MARKING GUIDE; UACE 2019
PHYSICS PAPER 2 (P510/2)

UGANDA NATIONAL EXAMINATIONS BOARD
NOVEMBER - DECEMBER, 2018

Page 2

UACE

Candidate's Name ....

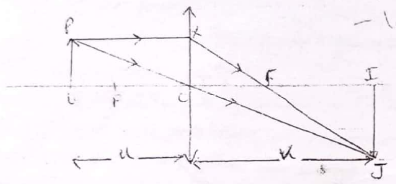
Signature .... Random No.

Subject .... Paper code ..../...... Personal Number

Do not write in this margin

Theoretical considerations:
- correct diagram & rays with arrows
- lines with arrows
- labels ✓✓

1 (c)(i)



From the ray diagram above, IJ is the image of OP.
Triangle PCO is similar to triangle CIJ, such that

$$\frac{OC}{CI} = \frac{OP}{IJ} \checkmark$$

hence $\frac{u}{v} = \frac{OP}{IJ}$

Likewise, triangle CXF is similar to triangle FIJ such that

$$\frac{CX}{IJ} = \frac{CF}{FI} \checkmark$$

but $CX = OP$, $CF = f$
and $FI = v - f$.

$$\Rightarrow \frac{OP}{IJ} = \frac{f}{v-f}$$

$$\therefore \frac{f}{v-f} = \frac{u}{v} \checkmark\checkmark$$

$$\Rightarrow fv = uv - uf$$

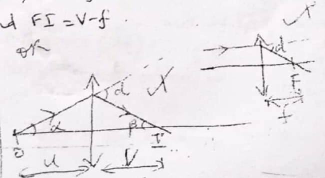
or $fv + uf = uv$

dividing through by uvf

$$\frac{fv}{uvf} + \frac{uf}{uvf} = \frac{uv}{uvf}$$

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

or



$d = \alpha + \beta$ ✓, for small angles
α, β measured in radians ✓

$\alpha \approx \tan\alpha = h/u$, $\beta \approx \tan\beta = h/v$ ✓ (4)

$\Rightarrow d = h/u + h/v$

For a small angle d produced by refraction, $d \approx \tan d = h/f$ ✓

$\therefore h/f = h/u + h/v$ ✓

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

54

copies

UACE

Do not write in this margin

UGANDA NATIONAL EXAMINATIONS BOARD
UGANDA ADVANCED CERTIFICATE OF EDUCATION
NOVEMBER - DECEMBER, 2018

DO NOT WRITE YOUR SCHOOL/CENTRE NAME OR NUMBER ANYWHERE IN THIS BOOKLET

Candidate's Name ..... PHYSICS P510/2

Signature ..... MARKING GUIDE UACE 2019. Random No.

Subject .... Paper code ..../...... Personal Number

READ THE INSTRUCTIONS BELOW CAREFULLY BEFORE USING THE ANSWER BOOKLET.

1. Use a blue or black ink ball pen. Work in pencil, other than graphs and drawings, will not be marked.
2. List the question numbers, in the order attempted, in the left-hand column of the boxes opposite. Do not list the multiple choice questions.
3. Write your answers on both sides of each sheet.
4. Do your rough work in this answer booklet. Cross through any work you do not want marked.
5. Do not fold, dismantle or tear any part of the answer booklet. Do not accept an answer booklet with missing pages. Folding, dismantling or tearing of the answer booklet is a malpractice and shall lead to cancellation of results. All work must be handed in.
6. Check that you have written the information required on each additional answer booklet used. Tie all the booklets used together.
7. Do not share your work with another candidate or expose your work such that another candidate can copy from it. Sharing or exposing your work may lead to cancellation of results.
8. Answer only the number of questions as instructed on the question paper. Answers to extra questions will not be marked.

Question number attempted	For Examiners' use only: Mark	Examiners' initials
Total		

Write here the number of answer booklets you have used

(2)

UGANDA NATIONAL EXAMINATIONS BOARD
NOVEMBER - DECEMBER, 2018

Page 3

UACE

Do not write in this margin

Candidate's Name ....

Signature .... Random No.

Subject .... Paper code ..../...... Personal Number

(ii) - When the object is placed between the lens and the principal focus of the lens
- When the distance between the object and the screen is less than four times the focal length of the lens (4f). $d < 4f$ where d is dist btn O & screen (3)
- When the object is at principal focus.
- ~~when screen is btn lens and its principal focus.~~

(b) An illuminated object is placed infront of the tube and a screen is placed facing the opposite end of the tube. The position of the screen is adjusted until a sharp image of the object is formed on the screen. The position of the front part of the tube is marked S_1. The position of the ~~screen~~ tube is then adjusted until a sharp image is formed on the screen again. The position of the front part of the tube is again marked S_2. The distance S_1S_2 is measured, d, and also the separation of the object from the screen l, is ~~also~~ measured (5)

The focal length of the lens can be calculated from

$$f = \frac{l^2 - d^2}{4l}$$

Note ① When O is placed infront Lens instead of tube deny marks for marking S_1, S_2, measuring d; and final expression Tot $2\frac{1}{2}/05$

② If lens is moved instead of tube then he/she loses $2\frac{1}{2}$ marks ie S_1, S_2, dist d and final expression.

