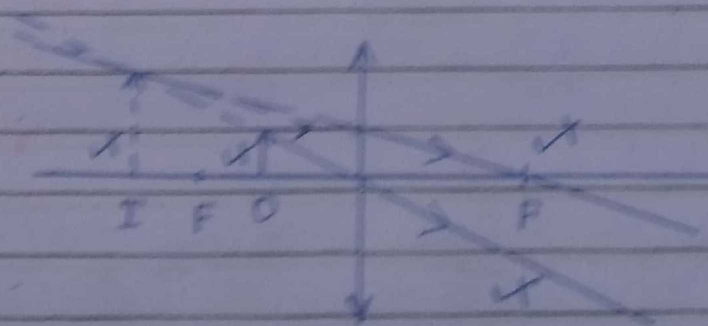
$AI = OI - OA = l - \left(\frac{l-d}{2}\right) = \frac{l+d}{2}$

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

$\Rightarrow l^2 - d^2 = 4lf.$

(05) ~~(04)~~

(ii)



- for O, F must be thick

(02)

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(5)

(iii) The image formed is virtual, upright / erect magnified

2 correct @ / 1 correct ½ / the rest 0 — (02)

If negated (that are wrong) eg virtual ≠ real

(c) $f = 20{\cdot}0\,cm$, $u = 7{\cdot}0\,cm$

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

$\Rightarrow \frac{1}{20} = \frac{1}{v} + \frac{1}{7{\cdot}0} \Rightarrow v = -10{\cdot}8\,cm$ — (04)

But $v = r$, the radius of curvature, $r = 10{\cdot}8\,cm$

Alternatively

$f = 20{\cdot}0\,cm$, $v = 7{\cdot}0\,cm$

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

$\Rightarrow \frac{1}{20{\cdot}0} = -\frac{1}{r} + \frac{1}{7{\cdot}0}$

$\Rightarrow r = 10{\cdot}8\,cm$

deny ½ if -ve value

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

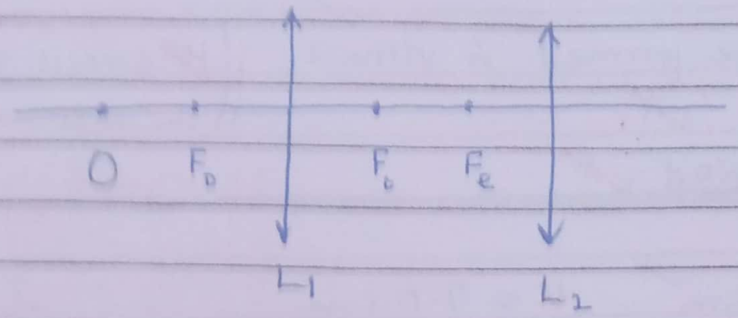
Reject distance

(ii) Accommodation is the process in which the focal length (cilliarly muscles) of the eye adjusts (alters) to enable the eye focus objects at different distances away from it. — (01)

OR: Ability of eye to see far and near objects

(4)

(c)



Action of L_1, $u = 1.5\,cm$, $f_o = 1.2\,cm$

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

$$\Rightarrow \frac{1}{1.2} = \frac{1}{1.5} + \frac{1}{v_o} \qquad \Rightarrow v_o = 6.0\,cm$$

Action of L_2, $f_e = 4.0\,cm$ $\quad v_e = -25\,cm$ (04)

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

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

- transfer error if $V_e = 25\,cm$ (loses 1)

$$\Rightarrow u_e = 3.45\,cm$$

Separation of the lens $= v_o + u_e$

$= 6.0 + 3.45$

$= 9.45\,cm$

- reverses lenses gets 1 mark maxm

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

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

- Constant amplitude
- Energy moves / transmits energy
- ~~[illegible]~~
- freq constant, ϕ changes
- Constant λ
- definite λ / Constant Speed

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

(ii) $y = y_1 + y_2$

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

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

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

$= A\sin 300\pi t$

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

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

$\lambda = 30\text{cm}$ (02)

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

$= \frac{2\pi \times 25}{30}$

$= 5.23\text{ rad}$ (02)

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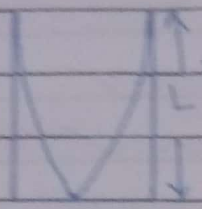
(6)

(c) Consider a wave form produced at the fundamental frequency f_0.

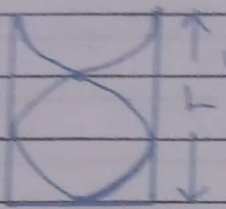


$L = \frac{\lambda_0}{4}$, $\lambda_0 = 4L$

$f_0 = \frac{V}{4L}$ $\Rightarrow V = 4Lf_0$

diagram must be accurate

For the 1st overtone.



