Name: MARKING SCHEME .... Index No: ....

232/2
PHYSICS (Theory)
PAPER 2

SIGNATURE: ....

DATE: ....

March/April 2013
2 hours

ALLIANCE GIRLS' HIGH SCHOOL

PRE-MOCK EXAMINATION

Instructions to candidates:

- This paper consists of two sections: **A** and **B.**
- Answer **ALL** the questions in section **A** and **B** in the spaces provided.
- **ALL** workings must be clearly shown.
- Mathematical tables and electronic calculations may be used.
- Take: Velocity of light in vacuum, $C = 3.0 \times 10^8$ m/s.
  electronic charge, $e = 1.6 \times 10^{-19}$ C.
  electron mass, $m = 9.1 \times 10^{-31}$ kg
  Planck's constant, $h = 6.63 \times 10^{-34}$ J.

For Examiner's use only

SECTION	QUESTION	MAXIMUM SCORE	CANDIDATE SCORE
A	1-12	25	
B	13	11	
	14	15	
	15	11	
	16	11	
	17	7	
	TOTAL SCORE	80	

This paper contains 14 printed pages. A candidate should check to ensure that all pages are printed as indicated

SECTION A (25 MARKS)

Answer ALL the questions in this section in the spaces provided after each question.

1. A ray of light is incident on a plane mirror at O as shown in **Figure 1**. The mirror is then rotated clockwise about O through an angle of 15^0 from position M_1 to position M_2.

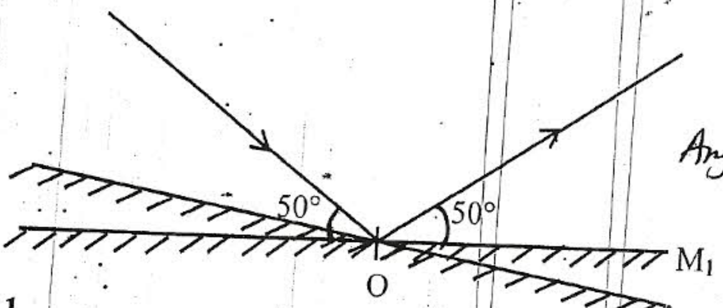

Figure 1

Alternative Working:
Angle $\theta = 2 \times i_{new}$
$= 2 \times (i_o + x)$
$= 2 \times (40 + 15)$
$= 2 \times 55°$
$= 110°$

Determine the angle between the incident ray and the final position of reflected ray after rotation. (1mk)

Angle θ = original $i + r$ + twice angle of rotation $= i_o + r_o + 2x$
$= 40° + 40° + 2 \times 15 = 80° + 30° = 110°$ ✓

2. A highly negatively charged rod is gradually brought close to the cap of a positively charged electroscope. It's observed that the leaf initially collapses and then diverges. Explain this observation. (2mks)

As the negative rod approaches the cap, electrons on the cap are repelled towards the plate and the leaf neutralizing positive charges hence the leaf falls. When -ve rod is very close to the cap more electrons are repelled to the plate and leaf making them more negative hence divergence. ✓

3. A wire has a resistance of 4 Ω. Determine the resistance of a wire of the same material which is three times as long but with half the diameter. (2mks)

$R = \frac{\rho L}{A}$ if $L_1 = 1$ m, $A_1 = 1$ m^2
then $4 = \frac{\rho \times 1}{1}$
Resistivity, $\rho = 4\ \Omega$m

$L_2 = 3$ m
$A_2 = \frac{1}{4}$ m^2
$R = \frac{\rho L}{A} = \frac{4 \times 3}{1/4}$ ✓
$= 4 \times 4 \times 3 = 48\Omega$ ✓

Note:
$A_1 = \pi\left(\frac{d}{2}\right)^2 = \frac{\pi d^2}{4}$
$A_2 = \pi\left(\frac{d}{2 \times 2}\right)^2 = \frac{\pi d^2}{16}$
$\frac{A_2}{A_1} = \frac{\frac{1}{16}\pi d^2}{\frac{1}{4}\pi d^2} = \frac{1}{16} \times 4$
$A_2 = \frac{1}{4} A_1$

Resistivity remains the same since it is the same material

Original Wire	New wire
R = 4	R = ?
L	L = 3L
D	D = D/2
r = D/2	r = D/4
	ρ = ρ

$\rho = \frac{RA}{L}$

$\frac{4 \times \pi D^2 / 4}{L} = \frac{R \times \pi D^2 / 16}{3L}$

$48\Omega = R$

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4. State **two** properties of cathode rays. (2mks)

