MARKING GUIDE OF PHYSICS II & III (2023-2024)

ASSOCIATION CARREFOUR UMUREZI

SECTION A /10marks

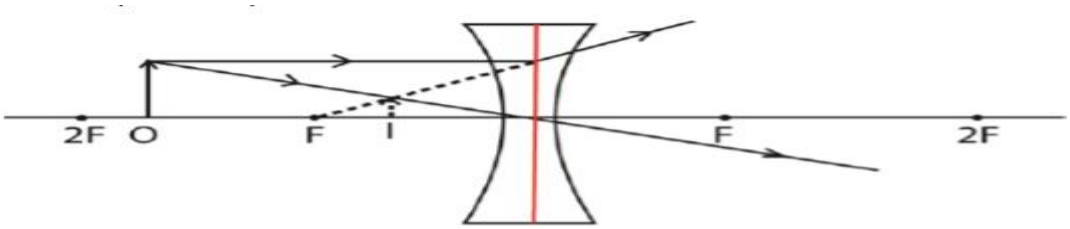
1.B 2.A 3.D 4.C 5.D 6.B 7.D

8.B 9.A 10.D

SECTION B /45marks

1. a. i. Principal focus of a concave lens is the point on the principal axis where rays of light parallel and close to principal axis appear to diverge from after refraction through the lens. **/0.5marks**

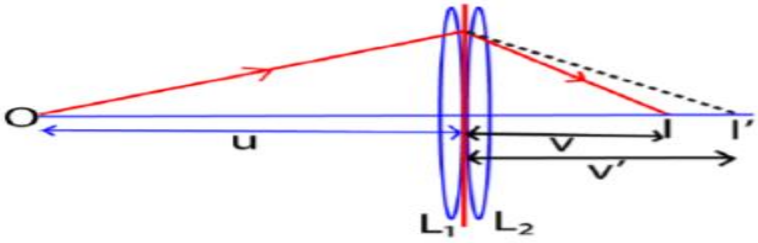
ii. **/1mark**



O=Object I= image

iii. It is virtual and diminished. **/0.5marks**

b. Consider two thin lenses L_1 and L_2 of focal length f_1 and f_2.



for lens L_1 $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ $\frac{1}{f1} = \frac{1}{u} + \frac{1}{v'}$ (1)

for lens L_2 , I' acts as the virtual object $\frac{1}{f2} = \frac{1}{-v'} + \frac{1}{v}$ (2)

add eqn (1) and (2) $\frac{1}{f1} + \frac{1}{f2} = \frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

thus $\frac{1}{f} = \frac{1}{f1} + \frac{1}{f2}$ proved. Where f is the total length of combined lenses.
/2marks

2. No deflection occurs at the entering surface, because the incidence angle is zero .At the second surface,$\theta_i = 30^0$(because its sides are mutually perpendicular to the sides of apex angle).

The Snell's law becomes$n_i sin\theta_i = n_t sin\theta_t$ or $sin\theta_t = \frac{1.55}{1} sin30^0$ from which

$\theta_t = 50.8^0$. **/1mark**

But $D = \theta_t - \theta_i = 50.8^0 - 30^0 = 20.8^0$. **/1mark**

3.a) The specific latent heat of evaporation of a liquid is the heat required to convert unit mass of it, at its boiling point into vapour at the same temperature. **/1mark**

b) For an adiabatic change involving an ideal gas $P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$ Where $\gamma = 1.67$ for a monatomic gas.

Hence, $P_2 = P_1(\frac{V_1}{V_2})^{\gamma} = (1.00X10^5)(\frac{20}{0.50})^{1.67} \frac{N}{m^2} = 4.47x10^7 \frac{N}{m^2}$

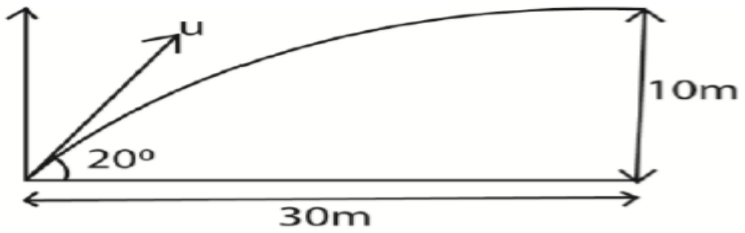
To find final temperature, we use $T_1 {V_1}^{\gamma-1} = T_2 {V_2}^{\gamma-1}$ that gives

$T_2 = T_1(\frac{V_1}{V_2})^{\gamma-1} = (285)(\frac{20}{0.50_2})^{(1.67-1)} = 3.4X10^3 K$ **/2marks**

4 a. **Time of flight** is the time taken by the projectile to move from the point of projection to the point where it lands on a plane through the point of projection. **/ 0.5marks**