(c) Action of the convex lens.

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

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{24}$$

$$v = \frac{240}{14} = 17.14\text{cm}$$

(3)

UGANDA NATIONAL EXAMINATIONS BOARD
NOVEMBER - DECEMBER, 2018

Page 4

UACE

Do not write in this margin

Candidate's Name ....

Signature .... Random No.

Subject .... Paper code ..../...... Personal Number

Action of the Concave lens

$u = -(17.14 - x)$ where x is the separation of the lenses.

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

$$-\frac{1}{18} = \frac{-1}{(17.14 - x)} + \frac{1}{18.6}$$

$$-\frac{1}{18} - \frac{1}{18.6} = \frac{-1}{(17.14 - x)}$$

$$0.1093 = \frac{1}{(17.14 - x)}$$

$$17.14 - x = 9.1495$$

$$x = 7.99 \simeq 8\text{ cm}$$

Accept u = ... then convert ... later ...

OR $\frac{1}{-18} = \frac{1}{u} + \frac{1}{18.6}$

$u = -9.15\ldots$

separation $= 17.\ldots$

$= 7.9\ldots$

$\simeq 8\text{cm}$

Note If $u = +ve$ ... for u but ... X ... (5)

(ii) Magnification

$$M = m_1 \times m_2 = \frac{v_1}{u_1} \times \frac{v_2}{u_2}$$

$$= \frac{17.14}{24} \times \left(\frac{18.6}{17.14 - 8}\right)$$

$$= \frac{17.14}{24} \times \frac{18.6}{9.14}$$

$$= 1.45$$

(3)

20

4

UGANDA NATIONAL EXAMINATIONS BOARD
NOVEMBER - DECEMBER, 2018

UACE

Candidate's Name ....

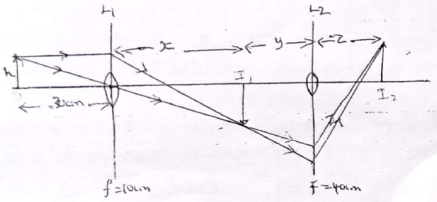
Signature .... Random No

Subject .... Paper code .... / .... Personal Number

Do not write in this margin

2 a(i) The incident ray, the normal and the refracted ray, at the point of incidence all lie in the same plane.
The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant for a given pair of media. (2)

(ii)



action of L1

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

$\frac{1}{10} = \frac{1}{30} + \frac{1}{x}$

$\frac{1}{x} = \frac{1}{10} - \frac{1}{30} = \frac{3-1}{30} = \frac{2}{30}$

$x = 15\text{cm}$

but $\frac{15}{30} \times \frac{z}{y} = 1$

$\frac{z}{y} = 2$

$\Rightarrow z = 2y$

Action of L2

$\frac{1}{40} = \frac{1}{y} + \frac{1}{z}$

$\frac{1}{40} = \frac{1}{y} + \frac{1}{2y}$ $\qquad y = 60\text{cm}$.

5

UGANDA NATIONAL EXAMINATIONS BOARD
NOVEMBER - DECEMBER, 2018

UACE

Do not write in this margin

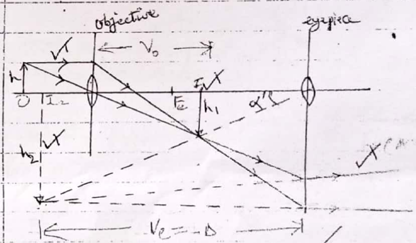
Candidate's Name ....

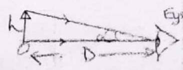
Signature .... Random No.

Subject .... Paper code .... / .... Personal Number

$\therefore$ Second lens should be placed at
$(x+y)$
$= (15+60) = 75\text{cm}$. from the first lens. (1)

b (i)





Magnifying power $M = \frac{\alpha'}{\alpha}$

$\tan\alpha = \frac{h}{D}$ and $\tan\alpha' = \frac{h_2}{D}$

for small angles, in radians $\tan\alpha \simeq \alpha$ $\quad \tan\alpha' \simeq \alpha'$

$\Rightarrow \alpha = \frac{h}{D} \qquad \alpha' = \frac{h_2}{D}$

$M = \frac{h_2}{h} = \frac{h_2}{h_1} \times \frac{h_1}{h}$

$\frac{h_2}{h_1} = \left(\frac{-D}{f_e} - 1\right) \quad \frac{h_1}{h} = \left(\frac{V_o}{f_o} - 1\right)$

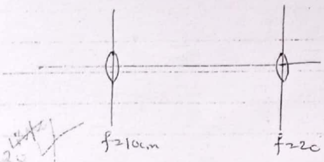
$\therefore M = \left(\frac{-D}{f_e} - 1\right)\left(\frac{V_o}{f_o} - 1\right)$

6/6

Candidate's Name ....
Signature .... Random No
Subject .... Paper code ...../..... Personal Number

Do not write in this margin

(ii)