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

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

$f_1 = 3f_0$ (04)

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

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

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

If $f_b' > f_b$, then $f_2 = f_1 + f_b$ either (03)

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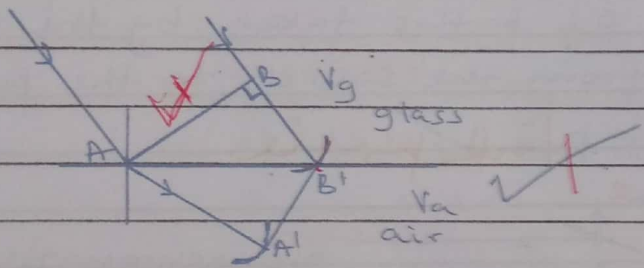
4(a)(i) It states that Every point on a wave front acts as a source of secondary wavelets, which move in the forward direction with the velocity of the wave, and the new wave front at any given time is the envelope which just touches the surfaces of the wavelets. (01)

(ii)

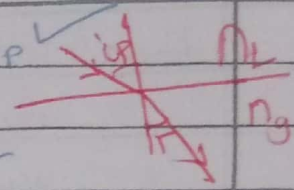


- incident beam
- refracted beam

Suppose V_g and V_a are the velocities of light in glass and air respectively. In the interval, t, when the wavelet from B moves to B^1, distance $BB^1 = V_g t$, the wavelet from A travels a distance $AA^1 = V_a t$ in air. By Huygen's principle, the new wavefront just touches the surface of the spheres of centres A and B of radii $V_g t$ and $V_a t$ respectively. The new wave front therefore is B^1A^1 (03)

$n_g \sin r = n_L \sin i_p$ But $r = 90 - i_p$ (8)

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



$\therefore i_p = 48.7°$

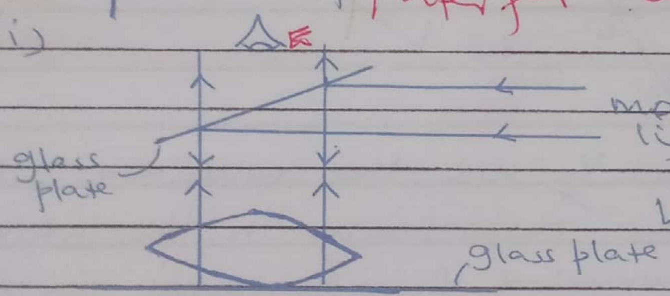
$\Rightarrow r_p = 90 - 48.7 = 41.3°$

(04)

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

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

(iii)



(glass plate, lens ~~missing~~)

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

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geometrical path difference optical different

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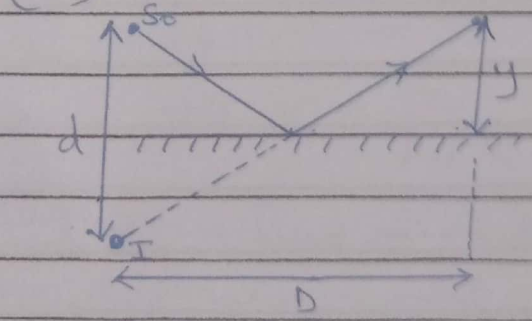
The two reflected waves superpose to form alternate dark and bright fringes which are observed at E.

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

Where the geometrical path difference is an Integral multiple of full wave length, a dark band is formed.

Where the geometrical path difference is an odd multiple of half the wave length, a bright fringe is formed. (06)

(c)



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

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

$y = \frac{\lambda D}{d} = \frac{600 \times 10^{-9} \times 51 \times 10^{-2}}{2 \times 3.00 \times 10^{-3}}$

$= 5.1 \times 10^{-5} m$ (03)

(d) - Blooming of lenses

- Testing for optical flatness
- ~~Stress analysis~~
- Determining wavelengths
- Determing speed of a wave or light. (01) 20

when force on a conductor 1m long & carrying I of 1A is 1N

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

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

or ~~Magnetic flux density is the magnetic flux threading an area of $1m^2$ perpendicular to the magnetic field.~~

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

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

N X circumference of the coil = length of the wire.