- Travel in straight lines ✓
- Possess kinetic energy and momentum ✓
- Are deflected by electric and magnetic fields (since they have a negative charge)
- Cause fluorescence of some substances (eg. zinc sulphide)

Any 2 properties

5. **Figure 2** is a graph showing the relationship between attractive force, F of two magnetic materials, A and B with time, t when current is switched on. Draw on the same axes the graphs of attractive forces with time for the two materials when current is switched off. (2mks)

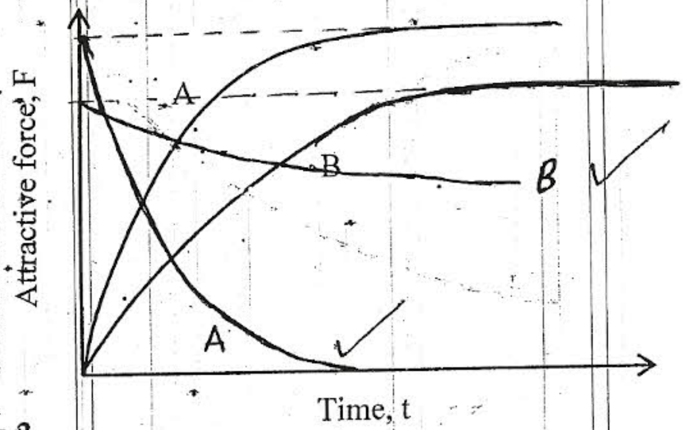

Figure 2

6. State one application of materials A given in question 5 above. (1mk)

- Making of electromagnets ✓
- Used as transformer cores
- Used for magnetic shielding/screening. Any one use.

7. A concave mirror of focal length 12 cm forms a virtual image of an object placed in front of it. If the distance between the object and the image is 32 cm, find the object distance from the mirror. (3mks)

$f = 12$ cm

$u + v = 32$

$u = 32 - v$

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

$\frac{1}{12} = \frac{1}{32-v} - \frac{1}{v}$ ✓

$\frac{1}{12} = \frac{v-(32-v)}{(32-v)v}$

$\frac{1}{12} = \frac{2v-32}{32v-v^2}$

$32v - v^2 = 24v - 384$

$v^2 - 8v - 384 = 0$ ✓

$P = 384$, $S = -8$ } $-24, 16$

$v^2 - 24v + 16v - 384 = 0$

$v(v-24) + 16(v-24) = 0$

$(v-24)(v+16) = 0$

$v = 24$ or -16 cm

$u = 32 - v$

$= 32 - 24$

$= 8$ cm ✓

OR

$f = 12$ cm

$u + v = 32$

$v = 32 - u$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{-v}$ — since virtual

$\frac{1}{12} = \frac{1}{u} - \frac{1}{32-u}$

$\frac{1}{12} = \frac{32-2u}{32u-u^2}$ ✓

$u^2 - 56u + 384 = 0$

$u = \frac{56 \pm \sqrt{1600}}{2}$

$u = \frac{56 - 40}{2}$

$u = \frac{16}{2}$

$= 8$ cm

/8

8. **Figure 3** shows the trace of a signal on the C.R.O.

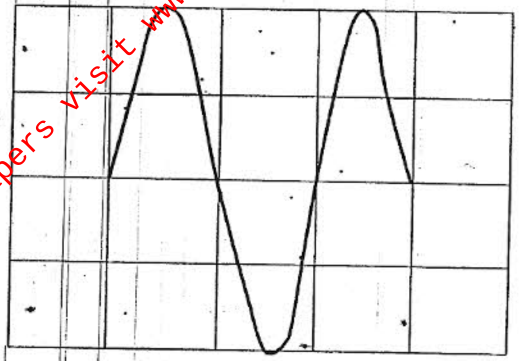

Figure 3

Given that the time base is set at 100 ms/div, determine the frequency of the signal. (3mks)

Period, $T = 2 \times 100 ms = 200 ms$ ✓

$= 0.2 s$

$f = \frac{1}{T} = \frac{1}{0.2}$ ✓

$= 5 Hz$ ✓

9. What is the main difference between X-rays and gamma rays? (1mk)

Gamma rays originate from energy changes in the nucleus of atoms while x-rays originate from energy changes associated with electron transition from higher energy to lower energy levels. ✓

10. Your home radio is tuned into a local radio station 184 km away. How many wavelengths is the radio station away from your receiver if the signal has a frequency of 750 KHz? (3mks)

$c = f\lambda$

$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{750000}$

$\lambda = 400 m$ ✓

$n\lambda = 184,000 m$

$n = \frac{184,000 m}{400 m}$ ✓

$n = 460$ wavelengths. ✓

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11. Define an electron-volt.