$f=10cm$ $f=20$

$\frac{1}{20} = \frac{1}{u_e} + \frac{1}{v_e}$

from

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$, In eyepiece for normal adjustment

$\frac{1}{20} = \frac{1}{u} - \frac{1}{25}$

$\frac{1}{u} = \frac{1}{20} + \frac{1}{25} = \frac{25+20}{20\times25}$

$u_e = 11.1cm$

$\Rightarrow V_o = 8.9\ cm$

$M = \left(\frac{-D}{f} - 1\right)\left(\frac{V_o}{f_o} - 1\right)$

$\therefore M = \left(-\frac{25}{20} - 1\right)\left(\frac{8.9}{10} - 1\right)$

$M = 0.2475$

$M = -\left(\frac{D}{f_e} + 1\right)\left(\frac{V_o}{f_o} - 1\right)$

$= -\left(\frac{25}{20} + 1\right)\left(\frac{8.9}{10} - 1\right)$

$= 0.2475$

(3)

(C) (i) Total internal reflection is a phenomenon that occurs when all incident light is reflected back into the same medium when the angle of incidence exceeds the critical angle and light is moving from a denser to a less dense medium. (1)

(ii) Critical angle is the angle of incidence in a denser medium for which the angle of refraction in a less dense medium is 90°. (1)

(d) When light from the sun is incident on the rain drops, it is refracted and dispersed in different directions. The eye at a given position receives one colour of light from each direction thus showing a spectrum of colours. (2)

20

Candidate's Name ....
Signature .... Random No
Subject .... Paper code ...../..... Personal Number

QUESTION 3

3(a) When two light waves meet, they superpose. Where the path difference is an integral multiple of full wave length, reinforcement takes place forming a bright fringe. Where the path difference is an odd multiple of half a wave length, cancellation takes place resulting into a dark fringe.
If sources are coherent, permanent alternate regions of bright and dark fringes are formed and are called interference patterns. Thus interference has occured. (03)

(b) To produce observable fringes, the waves should have constant phase relationship.
The amplitudes of the waves should also be equal or nearly equal.
Since emission of light is always sponteneous, the above conditions are only possible when the source is the same. (03)

(8)

Do not write in this margin

Candidate's Name ....
Signature .... Random No.
Subject .... Paper code ..../..... Personal Number

(c)(i) $a = 1.2mm = 1.2 \times 10^{-3} m$

$D = 18cm = 0.18m$

$y = \frac{2.5 \times 10^{-3}}{30} = 8.3 \times 10^{-5} m$

From $\lambda = \frac{ay}{D} = \frac{1.2 \times 10^{-3} \times 8.3 \times 10^{-5}}{0.18}$

$= 5.533 \times 10^{-7}$ m

(04mks)

(ii) As the separation of the screen from the slits is increased, the fringes become broader and less distinct (less intense) less bright.

(02mks)

d(i) $d \sin\theta = n\lambda$

where d = ~~separation~~ slit width

λ = wave length

θ = angular position

Defn of λ, d, θ any (2) @ 1mk

(02mks)

~~(ii) for the first wave~~ $d\sin\theta = n\lambda$ Not on syllabus.

(9)

Do not write in this margin

Candidate's Name ....
Signature .... Random No.
Subject .... Paper code ..../..... Personal Number

(ii) For the first wave length

$d \sin\theta = n\lambda$

$\sin\theta_2 = \frac{2\lambda}{d}$

$= \frac{2 \times 5.4 \times 10^{-7}}{2 \times 10^{-6}}$

$= 0.54$

$\therefore \theta_2 = 32.7^o$

For the second wavelength

$\sin\theta_2' = \frac{2\lambda'}{d}$

$= \frac{2 \times 5.7 \times 10^{-7}}{2 \times 10^{-6}}$

$= \cancel{0.54}\ 0.57$

$\theta_2' = 34.8^o$

$\therefore$ angular sep $= 34.8 - 32.7$

$= 2.1^o$

(04marks)

Now the way it is in the paper

$\sin\theta_2 = \frac{2 \times 5.4 \times 10^{-7}}{2 \times 10^{6}}$

$= 0.54 \times 10^{-12}$

$\theta_2 \approx 3.09 \times 10^{-11}$

For 2^{nd} λ

$\sin\theta_2' = \frac{2 \times 5.7 \times 10^{-7}}{2 \times 10^{-6}}$

$\theta_2' = 3.27 \times 10^{-11}$

Angular separation $= 0.18 \times 10^{-11}$

(iii) Violet will be nearer to the central maximum while red will be further off.

(02marks)

20

(10)

QN 4

(a) (i) A transverse wave is a wave in which the particles vibrate perpendicular to the direction of propagation ~~of the wave~~.

(ii). A longitudinal wave is a wave in which the particles vibrate along the direction of propagation ~~of the wave~~.

