PHYSICS P510/2 MARKING GUIDE 2024

(1)

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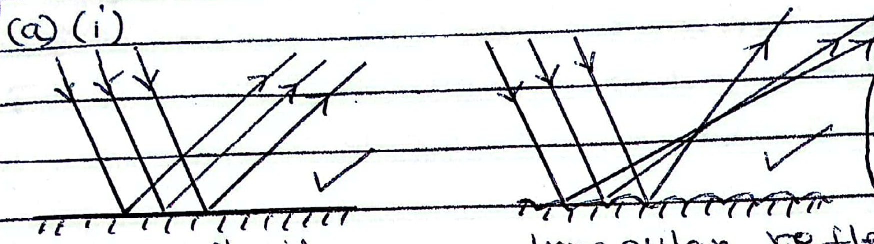
DRAFT

Subject: Physics II Paper code: P510/2

Level: PLE UCE UACE ✓ Year: 2024

(a) (i)



- nature of surfaces
- form of reflection
- arrows

- arrows must for other penalise

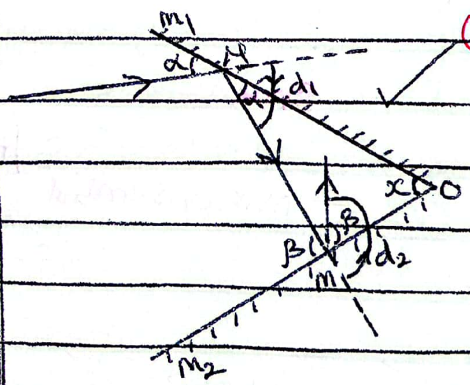
In regular reflection, an incident parallel beam falls on a smooth surface and is reflected parallel, while in irregular reflection, an incident parallel beam falls on a rough surface and is reflected as a scattered beam. (04)

- smooth / Polished surface	rough surface ✓
- reflected as parallel beam	reflected as scattered beam ✓ / in different directions

Deny polished (shinny) dull.

(ii) Consider a light ray incident on a plane mirror M_1 inclined to another plane mirror M_2 as shown below:

(Rays, angles & mirrors)



Let α and β be the glancing angles on M_1 and M_2 respectively.

The light ray undergoes deviations d_1 and d_2 as shown.

At M_1, $d_1 = 2\alpha$ clockwise

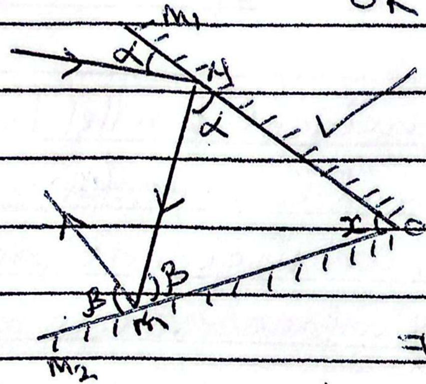
At M_2, $d_2 = 2\beta$ anticlockwise.

Net deviation, $d = d_1 + d_2 = 2(\beta - \alpha)$

From $\Delta OMM'$, $\alpha + x = \beta \Rightarrow x = \beta - \alpha$

$\therefore d = 2(\beta - \alpha) = 2x$. (04)

OR



$d_1 = 2\alpha$ clockwise

$d_2 = 2\beta$ clockwise

$d = d_1 + d_2 = 2(\alpha + \beta)$

From $\Delta OMM'$, $\alpha + \beta = 180 - x$

$\Rightarrow 2(\alpha + \beta) = 360 - 2x$

$d = 360 - 2x$

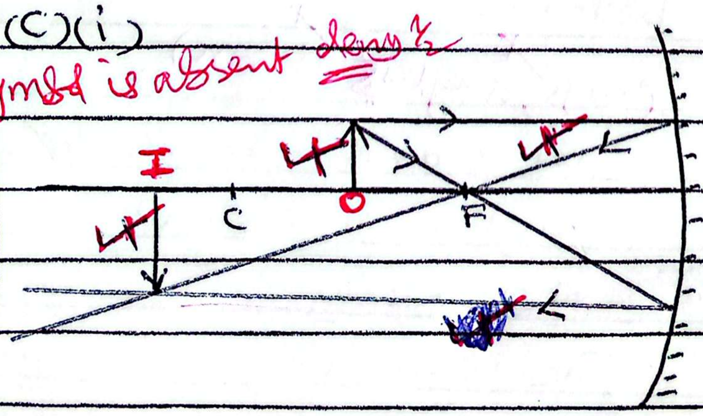
$d = 2x$ anticlockwise.

(b) marks redistributed additional 1 mark to

1.(a)(i) (04), (ii) (04), (c)(ii) 03, (d) 05.

(c)(i)

f mirror symbol is absent deny ½



- Position of the object
- ~~Once~~ reflection
- image beyond C real image
- mirror symbol

(02)

(ii)

$\frac{u}{f} = 1 + \frac{1}{m} \Rightarrow \frac{u}{24} = 1 + \frac{1}{3} \Rightarrow u = 32\,cm$ (03)

OR $\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{24} = \frac{1}{u} + \frac{1}{3u} \Rightarrow u = 32\,cm$

$n = \frac{R-d}{h}$ or $\frac{R-d}{h-d}$

3

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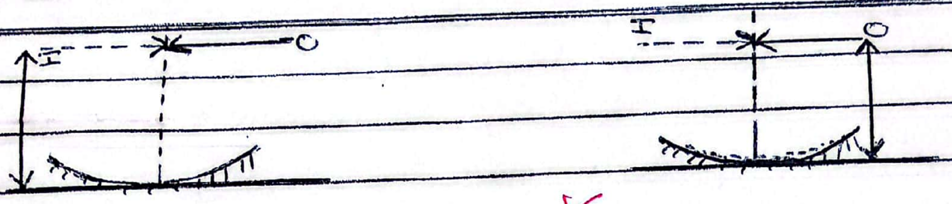
Using concave mirror of known R, candidate loses 1mk.

Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

(d)



first 2(½) ticks on diagram

A concave mirror is placed on a horizontal table with its reflecting surface facing upwards. An optical pin is clamped horizontally with its tip or end lying along the principal axis of the mirror. The optical pin is slowly raised or lowered until a position is obtained where it coincides with its image when there is no parallax. The distance from the mirror to the pin is measured as R. A small quantity of a liquid is poured into the mirror, and the optical pin is again adjusted until it coincides with its image. The distance between the pin and the mirror is measured as h. The refractive index of the liquid is obtained from

$n = \frac{R}{h}$; penalise 1mk for final expression if R or h is not measured (05)

(e) When a wide parallel beam of light is incident on a converging mirror ~~[illegible]~~, the reflected rays converge at different points along the axis of the mirror. A curve which passes through the point of intersection of the reflected and incident rays, forming a cusp at the principal focus of the mirror is known as a caustic curve. (02)

[first 2 half ticks can be recovered on ray diagram]

* rays drawn & caustic curve indicated

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Subject: .... Paper code: ....

