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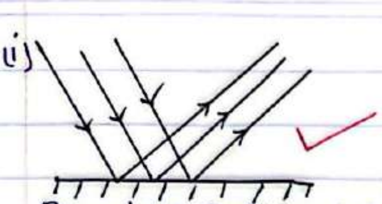
UNEB UACE P510/2 2024 GUIDE

BY MATIGO

1(a)(i)



Regular reflection

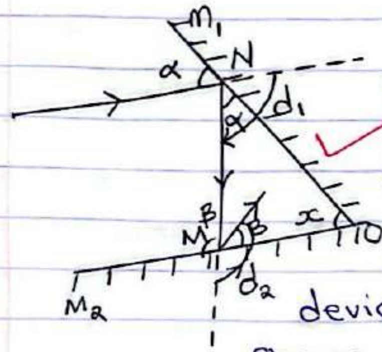
irregular reflection

- Nature of surfaces
- Form of reflection
- arows.

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

(ii) Consider a light ray Incident on a plane mirror m_1, Incident to another plane mirror m_2 as shown below.



- Rays ½
- Angles ½
- mirrors ½

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) ½

At m_2, $d_2 = 2\beta$ (anticlockwise) ½

Net deviation, $d = d_1 + d_2$ ½

$= 2(\beta - \alpha)$ ½

From ΔOMN, $\alpha + x = \beta \Rightarrow x = \beta - \alpha$ ½ 04

$\therefore d = 2(\beta - \alpha) = 2x$ ½

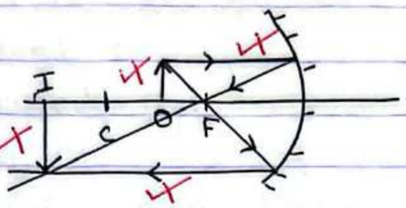
(b) Marks redistributed i.e additional 1 mark to; 1(a)(i) 04

(a)(ii) 04

(c)(ii) 03

(d) 05

(C)(i)



If mirror symbol is abscent deny ½

- Position of the object
- reflection
- Real Image beyond C
- mirror symbol.

02

(ii) $\frac{u}{f} = 1 + \frac{1}{m} \Rightarrow \frac{u}{24} = 1 + \frac{1}{3}$

$\Rightarrow u = 32cm$

03

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

$\Rightarrow u = 32cm$

(d)

using concave mirror of known R, Candidate loses 1 mark.

- A concave mirror is placed on a horizontal table with it's reflecting surface facing upwards.
- An optical pin is clamped horizontally with it's tip along the principal axis of the mirror
- The optical pin is slowly raised or lowered until a position is obtained where it coincides with it's Image when there is no parallax.
- The distance from the mirror to the pin is measured as R
- A small quantity of the test liquid is poured into the mirror and the position of the optical pin is again adjusted until it coincides with its Image with no parallax.
- The distance between the pin and the mirror is measured as h.
- The refractive Index of the liquid is obtained from $n = \frac{R}{h}$

(e) When a wide parallel beam of light is incident on a converging mirror, the reflected rays converge at different points along the axis of the mirror. A curve which passes through the points 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)

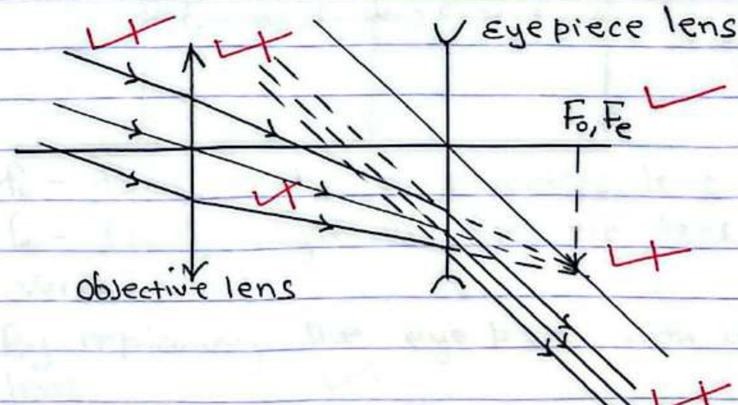
First 2 half ticks can be recovered on ray diagram.

