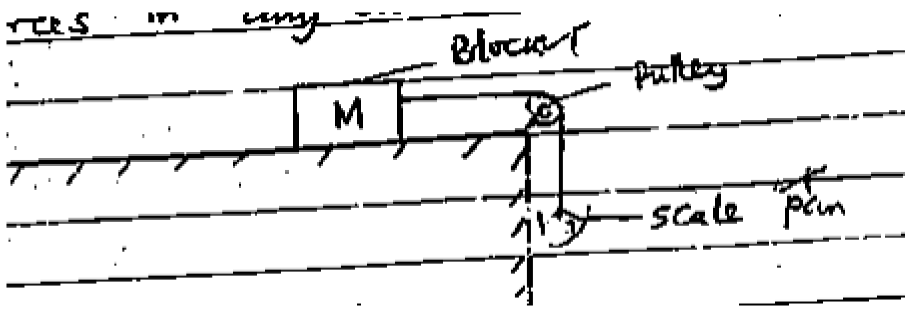
SET ONE
PRE REGISTRATION EXAMINATIONS 2024
Uganda Advanced Certificate of Education
PHYSICS P510/1 MARKING GUIDE
SECTION A

1 a) i) Is the product of force and perpendicular distance from the line of action of the force.

ii) Is a point where the resultant gravitational force acts.

b) Sum of clockwise moments is equal to sum of anticlockwise moments taken about the same point.
Sum of forces in any one direction is zero

c)



A block of known mass, M is placed on a flat table and connected to a scale pan using a light string.
A weight is placed on the scale pan and block given a slight push. More weights are added, block given a slight push until the block slides with uniform velocity. Weight of scale pan and contents is obtained. Experiment is repeated for blocks of different masses. A graph of weight scale pan and content against weight of block is plotted. The slope is calculated. The co efficient of kinetic friction, NR = S,

d) When a body in stable equilibrium is titled, its c.o.g is raised and on release it returns to the original position. When a body in unstable equilibrium is titled slightly, its c.o.g is lowered, P.E is reduced and on release, it falls down.

e. i) $Y = \frac{F.L}{A.e}$

$$[Y] = \frac{[F]\,[L]}{[A]\,[e]} = \frac{MLT^{-1}L}{L^2\ L}$$

$$= ML^{-1}T^{-2}$$

ii) $F = YA \propto \Delta\,\theta$

$= 2.0 \times 10^{II} X\ 2.5\ X\ 10^{-4}\ X\ 1.6\ X\ 10^{-7}\ (100 - 20)$

$= 640.0$ N

$E = \frac{1}{2}Fe$; $e = \propto i\Delta\,\theta$

$= \frac{1}{2} \times 640 \times 7.68 \times 10^{-6}$; $e = 1.6 \times 10^{-7} \times 0.6 \times 80$

$\therefore E = 2.46 \times 10^{-3}$ J

2 a i) Inertia is the reluctance of a body to start moving when at rest or to stop moving when in motion.

ii) Impulse is the product of force and time of action of the force.

b) For perfectly elastic collision momentum is conserved while for inelastic momentum is also conserved.
For elastic collision, R.E is conserved while for inelastic R.E is not conserved.
For elastic bodies separate after collision while for inelastic collision the bodies stick together.

c) By momentum conservation;

$m.u + M.O = (m + M)v$

$mu = (m + M)V$

V = speed just after collision.