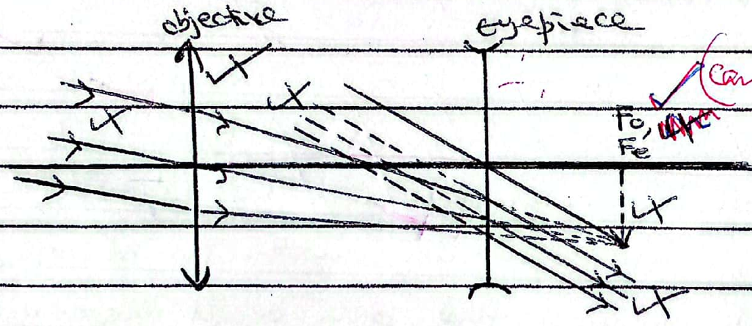
Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

2. (a)(i) Visual angle is the angle subtended at the eye by the object / image. ~~at the eye~~

(ii) The apparent size of the object or image is proportional to the visual angle. An object near the eye subtends a larger angle at the eye than a distant one, Hence a nearer object appears taller, (03)

(2nd mark can be scored on a diagram).

(b)(i)



(can be recovered in description)
- distant object
- Relative position of lenses
- apparent rays
- images

The objective lens is arranged with the eye piece such that their principal foci coincide. The objective forms a real image of a distant object on their common focal plane or (at its principal focus), and the eye piece forms a final virtual image at infinity. (05)

(ii) Advantages
- It forms an upright image
- It is short and therefore easily portable.

C(i)
- eyepiece replaced with concave lens ✓
- focal planes coincide ✓ or adjusting lenses

⑤ objective eyepiece

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Version 3

Version 2 C(i)

④ Accept Binoculars

Subject: ....

Paper code: 2f 2f

loses ½ mk only if f, fe & fo not defined

Level: PLE UCE UACE insert prisms btn objective & eyepiece

Year: ....

Limitations
- It has a virtual eye-ring. ✓
- It has a narrow field of view. ✓ (02)

C(i) By inserting a convex lens between the objective and eyepiece. The position of this lens is such that it is f_o+2f from objective and f_e+2f from eyepiece.

where f_o & f_e are objective & eyepiece focal lengths and f is focal length of erecting lens.

2f + fe from eyepiece

(ii) – It increases the length of the telescope thus making it less portable ✓
– It decreases the brightness of the final image. ✓, narrow field of view (01)

(d)(i) $M = \frac{f_o}{f_e} = \frac{200}{2} = 100$ ✓ (02)

(ii) $\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \Rightarrow \frac{1}{2} = \frac{1}{202} + \frac{1}{v} \Rightarrow v = 2.02\text{ cm}$ (02)

(iii) Linear magnification of eyepiece $= \frac{v}{u}$

$\frac{v}{u} = \frac{D_e}{D_o}$ where D_e = eyering diameter, D_o = objective diameter.

$\therefore \frac{2.02}{202} = \frac{D_e}{20}$

$\Rightarrow D_e = 0.2\text{ cm}$ (02)

or $M = D_o/D_e$ ✓

$100 = \frac{20}{D_e}$ ✓

$\therefore D_e = 0.2\text{cm}$

OR

(6)

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Subject: PHYSICS Paper code: 510/2

Level: ☐ PLE ☐ UCE ☑ UACE Year: ....

3a (i) Amplitude is the maximum displacement of a wave particle or particles in the wave from the equilibrium position. 01

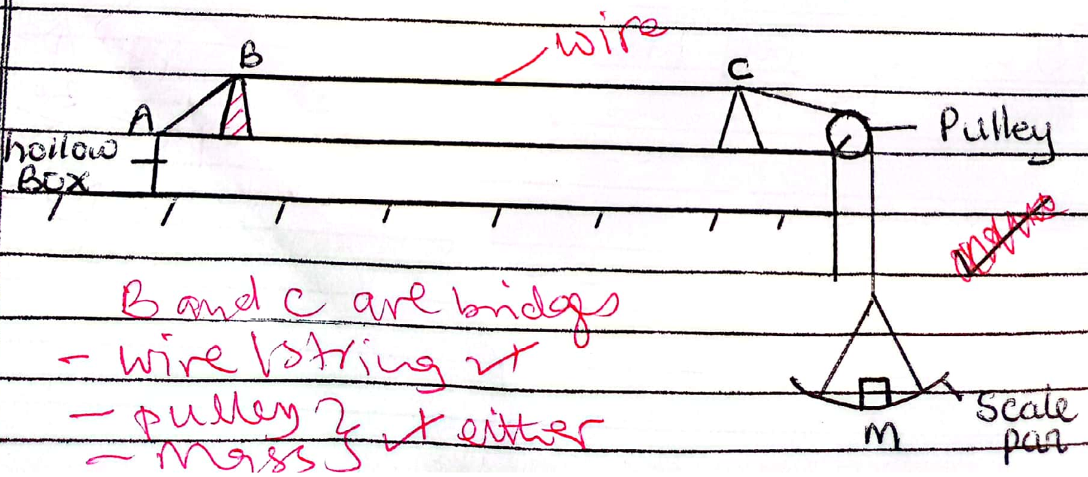
(ii) Transverse waves are waves which propagate by vibrations perpendicular to the direction of travel of the wave where as longitudinal waves are waves which propagate by vibrations which occur parallel to the direction of travel of the wave 01

OR ~~Transverse waves can be Polarised whereas longitudinal waves are not Polarised~~

OR Transverse waves propagate by formation of crests and troughs. whereas longitudinal waves propagate by formation of rarefactions and Compressions.

NB Accept "motion or move" for vibrations.

b



B and C are bridges

- wire/string ✓
- pulley } ✓ either
- Mass }

(7)

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Subject: PHYSICS Paper code: 510/2

Level: ☐ PLE ☐ UCE ☑ UACE Year: ....

The experiment is set up as shown above. The length L of the wire between the bridges B and C is fixed.
A suitable load m is attached to the free end of the wire. The wire is plucked in the middle and a tuning fork of known frequency f is sounded & held near the wire.
The mass is varied until the vibration of the wire resonates with that of the tuning fork.
The mass m and the corresponding frequency f are recorded in a table including values of f^2. The procedure is repeated with tuning forks of different frequencies f.
A graph of f^2 against m is plotted and it is a straight line through the origin. This implies that $f^2 \propto m$
but the tension $T = mg$

$\Rightarrow m = T/g \Rightarrow f^2 \propto T$ since

g is a constant and $f \propto \sqrt{T}$

06

NB Accept :- "when loud sound is heard" or "then resonance occurs"

- If plucking is not in middle, deny ½ mk
- Accept rider as detector but in this case the fork should be placed in middle of box

tuning fork placed near middle $ rider placed on wire
↑
detector

8

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Subject: PHYSICS Paper code: 510/2

Level: PLE UCE ✓ UACE Year: ....

3c (i) $L_1 + c = \lambda/4$ ——— (1)

$L_2 + c = \frac{3}{4}\lambda$ ——— (2)

$L_2 - L_1 = \lambda/2$

$\Rightarrow \lambda = 2(L_2 - L_1)$

But $V = f\lambda$

$\therefore V = 2f(L_2 - L_1)$

$= 2 \times 264 \times (0.963 - 0.315)$

$= 342\ m/s$

OR $V = 2f(L_2 - L_1)$

$= 2 \times 264 \times (0.963 - 0.315)$

$= 342\ m/s$

OR $V = 2f(l_2 - l_1)$
$= 2 \times 264(96.3 - 31.5)$
$= 34200\ cms^{-1}$

04

(ii) $L_1 + c = V/4f$

$31.5 + c = \frac{34200}{4 \times 264}$

$31.5 + c = 32.4$

$\Rightarrow c = 0.9cm$

02

3d (i) Beats are the periodic rise and fall in intensity of sound when two notes of nearly equal frequencies are sounded together

0

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DRAFT

Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

9

(ii) The test note is sounded together with a standard note of frequency f_1. The number n of loud sounds heard in a measured time t is recorded. The beat frequency $f_b = n/t$ is calculated. The frequency of the standard note is reduced slightly and the experiment is repeated. The new beat frequency f_b' is determined. 05

If $f_b' > f_b$ then the frequency f_2 is $f_2 = f_1 + f_b$

if $f_b' < f_b$ then the frequency $f_2 = f_1 - f_b$

OR

- A signal generator is sounded together with a test note to produce beats.
- The frequency of the generator is adjusted such that the time between loud sounds increases.
- Further adjustment is done until it takes longer to hear the next loud sound (for sound to die out or fade)
- The frequency f of the signal generator is recorded and this is the frequency of the test note.