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

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

3

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

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

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

05

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(ii) The magnetic field is perpendicularly into the ~~page~~ plane containing the coil 1

(c) $F = BILN$

$F = 0.2 \times 9.80 \times 1 \times 100 = 196.0\,N$

Additional force $= 196.0\,N$

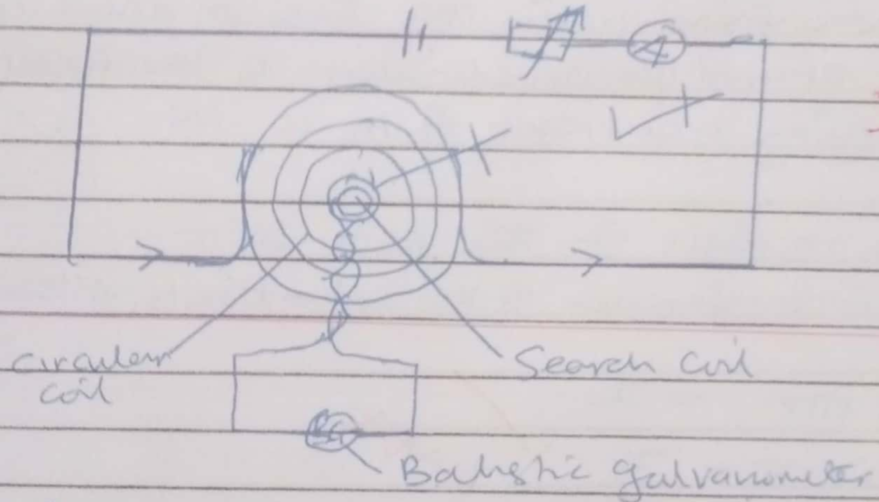
Additional weight $= mg$

$Mg = 196.0$ 2

$M \times 9.81 = 196.0$ $M = 19.98\,kg$

$m \approx 20\,kg$.

(d)



– upper complete circuit
– coil with BG

1 – shd turn the coil not withdraw

A search coil is placed at the centre of the circular coil carrying current with its plane parallel to that of the test coil. The coil is then pulled completely out of the field. The first throw, θ of the BG is noted together with the ammeter reading, I. The above procedures are repeated with different values of I obtained by adjusting the rheostat and the corresponding

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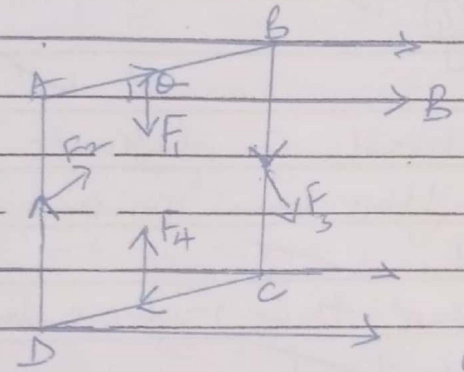
values of θ noted. The results are tabulated.
A graph of θ against I is plotted and a straight line through the origin is obtained $\Rightarrow \theta \propto I$
but $B \propto \theta$
$\therefore B \propto I$ 06

e(i)



Force on one turn of AB
$F_1 = BIL\sin\theta$ downwards
Force on one turn of AD
$F_2 = BIL$ inwards.
Force on BC $F_3 = BIL$ outwards
Force on DC $F_4 = BIL\sin\theta$ upwards.

F_1 & F_4 =, opposite

You can give directions on the diagram

F_1 and F_4 cancel out.
F_2 and F_3 forms a couple of moment
$$\tau = BIL \cdot L\cos\theta$$
for N turns
$$\tau = BILN\,L\cos\theta = BIL^2N\cos\theta$$
$$L^2 = A$$
$$\therefore \tau = NBAI\cos\theta$$ 4

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

$$F = \frac{\mu_0 I q v}{2\pi d}$$
$$= \frac{4\pi\times10^{-7}\times10\times1.6\times10^{-19}\times10^{7}}{2\pi\times0.02} = 1.6\times10^{-16}\,N$$

OR $B = \frac{4\pi\times10^{-7}\times10}{2\pi\times2\times10^{-2}} = 1.0\times10^{-4}\,T$

$F = Bqv = 1.0\times10^{-4}\times1.6\times10^{-19}\times10^{7}$
$= 1.6\times10^{-16}\,N$ 2

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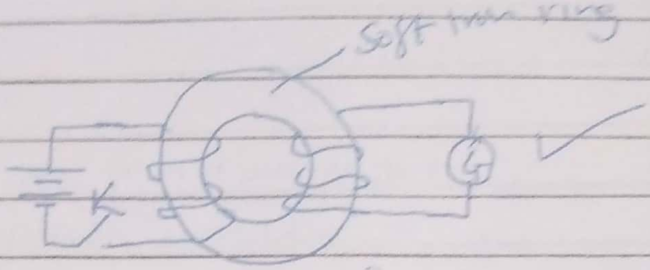
6a(i) Mutual Induction is the production of emf in a circuit due to the change in current in a nearby circuit. 1

(ii)



When switch K is closed, G deflects. This shows that current has been induced in the secondary coil. 2

(b) - The Iron core is laminated, this reduces amount of eddy current induced.