Note: statements shd not imply that the wave vibrates / oscillates Eg whose vibrations ✗

02

(b) $y = 0.01 \sin 2\pi (2t - 0.01x)$

Compare with

$y = a \sin(2\pi ft - \frac{2\pi}{\lambda}x)$

(i) $2\pi f = 4\pi$

$\Rightarrow f = 2Hz$

02

(ii) $\frac{2\pi}{\lambda} = 2\pi \times 0.01$

$\lambda = 100m$

$v = f\lambda$

$= 2 \times 100$

$v = 200 ms^{-1}$

03

(11)

(iii) Phase difference $\Delta\phi = \frac{2\pi}{\lambda} \cdot \Delta x$

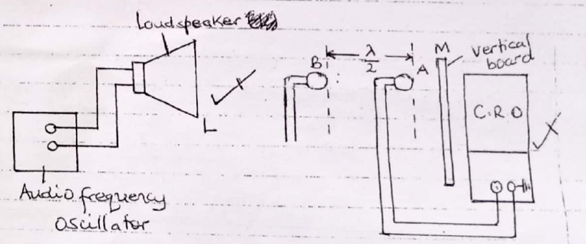
$= \frac{2\pi}{100} \times 50$

$= \pi$ radians

$= 180°$

02

(c)



The microphone is positioned infront of board M and connected to the Y-plates of the C.R.O. The microphone is moved from M towards L until the amplitude of the waveform increases to maximum. This position is noted A. The microphone is moved further towards L until the amplitude again increases to maximum. This position is again noted B. The distance between A and B is measured. The procedure is repeated and the average

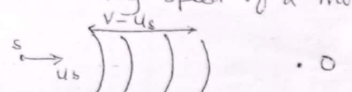
(12)

distance, d, between successive maxima is obtained. The speed of sound in air is then obtained from $v = 2df$, where f = frequency of a note from the loud speaker. (06)

(d)(i)
- Measurement of speed of a star.
- Determining the direction of motion of a star.
- Measurement of plasma temperatures.
- determining speed of a moving car.

Any two (02)

(ii)



The f' waves sent out by the source occupy a distance $V-U_s$. The apparent wavelength of the waves $\lambda' = \frac{V-U_s}{f'}$, where V is the velocity of waves relative to observer. (03)

The apparent frequency $f = \frac{V}{\lambda'} = \frac{V}{\frac{V-U_s}{f'}}$

$\therefore f = \left(\frac{V}{V-U_s}\right)f'$. Accept $f' = \frac{V}{\lambda'} = \left(\frac{V}{V-U_s}\right)f$

ALTERNATIVE FOR (C)

A long tube is filled with water. A vibrating tuning fork of known frequency f is held over the mouth of the tube. Water is gradually removed until a loud sound is heard. The length L_1 of air column is measured. Water is allowed out until a loud sound is heard again. The length l_2 of air column is measured. $V = 2f(l_2 - l_1)$.

OR.

The tube is filled with water and the expt repeated with other tuning forks. The lengths, l, of air column and corresponding frequencies are measured. Tabulate including values of $\frac{1}{f}$. A graph of l against $\frac{1}{f}$ is plotted. Slope, S, calculated. $V = 4S$

OR KUNDT'S TUBE

Candidate's Name ....
Signature .... Random No.
Subject .... Paper code ..... /..... Personal Number

(13)

OR $F = Bqu\sin\alpha$, but $q = It$, $u = \frac{L}{t}$

$F = B(It)\left(\frac{L}{t}\right)\sin\alpha$

$= BIL\sin\alpha$

OR $I = q/t$, but $t = L/u$ $\therefore I = \frac{qu}{L}$

$\Rightarrow u = \frac{IL}{q}$

$\therefore F = Bq \cdot \frac{IL}{q}\sin\alpha = BIL\sin\alpha$

5a(i) $F = Bqu\sin\alpha$ (1)

(ii) $F = Bqu\sin\alpha$

but drift velocity $u = \frac{I}{neA}$

Total free charges flowing per second through the conductor

$q = neAL$

$\therefore F = B \times neAL \times \frac{I}{neA}\sin\alpha$

$= BIL\sin\alpha$

where L is the length of the conductor

OR $I = q/t$, $u = L/t$

$\therefore \frac{L}{t} neA = \frac{q}{t}$

$q = neAL$

$F = B \cdot neAL \cdot \frac{I}{neA}\sin\alpha$ (3)

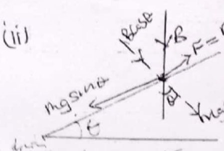
$= BIL\sin\alpha$

b(i) - Current flows in the bar in the direction BA

- ~~Plea~~ From Fleming's left hand rule, the bar BA will experience a magnetic force. (3)

- Thus the bar AB will move towards the Right.