Range is the horizontal distance from the point of projection to appoint where the projectile lands along the plane through the point of projection. **/0.5marks**

b) i)



Using y= X tanα – g $\frac{sec\alpha}{2u^2}$ X^2 10 = 30 tan20 - 9.81 $\frac{\sec 20}{2u^2}$.(30)^2

U= 71.5 m/s **1mark**

ii) U_x = 71.5 cos 20 = 67.188m/s U_y = U sinα – gt

$U_y = 71.5 \sin 20 - 9.81x\frac{30}{71.5cos20}$ $t= \frac{X}{Ux}$

Uy = 20.07 m/s $\tan\alpha = \frac{Ux}{Uy} = \frac{20.07}{67.188}$ and $\alpha = 16.6^0$ **/1mark**

c) . We have $v_{ox} = 20\frac{m}{s}cos40^0 = 15.3m/s$ and $v_{oy} = 20\frac{m}{s}sin40^0 = 12.9m/s$

Consider first the horizontal motion. $v_{ox} = v_o = v_x = 15.3m/s$ .Then $x = v_x . t$ and it gives

$50 = (15.3)t$ and $t = 3.27s$ **/1mark**

For the vertical motion ,taking down as positive

$y = v_{oy}t + \frac{1}{2}gt^2 = (-12.9)(3.27) + \frac{1}{2}(9.81)(3.27)^2 = 105m$ **/1mark**

Since y is positive, and since down is positive, the ball will hit the at 105m below the original level.

5. a) work function of a metal is a property of a metal which is defined as the minimum quantity of energy which is required to remove an electron from its surface. **/0.5marks**

ii) Photoelectrons are those electrons that are emitted from a metal surface when it absorbs light energy. **/0.5marks**

iii) Stopping potential is the minimum negative voltage applied to the anode to stop a photocurrent. **/0.5marks**

b) $E = \frac{hc}{\lambda} = \frac{(6.63x10^{-34}\,J.S)(3x10^8\frac{m}{s})}{200x10^{-9}m} = 9.95x10^{-19}J = 6.21eV$ **/1mark**

Then,from the photoelectric equation ,the energy of the fastest emitted electron is $6.21eV - 5.01eV = 1.20eV$. Hence a negative retarding potential of 1.20V is required.This is the stopping potental. **/1mark**

6.a) Kirchhoff's voltage law states that in any complete loop within a circuit, the sum of all voltages across components which supply electrical energy (such as cells or generators) must equal the sum of all voltages across the other components in the same loop(1mark). This law is a consequence of both charge conservation and the conservation of energy. **/1mark**

b) Subdivide the electric circuit into loops

Junction f : $I_3 = I_2 + I_1$ **/0.5marks**

Loop 1: fcdef : $-0.60 + I_3 + 8I_2 - 2.30 = 0$

$2.90 = 8I_2 + I_3$ **/0.5marks**

$2.90 = 8I_2 + I_1 + I_2 \rightarrow 2.90 = I_1 + 9I_2$ (1mark) eq 1

Loop 2 :abcfa: $0.5 - 2I_1 - 1I_3 + 0.6 - 1I_1 = 0$ $1.10 = 3I_1 + 1I_1 + 1I_2$

$1.10 = 4I_1 + 1I_2$ **/0.5marks**

Two equations with two unknown currents Multiply (eq. 2) by -9 we obtain -$9.90 = -36I_1 - 9I_2$ eq 3

Add (eq 1) and (eq 3): $-7.00 = -35\ I_1$ $I_1 = 0.2$ A **/0.5marks**

Put the value of I_1 into eq 2 we obtain $I_2 = 0.3$ A **/0.5marks**

$I_3 = 0.2$A $+0.3$ A$= 0.5$ A **/0.5marks**

7. a) From the principle of conservation of mechanical energy

$ME = KE + PE = constant$

where ***ME*** is the mechanical energy, ***KE*** is the kinetic energy and ***PE*** is the potential energy. It gives $mgh + 0 = 0 + \frac{1}{2}mv^2$ which leads to $v = \sqrt{2gh}$ **/1mark**

b) For the collision, write can write the law of momentum conservation as $p_{(before)} = p_{(after)}$

