MWALIMU EXAMINATIONS BUREAU

UACE RESOURCE PRE-MOCK EXAMINATIONS 2019

PHYSICS PAPER 2 MARKING GUIDE

SECTION A

1. a) i) **Angular magnification** (01mk)

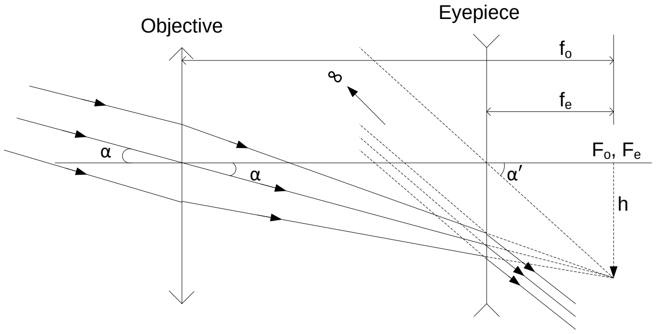
Angular magnification of an optical instrument is the ratio of the angle (α') subtended at the eye by the final image when using the instrument to the angle (α) subtended at the unaided eye by the object.
OR
Angular magnification or magnifying power is the ratio of the angle (α') subtended at the aided eye by the final image to the angle (α) subtended at the unaided eye by the object.

ii) **Resolving power** (01mk)

Resolving power of an optical instrument is its ability to form separate images for objects which are very close.
OR
Resolving power of a lens is its ability to reveal details of objects which must be very close to the eye.

b) i) With the aid of a ray diagram, describe the action of a Galilean telescope in normal adjustment. (05mks)

Diagram (2 ½ marks)



Rays of light from a distant object are refracted to form a **real image** on the focal plane of the **objective**. This plane is also the focal plane of the eye piece in normal adjustment. The eye piece thus acting **magnifying glass** forms a virtual **image at infinity**.

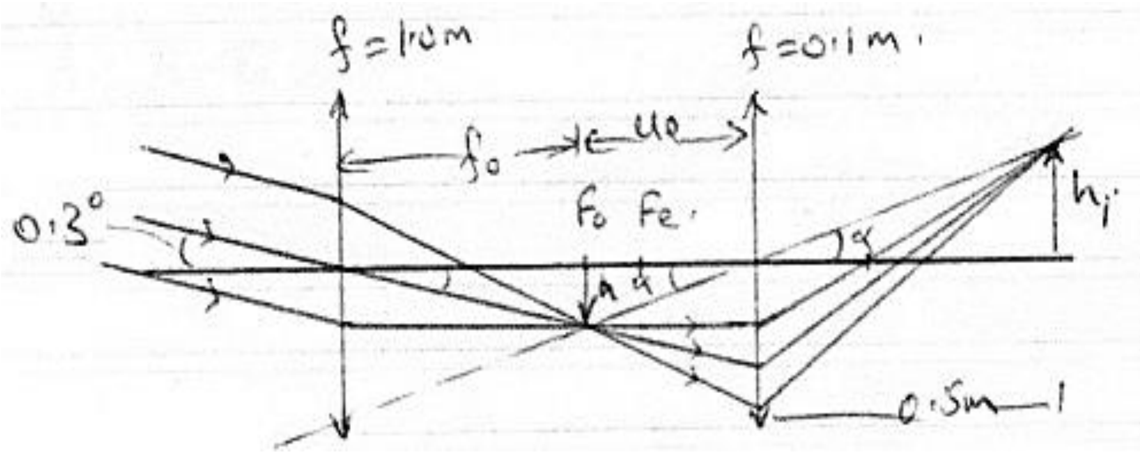
ii) Explain why Galilean telescope cannot be used to make precise determination of angular positions of objects being viewed. (02mks)

To get precise angular positions of objects viewed, the image should be real, so that the image height and image distance can be measured precisely. Galilean telescopes form virtual images.

c) A telescope has two lenses of focal lengths 1.0m and 0.1m and it is adjusted to produce an image of a distant object on a screen. The object subtends an angle of 0.30^0 at the telescope adjectives. Calculate.

i. The linear size of the image formed on the screen 0.5m from the eye piece. (04mks)

Solution:



$$h = f_o tan0.3^0 = 1\ tan0.3 = 5.24x10^{-3}m$$

$$now\ \frac{1}{U_e} = \frac{1}{f_e} - \frac{1}{u_e} \qquad \textbf{1mk}$$

$$= \frac{1}{0.1} - \frac{1}{0.5}$$

$$= \frac{0.5-01}{0.5} \qquad \textbf{1mk}$$

$$\therefore U_e = \frac{0.5}{0.4} = 1.25 \qquad \textbf{½ mk}$$

$$now\ \frac{h_1}{h} = \frac{0.5}{1.25} \qquad \textbf{½ mk}$$

$$h_1 = \frac{0.5}{1.25}\ x\ 5.24x10^{-3}$$

$$= 2.1x10^{-3}m \quad \mathbf{1mk}$$

ii. The distance between the objective and the screen. (01mk)

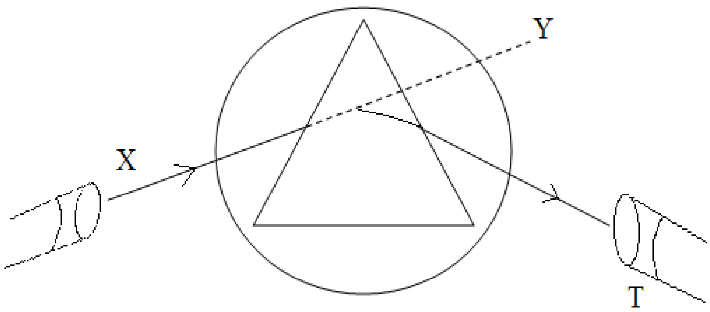
Solution:

$= f_0 + U_e + u_e$

= 1 + 1.25 + 0.5 = 2.75m

d) Describe an experiment in which the minimum deviation of a prism can be measured. (06mks)

Solution:



The refractive index is determined using a spectrometer. First, the telescope is adjusted to **focus parallel light**, the collimator is adjusted to **produce parallel light** and the **table is levelled**.
The prism is now placed on the table with its refracting edge facing **away from the collimator**. The telescope is turned to receive light from the **opposite side of the prism**. The table is turned, keeping the emergent light in sight until the **light just begins to move** in the opposite direction. The **angular position is noted**. The **prism is removed** and the telescope is turned to receive light **directly at Y**. this angular position is noted. The angle between the two positions **D is determined**, and this is the minimum deviation.