(ii)



When tilted the component of B perpendicular to the current $= B\cos\theta$

for equilibrium $mg\sin\theta = BIL\cos\theta$

$\tan\theta = BIL/mg$

$\tan\theta = \frac{0.1 \times 4 \times 5 \times 10^{-2}}{5 \times 10^{-3} \times 9.81} = 0.4$ (4)

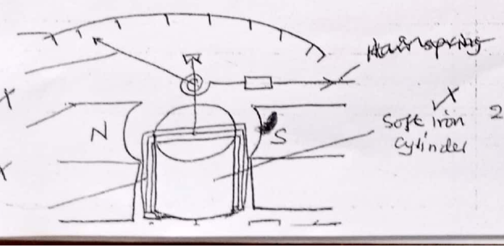
$\theta = \tan^{-1}(0.4) = 21.8°$

down the plane $F = mg\sin\theta$

force up the plane $F = BIL\cos\theta$

$mg\sin\theta = BIL\cos\theta$

c (i)



$2\frac{1}{2}$

Candidate's Name ....
Signature .... Random No.
Subject .... Paper code ..... /..... Personal Number

- Current to be measured is passed through the coil.
- The coil experiences magnetic torque, $\tau = BAnI$, and rotates
- This causes the springs to twist thus developing an opposing torque $\tau = K\theta$ where θ is the angle of turn. $3\frac{1}{2}$
- The rotation stops when $K\theta = BAnI$

Thus $\theta = \frac{NBA}{K} \cdot I$ since N, B, A and K are constant

$\theta \propto I$

(ii) Current sensitivity, $\frac{\theta}{I} = \frac{BAN}{K}$

Current sensitivity is large for:- large magnetic flux density B, large number of turns N of the coil, large area of the coil A and small torsional constant K of the hair spring. 3

(Any 3 factors @ $\frac{1}{2}$mk, effect $\frac{1}{2}$mk)

Candidate's Name ....

Signature .... Random No

Subject .... Paper code ..... / ..... Personal Number

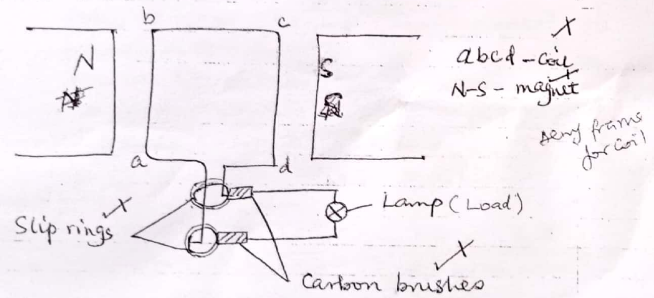
Do not write in this margin

Question 6

(a) - The magnitude of the induced e.m.f in a coil (conductor) is directly proportional to the rate of change of magnetic flux linkage ~~linking~~ with the coil (conductor). (01)

- The direction of the induced current (e.m.f) is always in the direction such that it (or tends to oppose) opposes the change causing it. (01)

(b)(i)



The coil is rotated at uniform angular speed. As side ab moves up and cd down e.m.f is induced in the coil in the direction abcd. After the vertical position, as side ab moves down and cd up the emf is induced in the coil reverses. Since the slip rings are permanently in contact with particular carbon brushes, current also reverses in the external circuit. (04)

Do not write in this margin

Candidate's Name ....

Signature .... Random No.

Subject .... Paper code ..... / ..... Personal Number

(b)(ii) - Eddy currents losses minimized by laminating the armature. (02)

- I^2R losses minimized by the use of wires of low resistance in the windings

Any two

- Friction losses minimized by lubricating the (moving) rubbing parts.

(C)(i) $N = 20$ $\omega = 50 \text{ rad s}^{-1}$ $B = 30\times10^{-3}T$, $r = 8.0\times10^{-2}$ m

$E = NAB\omega$

$= 20 \times 3.14 \times (8\times10^{-2})^2 \times 30\times10^{-3} \times 50$

$= 0.603$ V

but $E_{r.m.s} = \frac{E_0}{\sqrt{2}} = \frac{0.603}{\sqrt{2}}$ (03)

$= 0.426$ V

(ii) $P = I^2R$ or $\frac{V_{r.m.s}^2}{R}$

$P = \frac{0.426^2}{10}$ (02)

$= 0.018$ W

(d)(i) The capacitor is continuously charging and discharging. This causes continuous charge flow (current) in the bulb. (01)

(ii) When the capacitance is reduced, the reactance increases and therefore the charging and discharging current decreases. The bulb dims or may go off. (02)

e.(i) When the switch is broken, the magnetic flux linking the coil collapses. A large e.m.f is induced between the contacts creating high electric field intensity due which ionises air there. The ions meet and neutralise violently producing sparks. (2)

(ii) Magnetic (flux) field linking the shell changes inducing eddy currents in it. The magnetic field due to the eddy currents opposes motion of the bar magnet thus causing retardation. (2)

20

7(a)(i) Peak value is the maximum value of a.c. (01)

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

(b) Instantaneous power $= I^2R$

$= (I_0 \sin \omega t)^2 R$

$= I_0^2 \sin^2\omega t\, R$

$\langle P \rangle = \langle I_0^2 R \sin^2\omega t \rangle$

$= I_0^2 R \langle \sin^2\omega t \rangle$ but $\langle \sin^2 \omega t\rangle = \frac{1}{2}$

$\therefore \langle P \rangle = \frac{I_0^2 R}{2}$

Also, for direct current I_d, $P = I_d^2 R$ or $P = I_{rms}^2 R$.