- The soft Iron core is used which is easier to magnetised and demagnetised. 2

(c) EMF induced $\mathcal{E} = -\frac{d\phi}{dt}$, but $\phi = BA$

$\therefore \mathcal{E} = -B\frac{dA}{dt}$, Since angular speed is constant $\frac{dA}{dt} = \frac{A}{T} = Af = \pi r^2 f$ (3)

$\therefore \mathcal{E} = -B\pi r^2 f = -\frac{1}{2}B\omega r^2$.

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(14)

d(i) When the rod begins to ~~move~~ move downwards, it cuts the magnetic field ~~and~~ and current is induced in the circuit. Magnetic force comes into play, ~~which~~ which opposes the motion of the conductor. The force increases with increase in speed. When the force becomes equal to the weight of the rod, the rod begins to move with constant velocity.

(3)

(ii) At steady speed

$F = BIL = Mg$

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

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

$\Rightarrow u = \frac{MgR}{B^2L^2} = \frac{0.03 \times 9.81 \times 0.04}{0.2^2 \times 0.5^2}$

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

$F = BIL = Mg$

$0.03 \times 9.81 = 0.2 \times 0.5 \times I$

$I = 2.943A$

$E = IR = 2.943 \times 0.04$

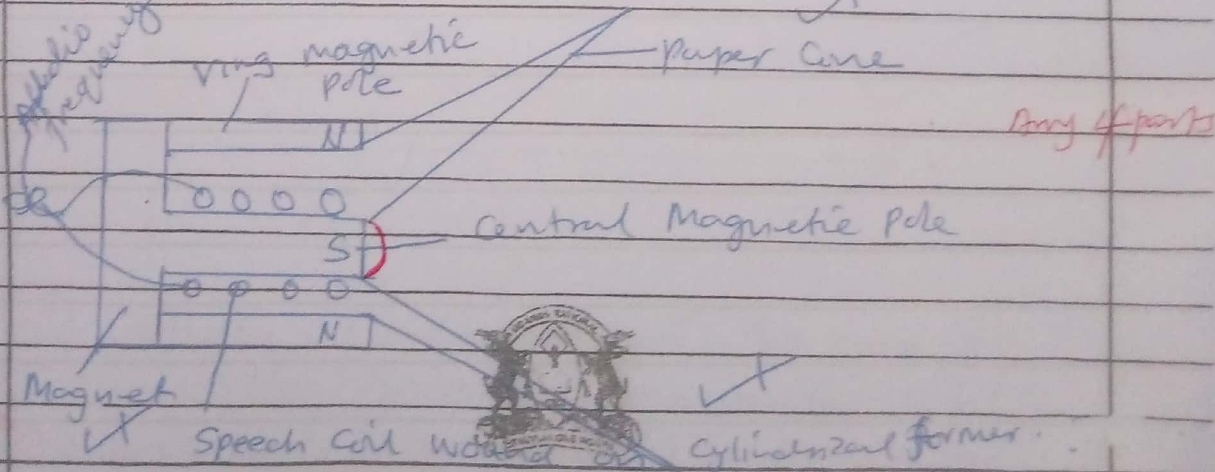
$= 0.1177V$

But $E = BLu$

$0.1177 = 0.2 \times 0.5 u$

$u = 1.177 m/s$

(e)



Any 4 parts

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When the audio frequency current flows in the coil, magnetic force acts on the coil causing it and the former to move in one direction. When the current reverses, the motion is also reversed. This causes the paper cone attaching to the former to move back and forth (or vibrate) at the frequency of the current, thus producing sound of the same frequency with the speech.

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

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

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

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

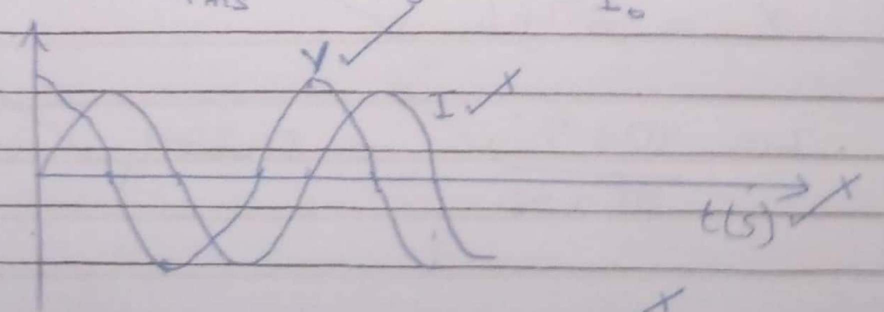
$\therefore V = L\frac{dI}{dt} = L\frac{d}{dt}(I_0 \sin 2\pi f t)$ 04

