P510/1
PHYSICS
Paper 1
AUGUST, 2018
2½ hours

JINJA JOINT EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS – AUGUST, 2018

PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*Attempt not more than **five** questions including at least one but **not more than two** from each of the sections **A**, **B** and **C**.*
Any additional question(s) answered will not be marked

Where necessary, assume the following constants:

Acceleration due to gravity, g	=	$9.81\ m\ s^{-2}$
Avogadro's number, N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Charge to mass ratio of an election	=	$\mathbf{1.7\ x\ 10^{11} CKg^{-1}}$
One electron volt, eV	=	$1.6 \times 10^{-19}\ J$
Planck's constant, h	=	$6.6 \times 10^{-34}\ J\ s$
Radius of the earth	=	$6.4\ x\ 10^{6}m$
Specific heat capacity of water	=	$4.2 \times 10^{3}\ J\ kg^{-1}K^{-1}$
Specific latent heat of fusion of ice	=	$3.36\ x\ 10^{3}JKg^{-1}K^{-1}$
Stefan's – Boltzmann's constant, δ	=	$5.67 \times 10^{-8}\ W\ m^{-2}K^{-4}$
Speed of light in Vacuum, c	=	$3.0 \times 10^{8}\ m\ s^{-1}$
Unified mass unit, U	=	$1.66 \times 10^{-27}\ kg$
Universal gas constant, R	=	$8.31Jmol^{-1}K^{-1}$

SECTION A

1. (a) (i) What is a satellite? (1 mark)

(ii) Derive an expression for the total mechanical energy of an earth satellite. (5 marks)

(iii) Explain what happens to a satellite when it falls to an orbit of a smaller radius. (4 marks)

(b) A satellite is travelling in a circular orbit which is 100km above the earth's surface. Find the period of the satellite. (5 marks)

(c) Describe a simple experiment to determine the acceleration due to gravity using a spiral spring and a set of masses. (5 marks)

$T = \frac{w}{2\pi} \frac{2\pi}{w}$

2. (a) (i) Define surface tension and find its dimensions. (4 marks)

(ii) Explain the effect of soap solution on the surface tension of water. (3 marks)

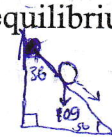
(b) Describe an experiment to determine the surface tension of a liquid by Jaeger's method. (6 marks)

(c) Derive an expression for the excess pressure in a bubble of air within a liquid. (3 marks)

(d) A thin circular wire of diameter 4.0cm and total mass 0.70g is gently pulled vertically from a water surface by means of a sensitive spring with spring constant $0.75Nm^{-1}$. When the spring is stretched 3.4cm from its equilibrium extension in air with no ring attached, the ring is on the verge of being pulled free from the water surface. Find the coefficient of surface tension of water. Neglect the mass of the lifted water. (4 marks)

3. (a) Define vector and scalar qualities and give two examples of each. (4 marks)

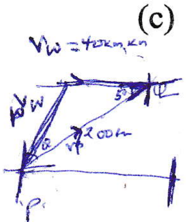
(b) A ball of mass 10kg hangs from a fixed point by a light inextensible string on a vertical wall. It is pulled aside horizontally by a boy and rests in equilibrium with the string inclined at an angle of 36° to the wall. Find the:



(i) pull of the boy (4 marks)

(ii) tension in the string (2 marks)

(c) (i) define the relative velocity of car A with respect to car B. (1 mark)



(ii) Two airfields P and Q are 500km apart with Q on a bearing of 060° from P. An aircraft which can travel at 200km in still air is to be flown from P to Q. If there is a wind of $40kmh^{-1}$ blowing from the west, find the course that the pilot must set in order to reach Q and find to the nearest minute the time taken. (6 marks)

(d) Describe an experiment to measure the centre of gravity of an irregular piece of cardboard. (3 marks)

4. (a) State the conditions for each of the following to be conserved.