$\therefore I_d^2 R = \frac{I_0^2 R}{2}$

$I_d^2 = \frac{I_0^2}{2}$

$I_d = \frac{I_0}{\sqrt{2}}$ but $I_d = I_{rms}$

$\therefore I_{rms} = \frac{I_0}{\sqrt{2}}$ (03)

(c) $I_{rms}^2 Rt = mc\Delta\theta \Leftrightarrow \frac{I_0^2}{2} Rt = mc\Delta\theta$

$I_0 = \sqrt{\frac{2mc\Delta\theta}{Rt}}$

$= \sqrt{\frac{2 \times 0.2 \times 4200 \times 1}{4 \times 60}}$ $= 2.646\text{A}$ (03)

OR $I_{rms}^2 Rt = mc\Delta\theta$

$I_{rms} = \sqrt{\ldots}$

$= 1.87\text{A}$

$I_0 = \sqrt{2} \times 1.87$

Candidate's Name .... circuit

Signature .... LCR Random No.

Subject .... Paper code ...../..... Personal Number

(d) Is when impedance is minimum and current is maximum in the circuit. OR Is when $Z = R$ & I is maximum, $(X_L = X_C)$

(e)(i) Initially, the current in the circuit is low and the lamp does not glow. give ($\frac{1}{2}$mk)

As the frequency is increased, the impedance decreases and the current grows.

Near the resonant frequency, the lamp will start to glow as the impedance decreases even more.

At the resonant frequency, the impedance is minimum, and the lamp will be at its brightest.

Increasing the frequency more will increase the impedance and the lamp will become less bright. (or goes off) (03)

(ii) At resonant frequency,

$$f_0 = \frac{1}{2\pi} \cdot \frac{1}{\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.4 \times 0.4 \times 10^{-6}}}$$

$$= \frac{10^3}{2\pi \times 0.4} = 397.9 \text{ Hz} \quad (03)$$

$$\approx 398 \text{ Hz}$$

(iii) Voltage across a capacitor, $V_C = I X_C$, apm

$$= I \times \frac{1}{2\pi f C}$$

$$Z = \sqrt{(X_L - X_C)^2 + R^2} = 10\Omega$$

$$\text{but } I = \frac{V}{Z} = \frac{V}{R} = \frac{0.01}{10} = 0.001 \text{A}$$

$$\therefore V_C = \frac{1 \times 10^{-3} \times 10^{6}}{2\pi \times 397.9 \times 0.4}$$

$$= 1\text{V} \quad (03)$$

Candidate's Name ....

Signature .... Random No.

Subject .... Paper code ...../..... Personal Number

7(f) The average power ~~for~~ a capacitor with an a.c is zero over a complete cycle since during one quarter cycle, the component takes power from the source and in the next quarter cycle, it returns it. Only the resistor absorbs power during the entire cycle. (02)

20

7(f) - In one quarter cycle as the capacitor charges power is transferred from the source to the capacitor.
- In the next quarter cycle as the capacitor discharges power is returned to the source. (02)

(d) ~~Deny~~ Defn of resonance freq: Resonance frequency: The frequency of alternating voltage ~~for~~ which impedance is minimum and the power output is maximum.

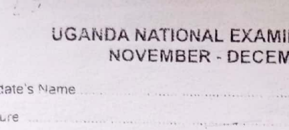
Candidate's Name ....
Signature .... Random No
Subject .... Paper code ..../.... Personal Number

QUESTION 8

8(a) Coulomb's law of electrostatics states that the force between two point charges is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between the charges. ✓ (1)

Being force b/n charged bodies

b(i)

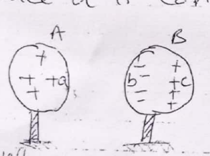


- Negative rod brought near neutral sphere
- Distribution of charge
- sphere is earthed in presence of rod
- Electrons flow to earth; sphere is +ve at zero potential.

A negatively charged rod is brought close to a conducting sphere which is earthed. (3)

Electrons driven from the sphere to the earth, leaving the sphere positively charged. But it is at zero potential since it is earthed. ✓

(ii)



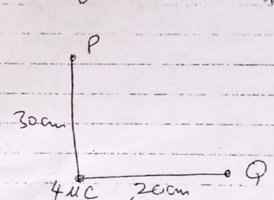
When a positively charged insulated sphere A is placed close to a neutral insulated sphere B, negative charges are attracted to the side close to A, ✓

Candidate's Name ....
Signature .... Random No
Subject .... Paper code ..../.... Personal Number

8 positive charges. Potential at A, $V = V_a + V_b + V_c$. Since V_b and V_c are of opposite signs and c is further from A, the negative charges at b effectively reduces the ~~pot~~ potential at a. ✓ (2)

OR Since -ve potential > +ve potential then V_a reduces

c(i)



$V = \frac{Q}{4\pi\varepsilon_0 r}$ ✓, $V_Q = \frac{9\times10^9 \times 4\times10^{-6}}{0.20} = 1.8\times10^5 V$

$V_P = \frac{9\times10^9 \times 4\times10^{-6}}{0.30} = 1.2\times10^5 V$ (5)