(1mk)

Electron-volt is the energy gained by an electron when accelerated by a potential difference of one volt.

12. **Figure 4** shows a circuit that is used to light a 3 V, 0.2 A bulb from a 12 V d.c. supply.

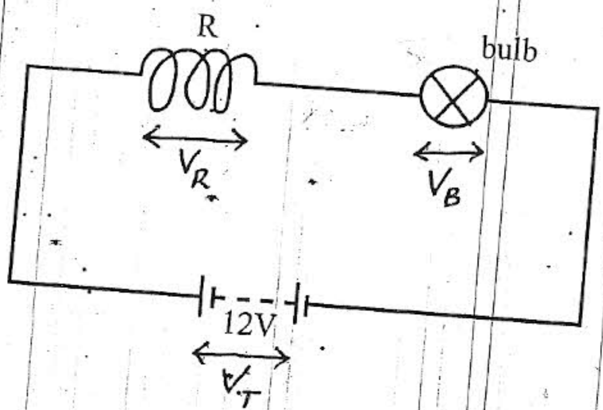

Figure 4

a) Determine the p.d. across the appliance R at the normal operation of the bulb. (1mk)

$V_R + V_B = V_T$

$V_R = 12 - 3 = 9V$

b) Determine the rate at which electrical energy is converted into heat energy in the appliance R.

(3mks)

Power = Rate of energy conversion

$P = IV$

$= 0.2 \times 9$

$= 1.8W$

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SECTION B (55 MARKS)

Answer All the questions in this section in the spaces provided after each question.

13 a) **Figure 5** shows an arrangement that can be used to determine the speed of sound in air.

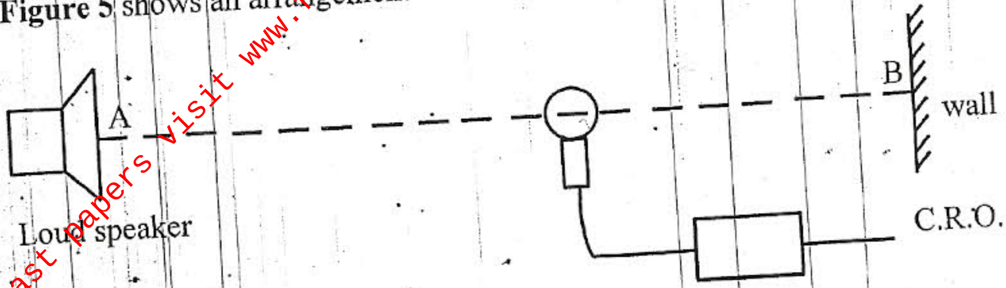
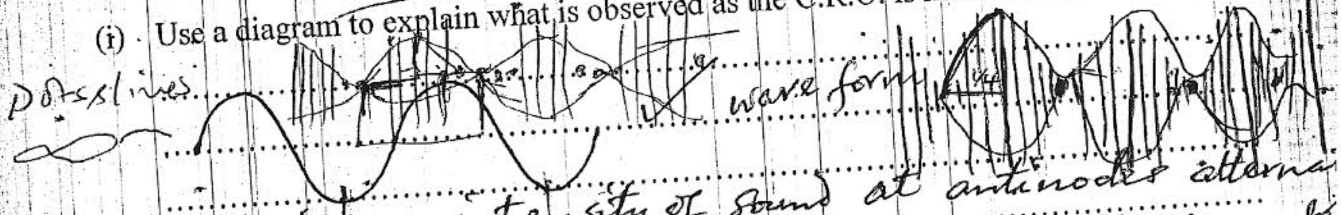


Figure 5

A microphone connected to a C.R.O. with its time-base off is moved along an imaginary line AB between the loudspeaker and the wall.