(i) linear momentum (1 mark)

(ii) mechanical energy of a body in motion. (1 mark)

(b) (i) State Newton's laws of motion (3 marks)

(ii) A particle X of mass 100g initially moving with a speed of $10ms^{-1}$ to the East collides with particle Y of mass 200g moving at $15ms^{-1}$ to the south. After collision X moves with a speed $5ms^{-1}$ on a bearing of 060° while Y moves with a speed V in the direction of S$(90 - \boldsymbol{\theta})$° E. Determine the values of V and Q. (5 marks)

(c) (i) What is uniform acceleration? (1 mark)

(ii) Sketch a distance – time graph for a uniformly accelerated motion. (1 mark)

(d) A stone is projected vertically upwards from a point 980m above the ground with a velocity of $49ms^{-1}$. Find how long it will take to reach the ground. (5 marks)

SECTION B

5. (a) (i) State Newton's law of cooling. (1 mark)

(ii) Describe an experiment to verify Newton's law of cooling. (6 marks)

(b) (i) What is a cooling correction? (1 mark)

(ii) Explain how a cooling correction can be obtained for a poor solid conductor. (5 marks)

(c) (i) define specific latent heat of fusion of ice. (1 mark)

(ii) A solid of mass 0.5kg and specific heat capacity 4.0 x $102Jkg^{-1}K^{-1}$ and temperature 90°C, is placed into a mixture of ice and 0.10kg of water contained in a vacuum flask. The final temperature is found to be 10°C. Calculate the mass of ice initially in the mixture. (6 marks)

$\rho = \frac{m}{V}$

$\frac{dQ}{dt} = mc\theta = \rho V c\theta$

Heat by solid = $m_s L_v + m_w c_w (10)$

$m_s c_s (90-10) =$

6. (a) What is meant by:

(i) thermal conductivity, (1 mark)

(ii) coefficient of thermal resistance. (1 mark)

(b) State two precautions that must be taken into account when measuring the thermal conductivity of a metal. (2 marks)

(c) Describe an experiment to determine the thermal conductivity of glass. (6 marks)

(d) (i) What is meant by a black body? (1 mark)

(ii) Using the same axes, sketch graphs to show the distribution of energy in the spectrum of black body radiation for two different temperatures. (2 marks)

(iii) Use the graph in c(ii) above to explain why the radiation becomes more white as the temperature increases. (2 marks)

(e) A spherical body of radius 20mm emits 65% of the radiation emitted by a black body and is at a temperature of 27°C. Calculate the initial rate of fall of temperature of the body if the surrounding temperature is -20°C, specific heat capacity of the body is $400JKg^{-1}K^{-1}$ and its density is $8300Kgm^{-3}$. (5 marks)

7. (a) (i) State the assumptions for ideal gasses that have to be modified when stating the expression for pressure of a real gas. (1 mark)

(ii) Derive the equation $P = \frac{1}{3}PC^{\bar{2}}$, for pressure, P of an ideal gas where the symbols carry their usual meaning. (5 marks)

$PV = nRT$

(b) (i) Define saturated vapour pressure. (1 mark)

(ii) A long uniform horizontal capillary tube, sealed at one end and open to air at the other contains air trapped behind a short column of water. The lengths of the air column at the temperature 27°C and 83°C are 10cm and 30cm respectively. Given that vapour pressures of water at 27°C and 30°C are 4.0 x 10^3***Pa*** and 62.0 x 10^3***Pa*** respectively, calculate the atmospheric pressure. (5 marks)

$L = 2\pi r$

$V = Al$

(c) (i) State the first law of thermodynamics. (1 mark)

(ii) What is meant by an isothermal and an adiabatic process? (2 marks)

(iii) A fixed mass of a gas is in an initial state A given by P_1, V_1, T_1. The gas expands adiabatically to state B given by P_2, V_2, T_2. It is then heated up at constant volume until it reaches the initial temperature at a state C, given by P_3, V_2, T_1. Show that γ is given by $\left(\frac{P_1}{P_3}\right)^{\gamma} = \frac{P_1}{P_2}$.