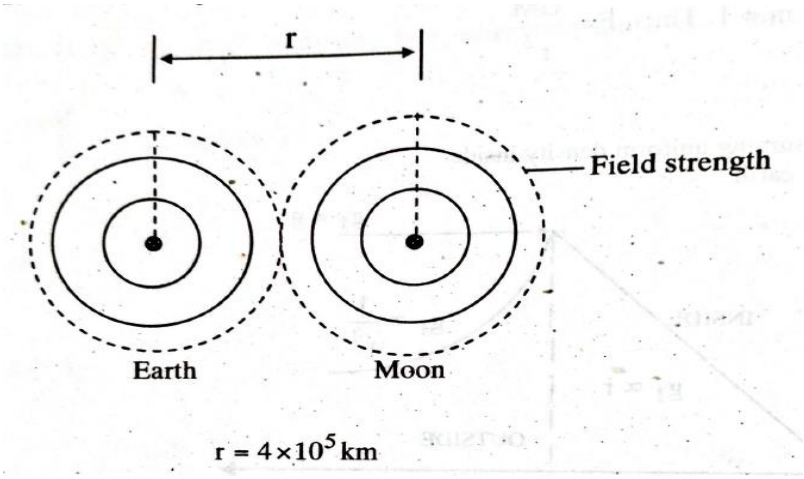
$mv = (m + m)V$ and $mv = (2m)V$. The speed after collision is $V = \frac{v}{2}$. **/1mark**

The two masses system will convert its kinetic energy $\boldsymbol{KE} = \frac{1}{2}(2m)V^2$ to

$\boldsymbol{PE} = (\boldsymbol{2mgh'})$ **/1mark**

Then $\frac{1}{2}(2m)V^2 = (2mgh')$ and the new height $h' = \frac{V^2}{2g} = \frac{v^2}{8g} = \frac{h}{4}$. Finally, we have $h' = \frac{h}{4}$. **/1mark**

8.Let M_e stands for mass of the earth and M_o stands for mass of the moon, then $M_e = 81M_o$. Let the mass of space craft be **m**



Let ***x*** be the distance from the centre of the point where the resultant force is zero. At the point where the resultant force is zero:
$Force\ due\ to\ earth = Force\ due\ to\ moon$

From Newton's law of gravitational: $F_{earth} = F_{moon}$ **/1mark**

$\frac{GM_e m}{x^2} = \frac{GM_O m}{(r-x)^2}$ and $\frac{M_e}{x^2} = \frac{M_O}{(r-x)^2}$ then $\frac{M_e}{M_O} = \frac{x^2}{(r-x)^2}$ .We can write $\frac{x}{r-x} = \sqrt{\frac{81M_o}{M_o}}$ **/1mark**

because $M_e = 81M_o$

$\frac{x}{r-x} = 9$ and $x = 9(r-x)$.We have $x = 9r - 9x$.

$10x = 9r$ thus, $x = \frac{9}{10}r = \frac{9}{10}x4x10^5 = 3.6x10^5 km$ .Therefore the distance from the centre of the earth is $3.6x10^5 km$. **/1mark**

9. Given: The frequency of turning fork fs = 400Hz. The speed of sound source

   Vs = $2m/s$

Asked: Apparent frequency f_o =?

a) Apparent frequency of unreflected sound waves coming directly to the observer is given by Formula: $fo = f_s \frac{V+V0}{V+VS}$ **/1mark**

$f_o = 400\frac{340+0}{340+2}$ and f_o = 397.7HZ **/1mark**

b) Apparent frequency sound waves coming to observer after reflection =? The wave crests reaching the wall are closer together than normally because the

fork is moving toward the wall. Therefore, the reflected wave appears to come from an approaching source.

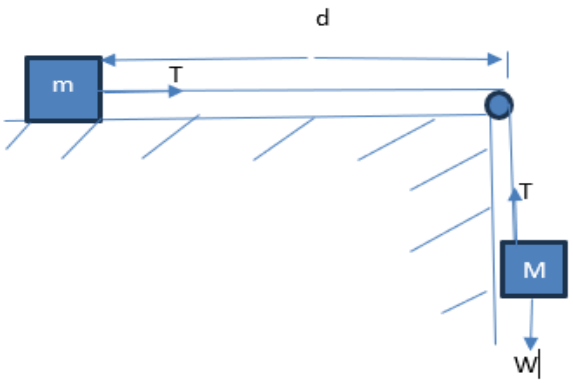
$fo = f_s \frac{V+V0}{V-VS}$ **/1mark**

$f_o = 400\frac{340+0}{340-2}$ then, $f_o = 402.4HZ$ **/1mark**

c) Beats per second = difference between frequencies

$Beats\ per\ second = (402.4Hz - 397.7Hz) = 4.7\ beats\ per\ second$ **/1mark**

10. Consider the following free body diagram that shows the forces acting on the system of the masses ***m*** and ***M***



Taking the positive direction of the motion as the left-to-right direction, we have: For the mass ***m*** **:** $T = m\,a$ (1) **/0.5marks** and

For the mass M: $W - T = M\,a$ (2)**/0.5marks**

$\begin{cases} T = m\,a\ (1) \\ W - T = M\,a\ (2) \end{cases}$ adding (1) and (2) gives $W = (m + M)a$ with $W = Mg$.

Therefore $a = \frac{Mg}{(m+M)}$ (3) **/1mark**

Because we have a uniformly accelerated motion, the distance ***d*** is given by

$d = \frac{1}{2}at^2$**(4)** since the motion starts from rest.