Max 6 marks for the explanation

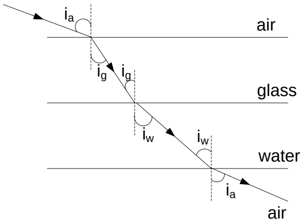
2. a) i) State the laws of refraction of light (02mks)

Solution:

- The incident ray, refracted ray, and the normal at the point of incidence all lie on the same plane.
- For two given media, the ratio of the sine of angle of incidence to the sine of angle of refraction is constant.

ii)

Consider a ray of monochromatic light incident in air and propagating in glass and water as shown below.



For a ray moving from air to glass, refractive index from air to glass, n_{ag} is given by

$$n_{ag} = \frac{\sin i_a}{\sin i_g}$$

$$\sin i_a = n_{ag} \sin i_g$$

For a ray moving from water to air, refractive index from water to air, n_{wa} is given by

$$n_{wa} = \frac{\sin i_w}{\sin i_a} = \frac{1}{n_{aw}}$$

$$\sin i_a = n_{aw} \sin i_w$$

Equating the two equations gives

$$\sin i_a = n_{ag} \sin i_g = n_{aw} \sin i_w$$

Writing the above equation in terms of absolute refractive index of air (n_a), glass (n_g), and water (n_w); we get

$$\sin i_a = n_g \sin i_g = n_w \sin i_w$$

Since refractive index of air, $n_a = 1$, we can write the above equation as

$$n_a \sin i_a = n_g \sin i_g = n_w \sin i_w$$

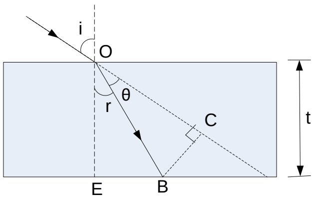
The above equation shows that when a ray is refracted from one medium to another, the boundary being parallel,

$$n \sin i = constant$$

b) A ray of light is incident at an angle of 40° at a piece of crown glass whose faces are parallel and 2.4cm apart. If the refractive index for a yellow light is 1.574, find the transverse displacement of the ray (04mks)

Solution:

Solution:



BC is the transverse displacement. **½ mk**

$$i = 40°, t = 2.4cm, n_g = 1.574$$

Taking snell's law at O, $n_g \sin r = \sin i$ **½ mk**

$$\sin r = \frac{\sin i}{n_g} = \frac{\sin 40}{1.574} = 0.4084$$ **½ mk**

$$r = 24.1°$$ **½ mk**

$$\cos r = \frac{OE}{OB}$$

$$OB = \frac{OE}{\cos r} = \frac{2.4}{\cos 24.1} = 2.63cm \qquad \text{½ mk}$$

$$\angle AOD = \angle EOC$$

$$i = (r + \theta)$$

$$\theta = (i - r) = (40 - 24.1) = 15.9° \text{ ½ mk}$$

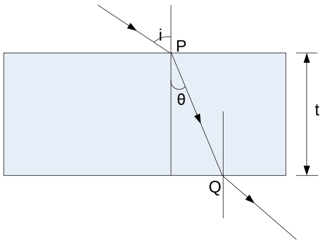
Finally, the transverse displacement BC is calculated as below

$$\sin\theta = \frac{BC}{OB} \qquad \text{½ mk}$$

$$BC = OB \times \sin\theta = 2.63 \sin 15.9 = 0.72cm \text{ ½ mk}$$

c)Time taken by light to emerge from a block of material placed in a vacuum (05mks)

Solution:



Given that T is the time taken by light to travel from P to Q in the medium.

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

Where, c is the speed of light in the vacuum, and v is the speed of light in the medium.

$$\cos\theta = \frac{t}{PQ}$$

$$PQ = \frac{t}{\cos\theta} = t\sec\theta$$

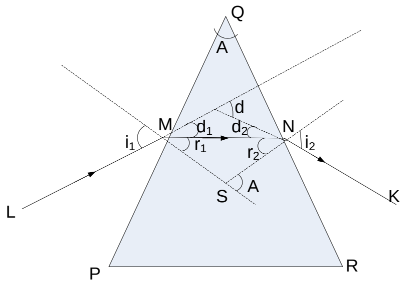
$$from, \qquad (time) = \left(\frac{distance}{speed}\right)$$

$$T = \left(\frac{PQ}{v}\right) = \left[\frac{t\sec\theta}{(^{c}/_{n})}\right] = \left[\frac{nt\sec\theta}{c}\right]$$