From $V^2 = v^2 + 2as$

$0^2 \quad = v^2 - 2gh$

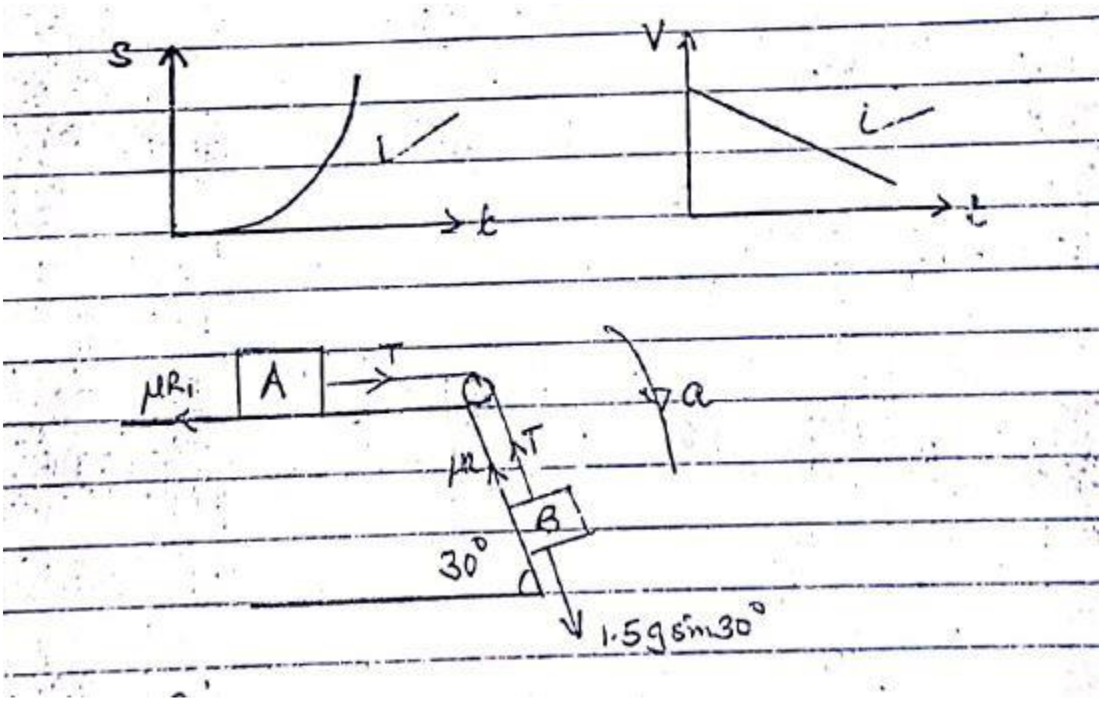
$V^2 \quad = 2gh$

$V \quad = \sqrt{2gh}$

$mu = (m + M)\ (2gh)^{\frac{1}{2}}$

$u = \frac{(m+M)\ (2gh)^{\frac{1}{2}}}{m}$

d i) Sum of K.E and P.E is equal to a constant in the absence of dissipative forces.
Or K.E + P.E = a constant



for body B:

$1.5g \sin\theta - (T + NR) = 1.5a$

$1.5 \times 9.81 \times \sin 30^0 n - (T + 0.3 \times 1.5 \times 9.81) \cos 30^0\ 1.5a$

$7.3575 - T - 4.4145 = 1.59$

$3.5345\ T = 1.5a$

For body A:

T – NR, = ma
T – 0.3 x 9.81 x 0.5 = 0.5a
T – 1.4715 = 0.5a ------(2)
(1) + (2) gives;
1.4715 = 2.0a
a = 1.032 ms^{-2}

ii) In (1) 2.943 – T = 1.5 x 1.034
$\therefore$ T = 1.99N

3a) i) Is the force exerted on a body of mass 1 kg placed in a gravitational field.
ii) Is the velocity a body must be fired with from the surface of a planet so that it goes beyond the gravitational influence of the planet.

b. Gravitational potential energy, P.E = mass x grav. Potential

$$\text{P.E} = \text{m x}\frac{\text{GM}}{\text{R}}$$

Kinetic energy, K.E $=\frac{1}{2}$ mv^2
To escape K.E =P.E

$$\frac{1}{2}mv^2 = \frac{\text{GmM}}{\text{R}}$$

$$v^2 = \frac{2\text{ GM}}{\text{R}}$$

On earth's surface $\frac{\text{GMm}}{\text{R}^2} = \text{mg}$

$$\text{GM} = \text{gR}^2$$

$$V^2 = \frac{2gR^2}{R}$$

$\sqrt{2gR}$

c. In orbit, satellite has mechanized energy, E $= \frac{-\text{GM}}{2}$
When it encounters resistance, energy is lost and satellite falls into orbit of smaller radius. In the new orbit P.E reduces since P. E$= \frac{-\text{GMm}}{\text{r}}$ but the K.E increases; K.E $= \frac{\text{GMm}}{2\text{r}}$
Increase in K.E Implies satellite speeds up and moves faster which causes a heating effect on the satellite.