(10)

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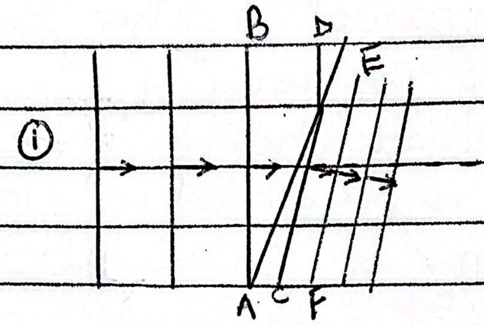
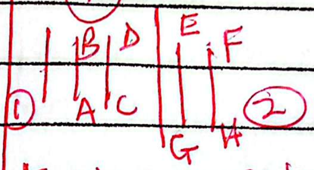
Subject: PHYSICS Paper code: 510/2

Level: ☐ PLE ☐ UCE ☑ UACE Year: ....

4a



OR method 3



As wave moves from ① to ② λ reduces. But $BD = AC$ and $EF = GH$ ⟹ EG is parallel to DC. Hence direction does NOT change

$BD = V_1 t$

$AC = V_2 t$

$\therefore V_2 < V_1$ and $AC < BD$

The direction of travel of the wave changes and hence refraction.

OR

As the wave moves from medium ① into ②, the wavelength reduces

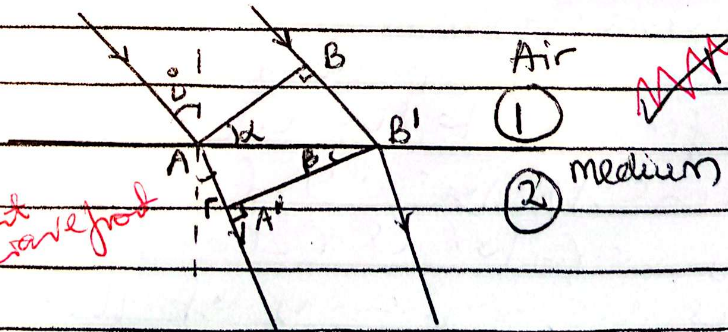
$\Rightarrow BD > CF$

Hence the new wavefront gets inclined

Hence direction of the wave changes which is refraction.

4b

Angles, media, incident beam, reflected beam, incident wavefront, Reflected wavefront



Huygen's Construction

Consider a plane wavefront AB. Every point on AB acts as a secondary source of wavelets

(11)

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Subject: PHYSICS Paper code: 510/2

Level: ☐ PLE ☐ UCE ☑ UACE Year: ....

In time t, secondary wavelets from A travel a distance AA'. $AA' = Vt$

During this time secondary wavelets from B travel to B'. $BB' = ct$

The tangent A'B' to the secondary wavelets is the new wavefront 05

From snell's law, the refractive index n is

$n = \frac{\sin i}{\sin r}$ but $i = \alpha$ and $r = \beta$ (can be scored on diagram)

$\Rightarrow n = \frac{\sin\alpha}{\sin\beta}$ But $\sin\alpha = \frac{BB'}{AB'}$ and $\sin\beta = \frac{AA'}{AB'}$

$\therefore n = \frac{BB'}{AB'} \div \frac{AA'}{AB'} = \frac{BB'}{AA'} = \frac{ct}{Vt} = \frac{c}{V}$

4C (i) When two waves of equal frequency and equal wavelengths (coherent sources) travel in the same medium, they superpose; where they meet in phase, reinforcement takes place resulting in maximum intensity. Where they meet completely out of phase cancellation takes place resulting in minimum intensity / soft sound. Permanent alternate regions of maximum and minimum intensity is therefore observed which is referred to as interference patterns 03

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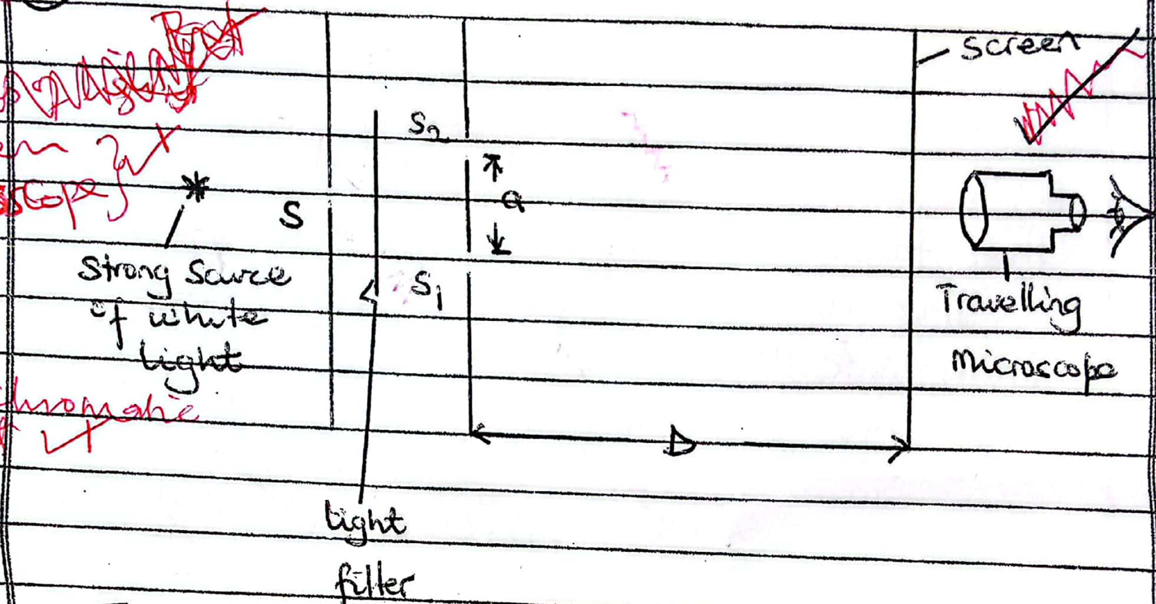
Subject: PHYSICS   Paper code: 510/2

Level: ☐ PLE ☐ UCE ☑ UACE   Year: ....