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

$\Rightarrow V_0 = 2\pi f L I_0$ $V \to 0$ from $I \to -ve$

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

(ii)



02

(iii) Initially, current is zero, the rate of change of current is maximum, implying the back e.m.f (supply voltage) is maximum

Since $E_b = -L\frac{dI}{dt} \Rightarrow E_b \propto \frac{dI}{dt}$

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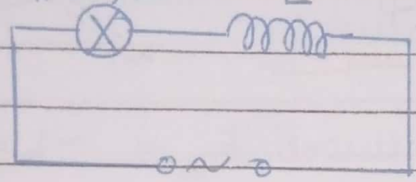
When current increases, its rate of change reduces, hence back e.m.f reduces. 02

When current is maximum, its rate of change is zero, hence voltage is zero

c (i)



OR

$V_L = \sqrt{V^2 - V_R^2}$

$V_L = 207.85\,V$

$X_L = 2\pi f L = \frac{V_L}{I} = \frac{207.8}{2}$

$= 103.9\,\Omega$

Impedence, $Z = \frac{V_{rms}}{I_{rms}} = \frac{240}{2} = 120\,\Omega$ 03

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

$= 60\,\Omega$

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

$X_L = 103.9\,\Omega$

(ii) $X_L = 2\pi f L$ 02

$L = \frac{103.9}{2\pi \times 50} = 0.23H$

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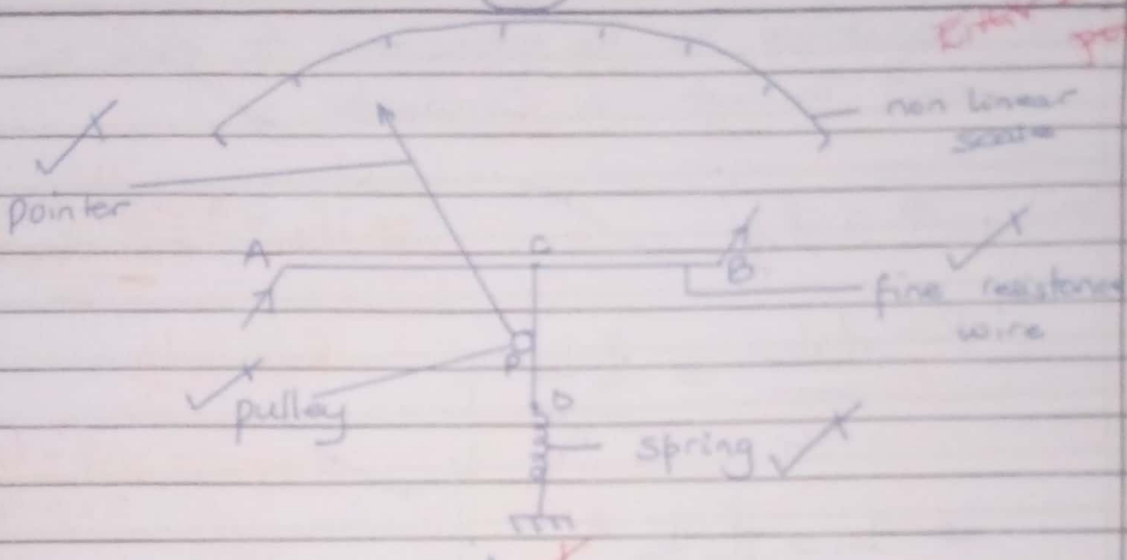
(d)



CD — fine rod

Current to be measured is passed through a fine resistance wire AB. The wire heats up, expands and sags. The sag is taken up by fine rod CD passing round pulley P. Hence pulley rotates causing the pointer to deflect over the scale

to be pulled down by spring

The deflection of the pointer is proportional to the sag and therefore proportional to the average of square of current

05

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(19)

8a (i) Resistance is the opposition to flow of current through a conductor. 01

(ii) $R = \rho \frac{L}{A}$

OR $R_m = \frac{4.6\times10^{-7}\times20}{\frac{\pi\times(0.54\times10^{-3})^2}{4}} = 40.195$

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

$R_n = \frac{\rho_n L_n}{A_n}$

$40.19 = \frac{10\times10^{-7}\times L_n}{\frac{\pi\times(0.5\times10^{-3})^2}{4}}$ 03

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

$l_n = 7.89m$

$L_n = \frac{4.6\times10^{-7}\times20\times0.5^2}{0.54^2\times10}$

$\therefore L_n = 7.89m$

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

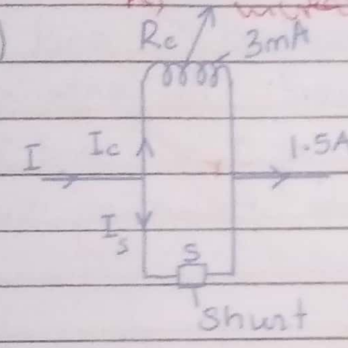
(20)

OR $I \propto \frac{1}{R}$ Also $R \propto L$ and $R \propto \frac{1}{A}$

When in perallel, the Cross-sectional area is increased and when is series, the length is increased. Hence more Current flows when in parallel and less Current when in series.