From the equation (4): $t^2 = \frac{2d}{a}$ **(5)**, therefore, replacing (3) into (5) gives that $t^2 = \frac{2d}{\frac{Mg}{(m+M)}} = \frac{2d(m+M)}{Mg}$ **.** Then $t = \sqrt{\frac{2d(m+M)}{Mg}}$ as required. **/1mark**

11. a)Nuclear fission is the disintegration of a very heavy nucleus into two lighter nuclei whereas nuclear fusion is the combining of two lighter nuclei into a heavier nucleus. **/1mark**

An example of nuclear fission: ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{1}_{0}n + Energy$

/0.5marks

An example of nuclear fusion: ${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n + Energy$ **/0.5marks**

b) ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{1}_{0}n$

Mass difference= $(235.04 + 1.01) - (140.91 + 91.91 + 3x1.01) = 0.2u$ **/1mark**

Energy released (in MeV) =932 x Mass difference (in u)

Energy released (in MeV) =932x0.2=186.4MeV

Since $235.04x10^{-3}kg\ of\ {}^{235}_{92}U$ contains $6.02x10^{23}$atoms, then 40kg of ${}^{235}_{92}U$ contains

$\frac{40x6.02x10^{23}}{235.04x10^{-3}} = 1.024x10^{26}atoms$. **/1mark**

Energy released by 40kg of ${}^{235}_{92}U = 1.024x10^{26}x186.4MeV = 1.9x10^{28}\ MeV$ **/1mark**

12.a) Half-life is the time taken for the number of active nuclei to be reduced to half of its initial value. **/1mark**

b)224g contains $6.0x10^{23}atoms$

$1.0x10^{-3}g$ will contain $\frac{1.0x10^{-3}}{224}x6.0x10^{23}atoms = 2.6x10^{18}atoms$ **/1mark**

The number of atoms of the isotopeafter 14.4 days is $\frac{14.4}{3.6} = 4\ half - lives$ **/0.5marks**

Hence,the number of active nuclei is $(\frac{1}{2})^4 of\ 2.6x10^{18}atoms = 1.6x10^{17}$. **/1mark**

SECTION C /30marks

13. Causes of climate change: **/10marks**

(Teacher should consider and judge the any five causes with their explanations **/2marks** for each)

Human causes (anthropogenic)

Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming. Most of these human activities all contribute to the increase of greenhouse gases. These include the following:

Deforestation: Today there is a lot of cutting down of trees reducing the percentage of oxygen in the atmosphere and increasing the carbon dioxide content in the atmosphere. This is leading to climate change.

Industrialization: The Industrial Revolution in the 19th century saw the large-scale use of fossil fuels for industrial activities. The burning of these fuels increase the carbon dioxide content in the atmosphere which contributes to climate change.

Population growth: The rapid population growth is another significant factor contributing to climate change. More and more land that was covered with vegetation has been cleared to make way for houses and cultivation. Natural resources are being used extensively for construction, transport and consumption and all this has contributed to a rise in greenhouse gases in the atmosphere.

Poor disposal of wastes such as plastics that remain in the environment for many years also cause damage. In addition, the use of fertilizers for farming has also contributed to water pollution resulting from the run-off of fertilizers into water bodies. Industries also produce side products like sewage which contains harmful chemicals to the environment.

Lack of alternative energy resources compel people to stick to the use of fossil fuels such as oil, coal and natural gas to obtain most of the energy needed to run vehicles, generate electricity for industries, household etc. These fossil fuels are responsible for the emission of huge amounts of greenhouse gases and other pollutants.

Poverty and ignorance could also be indirect factors leading to climate change. In most low developed countries, the levels of poverty and ignorance

are too high that people cannot afford environmental friendly energy sources and there is lack of sensitization to the population.

Natural causes of climate change

There are a number of natural factors responsible for climate change. Some of the more prominent ones are:

Volcanic eruptions: Volcanoes affect the climate through the gases and dust particles thrown into the atmosphere during eruptions. The effect of the volcanic gases and dust may warm or cool the Earth's surface, depending on how sunlight interacts with the volcanic material.

Change in the Earth's orbit: The earth makes one full orbit around the sun each year. The Earth's orbit around the Sun is an ellipse, not a circle but the ellipse changes shape. Sometimes it is almost circular and the Earth stays approximately the same distance from the Sun as it progresses around its orbit. At other times the ellipse is more pronounced so that the Earth moves closer and further away from the sun as it orbits. When the Earth is closer to the sun our climate is warmer than when it is further.

Increase in aerosols: Aerosols are liquids and solids that float around in the air. They may also include soot, dust, salt crystals, bacteria, and viruses. Aerosols scatter incoming solar radiation, lowering temperatures and causing a slight cooling for a few years after a major volcanic eruption.