(ii)

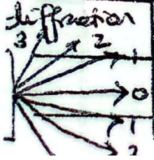
- Slits
- Source
- screen
- Microscope
- Monochromatic light



The set up is as above, where S, S_1 and S_2 are narrow slits through which light diffracts forming interference fringes on the transparent screen. The position of the screen is adjusted until where the fringes are seen clearly. The number of fringes occupying a measured length along the screen is counted and the width y of a single fringe determined. The distance D, of the double slits from the screen is measured using a metre rule and the separation, a, of the double slits determined using a travelling microscope. The wavelength λ, is now calculated from

$$\lambda = \frac{ay}{D}$$

4d $d = \frac{10^{3}}{500}$ $d\sin\theta = n\lambda$ where $\sin\theta = \frac{n\lambda}{d} = 1$



$\therefore n = d/\lambda = 10^{3}/500 \times 589 \times 10^{-9} = 3.39$

$\therefore$ maximum order of diffraction = 3

max no. of images is 7

(13)

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

QUESTION 5

(a) - Heating in the coil causes loss of energy due to electrical resistance of the wire. $\overline{03}$

- Heating in the core causes loss of energy due to eddy currents. (any 3)

- Heating in the core ~~causes~~ due to loss of energy due ~~to~~ to magnetic reversals.

- Energy loss due to ~~loss of~~ magnetic flux leakage.

(b)(i) Current in the transmission wire, $I = \frac{P}{V}$

$\Rightarrow I = \frac{200}{230} = 0.8696A$ $\overline{03}$

Power loss, $P = I^2R$

$= 0.8696^2 \times 3$

$= 2.27W$

(ii) At the power station the voltage is stepped up and current reduces.

Power loss, $P = I^2R$ or $P \propto I^2$ which is minimized. $\overline{03}$

At the machine, the voltage is stepped down to the required values to operate the machine.

(c) Magnetic flux linking N turns of the coil, $\phi = BAN\cos\theta$. But $\theta = 0$, $\overline{04}$

$\Rightarrow \phi = BAN$

The induced emf $E = -\frac{d\phi}{dt} = \frac{d}{dt}(BAN)$.

Since BAN is constant, $E = 0$

P.T.O

OR $\phi = NBA\cos\omega t$

$E = -\frac{d\phi}{dt}$

$= -NBA\frac{d}{dt}\cos\omega t$

$= \omega NBA\sin\omega t$

But ~~$\cos\omega t = 0$~~ $\Rightarrow E = 0$

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(14)

Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

(d)(i) Two circuits have a mutual inductance of 1 henry if the induced emf in the secondary coil is 1 V when the current in the primary coil changes at a rate of 1 ampere per second. 01

(ii) $E = -M\frac{dI}{dt} = -30 \times \frac{(0 - 1.5)}{0.002} = 22500V$ 03

(e)(i) When the armature of the motor rotates in the magnetic field, emf is induced in the coil. This emf opposes the supply (applied) voltage. This emf is called back emf.

(ii) - It reduces current which would have damaged the coil. 01

- Work done against back emf is converted into mechanical work / It increases efficience of the motor. any 1

20

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

(15)

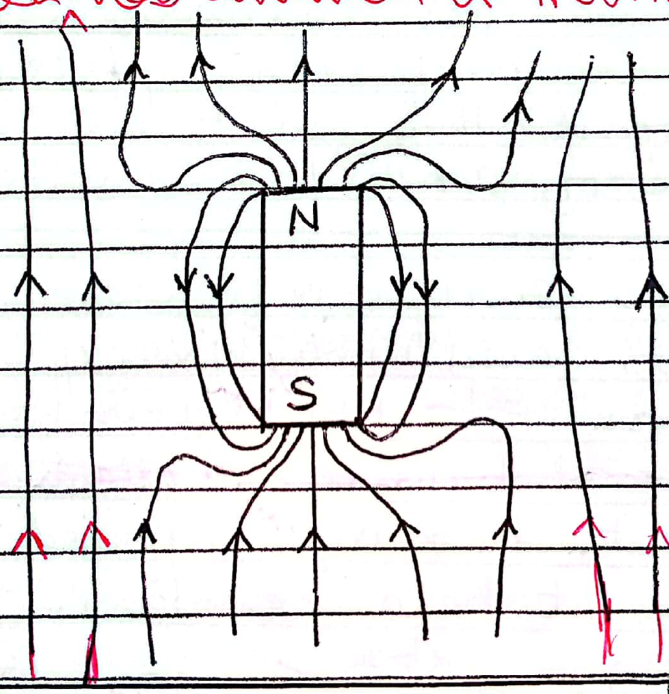
QUESTION 6

(a) (i) Magnetic field is a region in space where magnetic force is experienced. 01

(ii) Magnetic Saturation is said to occur when a given magnetic material has attained its maximum magnetic Strength such that further magnetisation does not increase its strength. 01

When magnet has attained its Maximum Strength

(b)(i)



Direction ✓

Pattern ✓ & orientation 01

(ii) The inductor is placed with the plane of its coil horizontal. The coil is turned through 180° about the vertical diameter. The first deflection θ₁ is noted. The coil is now placed with the plane of the coil vertical such that its plane is perpendicular to the N–S direction. (04)

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

The coil is now rotated through $180°$. The first deflection θ_h is noted. The angle of dip, δ is now calculated from $\delta = \tan^{-1}\left(\frac{\theta_v}{\theta_h}\right)$ ✓

Accept rotation through $90°$

(c)(i) The ampere is the value of current which if maintained in two infinitely long, parallel conductors of negligible cross-sectional area, placed in vacuum 1m apart they exert on each other a force of 2×10^{-7} N per metre length. ✓

(ii) When switch K is closed, current flows and wire WY experiences a force, $F' = BIL$ downwards.
~~Horizontal balance is attained when~~ weight $F = mg$ is placed in the scale pan. At balance $F \times PQ = F' \times YW$ since $\overline{PQ} = \overline{YW}$

$\Rightarrow mg = BIL$ ✓

$= (\mu_0 I n) I L$ ie $B = \mu_0 n I$ ✓

$\Rightarrow I = \sqrt{\frac{mg}{\mu_0 n L}}$ ✓

(17)

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

(d) (i) $B = \frac{\mu_0 I}{2\pi a}$ ✓

$B_Q = B_P - B_R$ ✓ $= \frac{4\pi \times 10^{-7}}{2\pi}\left(\frac{9}{0.03} - \frac{5}{0.05}\right)$ ✓ ✓ 04

$= 6\times10^{-5} - 2\times10^{-5}$

$\Rightarrow B_Q = 4.0\times10^{-5}T$ ✓

for $B_Q = B_P + B_R$ loses 2mks

Accept $B_Q = B_R - B_P$

(ii) $\frac{F}{L} = \frac{\mu_0 I_P I_R}{2\pi a}$ ✓ $= \frac{4\pi\times10^{-7}\times9\times5}{2\pi\times0.08}$ ✓ 03

$= 11.25\times10^{-5}\,Nm^{-1}$ ✓

(e) B - Magnetic flux density ✓ (02)

A - Area of the coil ✓

N - Number of turns ✓

K - Strength of the hairspring ✓

20

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

7a(i) Root Mean Square value of an a.c is the value of steady current which dissipates heat in a given resistor at the same rate as the a.c. (1)

(ii) Reactance is the non resistive opposition to the flow of an alternating current in an inductor or a capacitor or both. Accept and (1)

(iii) Impedence is the total opposition to the flow of an alternating current in an a.c circuit containing resistive and reactive components. (1)

(b) Consider a capacitor connected to an a.c source of $V = V_0 \sin\omega t$ and $I = I_0 \cos\omega t$

$P = IV = I_0 \cos\omega t \times V_0 \sin\omega t = I_0 V_0 \sin\omega t \cos\omega t$ (3)