Thus, Time taken by light to emerge from a block is given by

$$T = \frac{nt\sec\theta}{c}$$

d)



$$n_a = 1, n_g = 1.33, A = 72°, i_2 = 43°$$

(i). Taking snell's law at N, $n_a \sin i_2 = n_g \sin r_2$

$$\sin r_2 = \frac{n_a \sin i_2}{n_g} = \frac{1 \times \sin 43}{1.33} = 0.5128$$

$$r_2 = 30.85°$$

$$r_1 = A - r_2 = 72 - 30.85 = 41.15°$$

Taking snell's law at M, $n_a \sin i_1 = n_g \sin r_1$

$$\sin i_1 = \frac{n_g \sin r_1}{n_a} = \frac{1.33 \times \sin 41.15}{1} = 0.8752$$

$$i_1 = 61.07°$$

(ii). Total deviation, $d = (i_1 + i_2) - A$

$$d = (61.07 + 43) - 72 = 32.07°$$

SECTION B

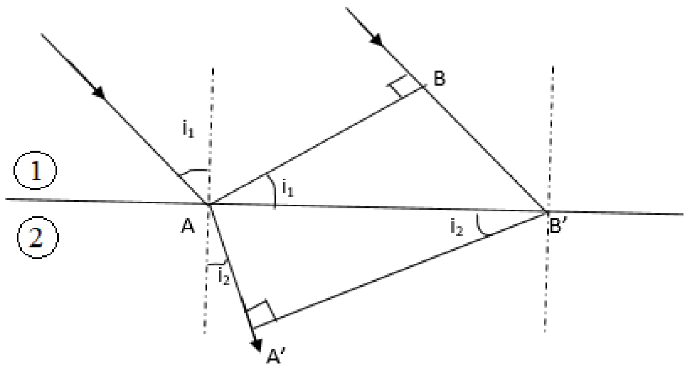
3. a) 1) State the principle of super position of wave.

When two waves travelling in the same medium meet, they superpose such that the resultant displacement at the point of meeting in the vector sum of the displacements by each of the waves of that point. (01mk)

ii) State **Huygens's principle**

Huygens's principle that every point on a wave front acts as a source of secondary wavelets which moves forward with the velocity of the wave. The new wave front in the envelope which touches the surfaces of all the wave lets.

iii) Use Huygens' Principle to show that for light travelling from one medium to another. Where $C_1$and C_2 are respective speeds.



Consider a wave front AB travelling in medium (1) incident on a plane boundary with medium (2) when A has just reached the boundary.

If in the interval t, B moves to B, then $BB^1 = C_1t$.

In the same interval A moves a distance $AA^1 = C_2t$.

Thus A^1B^1 in the new wave front now.

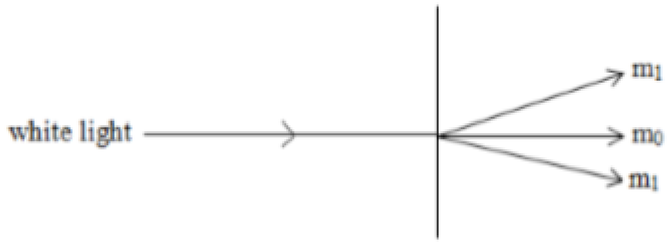
$$\frac{sin_1}{sin_2} = \frac{BB^1}{AB^1} / \frac{AA^1}{AB^1} = \frac{BB^1}{AA^1} = \frac{C_1t}{C_2t}$$

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

b) i). What is a plane transmission grating?

A plane transmission grating is a transparent on which many closely spaced lines are drawn using diamond pencil.

ii). Explain how a spectrum is produced by a diffractive (plane transmission grating)



Consider a narrow beans of white light incident normally on the grating as above.

Diffraction occurs at the slits. In certain direction the diffracting **wavelets interfere constructively**. The diffraction also causes separation of the colours where long wave length light in diffracted most while short wave length light is diffracted least. In the direction where a particular colour interferes constructively a bright band of that colour is formed. Thus in every direction of constructive interference a spectrum is formed. **Max 5mks**

c) Light of wave length $2x10^{-7}$m is incident on a plane transmission grating of 600 lines per cm. calculate,

i) The maximum order of the spectra formed

d $\sin\theta = n\lambda$ when $\sin\theta = 1$

$$n = \frac{d}{\lambda} = \frac{10^{-2}}{600} \div 2x10^{-7}$$

$$= \frac{10^{-2}}{600} \times \frac{10^{7}}{2} = 8$$

ii) The diffraction angle for the 1^{st} order spectrum

$$\sin\theta = \frac{\lambda}{d} = \frac{2x10}{10^{-2}} \times 600$$

$$= 12 \times 10^{-3} = \frac{12}{1000} = \mathbf{0.69^{o}}$$

iii)

Diffraction spectrum	Dispersion spectrum
- It is pure (has sharp images)	- It is impure (not sharp images)
- Long wave length light diffracted more	- Long wave length light refracted least
- Spectrum brighter	- Spectrum less bright

4. a) What is meant by a progressive Wave and wave front (02mks)

- Progressive wave is one in which energy is transmitted along the profile.
- Wave front is a section through an advancing wave on which all particles are vibrating in phase

b)

i) $y = 0.1 \sin(200\pi t - \frac{20\pi}{17}x)$

$y = 0.1\sin\left(200\pi t + \frac{20\pi}{17}x\right)$ **1mk**

ii) **The frequency of the wave** **(02mks)**

C.f $y = a \sin\left(2\pi f t - \frac{2\pi x}{\lambda}\right)$

$= 2\pi f t = 200\pi t$

$f = \frac{200\pi t}{2\pi f t} = 100\text{Hz}$

iii) Its speed $v = f\lambda$, $but \frac{2\pi x}{\lambda} = \frac{20\pi x}{17} \therefore \lambda = \frac{17}{10} = 1.7\text{m}$

$\therefore speed = 100 \times 1.7 = 70\text{ms}^{-1}$ **(02mks)**

iv) The phase difference in radians between a point 0.25m from 0 and a point 1.10m from 0.