Ocean currents: Oceans store a large amount of heat, so that small changes in ocean currents can have a large effect on coastal and global climate. Ocean currents carry vast amount of heat around the Earth. The direction of these currents can shift so that different areas become warmer and cooler.

Climate change mitigation Climate change mitigation refers to efforts to reduce or prevent emission of greenhouse gases that are warming our planet so as to limit the extent of climate change. Mitigation policies can substantially reduce the risks associated with human-induced global warming thereby stabilizing the greenhouse gas levels in a given time. The mitigation strategies may include the following:

14. a)i) Binding energy $E_{be} = \Delta mC^2$ **/1mark**

$E_{be} = [(A-Z)M_n + ZM_P - M_{nucleus}]xC^2$

$M_{nucleus} = (A-Z)M_n + ZM_P - \frac{E_{be}}{C^2}$ **/1mark**

ii) Binding energy of deuterium is given by: $E_{be} = [(2-1)M_n + (1)M_P - M_{nucleus}]xC^2$

$E_{be} = [(1)M_n + (1)M_P - (M_{nucleus}) - (1)M_e]xC^2$ where M_e is the mass of an electron

$\frac{E_{be}}{C^2} = M_n + M_P + M_e - M_{deuteriumatom}$

$\frac{E_{be}}{C^2} = M_n + (M_P + M_e) - M_{deuterium\ atom}$

Since $M_{hydrogen\ atom} = M_P + M_e$

$\frac{E_{be}}{C^2} = M_n + M_{hydrogen\ atom} - M_{deuterium\ atom}$

Therefore $M_{deuteriumatom} = M_n + M_{hydrogen\ atom} - \frac{E_{be}}{C^2}$ **/5marks**

b) Binding energy of deuterium is given by:

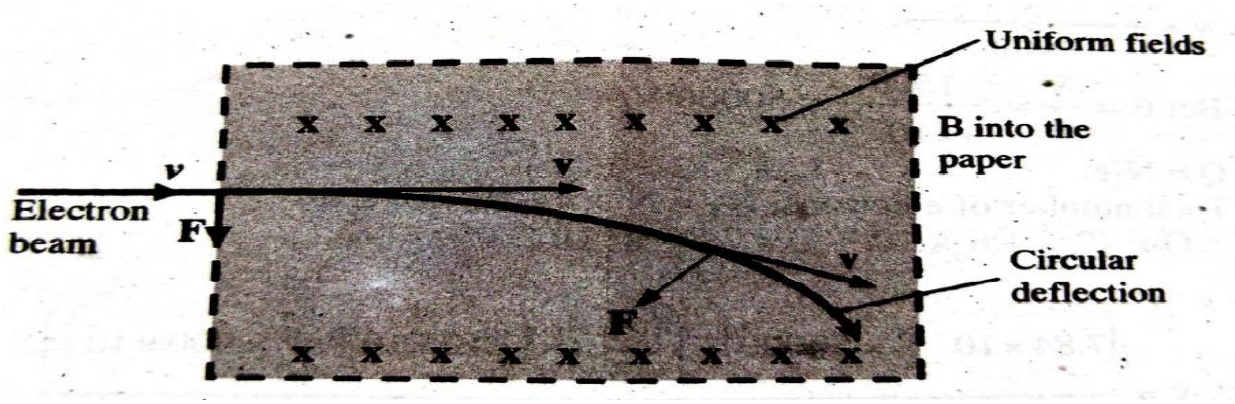
$E_{be} = \left[M_n + M_{hydrogen\ atom} - M_{deuterium\ atom}\right]xC^2$

$E_{be} = 1.00867u + 1.00783u - 2.01410u\ (3x10^8)^2 = 3.59x10^{-13}J$

Binding enery per nucleon of deuterium$\frac{3.59x10^{-13}J}{2} = 1.79x10^{-13}J = 1.12MeV$

/3marks

15. a)i)Consider anelectron beam moving with a speed v entering a uniform magnetic field of flux density B which is acting perpendicular to the direction of the motion



From the figure above, you can see that the magnetic force $F = Bev$ is always directed towards the center of the circular path of the electron beam. Thus, in this motion, the magnetic force provides the centripetal force.