2 a(i) Visual angle is the angle subtended at the eye by the object or image. (01)

(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)

Second mark can be scored on a diagram.

(b)(i)



The objective lens is arranged with the eyepiece 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)

b(ii) Advantages.

- It forms an upright Image. (01)
- It is short and therefore easily portable.

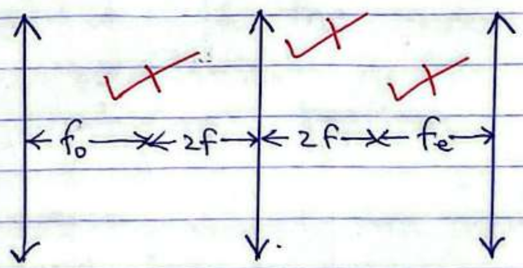
Limitations.

- It has a virtual eye-ring
- It has a narrow field of view. (01)

c(i) Version I

- A convex lens of short focal length is placed between the and the eye piece.
- It's position is such that it is a $f_o + 2f$ from the objective and $2f + f_e$ from the eye piece where f_o and f_e are the objective and eye piece lens respectively. (02)

Version 2.



(02)

f_o - focal length of objective lens.
f_e - focal length of eyepiece lens.

Version 3

- By replacing the eye piece with a concave lens.
- Adjust the eye piece such that the focal plane of the objective and the eye piece coincide (02)

(ii)
- Narrow field view
- virtual eyering. (01)
- Decreases the brightness of the final Image.

(d)(i) $M = \frac{f_o}{f_e}$

$= \frac{200}{2}$

$= 100$ (02)

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

(iii) $\frac{v}{u} = \frac{D_e}{D_o}$

$\frac{2.02}{202} = \frac{D_e}{20} \Rightarrow D_e = 0.2\,cm.$ (02)

ALT $M = \frac{D_o}{D_e}$

$100 = \frac{20}{D_e}$ (02)

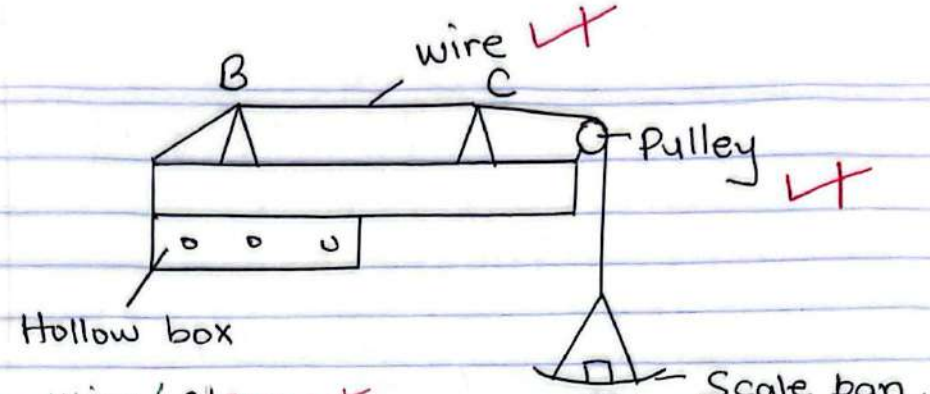
$D_e = 0.2\,cm.$

3(a)(i) Amplitude is the maximum displacement of a wave particle in the wave form 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)

NB Accept "motion or move" for vibrations.

(b)



- wire / string
- Pulley & mass

- 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 and held near the wire.
- 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 through the origin.
- This implies that $f^2 \alpha m$ but the tension $T = mg$.

$$m = T/g \Rightarrow f^2 \alpha T$$ (06)

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

3c(i) $l_1 + c = \frac{\lambda}{4}$ $\quad l_2 - l_1 = \frac{\lambda}{2}$

$l_2 + c = \frac{3\lambda}{4}$ $\quad \lambda = 2(l_2 - l_1)$

But $v = f\lambda$

$V = 2f(l_2 - l_1)$

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

$= 342 ms^{-1}$. 04

(ii) $l_1 + c = \frac{v}{4f}$

$31.5 + c = 32.4$ 02

$c = 0.9cm$.

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

(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 $f_b = \frac{n}{t}$ is calculated

The frequency of the standard note is reduced slightly and the experiment is repeated.