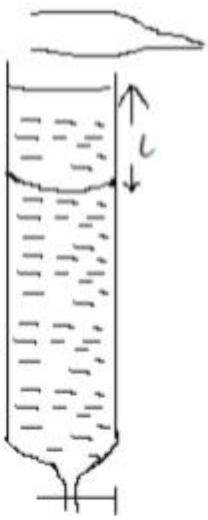
(02mks)

$\frac{2\pi x_2}{\lambda} - \frac{2\pi x_1}{\lambda} = \frac{2\pi}{\lambda} \times (x_2 - x_1)$

$= \frac{2\pi}{1.7}(1.1 - 0.25)$

$= 3.14$ rad

c) **Describe how speed of sound in air can be obtained by resonance method. (05mks)**



A long glass tube with a tap at the bottom is filled with water. A turning fork is sounded and held above the mouth of the tube. The tap is opened and water is drained out until a loud sound is heard. The tap is closed and the length l_1 of the air column is measured. The fork is again sounded and held above the tube. The tap is opened and the tube is drained further until a loud sound is heard. The tap is closed and the length l_2 of the air column is measured and recorded together with the frequency f of the turning fork. Velocity of sound is calculated from. $V = 2f(l_2 - l_1)$

d) Explain how to determine whether a star is receding or approaching to the earth. **(04mks)**

A spectral photograph of an arc light from an element known to be in the star is **taken in a laboratory.** A spectoral photograph of **light from the star** is taken **and compared** with that of the one taken from the lab. If the spectoral line has shifted to the blue end then the **star is approaching**. If there is a **red shift then the star is receding**.

e) Explain how a mechanical wave transmits energy without motion of medium particles.

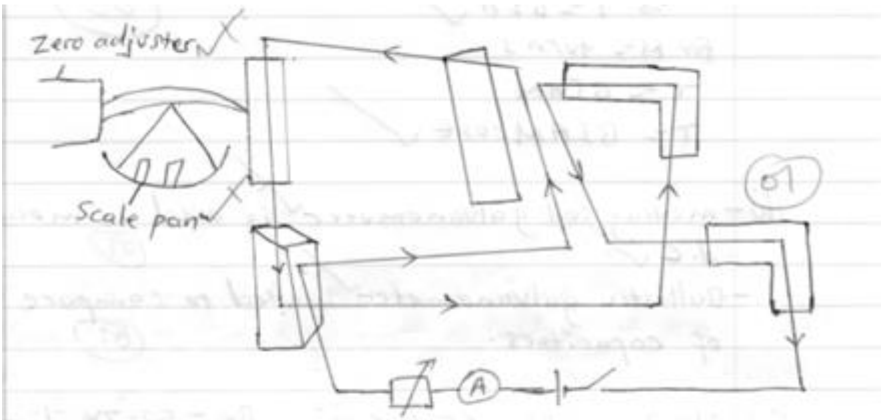
When a particle in the medium is disturbed, it transmits the disturbance to the next particle through colliding with it or pulling it. This particle also transmits to the next. This way the disturbance is transmitted along the profile. **(02mks)**

SECTION C

5. a) i) Define the ampere.

An ampere is the current which when flowing through two parallel infinitely long wires of negligible thickness placed 1m apart exert on each other a force of 2.0×10^{-7} N

ii) Describe how the magnetic flux density at the centre of a coil may be determined



With switch, K open, the plane is adjusted such that its surfaces are horizontal.

Switch, K is then closed and the plane is deflected

Masses are added into the the mass hanger to restore horizontal position of plane

At restoration 04

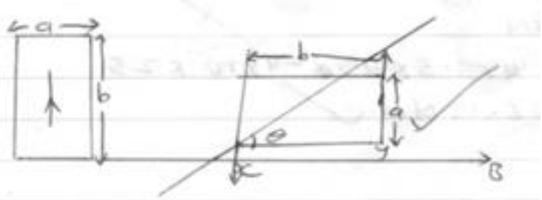
Weight of masses = force due to current

$mg = BIL$

The length of the plane is known and current determined from the ammeter.

$B = \frac{mg}{IL}$

(b) (i) A rectangular coil of, *N*, turns measuring *a* cm by *b* cm is placed in a uniform magnetic field of flux density, *B*. If a current of, *I*, flows through the coil, derive the expression for the magnetic torque experienced by the coil when the normal to the plane of the coil makes angle, θ, with the field. (05mks)



The force, F at x = Force at y

The work done by the force = force × distance

W.D = F × b But W.D = Torque, T

$\Rightarrow T = Fb$ also $F = BIL\cos\theta$

$T = BILb$ also $A = Lb$

$\Rightarrow T = BIA$

for N = turns

$T = BIAN$

$T = BIAN\cos\theta$

05

(ii) Name *two* devices, and state their functions, whose operations are based on magnetic torque on current carrying conductors. (02mks)

- Moving coil galvanometer is used to measure direct current

- Ballistic galvanometer is used to compare the capacitance of capacitors.

(c) A circular coil of 25 turns each of radius 12cm lies on a table. The earth's magnetic field intensity at the location of the coil is 52.7Am^{-1} while the angle of dip is 73.0^{0}. Find the:

(i) magnetic flux threading the coil. (04mks)

$N = 25$ turns, $r = 12\times10^{-2}$ m, $B_E = 52.7\,Am^{-1}$, $\alpha = 73^{\circ}$

$\alpha = \frac{R_B}{B}$, $\phi = ?$

$\phi = NAB\cos\theta$

$\cos\alpha = \frac{B_H}{B_R}$

$B_H = B_R\cos\theta = 52.7\cos 73 = 15.4\,T$

04

(ii) torque on the coil when a current of 1.5A is passed through it. (03mks)