(i) Use a diagram to explain what is observed as the C.R.O. is moved from A to B. (2mks)



Maximum intensity of sound at antinodes alternates with minimum intensity of sound at the node between points A and B of stationary wave produced

(ii) If the frequency of the sound remitted by the loudspeaker is 1655 Hz and the distance between a minimum and the next maximum is 0.05 m, calculate the speed of sound in air. (3mks)

Distance between a node and next antinode $= \frac{\lambda}{4}$

$\frac{\lambda}{4} = 0.05$

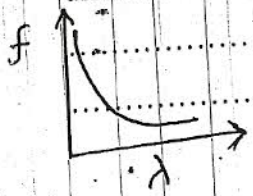
$\lambda = 0.05 \times 4 = 0.2\,m$

$V = f\lambda$

$= 1655 \times 0.2$

$= 331\,m/s$

(iii) If the frequency of the vibrating loudspeaker is decreased, what happens to the distance between two adjacent maximum? (1mk)



– Decreasing frequency increases wavelength hence distance between two adjacent maximum increase.

c) **Figure 6** shows a displacement-time graph for a progressive wave.

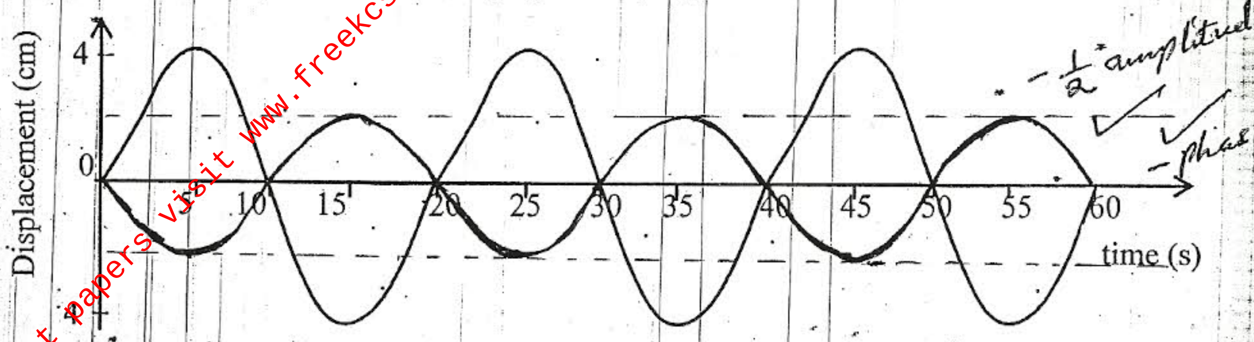


Figure 6

(i) On the same axes, sketch the graph of a wave with, same frequency but half – amplitude and completely (180°) out of phase with given wave. (2mks)

(ii) Determine the period, T of the wave. (1mk)

$T = 20\ s$

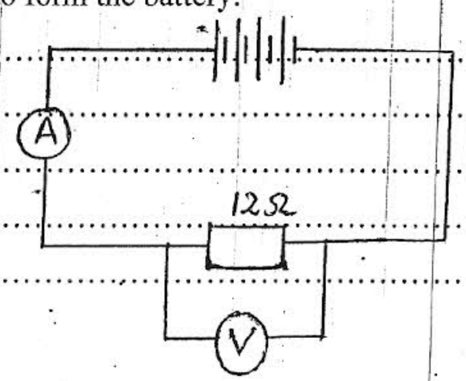
(iii) Determine the frequency of the wave. (2mks)

$f = \frac{1}{T} = \frac{1}{20}$

$= 0.05\ Hz$

14. a) Four identical dry cells of e.m.f 1.5V are connected to form a battery. The battery is then connected in series with an ammeter of negligible resistance and a coil of nichrome wire of fixed resistance of 12 Ω. the ammeter reads 0.3 A. A voltmeter connected across the coil also gives a reading.