Where γ is the ratio of the molar heat capacities of the gas.

SECTION C

8. (a) What are the differences between beta particles and gamma rays? (3 marks)

(b) You are provided with a radioactive source. Use an expansion cloud chamber to determine the type of radiation given off by the source. (9 marks)

(c) State two uses and two health hazards of nuclear radiation. (2 marks)

(d) A freshly prepared sample of a radioactive isotope contains 10^{20} atoms. The half life of the isotope is 12 hours. Calculate the;

(i) initial activity (3 marks)

(ii) number of radioactive atoms remaining after one hour. (3 marks)

9. (a) (i) What is meant by an absorption spectrum? (1 mark)

(ii) Define the terms ionization energy and excitation energy of an atom. (2 marks)

(b) The energy levels of the hydrogen atom are given by the expression $E_n = -2.16 \times 10^{-18}$J, where n is an integer. $E_n = \frac{-2.16 \times 10^{-18}}{n^2}$ J

(i) What is the ionization energy of the atom? (1 mark)

(ii) What is the wavelength of the line which arises from transitions between n=3 and n=2? State the region where it lies. (3 marks)

(c) (i) Explain the experimental observations made in alpha scattering experiment by Rutherford. (4 marks)

$E_1 = hf = h\frac{c}{\lambda}$

(ii) In experiment c(i) alpha particles of mass 7.0×10^{-27}kg and speed $2.0 \times 10^{7}ms^{-1}$ were fired at a gold nucleus. What was the closest distance of approach between an alpha particle and the gold nucleus? (Atomic number of gold = 79).

(d) State the characteristic features of photoelectric effect. (4 marks)

10. (a) (i) Define specific charge of an electron. (1 mark)

(ii) Describe how the specific charge of an electron is measured by the fine bean method. (6 marks)

(b) An electron emitted from a hot cathode is accelerated by a p.d of 10^3V. The electron then enters at right angles into a uniform magnetic field of flux density 10^{-3}T. Calculate the;

(i) initial speed of the electron (3 marks)

(ii) radius of its path (3 marks)

(c) (i) What is thermionic emission? (1 mark)

(ii) Describe the mechanism of thermionic emission. (4 marks)

(d) State any two precautions taken during Millikan's oild drop experiment. (2 marks)

 End.

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UGANDA ADVANCED CERTIFICATE OF EDUCATION

P510/1 PHYSICS

MARKING GUIDE 2018

1. a) (i) A satellite is any small mass which orbits a much larger mass.

(ii) Let a satellite of mass, m revolve in a circular orbit of radius, r_o with speed, v. let M_e e the mass of the earth.

$$\frac{MV^2}{r_o} = \frac{GM_e m}{r_0^2} \rightarrow mV^2 = \frac{GM_e m}{r_o}$$

$$K.e = \frac{1}{2} MV^2 = \frac{GM_e m}{2r_o}$$

The work done by the gravitational force in moving a distance Δr towards the earth = force × distance = $\frac{GM_e m}{r^2} \Delta r$

Hence the potential energy at a point distance r_o from the centre of the earth is given by $V r_o$ = $\int_{\infty}^{r_o} \frac{GM_e m}{r_0} dr = \frac{-GM_e m}{r_o}$

Thus total mechanical energy =

$$K.e + V_{r_o} = \frac{GM_e m}{2r_0} - \frac{GM_e m}{r_o} = \frac{-GM_e m}{2r_o} = \frac{gr_e^2 m}{2r_o}$$

(iii) Kinetic energy of the satellite increases, while potential energy decreases. Thus the speed of a satellite increases when it falls to an orbit of a smaller radius. Frictional force increases and the temperatûre of the satellite rises and may burn out if no precautions were taken.