$A = \pi r^2 = \pi(12\times10^{-2})^2$

$\Rightarrow A = 45.24\times10^{-3}\ m^2$

$\Phi = NAB$

$= 25\times45.24\times10^{-3}\times15.4$

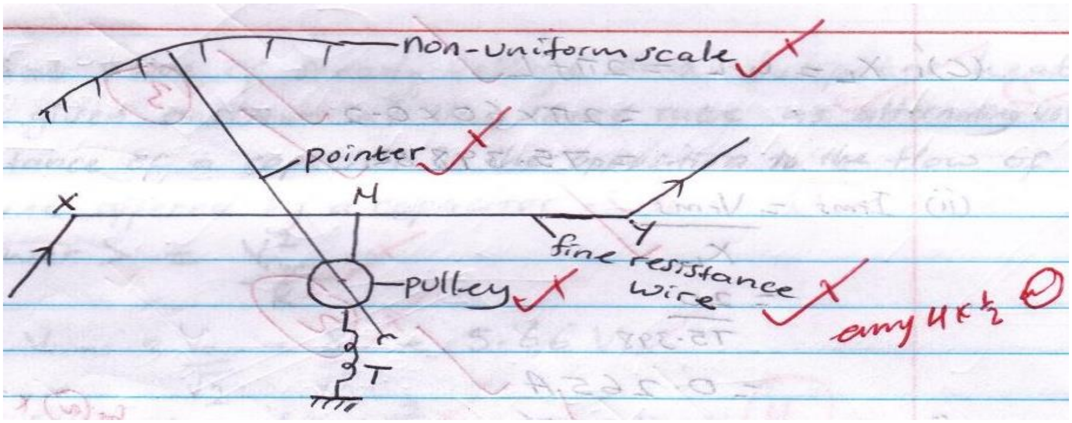
$\Phi = 17.42\ mT$ 03

$T = BIAN$

$T = 15.4\times1.5\times45.24\times10^{-3}\times25$

$T = 26.13\ Nm$

6. **(a)**



Current to be measured is passed through resistance wire xy. The wire gets hot, expands and sags. The sag is taken up by NT which is kept taut by the spring. This causes the pulley to rotate and the pointer attached to it in turn rotates. The rotation is proportional to the sag and the deflection of the pointer is proportional to the r.m.s value of current hence a non-uniform scale.

Tt 05

(b) *Capacitor;* during the first quarter of the cycle the capacitor charges and energy is stored in the electrostatic field of the plates. When current decreases in the next quarter, the capacitor discharges and in a complete cycle the mean power is zero.

Inductor; when the current increases in the first quarter, the back emf opposes the rise of current and the current flows against ε And therefore does work against it.

The total work done in bringing the current is stored in the magnetic field.

When the current decreases in the next quarter, the back emf ε causes it to act as a generator returning the energy stored in the magnetic field to the source. Therefore in a complete cycle mean power is zero.

Tt 06

(c) (i) $X_L = \text{WL} = 2\pi fL$

$= 2\pi \times 60 \times 0.2$

$= 75.398\Omega$ **3mks**

(ii) $\text{Irms} = \frac{Vrms}{X_L}$

$= \frac{20}{75.398}$

$= 0.265A$ **2mks**

(d) Reactance is the combined non-resistive opposition to the flow of a.c through a capacitor resistor and inductor. **1mk**

7. (a) (i) Is that value of steady voltage that dissipates heat in a given resistor at the same rate as alternating voltage **1mk**

(ii) Reactance of a capacitor is the opposition to the flow of current offered by a capacitor. **1mk**

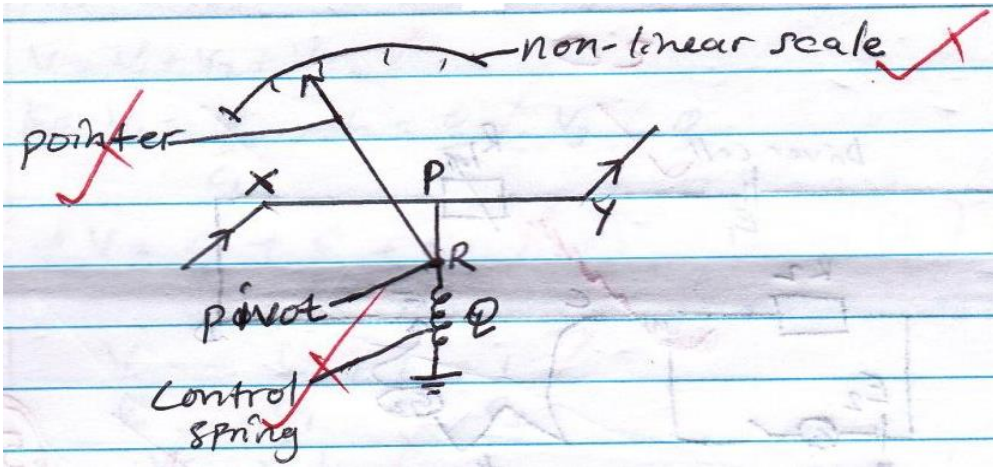
(b) $< \text{power} > = \frac{{V_{rms}}^2}{R}$

But $\text{Vrms} = \frac{V_o}{\sqrt{2}} = \frac{8}{\sqrt{2}} = 5.66\text{V}$

$< \text{power} > = \frac{(5.66)^2}{6} = 5.34\text{W}$

Hence from $< \text{power} > = {I_{r.ms}}^2 R$ ${I_{r.ms}}^2 = \frac{5.34}{6}$ $I_{r.ms} = 094\text{A}$ **Tt 04**

(c)



XY is a wire whose resistance is known. When current flows through XY, heat is given out mainly by convection at a rate equal to the average rate at which heat is developed in the wire. This makes the wire to expand and sags. The sag is taken up by a second fine wire PQ held taut by spring round the pulley, R attached to the pointer which rotates it making a certain deflection.

The deflection is roughly proportional to the average rate at which heat is developed in XY and hence is proportional to the average value of the square of a.c. The scale is non-uniform.