So,$magnetic\ force = centripetal\ force$

$Bev = \frac{m_e v^2}{r}$ and $v = \frac{Ber}{m_e}$ but $v = \omega r$ Where

m_e *is the mass of electron and* ω *is the angular velocity*

Then , $\omega r = \frac{Ber}{m_e}$ and $\omega = \frac{Be}{m_e}$ but $\omega = 2\pi f$ and we can write that $2\pi f = \frac{Be}{m_e}$

.Therefore, $f = \frac{Be}{2\pi m_e}$ **/2marks**

Where B *is Magnetic flux density and* e *is electron charge*

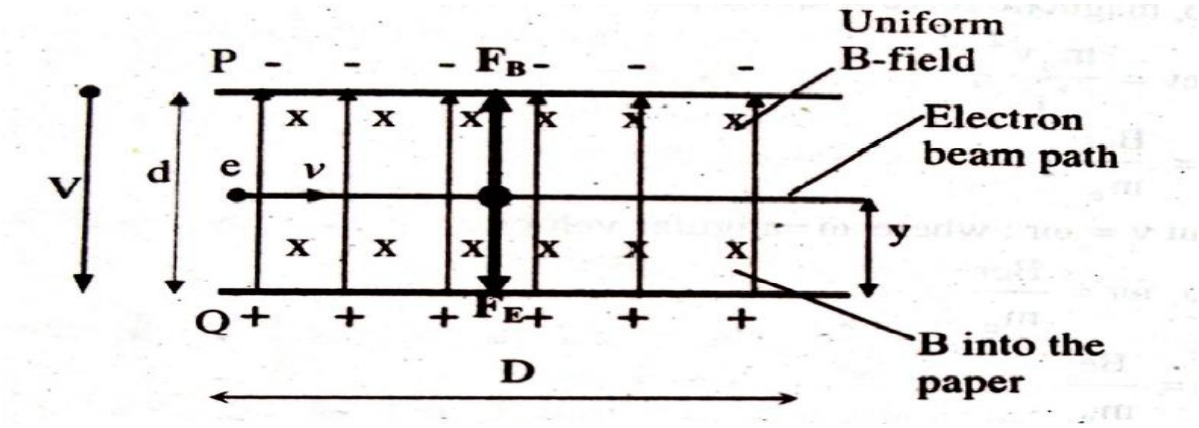
ii) From part (i), $f = \frac{Be}{2\pi m_e} = \left(\frac{B}{2\pi}\right)\left(\frac{e}{m_e}\right)$ Where $B = 0.6T$

$\frac{e}{m_e} = Charge\ to\ mass\ ratio\ for\ electron\ beam = 1.8x10^{11}Ckg^{-1}$.

Therefore, $f = \frac{0.6}{2\pi} x 1.8x10^{11}Hz = 1.7x10^{10}Hz$ **/2marks**

iii)From $v = \omega r$, $v = 2\pi fr$ and, $r = \frac{v}{2\pi f} = \frac{2x10^7}{2\pi x 1.7x10^{10}} m = 1.9x10^{-4}m$ **/2marks**

b)



The force on an electron charge moving between the plates in uniform electric field is directed towards the positive plate. For no deflection, magnetic force (F_B) on an electron must be equal to and directed in opposite direction to the force on an electron due to electric field (F_E).

$F_B = F_E$ **/1mark** and $Bev = eE$

$Bv = E$ then, $B = \frac{E}{v}$ /1mark Where velocity $v = 2.5x10^6 \frac{m}{s}$

Potential difference, $V = 120V$ and separation d=6cm=$6x10^{-2}m$

$E = \frac{V}{d} = \frac{120}{6x10^{-2}} Vm^{-1} = 2000Vm^{-1}$ **/1mark**

$B = \frac{2000}{2.5x10^6} T = 8x10^{-4}T$ **/1mark**

16. a) i. (C) using $\frac{\beta}{\alpha} = \frac{fo}{fe}$ $\frac{\beta}{20} = \frac{60}{5}$ $\beta = 24^0$ **/2marks**