(OR) $I \propto 1/R$, when in parallel, effective resistance is reduced hence current increases/larger. When in series, the effective resistance increases, hence current is reduced. (07)

(ii)



$$I = I_c + I_s$$

$$\Rightarrow I_s = I - I_c = 1.5 - 3\times10^{-3}$$

$$= 1.497\,A$$

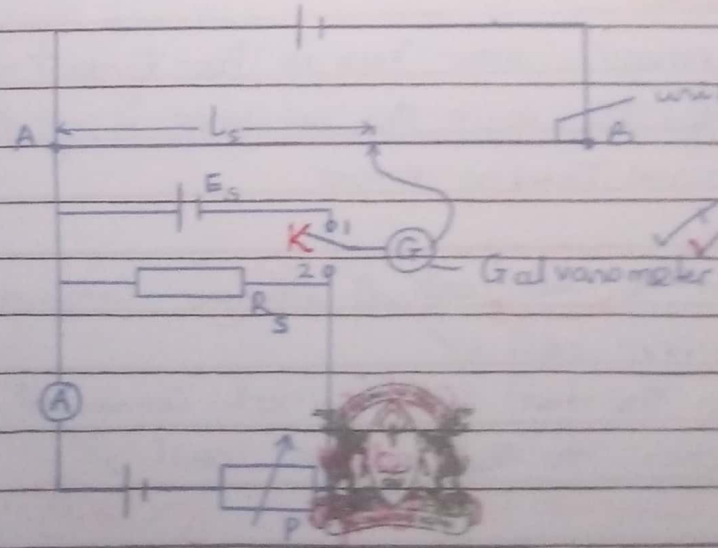
P.d across the Components (03)

$$I_c R_c = I_s S$$

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

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

C(i)



any four (upper circuit, lower circuit)

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

both E_s and R_s

06

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

graph of I_a against I_r ... graph of calibration

C (ii) - non-uniformity of the slide wire. Resistance per cm will not be constant and hence the calculation not ~~Correct~~ accurate. 02

- End errors. when there is poor contact at the ends of the wire, the resistance is not accounted for, hence causing errors.

- Loose connections

(iii) - when the test cell is ~~stronger~~ larger compared to ~~that~~ of the driver cell emf's 02

- when the test cell is not connected in opposition to the driver cell

(ii) - when current is left on for long, it

20

- overheating of the slide wire changes p.d/cm or
- Running down of the driver cell also changes p.d/cm.

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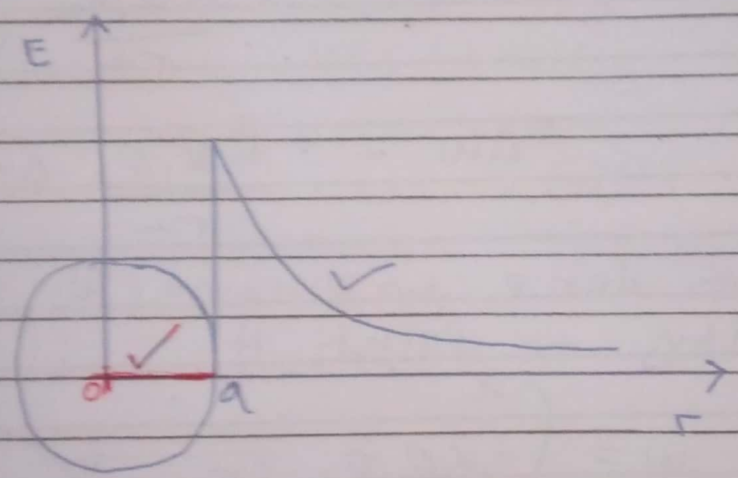
9(a) (i) Electric field is the region in space where electric force/intensity is experienced.

reject force only

(ii) Electric field strength is the force experienced by a positive charge of 1C placed in an electric field. 02