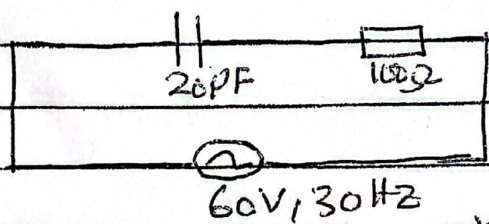
$= \frac{1}{2} I_0 V_0 \sin 2\omega t$

$\langle P \rangle = \frac{I_0 V_0}{2} \langle \sin 2\omega t \rangle$, but $\langle \sin 2\omega t \rangle = 0$

$\langle P \rangle = 0$

If $I = I_0 \sin\omega t$, deny $\frac{1}{2}$

(c)



For a capacitor $X_C = \frac{1}{C\omega} = \frac{1}{20\times10^{-6} \times 2 \times 3.14 \times 30} = 265.4\Omega$

$Z = \sqrt{X_C^2 + R^2} = \sqrt{265.4^2 + 100^2} = 283.6$ (5)

$V = IZ \Rightarrow I_0 = \frac{V_0}{Z} = \frac{60}{283.6} = 0.212A$

$I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{0.212}{\sqrt{2}} = 0.15A$

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$V=V_0, I=0$ ✓

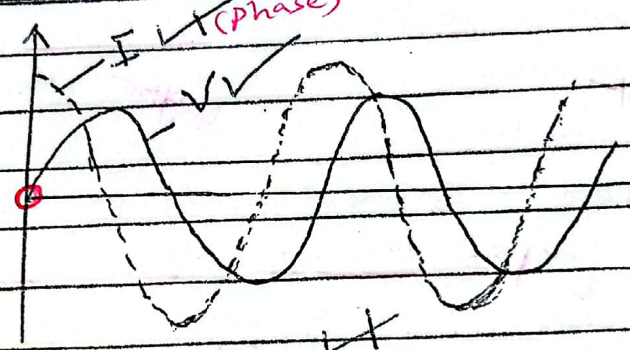
{ fully charged opposition maxm rate of Δ of V = 0 } ✓

Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

(19)

d(i)



(2)

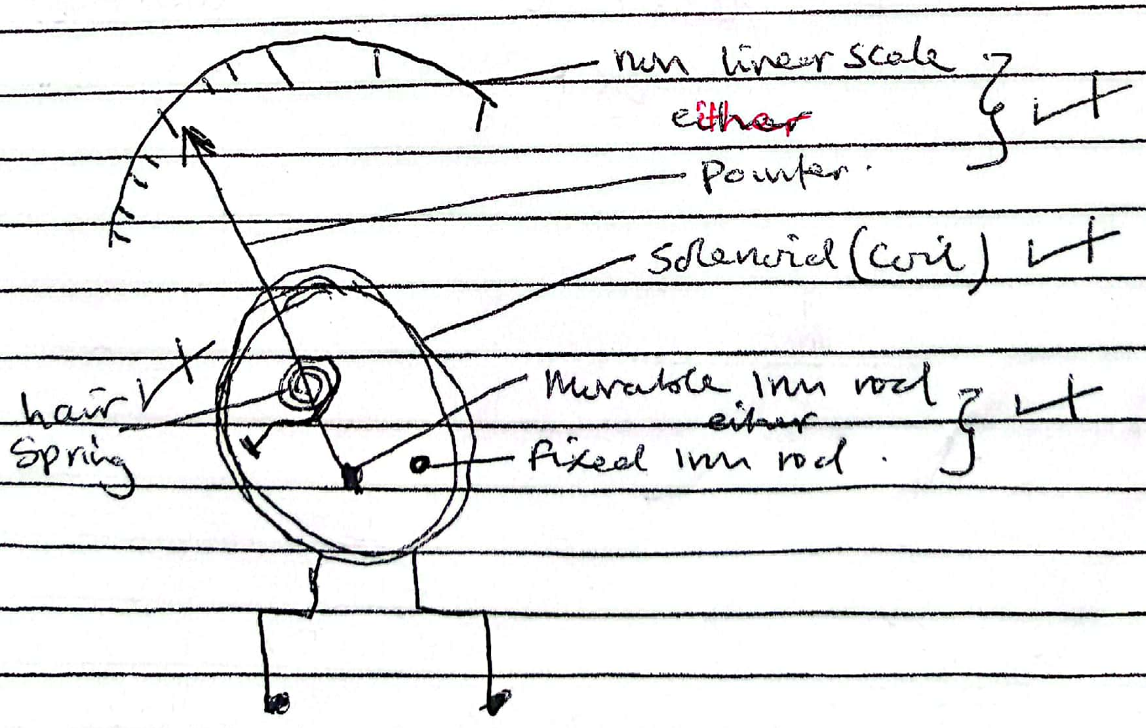
(ii) When $V=V_0$, $I=0$ ✓ the capacitor is fully charged plates repulsion to any charge coming to the capacitor plates is maximum.

When $V=0$, I is maximum the capacitor is completely empty (discharged), opposition to the flow of charge to the plates is zero ✓ so current is maximum.

(2)

$\frac{dv}{dt}$ = 0 when V_0 max, $I=0$

(e)



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DRAFT

Subject: ....

Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE

Year: ....

20

Current to be measured is passed through the coil. Whatever the direction of the current the rods get magnetised in the same sense and repel. The movable rod is pushed away (repelled) and as it moves, it turns the pointer over the scale until it is stopped by the restoring torque of the spring. The deflection of the pointer is proportional to the magnetic force. Hence the deflection is proportional to the square of the average current. (3)

$F = BIl$, but $B = \mu_0 n I$

$\therefore B \propto I$

$F = \mu_0 n I^2 l$

$\therefore F \propto I^2$

Accept magnetisation is proportional to current instead of force

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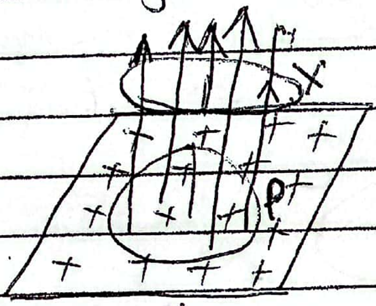
Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

SECTION D

8a(i) Electric field: Is a region in space where electric force is experienced. (1)

Electric flux: Is the product of electric field intensity and the area it links normally. (1)

(b)



Consider a plane conductor, P of surface charge density σ and plane X of area S.

$$\phi = \frac{\text{charge enclosed by X}}{\text{permittivity of the medium}}$$

$$= \frac{\sigma \times S}{\varepsilon_0} \quad \text{but } Q = \sigma \times S$$ (3)

$$\phi = E \times S$$

$$\therefore E \times S = \frac{\sigma \times S}{\varepsilon_0}$$

$$E = \frac{\sigma}{\varepsilon_0}$$

c(i) Electric force on the drop $= qE = q\frac{V}{d}$

For equilibrium $\frac{qV}{d} = mg$

Upthrust negligible since drop is small.

$$q = \frac{mgd}{V} = \frac{5.9 \times 10^{-14} \times 9.81 \times 2 \times 10^{-2}}{20 \times 10^{3}} = 5.7879 \times 10^{-19} C$$ (04)

Now $q = ne \Rightarrow n = q/e = \frac{5.7879 \times 10^{-19}}{1.6 \times 10^{-19}} = 3.6$

n = 3 electrons or 4 electrons.