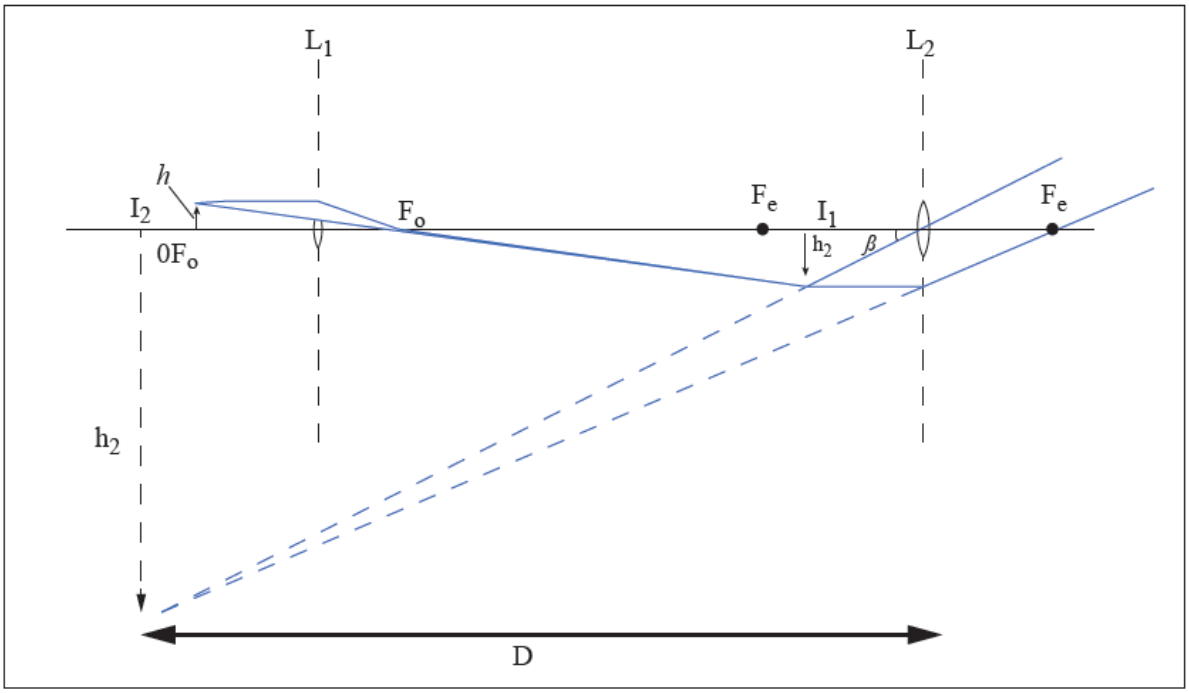
ii. (d) using LD = fo + Ue = fo + $\frac{fe\,.\,D}{fe+D}$ = 50 + $\frac{5X\ 25}{5+25}$ = $\frac{325}{6}$ cm **/2marks**

b) If the final image is at infinity, the objective forms an image at the focal point of the eyepiece. Position of an image formed by objective = separation - focal length of eyepiece :V = 22.1 – 2.5 = 19.5 cm

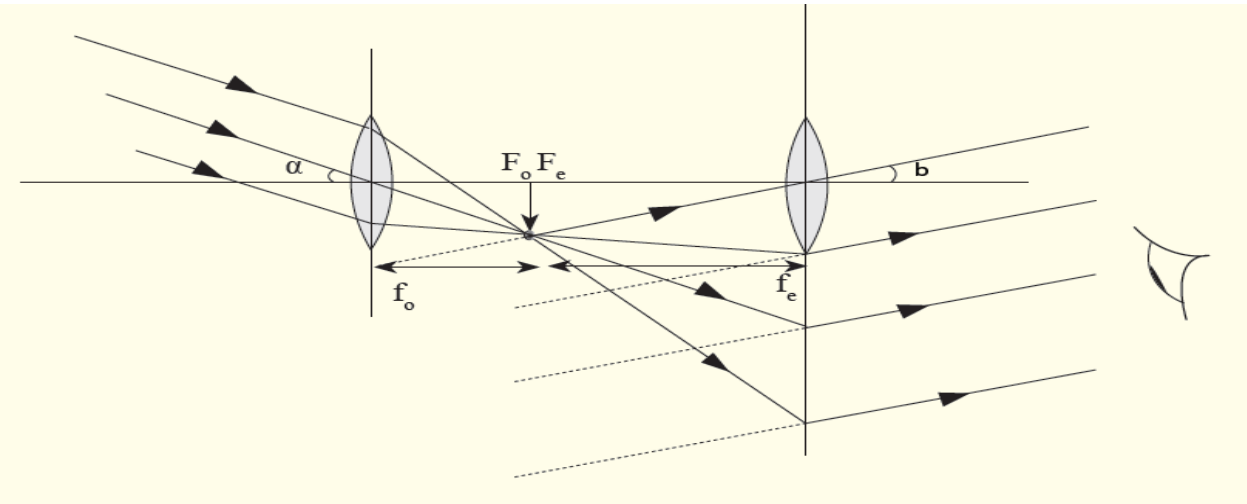
Magnifying power M = ($\frac{Vo}{fo}$ - 1) $\frac{D}{fe}$ = ($\frac{19.5}{1.6}$ - 1) $\frac{25}{2.5}$ = 111.8 **/2marks**