- The new beat frequency f_b' is determined

If $f_b' > f_b$ then the frequency

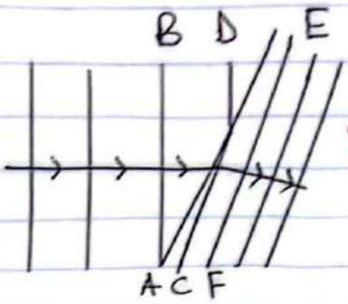
$f_2 = f_1 + f_b$.

- If $f_b' < f_b$ then the frequency

04

$f_2 = f_1 - f_b$.

4a (i)



$BD = V_1 t$

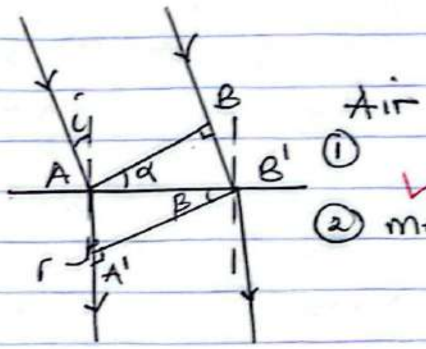
$AC = V_2 t$

$\therefore V_2 < V_1$

and $AC < BD$

The direction of travel of the wave changes an hence refraction. 03

(b)



01

Huygen's construction.

Consider a Plane wavefront AB every point on AB acts as a secondary Source of wavelets.

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 in the new wave front

From snell's law, the refractive index n is $n = \frac{\sin i}{\sin r}$ but $i = \alpha$ and $r = \beta$

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

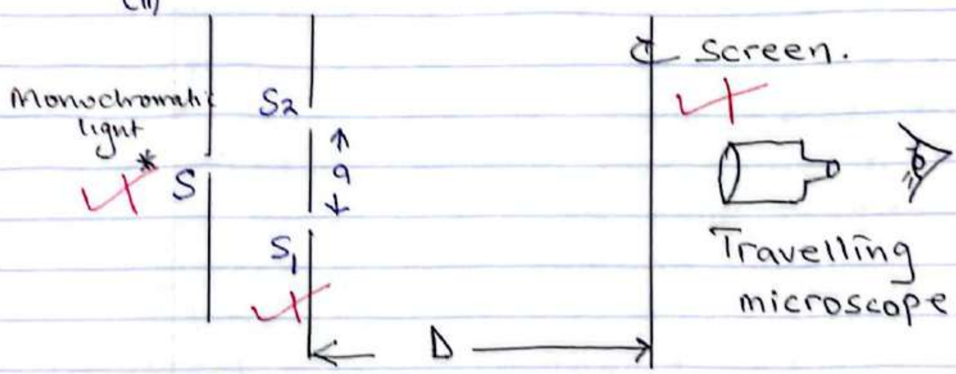
$$\therefore \quad n = \frac{BB'}{AB'} \div \frac{AA'}{AB'}$$

$$n = \frac{BB'}{AA'} = \frac{ct}{vt}$$

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

4(c)(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.
Permanent alternate regions of maximum and minimum intensity is therefore observed which is referred to as interference patterns. (03)

(ii)



- The apparatus is set up as shown above.
- 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, $\lambda = \frac{ay}{D}$ (05)

4(d) $d = \frac{1\times10^{-3}}{500}$

$d\sin\theta = n\lambda$ {For maximum}

$d\sin 90 = n\lambda$

$n = \frac{1\times10^{-3}}{500\times589\times10^{-9}}$

$n = 3.39$.

Hence maximum order = 3.

maximum number of diffraction image obtained is 7 (04)

5(a) - Heating in the coil causes loss of energy due to electrical resistance of the wire.

- Heating in the core causes loss of energy due to eddy currents.

- Heating in the core due to loss of energy due to magnetic reversals. (03)

- Energy loss due to magnetic flux leakage.