(i) Draw a circuit diagram described above, clearly showing how the cells were connected to form the battery. (1mk)



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(ii) What is the e.m.f of the battery? (1mk)

$E = 1.5 \times 4 = 6V$ ✓

(iii) Determine the voltmeter reading across the coil. (2mks)

$V = IR$

$= 0.3 \times 12$ ✓

$= 3.6V$ ✓

(iv) Determine the internal resistance of each dry cell. (3mks)

$E - V = Ir$

$6 - 3.6 = 0.3r$ ✓

$r = \frac{2.4}{0.3} = 8\Omega$ ✓

For each cell;

$r = \frac{8}{4}$

$= 2\Omega$ ✓

(v) Calculate the value of the resistor which must be connected with the nichrome wire to increase the ammeter reading to 0.5 A. (3mks)

$E = V + Ir$

$6 = V + 0.5 \times 8$

$V = 6 - 4$

$V = 2V$

$R_E = \frac{V}{I} = \frac{2}{0.5}$

$R_E = 4\Omega$ ✓

R_2 is connected in parallel with nichrome (R_1)

$R_E = \frac{R_1 R_2}{R_1 + R_2}$

$4 = \frac{12R_2}{12 + R_2}$ ✓

$48 + 4R_2 = 12R_2$

$48 = 8R_2$

$\therefore R_2 = \frac{48}{8}$ ✓

$= 6\Omega$

b) **Figure 7** shows a circuit that was used determine the internal resistance of a cell.

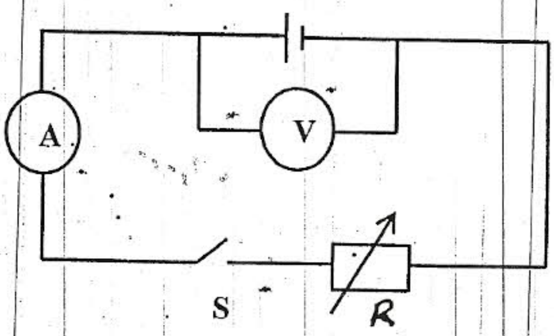

Figure 7

$Ir = \frac{2.4V}{8\Omega}$

$V = IR$

0.3×12

$= 3.6V$

When switch S was closed and R varied values of p.d. across the cell and the corresponding current through the cell were noted. From the experiment the following graph was plotted (**not drawn to scale)** as shown in **Figure 8.**

$R_E = \frac{4}{0.5} = 8\Omega$ Re

$R_E = \frac{R_1 R_2}{R_1 + R_2} = 4$

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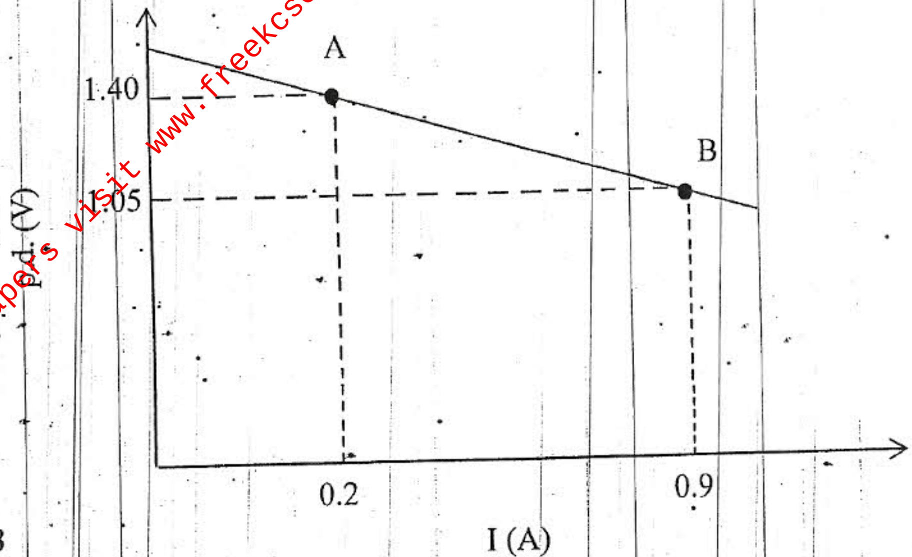


Figure 8

Given that the equation of the graph is V = E – Ir, use the graph to determine;

(i) The internal resistance, r, of the cell. (3mks)

$V = (-r)I + E$

$y = mx + c$

Slope $= -r$ ✓

Slope $= \frac{\Delta V}{\Delta I} = \frac{1.4 - 1.05}{0.2 - 0.9}$ ✓

$= \frac{0.35}{-0.7}$

$= -0.5\,\Omega$

$\therefore -r = -0.5\,\Omega$

$r = \underline{0.5\,\Omega}$ ✓

(ii) The e.m.f, E, of the cell. (2mks)

$V = -rI + E$

$V = -0.5I + E$

– when $V = 1.4$ V and $I = 0.2$ A

then $1.4 = -0.5 \times 0.2 + E$ ✓

$1.4 = -0.1 + E$

$E = 1.4 + 0.1$

$= \underline{1.5\ V}$ ✓

OR.