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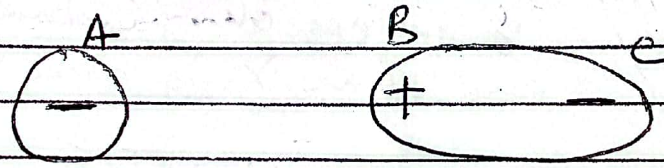
Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

c(ii) The material is enclosed in a metal can and placed in the electric field. Charge (electric field) inside the can is zero. The electric field due to the metal plates only affects distribution of charge on the outer surfaces of the metal can. Hence the material is shielded. (3)

(d)



Consider a negatively charged material A. When a neutral conductor BC is brought near it as shown above, positive charge is induced on its near side B and negative charge on side C. (Can be awarded on diagram)

The potential ~~due to~~ at A is the sum of potentials due to its charge and the nearby charges. (4)

Since the positive charge is closer to A, the resultant potential due to the induced charge is positive. This reduces the negative potential of A. increases

reduces potential
increases potential
reduces negative negative potential

Full conclusion

(23)

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

(e) When a pin is placed on a charged conductor, (high charge density) Charge concentrates at the sharp point of the pin.
A high electric field intensity develops around the sharp point which ionises air there, ions of opposite charge are attracted and neutralized. (4)
Thus the conductor loses charge faster.

OR

When a pin is placed on a charged conductor, Charge concentrates at the sharp point of the pin.
A high electric field intensity develops around the sharp point. (4)
The electric field intensity exerts strong attraction to the opposite charge or space charge in the space, which are then neutralized.
This way the conductor loses charge faster.

24

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

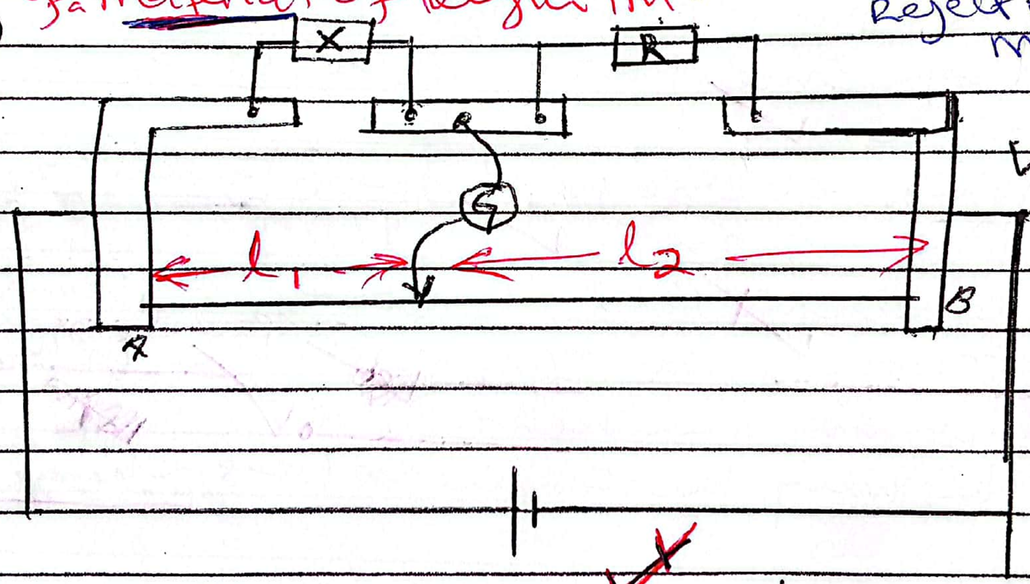
9 (a)(i) Temperature coefficient of resistance is fractional change in resistance at 0°C per kelvin (degree celcius) rise in temperature.

(ii) Resistivity is the resistance of a material of length 1m and cross sectional area of $1m^2$. 02

Resistance across opposite faces of a cube of a material of length 1m.

Reject without material

(b) (i)



$-\frac{1}{2}$ for cells

$-\frac{1}{2}$ for upper circuit

Unknown resistance X is connected in left hand gap of the ~~brg~~ bridge and standard resistance R is connected in right hand gap of the bridge. (can be scored on diagram)

For a known value of R, the jockey is tapped along the wire AB until the galvanometer shows no deflection.

25

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

- The balance length L_1 and L_2 are measured.
- The experiment is repeated for several values of R and results are tabulated including $\frac{L_2}{L_1}$
- A graph of R against $\frac{L_2}{L_1}$ is plotted and its slope S is determined.
- The resistance R_x of X is given by $R_x = S$.

If no graph misses $\frac{1}{2}$ mark and $R_x = \frac{L_1}{L_2}R$ is 1 mark

05

(ii) when the balance point is near the middle point of slide wire, the errors in balance lengths on either sides are small compared to balance length. The error in the ratio of the balance lengths is small. Hence the error in resistance to be determined is small / accuracy is higher / higher accuracy

c $R = \frac{\rho l}{A}$

$= \frac{4.4 \times 10^{-7} \times 200 \times 10^{-2}}{0.001 \times 10^{-4}}$

26

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DRAFT

Subject: ....

Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE

Year: ....

$R = 8.8\Omega$

OR $R = \rho l / A$

$R_1 = \frac{4.4\times10^{-7}\times100\times10^{-2}}{0.001\times10^{-4}} = 4.4\Omega$

$R_1 = R_2 = \frac{R}{2}$

$= \frac{8.8}{2}$

$= 4.4\Omega$

$R_2 = 4.4\Omega$

$R_e = \frac{4.4\times4.4}{4.4+4.4} = 2.2\Omega$

Total resistance $R_T = \frac{4.4\times4.4}{4.4+4.4} + \frac{1\times1}{1+1}$

$r = \frac{1\times1}{1+1} = 0.5\Omega$

$R_e = 2.2+0.5 = 2.7\Omega$

$= 2.7\Omega$

$I = \frac{e.m.f}{R_T}$

$= \frac{1.5}{2.7}$

$= 0.556\ A$

06

d $P = I^2R$

But $I = \frac{E}{R+r}$

$P = \left(\frac{E}{R+r}\right)^2 R$

$P = \frac{E^2R}{(R+r)^2}$

27

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DRAFT

Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

$$\frac{dP}{dR} = \frac{E^2\left[(R+r)^2 - 2R(R+r)\right]}{(R+r)^4}$$

$$= E^2\frac{(r-R)}{(R+r)^3}$$

For max power

$\frac{dP}{dR} = 0$ thus $r - R = 0$

$R = r$

04

28

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Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

10(a)(i) Dielectric constant is the ratio of capacitance of a capacitor with a dielectric material between it's plates to capacitance of the same capacitor with out dielectric

or

is ratio of permittivity of dielectric to permittivity of free space

Deny per unit

(ii) Dielectric strength is the maximum p.d per ~~unit~~ metre thickness which a dielectric can with stand without conducting / insulation breaks down

Deny breaku

Accept Potential gradient, Electric field intensity.

(b) - when a dielectric is placed between the plates of a charged capacitor it's molecules get polarised.

- The charges inside the dielectric cancel each others and surfaces of dielectric acquire charge opposite to charge of the plate near the surface.

- since those are bound charges then can not be neutrilized

- charged capacitor, polarisation, adjacent plates reduced by the charges
- potential of negative plate ... potential of +ve plate
- Negative charge
- pd reduces
- $C = \frac{Q}{V}$
- C reduces

29

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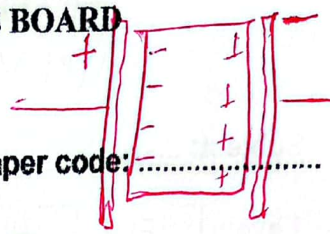
Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE

Year: ....