(b)(i) $I = \frac{200}{230} = 0.8696\,A$

Power loss $= I^2R$

$= 0.8696^2 \times 3$

$= 2.27\,W$

(ii) At the power station the voltage is stepped up and current reduces.
power loss; $P = I^2R$
At the machine the voltage is stepped down to the required values to operate the machine. 03

(c) Magnetic flux linking.

$$\phi = BAN\cos\theta \quad \text{But } \theta = 0.$$
$$\phi = BAN$$

The Induced emf, $E = -\dfrac{d\phi}{dt}$

$$= \frac{d(BAN)}{dt}$$ 04

Since BAN is constant, $E = 0$.

d(i) If the Induced emf in the secondary coil is 1V when the current in the primary coil changes at a rate of 1 ampere per second. 01

(ii) $E = -M\dfrac{dI}{dt}$

$$= -30 \times \left(\frac{0 - 1.5}{0.002}\right)$$ 03

$$= 22500\,V$$

(e)(i) When the armature of the motor rotates in the magnetic field, emf is induced in the coil. This emf opposes the applied voltage. This emf is called back emf. 02

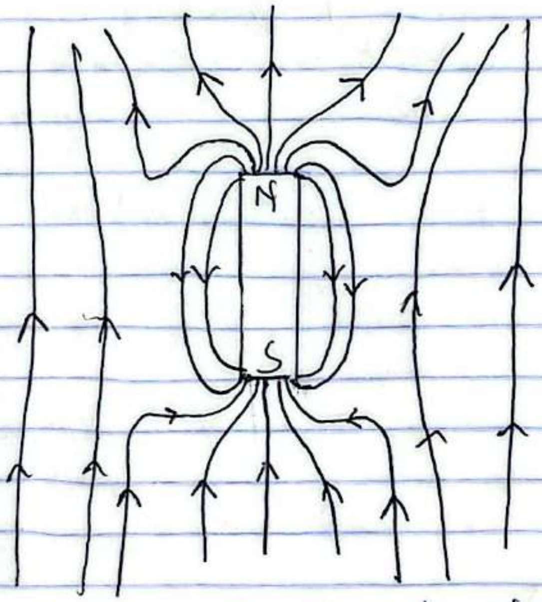
(ii) - It reduces current which woud have damaged the coil. 01

- Work done against back emf is converted into mechanical work which Increases ~~efficience~~ of the motor.

6(a)(i) Is a region in space where magnetic force is experienced.

Magnetic Saturation is said to occur when a given magnetic material has attained it's maximum magnetic Strength such that further magnetisation doesnot Increase it's strength. 01

b(i)



Direction 1
Pattern 1

(ii) The Inductor is placed with the plane of it coil horizontal. The coil is turned through 180° about the vertical diameter. The first deflection θ_i noted. The coil is now placed with the plane of the coil vertical such that it's plane is perpendicular to the N-S direction.

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

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. 01

(ii) When switch K is closed, current flows and wire WV experiences a force, $F = BIL$ downwards.

$$F = mg$$

$$F \times PQ = F' \times YW$$

$\Rightarrow$ $mg = BIL$ Since $\overline{PQ} = \overline{YW}$

$$\Rightarrow (\mu_0 In) Il \quad \text{i.e } \mu_0 nI$$

$$\Rightarrow I = \sqrt{\frac{mg}{\mu_0 nL}}$$

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

$$B_Q = B_P - B_R$$

$$= \frac{4\pi\times10^{-7}}{2\pi}\left(\frac{9}{0.03} - \frac{5}{0.05}\right)$$

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

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

(ii) $\frac{F}{l} = \frac{\mu_0 I_P I_R}{2\pi a} = \frac{4\pi\times10^{-7}\times9\times5}{2\pi\times0.08} = 11.25\times10^{-5}\,Nm^{-1}$

(e) B – Magnetic flux density

A – Area of the coil.

N – Number of turns – K – Strength of the hair spring.

7(a)(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 (01)

(ii) Reactance is the non resistive opposition to the flow of an alternating current in an Inductor or a capacitor. (01)

(iii) Impedence is the total opposition to the flow of an alternating current in an a.c circuit containing resistive and reactive components. (01)

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

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

$= I_0 V_0 \sin\omega t \cos\omega t$

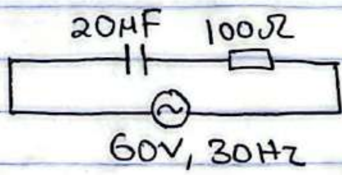
$= \frac{1}{2} I_0 V_0 \sin 2\omega t.$

03

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

$\langle P \rangle = 0$

(c)