(b)



default ½ if radius or sphere not indicated

(c)(i) Electric potential energy is the work done to move a positive charge from infinity to a point in an electric field 01

relax on +ve

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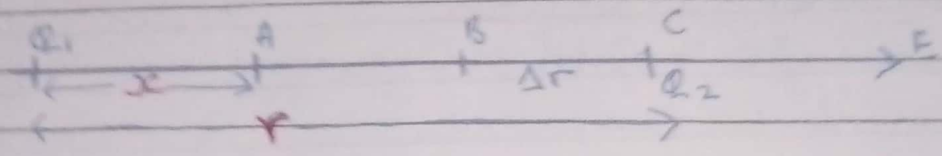
(ii)



Small work done to move Q_2 from C thr' distance Δr, $\Delta W = -F\Delta r$

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

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

Total work done to move Q_2 from ~~init~~ infinity to point A

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

(change variables & limits)

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

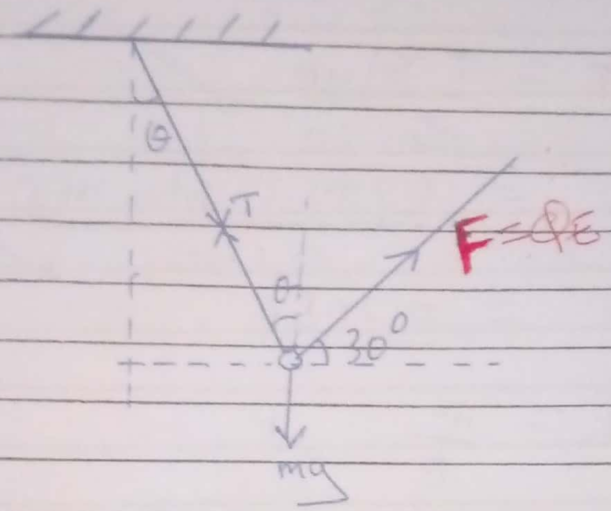
$$= \frac{KQ_1Q_2}{x} = \frac{Q_1Q_2}{4\pi\varepsilon_0 x}$$

04

for $V = \frac{KQ}{x}$ ← max 3mks

24

d



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

$\theta = 14.5°$

Resolving using F to determine units.

Resolving vertically

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

Resolving horizontally

$T\sin\theta = F\cos 30$ --- (ii) ✓

from (i) and (ii)

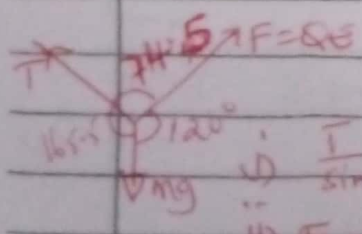
$$\frac{mg - T\cos\theta}{T\sin\theta} = \tan 30°$$

$$T = \frac{mg}{\sin\theta\tan 30 + \cos\theta}$$ ✓

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

$= 0.7053\ N$ ✓

OR



(i) $\frac{T}{\sin 120} = \frac{mg}{\sin 74.42} = \frac{80\times 10^{-3}\times 9.81}{\sin 74.5}$ ∴ $T = 0.7054N$ 02

(ii) $F = \frac{80\times 10^{-3}\times 9.81}{\sin 74.50}\times \sin 165.5 = 0.204N$

$Q = F/E = \frac{0.204}{1.5\times 10^{6}} = 1.36\times 10^{-7}C$

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(ii) From (ii)

$$F = \frac{T \sin\theta}{\cos 30}$$

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

$$= 0.2039$$

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

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

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

03

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

03

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6 The divergence of the leaf reduces then increases

As the body approaches the cap, it repels electrons from the cap to the plate and the leaf. This reduces the charge on the plate and the leaf. Thus divergence of the leaf reduces ~~until they are neutralised~~

On approaching the cap further more electrons are repelled to the plate and the leaf making the leaf to diverge.

03

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

(ii) Dielectric strength is the maximum potential gradient / electric field intensity which the dielectric material can with stand without it's insulation breaking down 01 ✓

(b)(i) - To seperate the capacitor plates ✓

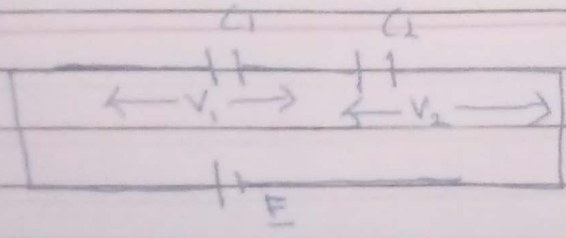
- To increase the capacitance ✓

- To reduce on chance of dielectric break down when large p.d is applied ✓ any two

- increase dielectric strength

(ii) chemical energy → electrical energy → heat energy; electric potential energy 02

(c)