- charges on capacitor
- adjacent surface charge

- an electric field intensity is developed between the surfaces of a dielectric in direction opposite to that of applied field.
- The resultant electric field intensity reduces. from $E = \frac{V}{d}$ p.d V reduces.

Also from $C = \frac{Q}{V}$, capacitance of capacitor increases. 05

Note: If battery in place, talk about more charge flows to capacitor plates. From $Q = CV$, C increases.

c charge stored, $Q = CV$

$= 50 \times 45 \times 10^{-6}$

$= 2.25 \times 10^{-3}$ C

after inserting $c' = 2 \times 50 = 100 \mu F$

$C_T = C' + C''$

$= 100 + 60$

$= 160 \mu F$

$V = \frac{Q}{C_T} = \frac{2.25 \times 10^{-3}}{160 \times 10^{-6}} = 14.1$ V

$C_0V_0 = (C_1 + C_2)V$

OR $V = \frac{C_0V_0}{C_1 + C_2}$

$= \frac{50 \times 45 \times 10^{-6}}{[(50 \times 2) + 60] \times 10^{-6}}$

$= 14.1$ V

04

(ii) $E_1 = \frac{1}{2}CV^2$

$= \frac{1}{2} \times 50 \times 10^{-6} \times 45^2$

$= 5.06 \times 10^{-2}$ J

After comb.

$E_2 = \frac{1}{2} \times 160 \times 10^{-6} \times 14.1^2$

$= 1.59 \times 10^{-2}$ J

$\Delta E = E_1 - E_2$

$= (5.06 - 1.59) \times 10^{-2}$

$= ~~9.4 \times 10^{-3}~~$ J

3.47×10^{-2} J

04

On

$Q = C_1V_1 = (C_1 + C_2)V_f$

$50 \times 10^{-6} \times 45 = (100 + 60)V_f$

$V_f = \frac{50 \times 45 \times 10^{-6}}{160 \times 10^{-6}} = 14.1\,V$

(04)

30

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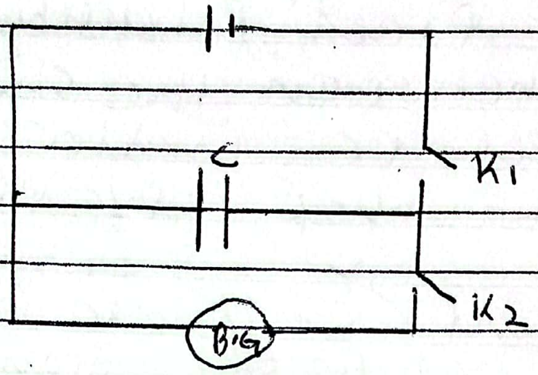
Subject: .... Paper code: ....

Level: ☐ PLE ☐ UCE ☐ UACE Year: ....

d (i)



without BG give for charging

A capacitor of capacitance C_1 is connected at C. Switch K_1 is closed and after some time K_1 is opened. K_2 is closed and max deflection θ_1 of B.G is noted. The capacitor of C_1 is replaced with another capacitor of capacitance C_2 and above procedures are repeated.

The new deflection θ_2 of B.G is noted.

Capacitances are compared from $\frac{C_1}{C_2} = \frac{\theta_1}{\theta_2}$ 04

(ii) - It separates the capacitor plates

- Increases capacitance of capacitor 01

- increases dielectric strength.

END

SECTION A

1. (a) (i) With the aid of diagrams, differentiate between **regular** and **irregular** reflection. *(03 marks)*

(ii) Show that if two plane mirrors are inclined at an angle, x, then the total deviation of a light ray produced is $2x$ after reflection once on each mirror. *(03 marks)*

(b) Describe an experiment to determine the focal length of a concave mirror using a plane mirror and a pin. *(04 marks)*

(c) (i) Sketch a ray diagram to show how a concave mirror forms a magnified real image of a real object. *(02 marks)*

(ii) A concave mirror of radius of curvature 48 cm produces a real image whose size is three times that of the object. Determine the object position. *(02 marks)*

(d) Describe an experiment to determine the refractive index of a liquid using a concave mirror. *(04 marks)*

(e) Explain the meaning of a **caustic curve**. *(02 marks)*

2. (a) (i) What is meant by **visual angle**? *(01 mark)*

(ii) An observer views a series of electric poles in a straight line. Explain why the pole nearer to the observer appears taller than the rest. *(03 marks)*

(b) (i) With the aid of a ray-diagram, describe how a telescope consisting of a convex lens and a concave lens can be adjusted to form a final image at infinity. *(05 marks)*

(ii) What are the **advantages** and **limitations** of the telescope in (b) (i). *(02 marks)*

(c) (i) Describe how you can modify an astronomical telescope to produce an erect final image at infinity. *(02 marks)*

(ii) Give two major **disadvantages** of this modification. *(01 mark)*

(d) The objective of an astronomical telescope in normal adjustment has a diameter of 20 cm and a focal length of 200 cm. The eye-piece has a focal length of 2 cm. Calculate the;

(i) magnifying power of the telescope. *(02 marks)*
(ii) position of the eye-ring. *(02 marks)*
(iii) diameter of the eye-ring. *(02 marks)*

SECTION B

3. (a) (i) What is an amplitude of a wave? *(01 mark)*

(ii) What is the difference between transverse and longitudinal waves? *(01 mark)*

(b) Describe, with the aid of a diagram, an experiment to show how the fundamental frequency varies with tension in a given wire. *(06 marks)*

(c) A glass tube open at the top, is held vertically and filled with water. A tuning fork vibrating at 264 Hz, is held above the tube and water is allowed to flow out slowly. The first resonance occurs when the water level is 31.5 cm from the top while the second resonance occurs when the water level is 96.3 cm from the top.

Find the;

(i) speed of sound in air. *(04 marks)*

(ii) end correction. *(02 marks)*

(d) (i) What are beats? *(01 mark)*

(ii) Describe an experiment to determine the frequency of a note using beats. *(05 marks)*

4. (a) With the aid of a diagram, explain what happens when waves move from less dense to dense media. *(03 marks)*

(b) Use Huygens' construction to show that the refractive index, n, of a medium is given by

$$n = \frac{c}{v},$$

where c is the velocity of light in air, and v is the velocity of light in the medium. *(05 marks)*

(c) (i) Explain how interference patterns are formed. *(03 marks)*

(ii) Describe how the wavelength of light may be determined using Young's double slit experiment. *(05 marks)*

(d) A diffraction grating has 500 lines per mm and is illuminated normally with monochromatic light of wave length 589 nm. Find the maximum number of diffraction images obtained. *(04 marks)*

SECTION C

5. (a) Explain the sources of energy loss in a transformer when in use. *(03 marks)*

(b) A machine rated 200 W is operated at 230 V. The resistance of the transmission line from the power station to the machine is 3 Ω.