$P.d. = V_Q - V_P = \cancel{(1.8-1.2)\times10^5}$

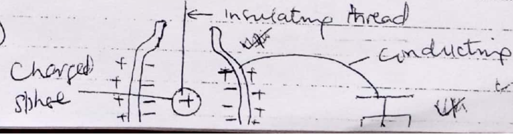
$= (1.8-1.2)\times10^5$

$= 6.0\times10^4 V$ ✓

(ii) $W = VQ_q = 1.0\times10^{-6} \times 1.8\times10^5$ ✓

$= 0.18 J$ ✓ (3)

(d)



Candidate's Name ....
Signature .... Random No.
Subject .... Paper code ..../..... Personal Number

A positively charged metal sphere is lowered into a metal can connected to the cap of a neutral gold leaf electroscope. The leaf of the electroscope is seen to diverge. The sphere is withdrawn from the can and the leaf of the electroscope is seen to collapse.
The sphere is lowered into the can again, the leaf of the electroscope diverges by the same amount.
The sphere is then made to touch the inner surface of the can and then withdrawn. The divergence remains the same.
The sphere is tested for charge and is is found to be completely discharged.
Hence there is no charge inside the metal can, but since the electroscope remains diverged, charge exists on the outside surface of the can.

(5)

Candidate's Name ....
Signature .... Random No.
Subject .... Paper code ..../..... Personal Number

Q.9 a(i) Emf of a battery is energy supplied by the battery to drive 1C of charge round a complete circuit. (1)

or: Pd across terminals of battery on open circuit

or: Ratio of power generated by battery to current delivered

a(ii) Moisture in the room contains ions these allow electric conductions between the terminals of the battery and therefore the emf of the battery reduces (2)

(b) Effective internal resistance $= \frac{0.8 \times 0.8}{0.8 + 0.8}$

$= 0.4\,\Omega$

Effective resistance in the external circuit

$= \frac{3 \times 3}{3+3} = \frac{9}{6} = 1.5\,\Omega$

Total resistance $R_T = 1.5 + 0.4 = 1.9\,\Omega$

Current supplied $= \frac{E}{R_T} = \frac{1.5}{1.9}$ — for $E = 1.5V$

$= 0.789\ A$ (4)

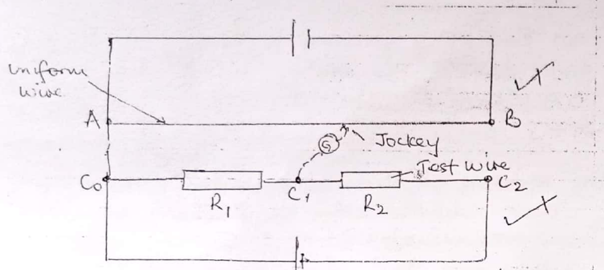
Do not write in this margin

Candidate's Name ....

Signature .... Random No.

Subject .... Paper code ..../...... Personal Number

(c)



The circuit is connected as above. R_2 is test resistance wire while R_1 is known resistance. A is connected to C_0 and the galvanometer is connected to C_1. The jockey is tapped at different points along uniform wire AB until the galvanometer shows no deflection. The balance length L_1 from A is recorded.
A is now disconnected from C_0 and the galvanometer is disconnected from C_1. A is connected to C_1 and the galvanometer to C_2. The jockey is tapped at different points along AB until the galvanometer shows no deflection. (or the experiment is repeated). The balance length L_2 from A is again recorded.
The resistance R_2 is now calculated from

$$R_2 = \frac{L_2}{L_1} \times R_1$$

(6)

Do not write in this margin

Candidate's Name ....

Signature .... Random No

Subject ....X.......... Paper code ..../...... Personal Number

(d)(i) $E_x = \frac{3.4}{100} \times 53 = 1.8V$, K_1 closed p.d/cm $= \frac{3.4}{1..}$

(ii) $\therefore 1.8 = I_d \times 2 + I_d \times \frac{4}{100} \times l$, K_1 open, p.d/cm $= \frac{4}{..}$

$$\left(1.8 - \frac{3.4}{6} \times 2\right) = \frac{3.4}{6} \times \frac{100}{4} \times l$$

$$\therefore \quad L = 29.4 \text{ cm}$$

(3)

(ii) when both k_1 and k_2 are closed

$$I_t \times S = I_d \times \frac{4}{100} \times 44.1$$

$$= \frac{3.4}{100} \times 44.1$$

$$= 1.5 \quad \text{——— (1)}$$

~~when K_1 is closed and K_2 is open~~

$$I_t (5+r) = 1.8 \quad \text{——— (2)}$$

$$\frac{(2)}{(1)} \quad \frac{(5+r)}{5} = \frac{1.8}{1.5}$$

$$r = \frac{1.8}{1.5} \times 5 - 5$$

$$= 1.0\Omega$$

(4)

OR

$r = R_s\left(\frac{L}{l} - 1\right)$

$r = 5\left(\frac{53}{44.1} - 1\right)$

$r = 1.0\Omega$

OR

$\left(\frac{E_x}{5+r}\right) \times 5 = \frac{3.4}{100} \times 44.1$

$\left(\frac{1.8}{5+r}\right) \times 5 = \frac{3.4}{100} \times 44.1$

$r = 1.0\Omega$

OR

$5 I_t = 1.5 \Rightarrow I_t = 0.3A$

$\ldots = 0.3(5+r) \Rightarrow r = 1\Omega$ (..)