For a capacitor

$X_c = \frac{1}{\omega C} = \frac{1}{20\times10^{-6} \times 2 \times 3.14 \times 30}$

$= 265.4\,\Omega$

$Z = \sqrt{X_c^2 + R^2}$

$= \sqrt{265.4^2 + 100^2}$

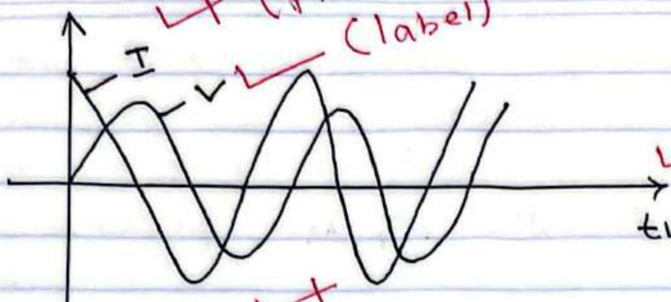
$= 283.6$

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

05

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

d(i)

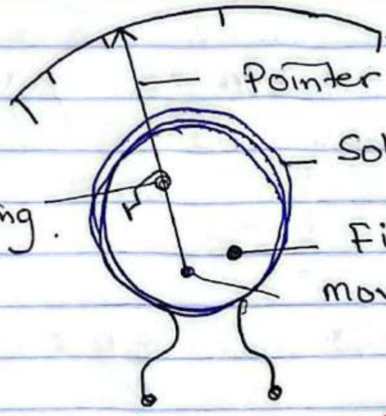


02

(ii) When $V = V_0$, $I = 0$ the capacitor is fully charged. when 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. 02

(e)



(02)

- 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 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. 03

8(a)(i) Electric field is a region in space where electric force is experienced. 01

Electric flux is the product of electric field intensity and the area it links normally 01

(b) Version I

$\phi = \frac{Q}{\varepsilon_0}$ $Q = \sigma A$

$\phi = \frac{\sigma A}{\varepsilon_0}$ But $\phi = E \cdot A$

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

$E = \frac{\sigma}{\varepsilon_0}$ 03

Version II

From $Q = 4\pi\varepsilon_0 r^2 E$

$Q = \sigma A = \sigma 4\pi r^2$

$4\pi\varepsilon_0 r^2 E = \sigma 4\pi r^2$

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

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

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

$q = \frac{mgd}{V}$

$= \frac{5.9\times10^{-14}\times9.81\times2\times10^{-2}}{20\times10^{3}}$

$= 5.78\times10^{-19}C$

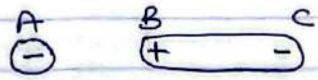
Now $q = ne$

$n = \frac{5.7879\times10^{-19}}{1.6\times10^{-19}} = 3.6$ 04

$n =$ 3 electrons or 4 electrons.

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. 03

(d)



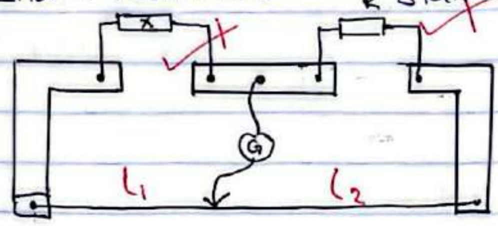
Positive charge is induced on it's near side B and negative charge on side C.
The potential at A is the sum of potentials due to it's charge and the nearby charges.
Since the positive charge is closer to A the resultant potential increases due to the induced positive charge. This reduces the negative potential..

(e) When a pin is placed on a charged conductor.
Charge concentrates at sharp points of the charged conductor.
A high electric field intensity develops around the sharp points which ionises air - there.
Ions of opposite charge are attracted and neutralized.

9(a)(i) Temperature co-efficient of resistance is fractional change in resistance at 0°C per degree Kelvin rise in temperature. 01

(ii) Resisitivity is the resistance of a material of length 1m and cross sectional area of $1m^2$ 01

b(i) unknown resistance R Standard resistance, R.