d. A spring is clamped on a retort stand and a pointer fixed at the free end. A meter rule is placed next to the pointer. Initial position of pointer is noted and recorded. A known weight is attached to the spring and new position of pointer is noted and recorded. Extension e on spring is calculated mass is given a slight displacement and released. Time, t for 10 oscillations is obtained. Period T is calculated and valve of T^2 is got. Procedure is repeated for other masses.
A graph of T^2 against extension is plotted slope, S is obtained and g is got from

$$g = \frac{4\pi^2}{5}$$

e i) Banking a track is the building of a track around a corner with the outer edge raised above the inner edge so that a car ca negotiates the curve without relying on friction.

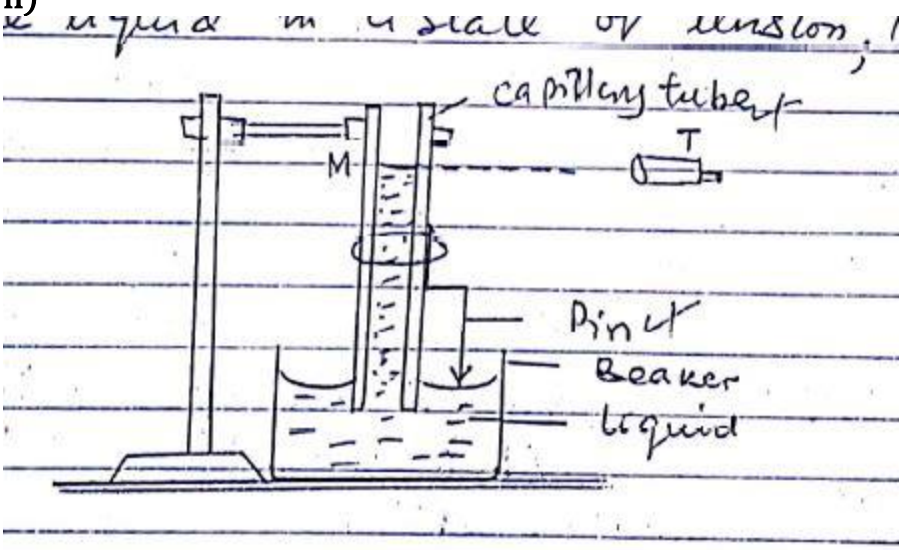
ii) $v^2 = rg \tan\theta \Rightarrow 100^2 = 5000 \text{ x } 9.81 \tan\theta$

$\theta = 11.5^0$

4a i) Is the force per unit area acting between two layers of third in a region of unit velocity gradient.
ii) Surface tension is the force per unit length acting at right angles to a length in the surface.

b i) Molecules inside a liquid are spaced at equilibrium separation. The molecules move about and the average force on a molecule inside the liquid is zero. Molecules near the surface have more separation then those inside.
The average separation between molecules is greater than equilibrium. Therefore, there are attractive forces that link surface molecules. This puts the surface of the liquid in state of tension; thus, the surface tension.