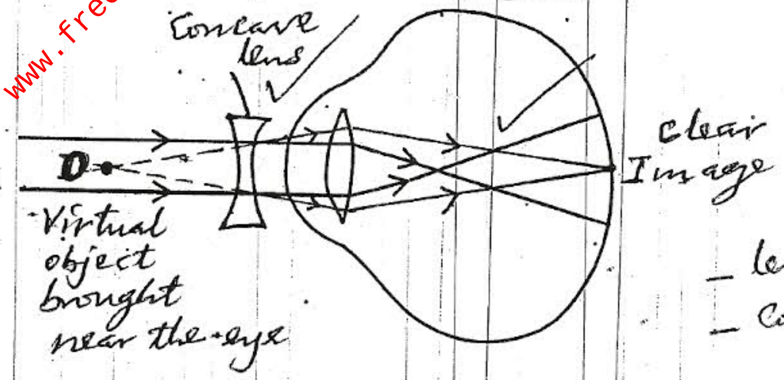
– When $V = 1.05$ V and $I = 0.9$

$1.05 = -0.5 \times 0.9 + E$

$\therefore E = 1.05 + 0.45$

$= \underline{1.5\ V}$

15. a) A defective eye focuses a distance.object as shown in **Figure 9**.



– lens type ✓
– Correct rays ✓

Figure 9

(i) State the eye defect shown above. (1mk)

Short sight / Near sight / myopia. ✓

(ii) Identify any **two** possible causes of this eye defect. (2mks)

– Too long eye ball. ✓
– thicker eye lens / (with short focal length). ✓

(iii) Draw a suitable ray diagram **on the same figure above** to show how this eye defect can be corrected. (2mks)

b) **Figure 10** shows an object O placed in front of a converging lens whose principal focus is F.

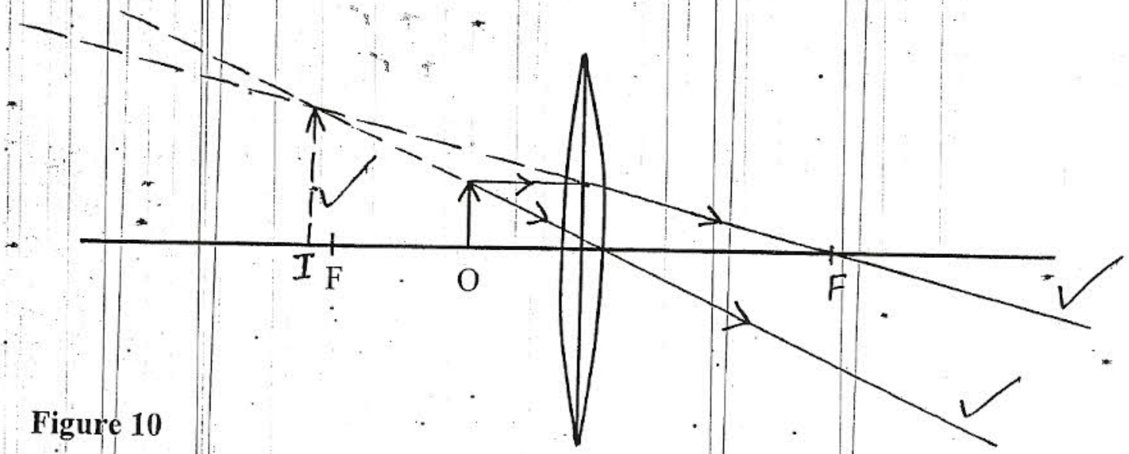


Figure 10

On the figure, draw a ray diagram to locate the image formed. (3mks)

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I. Increasing the amount of current through the filament. (1mk)

Increases the intensity/quantity/amount of X-rays produced.

II. Lowering the value of p.d. between A and B. (1mk)

Reduces the quality/energy/strength/frequency of X-rays produced.