- Apparatus is connected as shown above
- For a known value of R, the Jockey is tapped along the wire AB until the galvanometer shows no deflection.
- The balance lengths l_1 and l_2 are measured
- The experiment is repeated for different values of R and results obtained are tabulated. including $\frac{l_2}{l_1}$
- A graph of R against $\frac{l_2}{l_1}$ is plotted and it's slope s is determined.
- The resistance R_x of x is given by 05
  $R_x = s$

(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 balance length is small.
Error in the resistance to be determined is small and accuracy higher 03

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

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

$R = 8.8\Omega$

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

$= \frac{8.8}{2}$

$= 4.4\Omega$

Total resistance, $R_T = \frac{4.4 \times 4.4}{4.4 + 4.4} + \frac{1 \times 1}{1 + 1}$

$= 2.7\Omega$

$I = \frac{1.5}{2.7}$ 06

$I = 0.556A$

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

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

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

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

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

For max power 04

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

$R = r$

10(a)(i) Dielectric strength 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 01

or

Is ratio of permitivity of dielectric to permitivity of free space.

(ii) Dielectric strength is the maximum p.d per metre thickness which a dielectric can with stand without conducting. 01

(b) - When a dielectric is placed between plates of a charged capacitor, it's molecules get polarized.

- The surfaces of the dielectric develop charges opposite to those on the adjacent plates.

- The positive charges reduces the negative potential of the negative plate and negative charge reduces the positive potential of the positive plate. Thus the p.d between the plates reduces. 05

capacitance $= \frac{Q}{V}$ hence the capacitor increases.

(c) $Q = CV$

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

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

After Inserting $C' = 2 \times 50 = 100\mu F$

$C_T = C' + C''$

$= 100 + 60$

$= 160\mu F$ 04

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

Scanned with CamScanner

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

$= \frac{1}{2} \times 50 \times 10^{-6} \times 4.5^2$

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

After combination

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

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

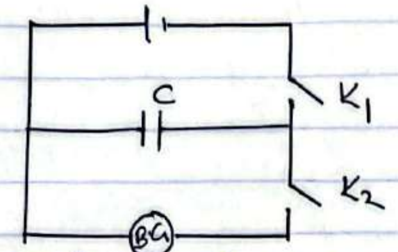
$\Delta E = E_1 - E_2$

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

$= 3.47 \times 10^{-2}\,J$.

04

d (i)



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 maximum deflection θ_1 of the Ballistic galvanometer 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 seperates the capacitor plates
Increases capacitance of capacitor.
Increases dielectric strength.

01

END.

BY MATIAO. 0702048636.

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)*

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**.

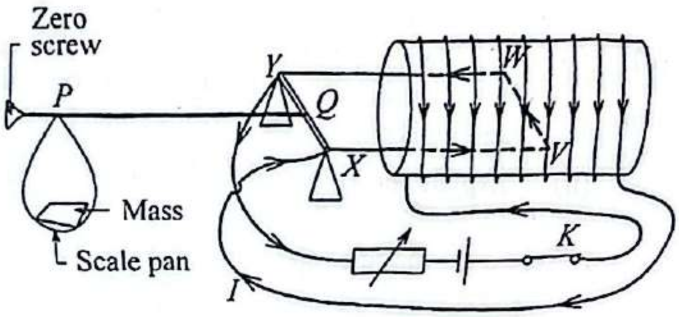


Fig. 1

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.

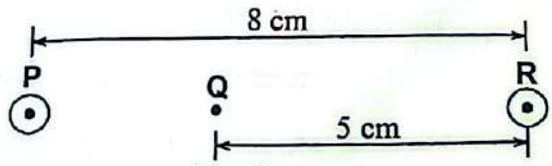


Fig. 2

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 30 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.

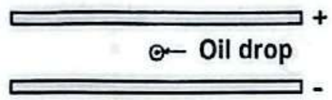


Fig. 3

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.

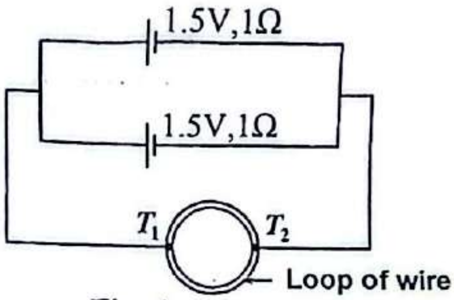


Fig. 4

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