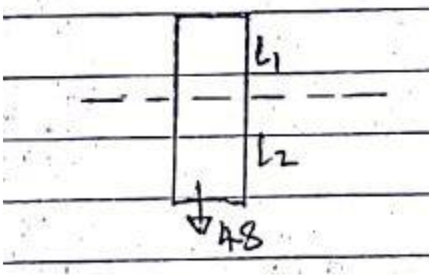
ii)



A pin bent a t right angle in two parts is attached to a capillary tube using rubber band. The pin is adjusted until its tip just touches the surface of liquid in a beaker. A traveling microscope, T is focused on the meriscus, M. The scale reading S, is noted and recorded. Beaker is carefully removed leaving the capillary tube and pin in position. Travelling microscope is now focused on the tip of the pin. New scale reading S_2 is noted and recorded. The capillary rise h = I $S_2 - S_1$ I. The radius r of capillary tube is obtained by measuring its diameter, d. For known angle of contact, θ the surface tension, $\propto$ is given by $\propto = \frac{\ell h r g}{2\cos\theta}$; ℓ = density of liquid

c. Archimedes' principle states that when a body is wholly or partially immersed in a fluid, it experiences an upthrust equal to weight of fluid displaced.

d. i)



Mass of hydrometer = mass of water displaced

$48 = $ Volume displ x density

$48 = AL_2\ell$

$48 = 0.8 \text{ X } L_2 \text{ X h}$

$L_2 = 60.0\text{cm}$

Volume = (60.0 + 6) x 0.8 = 52. 8cm^3

or V = 5.28 x 10^{-5}m^3

ii) Mass of hydrometer = mass of liquid displaced

48 = 0.8L x 1.4

L = 42.9cm

Length above surface L = 66.0 – 42.9

L = 23.1cm

e) Laminar flow is a type of flow where equidistant layers from; of flow have same velocity, the flow line are parallel and the flow is orderly.
Turbulent flow is a type of flow where equidistant layers from axis of flow have varied velocities, the flow lines are not parallel and the flow is disorderly.

SECTION B

5a i) Is the physical property which varies linearly and continuously with change in temperature.

Pressure of gas at constant volume, length of liquid column.

ii) Coil of thermometer is placed in a medium at triple point of water. Resistance Rtr is measured and recorded.
Coil is placed in contact with object whose temperature is unknown. Resistance, R_T is measured and recorded. The unknown temperature is given by $T = \frac{RT}{Rv} \times 273.16K$

b i). Newton's law of cooling states that the rate of cooling of a body is proportional to the excess temperature over the surroundings.

ii) A thermometer is suspended in air and the room temperature, θ_R, is recorded. Hot liquid is poured in a calorimeter and placed near an open window.
Temperature, θ of liquid is recorded at equal time interval. A graph of θ against time is plotted.
Gradient to the curve is got at $\theta = \theta_1$,. More gradients are got at θ_2, θ_3,---θ_6, The gradient gives the rate of fall of temperature. For each temperature value used to find the gradient, calculate the excess temperature, (θ - θ_2). A graph of rate of temperature fall against excess temperature is plotted.
A straight-line graph through the origin verifies Newtons' law of cooling.

c. Molecules in a solid vibrate about a fixed pattern.
When a solid is heated its temperature increases due to increase in internal energy due to increased K.E of the molecules. They vibrate more and there is increased separation. Continued heating increases the temperature to the melting point. Here the separation

becomes so large that the regular pattern collapses. The solid liquifies without change in temperature.

d. $Mc \Delta \theta = m_1 lf + (m_1 + m_2)\, c \Delta \theta \; + c \Delta \theta$

$2 \times 400\,(\theta - 20) = 0.055 \times 3.4 \times 10^5 + (0.055+0.23)\, 4200 \times (20.0 + 64 \times 20$

$\theta - 20 = 91.5$

$\therefore\ \theta = 569^0C$

6 a i) Is a process which takes place at constant temperature

ii). For a diabatic change; gas is enclosed in a thick-walled vessel which is poorly conducting and process is rapid such that no heat enters or leaves.

b i) All matter consists of tiny particles in a state of motion increases with increase in temperature.

ii) Smoke is confined in a smoke cell. The smoke cell is strongly illuminated by light from an arc source.