(iii) What property of lead makes it suitable for use as shown in the figure? (1mk)

Lead has high density hence X-rays cannot penetrate through easily.

b). An X-ray tube operates at a potential of 80 kV. Only 0.5% of the election energy is converted to X-rays, while heat is generated at the anode at the rate of 99.5 J/s. Determine the;

(i) Tube current. (2mks)

$P = IV$

when power of electron, $P = 99.5 + 0.5$

$= 100W$

$I = \frac{P}{V} = \frac{100}{80,000}$

$= 1.25 \times 10^{-3} A$

or $1.25 mA$

(ii) Average velocity of the electrons hitting the target. (2mks)

$eV = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 80,000}{9.1 \times 10^{-31}}}$ Substitution

$= \sqrt{2.8131868} = 1.677 \times 10^8 m/s.$

(iii) Minimum wavelength of the X-rays. (2mks)

$E = eV = h\frac{c}{\lambda}$

$eV = 1.6 \times 10^{-19} \times 80,000$

$= 1.28 \times 10^{-14} J$

$\lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.28 \times 10^{-14}}$

$= 1.554 \times 10^{-11} m$

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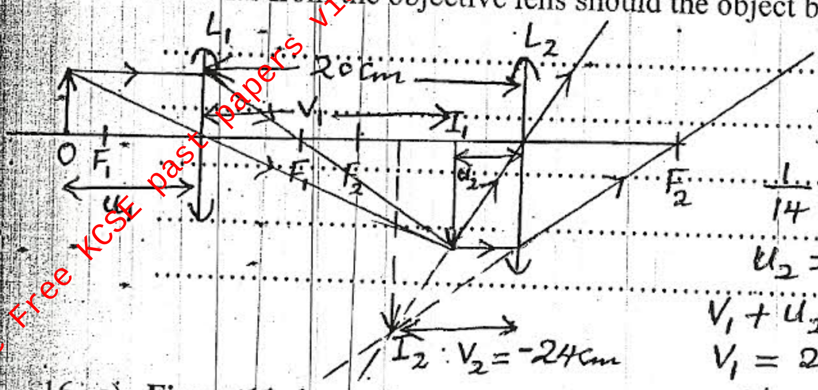
c). The focal length of the objective and eye-piece lenses of a compound microscope are 4 cm and 14 cm respectively and they are separated by a distance of 20 cm. A person whose distance of distinct vision is 24 cm uses the microscope to see a small object. Determine how far from the objective lens should the object be placed. (3mks)



$f_1 = 4$cm ; $f_2 = 14$cm

$\frac{1}{f_2} = \frac{1}{u_2} + \frac{1}{v_2}$

$\frac{1}{14} = \frac{1}{u_2} + \frac{1}{-24}$ ✓

$u_2 = 8.842$ cm

$V_1 + u_2 = 20$

$V_1 = 20 - 8.842$

$V_1 = 11.158$ cm

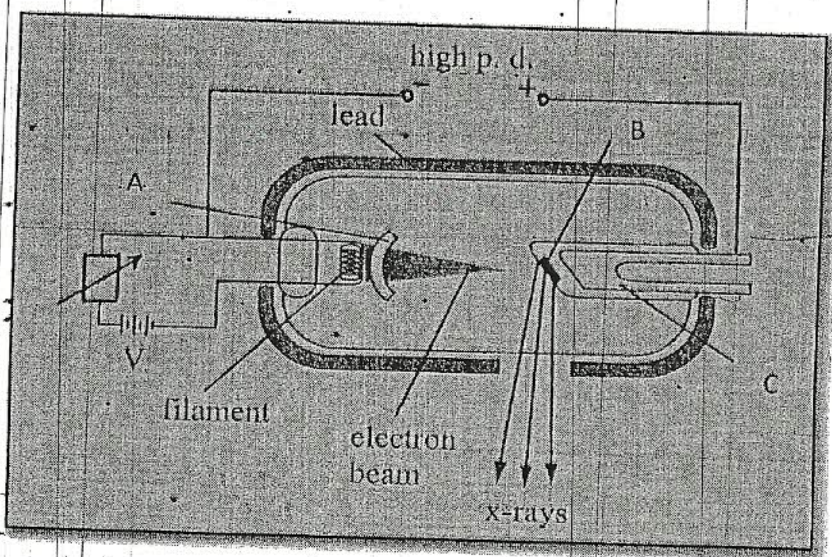
$\frac{1}{f_1} = \frac{1}{u_1} + \frac{1}{V_1}$

$\frac{1}{4} = \frac{1}{u_1} + \frac{1}{11.158}$ ✓

$u_1 = 6.235$ cm ✓

object should be placed 6.235cm from objective len[s]

16. a) **Figure 11** shows the parts of an x-ray tube.