Tt 05

(d) (i) $I = \frac{dQ}{dt}$

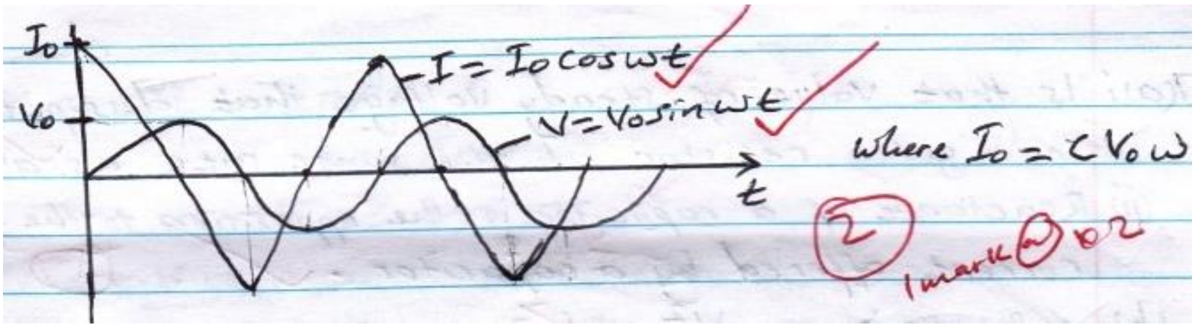
$= \frac{d}{dt} cv = c\frac{d}{dt}\ Vo \sin wt$

$= Vow \cos wt$

where $Q -$ charge

$I -$ current at time t **3mks**

(ii)



(iii) $V = V_o \sin wt$

$I = I_o \cos wt = Io \sin\left(\frac{\pi}{2} + wt\right)$

It is evident that current and voltage are $\frac{\pi}{2}$ out of phase. Voltage reaches a maximum value a quarter cycle later than current that is the voltage lags behind the current by $\frac{\pi}{2}$ radians or current leads voltage by $\frac{\pi}{2}$radians.

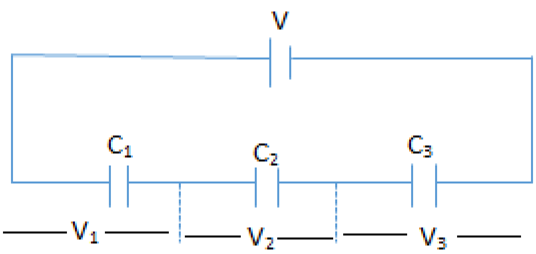
8.(a) (i) Capacitance of a capacitor is the ratio of the magnitude of charge on either plates of a capacitor to the p.d between the plates. **1mk**

OR: is the magnitude of change required to raise the potential of a given conductor by 1V.

(ii) A dielectric material is a material which does not allow charge to flow through it.

1mk

(b)



Charge on each capacitor is the same and let it be Q. p.d across the capacitors are different and

$V = V_1 + V_2 + V_3$

but $V_1 = \frac{Q}{C_1}$, $V_2 = \frac{Q}{C_2}$, $V_3 = \frac{Q}{C_3}$

$$V = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

$$\frac{V}{Q} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

but $\frac{V}{Q} = \frac{1}{C}$ where C is the effective capacitance of the three capacitors in series.

$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ **Tt 04**

(c) (i) Capacitance in series $C_1 = \frac{4\times2}{4+2} = \frac{8}{6} = \frac{4}{3}$ μF

Effective capacitance in parallel, $C_2 = \frac{4}{3} + 3 = \frac{4+9}{3} = \frac{13}{3}$NF

Total capacitance in series $C_3 = \frac{\frac{13\times5}{3}}{\frac{13+5}{3}} = 6\frac{\frac{5}{3}}{\frac{28}{3}} = \frac{65}{28}$μF

Charge stored $Q = CV = \frac{65}{28} \times 10^{-6} \times 12$

Charge on 5μF capacitor = 27.9NC **Tt 03**

(ii) Energy stored in the 3μF capacitor p.d across the 5μF capacitor $= \frac{Q}{C} = \frac{27.9\times10^{-6}}{5\times10^{-6}} = 5.58$V

p.d across the parallel network $= 12 - 5.58 = 6.42$V

Hence energy stored on the 3μF capacitor $E = \frac{1}{2}CV^2 = \frac{1}{2} \times 3 \times 10^{-6} \times 6.42^2$

$= 6.182 \times 10^{-5} J$

3mks

(iii) p.d across the 4μF capacitor $Q = CV = 3 \text{ x } 10^{-6} \text{ x } 6.42$

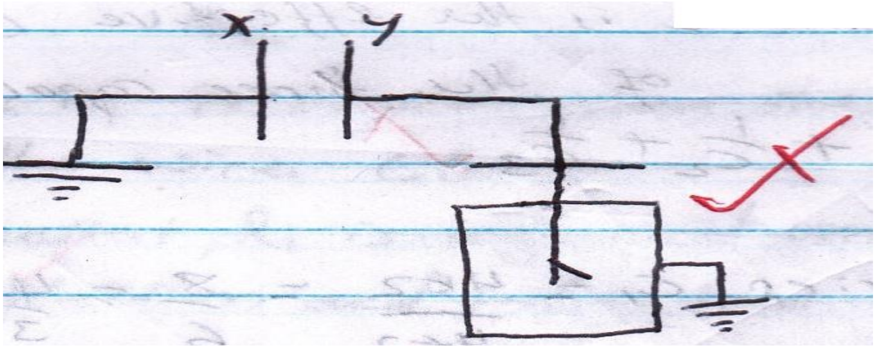
$= 19.26 \text{ x } 10^{-6}$ C

Charge on the series network $= (27.9 - 19.26) \times 10^{6} = 8.64 \times 10^{-6}$C

$$\text{p.d across the } 4\mu F \text{ capacitor} = \frac{Q}{C} = \frac{8.64\,x\,10^{-6}}{4\,x\,10^{-6}} = 2.16V$$

Tt 04

(d)