The microscope is used to view the inside of the smoke cell. Smoke particles are seen moving randomly within the smoke cell, the random motion is due to continual random impacts by gas molecules.

iii) Let m = mass of gas molecule $\quad \ell$=length of cable

u = initial speed of molecule

t = time taken from one wall of cube and back

Initial momentum = mu

Final momentum = -mu

Change in momentum = 2mu

Time taken for change in momentum, $t = \frac{2l}{u}$

Rate of change in momentum $= 2mu \times \frac{u}{2l} = \frac{mu^2}{l}$

$\Rightarrow$ force, $f = \frac{mu^2}{l}$

Pressure = force ÷ area

$P = \frac{mu^2}{l} \times \frac{1}{l^2} = \frac{mu^2}{l^3}$

For N molecules total pressure is given by

$P = \frac{m_1^2}{l} + \frac{m_2^2}{l} + \text{---------} + \frac{mu_N^2}{l^3}$

$= \frac{m}{l^3}\left(u_1^2 + m_2^2 + \text{------} + u_N^2\right)$

$U^2 = \frac{u_1^2 + u_2^2 + --- + u_N^2}{l}$

$u_1^2 + u_2^2 + \text{--------} + u_N^2 = NU^2$

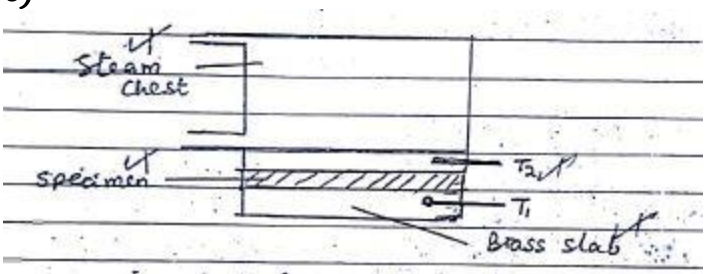
$P = \frac{NMU^2}{l^3};\ \frac{NM}{l^3} = \ell$, density of gas

$P = \ell\, \overline{U}^2$

7 a) Is the rate of heat transfer per unit cross – sectional area, per unit temperature

b) A liquid contains molecules that move above variable positions. When liquid in a container is heated at the bottom, it expands because of less dense and rises to the top. The cold liquid which is more dense sinks to take place of warm risen liquid. This movement of the liquid creates a convection current that carries heat to all parts of the liquid with actual movement of the liquid.

c)



Specimen is cut in form of a disc of thickness, x and cross – sectional area, A. Disc is sand witched between brass slab and steam chest. The adjoining faces are smeared with Vaseline to improve thermal contact. Steam is passed through the steam chest until the thermometers T_1 & T_2 show steady temperatures. Temperatures Q_1 and Q^2 are recorded. At steady state; $\frac{Q}{t} = \frac{KA(\theta_2 - \theta_1}{x}$

Specimen is removed and slab is directly heated until its temperatures is at least 10^0C above θ_1.

The steam chest is removed and specimen. Put back on the brass slab. The temperature of the slab is recorded at equal time interval until it falls below θ_1. A graph of temperature against time is plotted. The slopes to the graph at $\theta = \theta_1$ is calculated. The rate of heat loss by slab at θ_1 is given by $\frac{Q}{t}$ = mcs where m = mass of slab

C = specific heat capacity of brass

$\Rightarrow \frac{KA(\theta_2 - \theta_1}{x} = \text{mcs}$

$\therefore K = \frac{mcs\,x}{A(\theta_2 - \theta_1}$. Thus, thermal conductivity K can be calculated.

ii) Thin to create a steep temperature gradient.

Large cross – sectional area to allow equate heat flow.

d i) A black body is a body that absorbs all radiation incident on it, reflects and transmits none.

ii) Stefan's laws states that the power radiated per unit surface area is proportional to the fourth power of the absolute temperature.