(i) Calculate the power lost in the cables if transmission is done at 230 V. *(03 marks)*

(ii) Explain how this power can be transmitted to the machine with minimum loss using the same cable. *(03 marks)*

(c) A rectangular coil of N turns, each of area A is rotated at constant angular velocity, ω, with its plane perpendicular to a uniform magnetic field of flux density B. Derive an expression for e.m.f induced in the coil. *(04 marks)*

(d) (i) What is meant by the statement that two coils have a mutual inductance of 1 henry? *(01 mark)*

(ii) The mutual inductance of two coils is 30 henrys. A current of 1.5 A in the primary coil is reduced at a steady rate to zero in a period of 0.002 s. Calculate the e.m.f induced in the secondary coil. *(03 marks)*

(e) (i) Explain what is meant by back e.m.f in a motor. *(02 marks)*

(ii) State one advantage of back e.m.f in a motor. *(01 mark)*

6. (a) Define the following:

(i) Magnetic field. *(01 mark)*

(ii) Magnetic saturation. *(01 mark)*

(b) (i) Draw the magnetic field pattern for a bar magnet placed with its north pole facing the earth's north pole. *(01 mark)*

(ii) Describe an experiment to determine the angle of dip at a given place using an earth inductor. *(04 marks)*

(c) (i) Define an Ampere. *(01mark)*

(ii) A rectangular metal frame XVWY is pivoted about a horizontal axis XY such that the length PQ is equal to the length YW. The end VW lies half-way inside the solenoid of n turns per metre. The solenoid is arranged so that its magnetic field of flux density B is perpendicular to VW and the metal frame is connected in series with the solenoid as shown in figure 1.

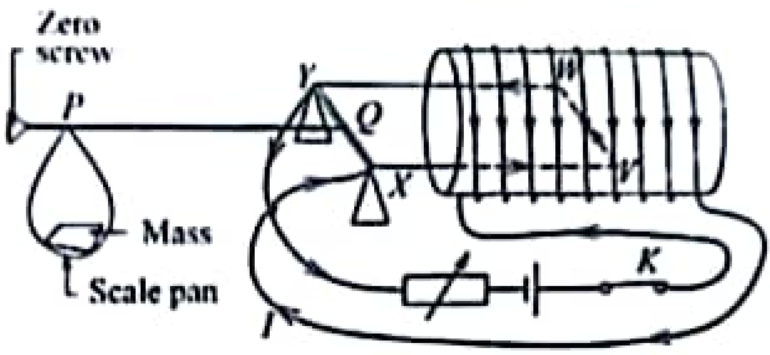


Fig. 1

When switch K is closed, the frame balances when the mass on the pan is m. Show that the current I, flowing is given by

$$I = \sqrt{\frac{mg}{\mu_0 nl}}$$ where l is length of side VW.

(03 marks)

(d) Figure 2 shows two wires P and R carrying currents of 9 A and 5 A out of the paper.

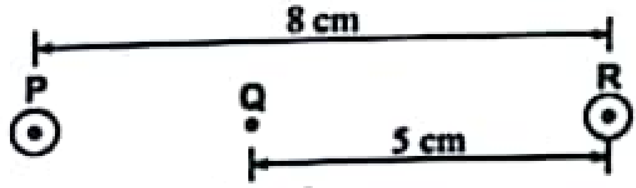


Fig. 2

Find the;

(i) magnetic flux density at point Q. *(04 marks)*

(ii) force per metre acting on wire P. *(03 marks)*

(e) State four factors which determine the current sensitivity of a moving coil galvanometer. *(02 marks)*

7. (a) What is meant by the following;

(i) Root mean square value of an alternating current, *(01 mark)*

(ii) Reactance, *(01 mark)*

(iii) Impedence? *(01 mark)*

Turn Over

(b) Show that the average value of power dissipated in a capacitor in a complete cycle is always zero. *(03 marks)*

(c) A capacitor of 20 μF is connected in series with a resistor of 100 Ω across an a.c source of frequency 50 Hz and peak voltage 60 V.

Determine the root mean square value of the current that flows. *(05 marks)*

(d) (i) On the same axes, draw graphs of voltage $V = V_0 \sin \omega t$ and the resulting current against time for a circuit in which the a.c supply is connected across a capacitor. *(02 marks)*

(ii) Explain the values of I when $V = V_0$ and when $V = 0$. *(02 marks)*

(e) Describe the mode of operation of a repulsive type of ammeter. *(05 marks)*

SECTION D

8. (a) What is meant by the following:

(i) Electric field. *(01 mark)*

(ii) Electric flux? *(01 mark)*

(b) Show that the electric field intensity at a distance from a charged plane conductor is independent of the distance from the conductor. *(03 marks)*

(c) (i) Figure 3 shows two oppositely charged long parallel metal plates at a separation of 2 cm with a p.d of 20kV between them.

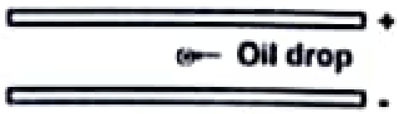


Fig. 3

When a negatively charged oil drop of mass 5.9×10^{-14} kg is introduced in the space between the plates, it remains suspended in space. Estimate the number of electrons in the oil drop. *(04 marks)*

(ii) Explain how a neutral material placed between the plates in figure 3 can be shielded from the electric field. *(03 marks)*

(d) Explain how the presence of a neutral conductor near a negatively charged material affects the potential of the material. *(04 marks)*

(e) Explain why a charged spherical conductor loses charge faster when a pin is placed on it with the sharp point sticking out. *(04 marks)*

9. (a) Define the following:

(i) Temperature coefficient of resistance *(01 mark)*

(ii) Electrical resistivity *(01 mark)*

(b) (i) Describe an experiment to measure an unknown resistance using a metre bridge. *(05 marks)*

(ii) Explain why the balance point of a metre bridge should be close to the middle of the slide wire. *(03 marks)*

(c) A piece of wire of length 200 cm and cross-sectional area 0.001 cm^2 has a resistivity of 4.4×10^{-7} Ωm. The ends of the wire are joined together to form a loop. Terminals T_1 and T_2 are fixed across the diameter of the loop and connected to two cells in parallel, each of e.m.f 1.5 V and internal resistance 1 Ω as shown in figure 4.

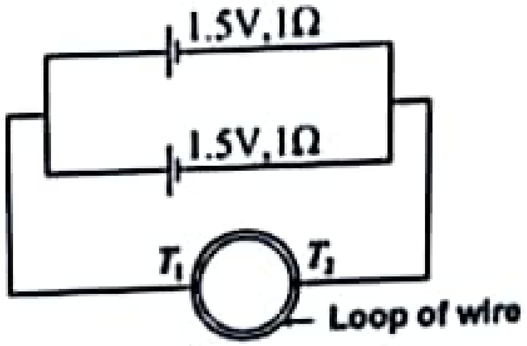


Fig. 4

Find the total current that flows in the circuit. *(06 marks)*

(d) Show that a given source of e.m.f delivers maximum power for a load when the resistance of the load is equal to the internal resistance of the source. *(04 marks)*

10. (a) Define the following:

(i) Dielectric constant. *(01 mark)*

(ii) Dielectric strength. *(01 mark)*

(b) Explain using molecular theory, the effect of a dielectric material on the capacitance of a capacitor. *(05 marks)*

(c) A capacitor of 50 μF is charged fully to a p.d of 45 V. The capacitor is then disconnected and a dielectric material of dielectric constant 2 is inserted between its plates. If it is then connected across an uncharged capacitor of 60 μF, determine the;

(i) p.d across the combination. *(04 marks)*

(ii) change in energy initially stored in both capacitors. *(04 marks)*

(d) (i) Describe how a ballistic galvanometer can be used to compare capacitances of two capacitors. *(04 marks)*

(ii) State any two functions of a dielectric material in a capacitor. *(01 mark)*

END