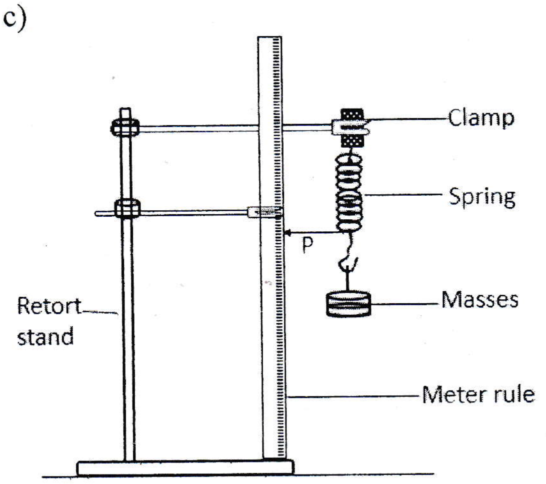
b) $R = (6.4\times 10^6 + 0.1 \times 10^6) = 6.5\times 10^6$

from $mRw^2 = \frac{GM_e m}{R^2} \rightarrow w^2 = \frac{GM_e}{R^3}$

but $w = \frac{2\pi}{T} \rightarrow \frac{4\pi^2}{T^2} = \frac{GM_e}{R^3}$ but $GM_e = gr_e^2$

$$\rightarrow T^2 = \frac{4\pi^2 R^3}{gr_e^2} = \frac{4\pi^2(6.5\times10^6)^3}{9.81(6.4\times10^6)^2} \quad \therefore T = 5.194 \times 10^3 \text{ s}$$

c)



P = pointer

One end of the spring is clamped to a stand as shown. A pointer is fitted to the free end of the spring and the metre rule is clamped besides the spring as shown. The initial position of the pointer is noted. A known mass is attached to the free end of the spring. The new position of the pointer is noted.

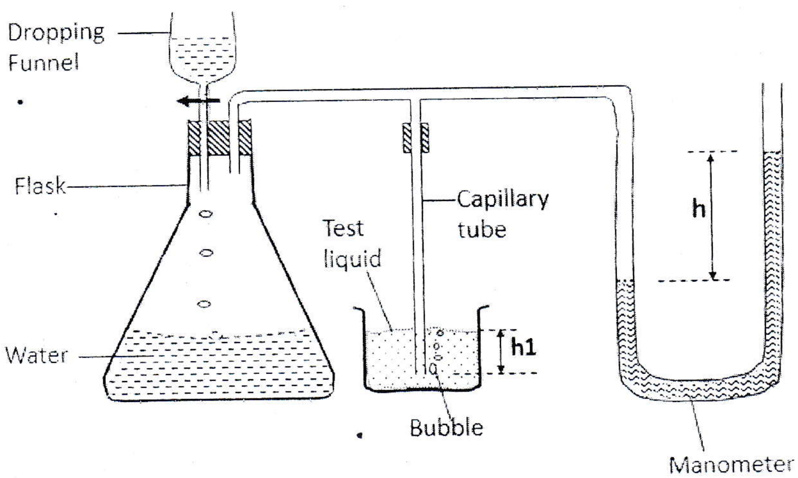
Hence the extension x is determined. The mass is displaced through a small vertical distance to make it oscillate. The time for twenty complete oscillations is determined and hence the period, T obtained. The procedures are repeated for different masses. A graph of T^2 against x is plotted and the slope s determined. $g = \frac{4\pi^2}{s}$

2. a) (i) Surface tension is the force acting perpendicularly on one side of an imaginary line of length one metre drawn in the surface of a liquid.

$$[\gamma] = \frac{[force]}{[length]} = \frac{MLT^{-2}}{L} = MT^{-2}$$

(ii) Surface tension is due to cohesive forces between water molecules. When soap solution is added to pure water, it mixes with water. The molecules of soap will be between molecules of water. The presence of molecules of soap reduces the cohesive forces between water molecules hence reduction in surface tension of water.