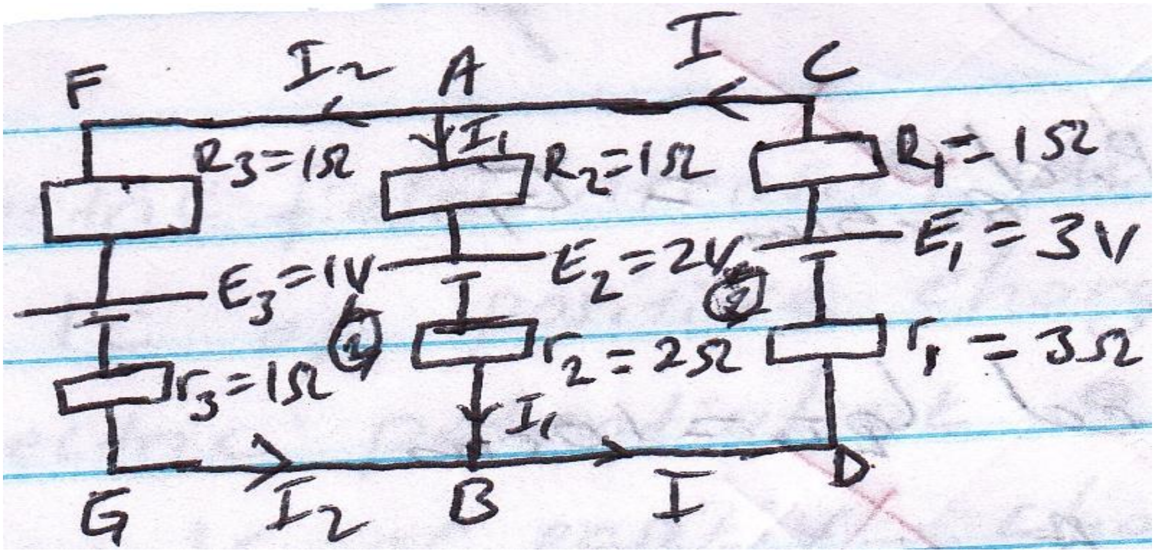
The apparatus are set up as a bove. XY are capacitor plate Y is charged and the divergence of the leaf of the electroscope is noted. A dielectric material is now placed between the plates and the divergence of the leaf is seen to reduce. This implies that the p.d between the plates has reduced. Now capacitance C = Q/V where V is the p.d between the plates and Q is the charge stored on the capacitor. If V has reduced then C has increased hence C∞ ε since permittivity of the material is greater than that of air. **Tt 04**

9. (a) At any electric junction the total current flowing into the junction is equal to the total current flowing out of the junction. **1mk**

OR: The algebraic sum of current at the junction of the electric circuit is zero.

For any closed loop in an electric circuit, the algebraic sum of the emfs is equal to the algebraic sum of the p.ds in that circuit. **1mk**

(b)



$I_1 + I_1 = I - - - - - - (1)$

for loop (1)

$-1 + 2 = I_2 + I_2 - I_1 - 2I_1$

$2I_2 - 3I_1 = 1$ --------------(2)

for loop (2)

$-2 + 3 = I_1 + 2I_1 + 3I + I$

$3I_1 + 4I = 1 - - - - - - (3)$

From (1), (2)and (3)

$$I_1 + \frac{1 + 3I_1}{2} = \frac{1 - 3I_1}{4}$$

$4I_1 + 2 + 6I_1 = 1 - 3I_1$

$$13I_1 = -1, I_1 = \frac{-1}{13}\text{A}$$

$$\therefore \text{The magnitude of } I_1 = \frac{-1}{13}\text{A}$$

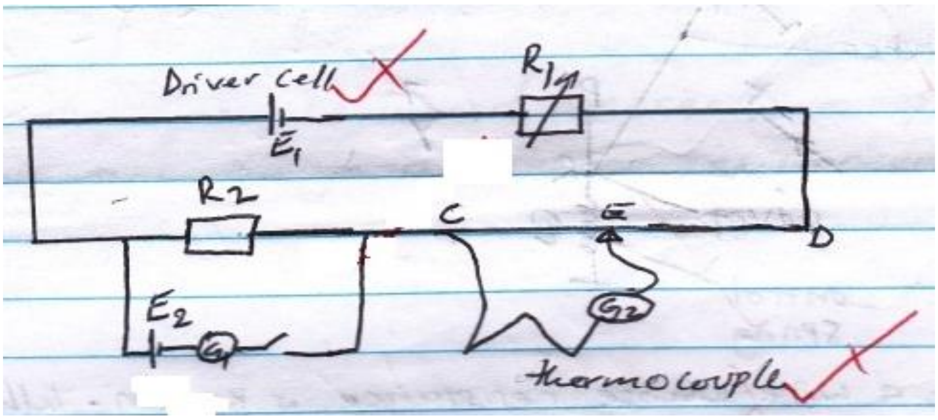
$p.d_{AB} = I_1R_2 + 2 + I_1r_2$

$$= \left(\frac{1 \times 1}{13}\right) + (2) + \left(\frac{1 \times 3}{13}\right)$$

$$= \frac{29}{13} = 2.23V$$

Tt 06

(c)



Switch K_1 is closed when the point E is not in contact with the wire CD.