ei) Power radiated = $AST^4 = 4\pi r^2 \delta T^4$

power received = $\frac{10}{4\pi R^2} x 4\pi r^2 \delta T^4$

power re-radiated =AST^4 = $4x106T^4$

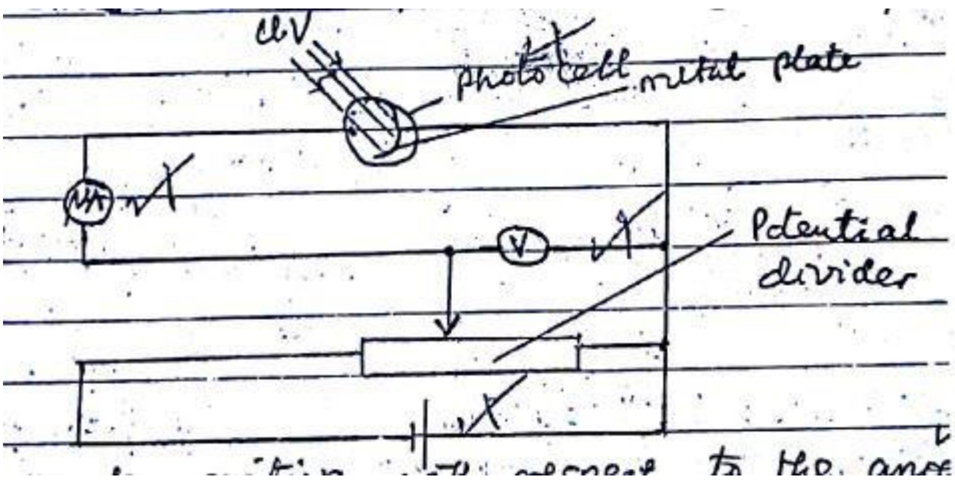
$$\frac{10}{4\pi R^2} x4\pi r^2 6T^4 = 106T^4$$
$$\frac{r^2}{R^2} T^4 = T^4$$
$$\left(\frac{20}{50}\right)^2 T^4 = 313^4$$
$$\therefore T = 494.9k$$

ii) short wave radiation from the sum penetrates glass and is absorbed by plants and the soil. Temperature of plants and soil increases and they re-radiate long wave length radiation which is trapped within the green house. The trapped radiation increases temperature of the green house. The increase in temperature is of green house is called greenhouse offset.

SECTION C

8ai) work function is the minimum energy required for an electron to be emitted by a metal surface

ii) Stopping potential is the positive potential which must be applied to a metal surface to stop photoelectric emission at a particular light fregue



Cathode is made positive with respect to the anode
A monochromatic beam is directed onto the cathode of a photocell as above. The potential of the plate is increased positively until the microammeter reading is zero. The voltmeter reading is noted and recorded. The value recorded is the slopping potential.

C Most alpha particles were deflected through the foot and few alpha particles were deflected through sr angles less than 90°
Very few alpha particles were deflected through angles greater than 90°

di) An energetic electron penetrates the atom to displace an electron to a high energy level. Atom becomes excited and unstable. An electro later and in random manner falls from his energy level to occupy vacancy left in the lower energy level. This electron transition is accompanied by emission of electromagnetic radiation of definite frguency and is characteristic of the electronic structure of the largest atoms.

ii) $ev = h\delta max = h\frac{c}{\lambda min}$

$1.6x10^{-19}x12x10^{3} = \frac{6.6x10^{-34}x30x10^{8}}{\lambda min}$

$\therefore \lambda\ min = 1.03x10^{-10}m$

ei) the energy value is negative because an electron is bound to the nucleus therefore work has to be done to move the electron to infinity where energy of electron is zero