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

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

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

$\therefore V_1 = \left(\frac{C_2}{C_1 + C_2}\right) E$ 04

$V_1 = \frac{Q}{C_1}$ ✓ and $C = \frac{C_1 C_2}{C_1 + C_2}$ ✓ $\Rightarrow V_1 = \left(\frac{C_1 C_2}{C_1 + C_2}\right) E \cdot \frac{1}{C_1} = \left(\frac{C_2}{C_1 + C_2}\right) E$

& $Q = CE$ ✓ $\therefore Q = \left(\frac{C_1 C_2}{C_1 + C_2}\right) E$ ✓

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d (i) $C_0 = 16\mu F$

(ii) $C_d = \varepsilon_r C_0$

$= 16 \times 4$

$= 64 \times 10^{-6} F$

$\Delta E = E_d - E_0$

$= \frac{1}{2}(C_d - C_1)V^2$

$V_0 > V_d$

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

$= 864 J$

04

or

$E = \frac{1}{2}CV^2$

$C_d = 4 \times 16 \times 10^{-6}$

$= 64 \times 10^{-6} F$

$E_d = \frac{1}{2} \times 64 \times 10^{-6} \times 6000^2$

$E_0 = \frac{1}{2} \times 16 \times 10^{-6} \times 6000^2$

$\Delta E = E_d - E_0$

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

$= 864 J$

(iii) when dielectric is removed capacitance reduces (charge reduces) hence energy reduces since pd is constant.

01

• Returned to source and some

• Dissipated as heat.

Some energy is returned to source & part of it dissipated as heat in wires.

OR $Q = CV$ // $CV_1 = C_2V_2$ // $C_1V_1 = C_2(E - V_1)$ // $V_1(C_1 + C_2) = C_2E$, $V_1 = \left(\frac{C_2}{C_1 + C_2}\right)E$

OR $V = V_1 + V_2$ // $\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2}$ // $C = \frac{C_1C_2}{C_1 + C_2}$ // $\frac{C}{C_1} = \frac{C_2}{C_1 + C_2}$ // $\frac{Q}{V} \times \frac{V_1}{Q} = \frac{C_2}{C_1 + C_2}$

$\therefore V_1 = \left[\frac{C_2}{C_1 + C_2}\right]E$

OR $C_0 = C/4 = 16/4 = 4\mu F$

$E_1 = \frac{1}{2}CV^2 = \frac{1}{2} \times 16 \times 10^{-6} \times 6000^2 = 288 J$

$E_2 = \frac{1}{2} \times 4 \times 10^{-6} \times 6000^2 = 72 J$

$\Delta E = E_1 - E_2 = 288 - 72 = 216 J$

OR $E = \frac{1}{2}CV^2$

$\Delta E = E_1 - E_2$

$= \frac{1}{2}(C_1 - C_2)V^2$

$\therefore \Delta E = \frac{1}{2}(16 - 4) \times 10^{-6} \times 6000^2$

$= 216 J$

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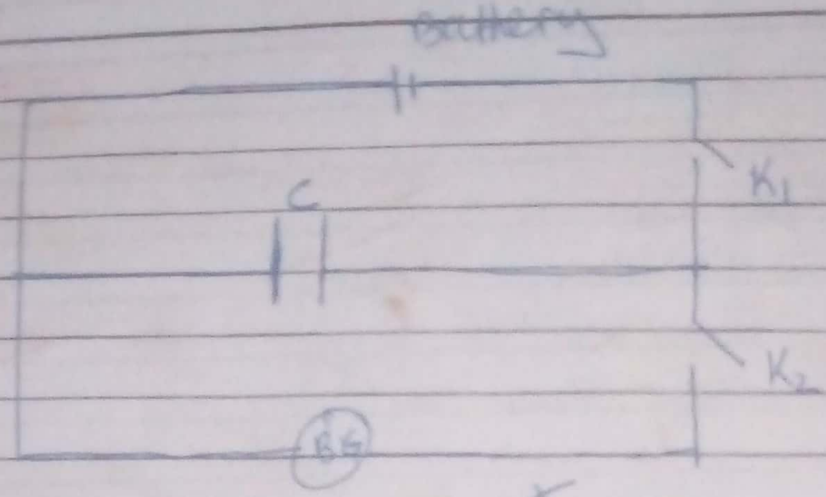
(e)



- A standard capacitor of capacitance C_s is connected at position C
- Leaving switch K_2 open switch K_1 is closed, K_1 is opened and K_2 closed. The max^m deflection θ_1 is noted
- The standard capacitor is replaced with test capacitor of capacitance
- The procedure is repeated and new max deflection θ_2 of B.G is noted.
- C is determined from

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

04