- The Rheostat, R_1 is adjusted until the galvanometer G_1 shows no deflection and p.d in 1cm is determined and noted.
- The jockey, E is then tapped a long CD until when the galvanometer G_2 shows no deflection.
- The balance length L_{CE} is measured and noted.
- Then the emf of the thermocouple E_T is given by $E_T = \frac{p.d}{cm} \times L_{CE}$ where p.d/cm is p.d in 1cm **Tt 05**

(d) (i) With S_1 and S_2 open, $LQT = 62.5cm$

$$p.d_{LQP} = 10I_{QP}, I_{QP} = \frac{2}{12 + 10 + 0} = \frac{2}{25}A$$

$$p.d_{LQP} = 10 \times \frac{2}{25} = \frac{4}{5} V$$

$$p.d/_{cm} = K = \frac{4}{5} \div 100 = \frac{4}{500} Vcm^{-1}$$

$$p.d_{62.5cm} = \left(\frac{4 \times 62.5}{500}\right) = 0.5V$$

At balance length $\mathrm{p.d_{62.5cm}} = \mathrm{E_1}$

$\mathrm{E_1} = 0.5\mathrm{V}$ **2mks**

(**ii**) with $\mathrm{S_1}$ and $\mathrm{S_2}$ closed $\mathrm{LQT} = 10\mathrm{cm}$

$$\mathrm{I'QP} = \frac{2}{10} = \frac{1}{5}\mathrm{A}$$

$$\mathrm{K'} = \left(10 \times \frac{1}{5}\right) \div 100 = \frac{1}{50}\mathrm{Vcm^{-1}}$$

$$\mathrm{p.d_{10cm}} = \frac{1}{50} \times 10 = \frac{1}{5}\mathrm{V}$$

for the lower crcuit

$$\mathrm{p.d_r} = \mathrm{I_r.r}$$

$$= \left(\frac{0.5}{5+\mathrm{r}}\right)5, \text{at balance lenth } \mathrm{p.d_{10cm}} = \mathrm{p.dr}$$

$\frac{0.5\times5}{5+\mathrm{r_1}} = \frac{1}{5}$, $\mathrm{r_1} = (0.5 \times 25) - 5 = 7.5\Omega$ **2mks**

$$\text{(iii) } \mathrm{p.d_{QT}} = \frac{4}{500} \times \mathrm{QT}\ \mathrm{p.d_r} = \frac{0.5 \times 5}{5 + 7.5} = 0.2\mathrm{V}$$

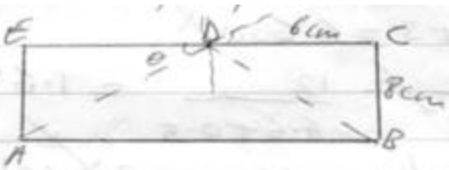
$$\text{at balance length } \mathrm{p.d_{QT}} = \mathrm{p.d_r}\ \frac{4 \times \mathrm{QT}}{500} = 0.2$$

$$\mathrm{QT} = \frac{0.2 \times 500}{4}$$

$\mathrm{QT} = 25\mathrm{cm}$ **3mks**

10. (a) (i) The force between two point charged is directly proportional to the product of the magnitude of the charges and inversely proportional to the square of their separation. **1mk**

(ii)



$\overline{DB} = \sqrt{8^2+6^2}$

$\overline{DB} = 10cm = AD$

$\theta = \tan^{-1}\left(\frac{8}{6}\right) = 53.1^\circ$

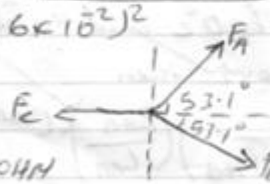
Using $F = \frac{kQ_1Q_2}{r^2}$

$F_A = \frac{9\times10^{9}\times 7.9\times10^{-6}\times 2.5\times10^{-6}}{(10\times10^{-2})^2} = 17.78N$

$F_B = \frac{9\times10^{9}\times 3.4\times10^{-6}\times 2.5\times10^{-6}}{(10\times10^{-2})^2} = 7.65N$

06

$F_C = \frac{9\times10^{9}\times 5.4\times10^{-6}\times 2.5\times10^{-6}}{(6\times10^{-2})^2} = 33.75N$



Resolving

$F_V = 17.78\sin53.1 + 0 - 7.65\sin53.1$

$F_V = 8.04N$

$F_H = 17.78\cos53.1 - 33.75 + 7.65\cos53.1$

$F_H = -18.48N$

$F_R = \sqrt{8.04^2+18.48^2} = 20.15N$, $\alpha = \tan^{-1}\left(\frac{8.04}{18.48}\right) = 23.5^\circ$

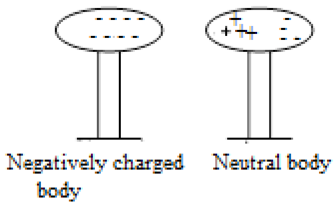
⇒ the force is 20.15N at 23.5° to the horizontal.

b) (i)

– A positively charged rod is brought near a conductor to be charged.
- positive charges are repelled to the far end and negative charges are attracted to the near end.
- when an earth connection is momentarily made at the far end, electrons from the earth, neutralise the positive charge there.
- when the earth connection is broken and the body taken away, the body is left with a negative charge.

(ii)

When a neutral conductor (i.e. with positive and negative charges equal in number) is brought near negatively charged material as demonstrated below,



Negative charges on the neutral conductor will be repelled to the remote end of the conductor; leaving positive charges on the side close to the charged body. This creates an electric field opposite to that of the charged material, hence reducing the potential of the material.

(iii)

A charged electroscope of known charge is used. The charged body is brought near the brass cap of the electroscope. Increased divergence of the leaf implies that the charged body and the electroscope have similar charges, while, a fall on the leaf implies that the charged body has an opposite charge to the electroscope. When divergence remains the same, then the body is not charge.

c)

The pointed electrode, E_1 is connected to a positive terminal of an extra high tension supply. Due to the pointed surfaces of the electrode, E_1 a very high electric field intensity is set up which causes the air around it to be ionised. The negative charges drift to the earth while positive ions are repelled to the silk belt which takes them near electrode E_2 causing ionisation of air around due to high electric field intensity. Negative charges are repelled to the top of the silk belt and discharged before passing over the pulley. The process continues as the sphere gain an increase in magnitude of charges on its surface and the electric potential on the surface grows.

05

End