TOTAL 20

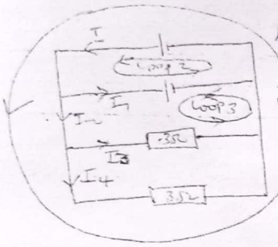
Candidate's Name ....

Signature .... Random No.

Subject .... Paper code ..../.... Personal Number

ALTERNATIVES

(b)



Loop1

$I_2 = I - I_1$, $I_2 = I_3 + I_4$

$\therefore I_4 = I - I_1 - I_3$

Loop1

$1.5 = 0.8I + 3(I - I_1 - I_3)$

$1.5 = 3.8I - 3I_1 - 3I_3$ —— (1)

Loop2

$1.5 - 1.5 = 0.8I + 0.8I_1$ —— (2)

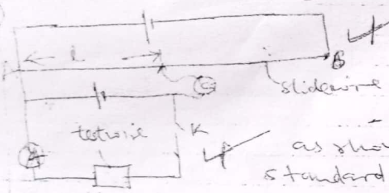
$I = -I_1$

$1.5 = -0.8I_1 + 3I_3$ —— (3)

$I = 0.3947A$, $I_3 = 0.3947A$ $\therefore I_2 = 0.789A$

(04)

(c)



- The circuit is connected as shown above. E_s is a standard emf. With switch K open, the jockey J is tapped along the slide wire until G shows no deflection. The balance length l_s is measured. Switch K is closed and the ammeter reading I is recorded. The jockey is tapped along the slide wire until G shows no deflection. The balance length, l is measured. The resistance R of the test wire is calculated from $R = \frac{E_s l}{I l_s}$.

(06)

(27)

10a(ii) Chemical → electrical → electrostatic PE → heat

Candidate's Name ....

Signature .... Random No.

Subject .... Paper code ..../.... Personal Number

Q10a(i) A ~~farad~~ is the capacitance of the capacitor if a p.d of one volt is across it when it carries a charge of 1C (1)

(a)(ii) Chemical energy in the cell.

↓

Electrical energy in the wires

↓

Electrostatic potential energy when the charge is being stored on the capacitor plates + Heat (2)

Summary: Chemical energy → electrical energy → Electrostatic energy + Heat

b(i) Dielectric Constant is the ratio of permittivity of the material to the permittivity of free space. (1)

b(ii) let C_0 = capacitance without dielectric

C_1 = capacitance with a dielectric

Then $C_0 = \frac{Q}{V_0}$ and $C_1 = \frac{Q}{V_1}$

But $\varepsilon_r = \frac{C_1}{C_0} = \frac{V_0}{V_1} = \frac{100}{30}$

$\therefore \varepsilon_r = 3.33$ (3)

OR

$Q = 100C_0$

$Q = 30\varepsilon_r C_0$

$30C_0\varepsilon_r = 100C_0$

$\varepsilon_r = 3.33$

Candidate's Name ....

Signature .... Random No. ....

Subject .... Paper code .... / .... Personal Number ....

10(c)(i) Initial charge

$Q = C_1V_1 = 60\times10^{-6}\times120$

$= 72\times10^{-4}$ C

Final charge $= (C_1+C_2)V$

$= (60+20)\times10^{-6}V$

But initial charge = Final charge

$\Rightarrow 80\times10^{-6}V = 72\times10^{-4}$

$V = \frac{72\times10^{-4}}{80\times10^{-6}}$

$= 90$ V (3)

(ii) Initial energy stored

$= \frac{1}{2}C_1V_1^2$

$= \frac{1}{2}\times60\times10^{-6}\times120^2$

$= 0.432$ J

Final energy stored

$= \frac{1}{2}\times80\times10^{-6}\times90^2$

$= 0.324$ J

Energy difference

$= 0.432 - 0.324$

$= 0.108$ J

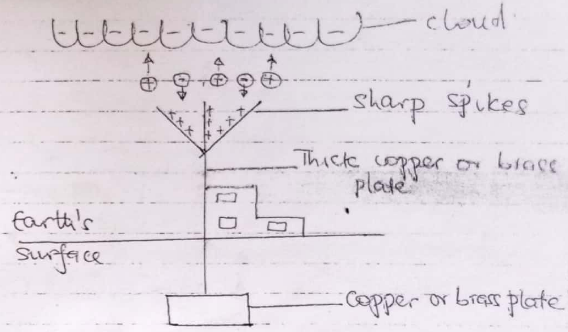
The energy difference is due to energy lost as heat in the connecting wires (5)

Candidate's Name ....

Signature .... Random No. ....

Subject .... Paper code .... / .... Personal Number ....

Q.10(d)



When a charged cloud passes over a lightning conductor, it induces opposite charge on the spikes of the conductor. The high charge density at spikes produces a high electric field intensity on the spikes to ionises air around it. The charge similar to those on the spikes is repelled to the cloud and neutralise charge on the cloud while those of opposite charge are attracted and are discharged at the spikes. [In this way the charge from the cloud is safely conducted to the ground.]

(5)

TOTAL 20