c) Rays diagram of compound microscope and astronomical telescope

i)Image formed by a compound microscope in normal adjustment **/2marks**



ii)Image formed by an astronomical telescope in normal adjustment **/2marks**

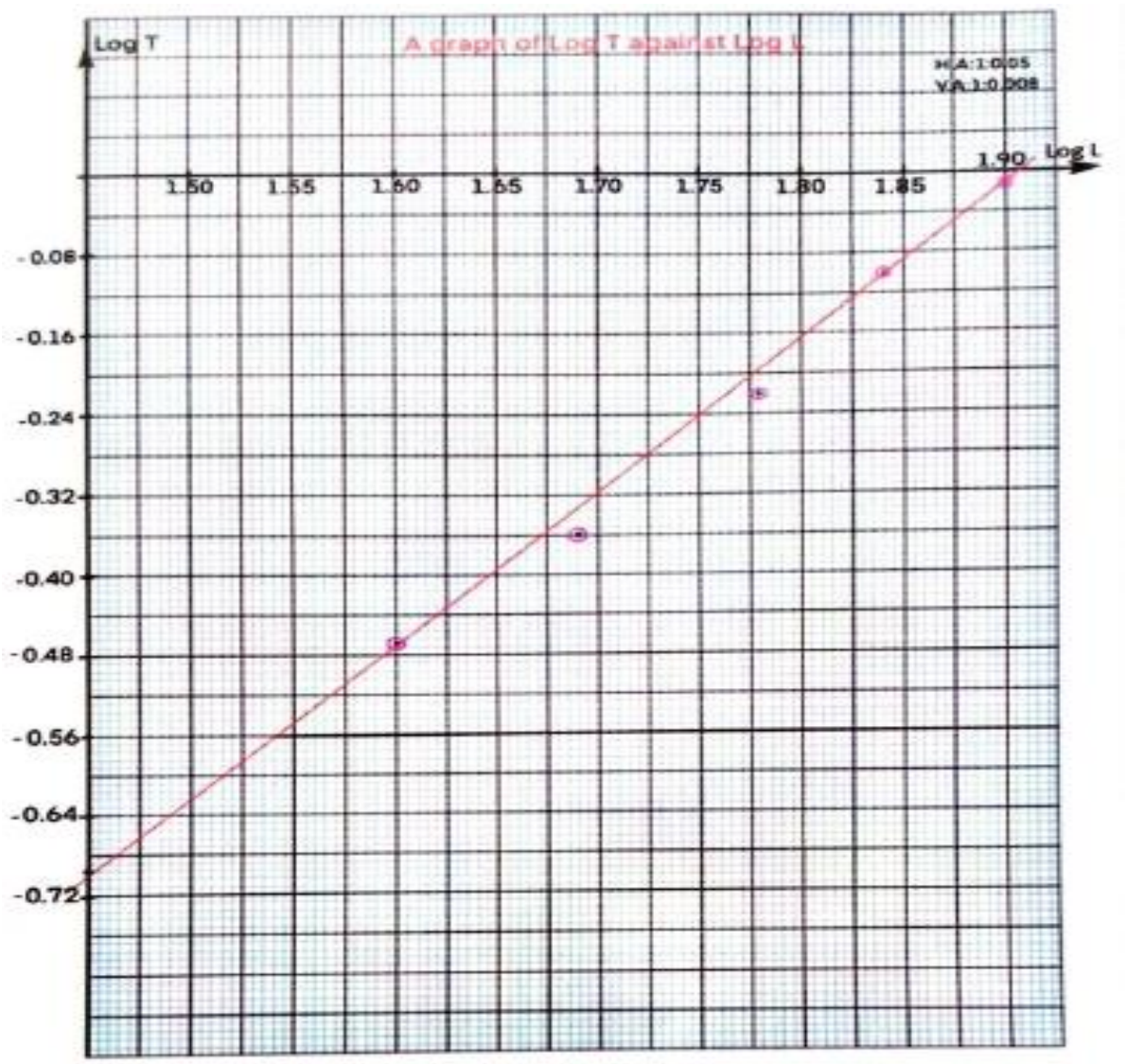


SECTION D /15marks

1.Table of results (**0.25marks for each correct value, physical quantity with correct unit and a table format=5marks**)

L/cm	t/s	T/s	$\log T$	$\log L$
80.000	9.500	0.950	- 0.020	1.900
70.000	7.850	0.785	- 0.100	1.840
60.000	6.060	0.606	- 0.220	1.780
50.000	4.600	0.460	- 0.340	1.690
40.000	3.410	0.341	- 0.470	1.600

2. A graph of $\boldsymbol{logT}$ against $\boldsymbol{logL}$ **/5marks)**



3.*The gradient* $\boldsymbol{m} = \frac{\Delta logT}{\Delta logL} = \frac{(0.02-(-0.56))}{1.92-1.54} = \frac{0.58}{0.38} = 1.526$ **(1mark)**

4. Intercept C, on the vertical axis $C = -0.69$ **(1mark)**

5. Constant $\boldsymbol{a}$ is obtained from $\boldsymbol{C} = \log a$ and $a = 10^{c} = 10^{(-0.69)} = 0.204$ **(1mark)**

6. $\boldsymbol{T = aLm} = 0.204x70.0x1.526 = 21.8s \approx 22s$ **(1mark)**

7. $logT = m\ logL + loga = 1.526log70 + log\ 0.204 = 2.81 + (-0.69) = 2.119$

$logT = 2.119$ and $T = 10^{(2.119)} = 131s$

$T = 131s$ **(1mark)**