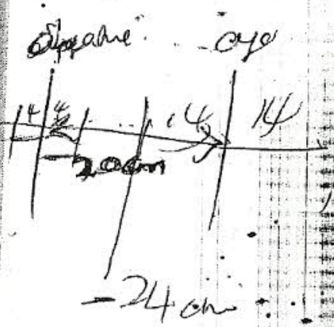


Figure 11

(i) Identify the following parts.

I. A - Cathode ✓ or focusing Cathode. (1mk)

II. Metal B - Tungsten ✓ or Molybdenum (1mk)

(ii) State the effect of the following adjustments on X-rays produced.

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17. a) **Figure 12** shows a 10 µF capacitor being charged from a 12V battery by connecting to the switch terminal R. The switch is then connected to S to charge the 4 µF capacitor.

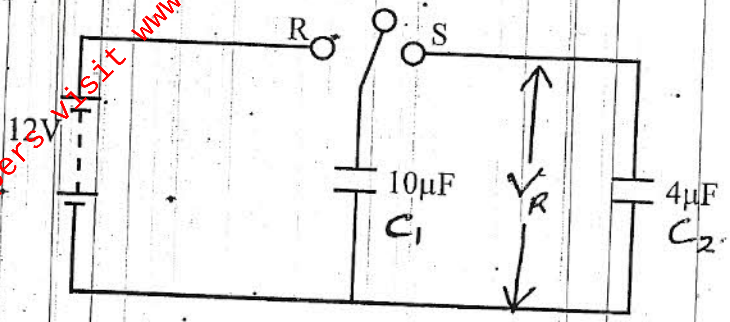

Figure 12

Determine the resultant p.d. between the two capacitors. (3mks)

Total charge to be shared, $Q = C_1V$
$= 10\times10^{-6}\times12$
$= 1.2\times10^{-4}C$ ✓

$Q = Q_1 + Q_2$
$Q = C_1V_R + C_2V_R$
$Q = (C_1 + C_2)V_R$

$V_R = \frac{Q}{C_1+C_2}$
$= \frac{1.2\times10^{-4}}{(10+4)\times10^{-6}}$ ✓
$= \frac{1.2\times10^{-4}}{14\times10^{-6}}$
$= 8.571\ V$ ✓

b) Figure 13 shows an electrical circuit with three capacitors A, B and C of capacitance 4.0µF, 5.0µF and 2.0µF respectively, connected to a 12V battery.

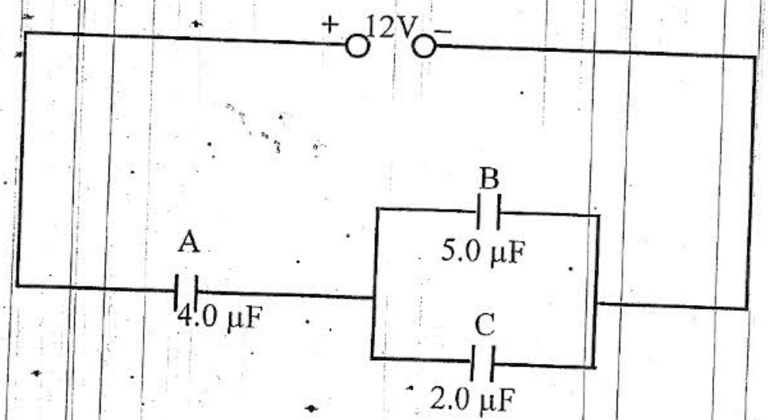

Figure 13

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Determine the;

(i) Combined capacitance of the three capacitors. (2mks)

$$C_T = \left(\frac{1}{C_A} + \frac{1}{C_B + C_C}\right)^{-1}$$

$$C_T = \left(\frac{1}{4} + \frac{1}{5+2}\right)^{-1}$$

$$= \left(\frac{1}{4} + \frac{1}{7}\right)^{-1} \text{ or } \frac{4 \times 7}{4+7} = \underline{2.545\,\mu F}$$

(ii) Charge on capacitor A. (2mks)

Total charge in the circuit

$$Q = C_T V$$

$$= 2.545 \times 10^{-6} \times 12$$

$$= \underline{3.054 \times 10^{-5}\,C} \text{ or } \underline{30.54\,\mu C}$$

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