ii) $E_2 - E_1 = h\frac{c}{\lambda}$

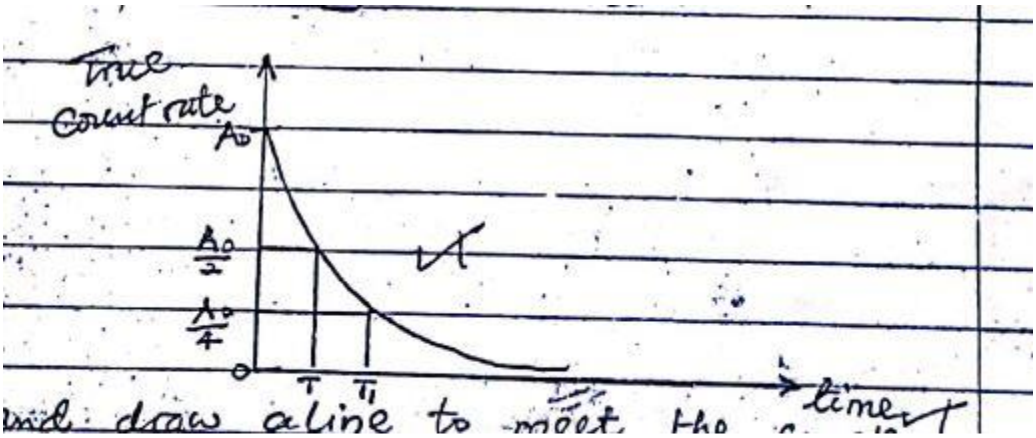
$(-21.4 - {}^{-}24.6)x1.6x10^{-19} = \frac{6.63x10^{-34}x3.0x10^{8}}{\lambda}$

$\therefore \lambda = 3.88x10^{-7}m$

9ai) Is the energy required to split the nucleces into its protons and neutrons.

ii) Is one twelfth the mass of one atom of carbon-12 isotope

b GM tube is put on and background count rate is noted and recorded. A source of radiation is placed near the GM tube and the count rate is recorded at equal time interval. A graph background count rate is subtracted from the measured count rate to get the true count rate. A graph of true count rate is plotted against time.



Get $\frac{A_0}{2}$ and draw a line to meet the curve, Drop appendicular to the teme-axiz. Read off T.

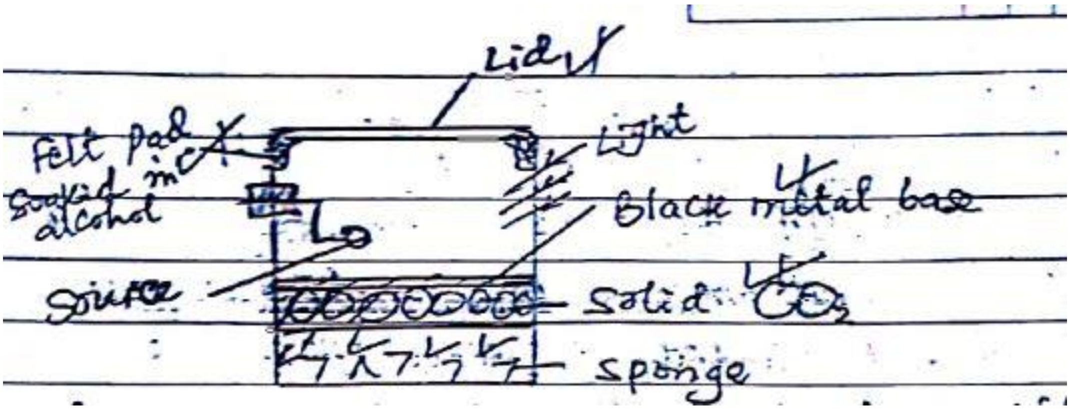
Repeat for $\frac{A_0}{4}$ and read off T_1

Half-lite $T\frac{1}{2} = \frac{T+T_1}{2}$

C Nuclear fusion is a process where two small nuclei combine to form a hearier nucleus accompanied by the release of energy.

Nucleus fission is a process where a heavy nucleus splits into two lighter nuclei compared by the release of energy

d



Top of chamber is at room temperature while bottom is kept at very low temperature by solid CO_2. This creates a temperature gradient between top and bottom of chamber. Air in the chamber is saturated with alcohol vapour from the felt ring. The saturated air diffuses downwards into the cooler region until it becomes supersaturated. When the source is exposed, it ionizes the air molecules and leaves a trail of ions along its path. The supersaturated vapour condenses on the ions forming a sense of droplets. The droplets can be viewed by light scattered from them when the chamber is illuminated. The length and ethicalness of track show the extent to which ionisation has occurred.