b)



The atmospheric pressure P is measured using a barometer. The radius of the capillary tube is measured using a travelling microscope. The apparatus is arranged as shown above. The pressure inside the apparatus is increased gradually by allowing water to enter the flask from the dropping funnel. An air bubble grows at the end of the capillary tube in the beaker in the test liquid and as it does so the pressure rises to a maximum and then falls as the bubble breaks away. The maximum pressure, h recorded by the manometer is measured. The depth h_1 from top of liquid in beaker to the end of capillary tube immersed in liquid is measured. Pressure inside bubble = $P + h\rho g$. P is density of liquid in manometer and g is acceleration due to gravity. Pressure in liquid outside bubble = $P + h_1 \rho_1 g$. ρ_1 is density of test liquid,

$$\frac{2\gamma}{r} = (P + h\rho g) - (P + h_1\rho_1 g)$$

$$\therefore \gamma = \frac{rg}{2}(h\rho - h_1\rho_1)$$

c) Consider a bubble of radius, r in a liquid of surface tension. Let P be atmospheric pressure and P excess pressure inside the air bubble.

$$P\pi r^2 + 2\pi r\gamma = (P + \rho)\pi r^2$$

$$\therefore P = \frac{2\gamma}{r}$$

d) $Kx = mg + \gamma l$, $l = 2(2\pi r)$

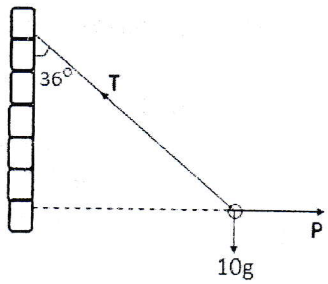
$$\gamma = \frac{Kx - mg}{4\pi r}$$

$$= \frac{0.75 \times 3.4 \times 10^{-2} - 7.0 \times 10^{-4} \times 9.81}{4\pi\ (2 \times 10^{-2})}$$

$$= 7.6 \times 10^{-2}\ \text{Nm}^{-1}$$

3. a) A vector quantity is a physical quantity whose magnitude and direction are stated. e.g. force, velocity. A scalar quantity is a physical quantity whose magnitude alone is stated e.g. mass, work.

b) (i)



Resolving horizontally;

$T \sin 36 = P$ .... (i)

Resolving vertically;

$T \cos 36 = 10g$ .... (ii)

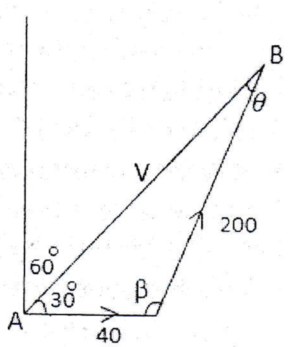
Dividing (i) by (ii) $\tan 36 = P/10g$

$\therefore P = 10 \times 9.81 \tan 36 = 71.2N$

(ii) From (ii) $T = \dfrac{10 \times 9.81}{\cos 36} = 121.2N$

c) (i) is the velocity of car A as seen by the driver of car B.

(ii)



$$\frac{200}{\sin 30} = \frac{40}{\sin\theta}$$

$\text{Sin}\theta = \dfrac{\sin 30}{5}$ $\therefore \theta = 5.74°$

$\beta = 180 - (30 + 5.74) = 144.26°$

Course $(144.26 - 90) = 054.26°$

$V^2 = 40^2 + 200^2 - 2x40x200\cos 144.26$

$\therefore V = 233.6\text{kmh}^{-1}$

Time taken $= \dfrac{distance}{speed} = \dfrac{500}{233.6} \approx$ 2hours 8minutes

d) Make three holes around the edges of the cardboard. Suspend the cardboard to swing through one of the holes from a pin and suspend a plumb line from the pin and locate its position. Mark the outline of the plumb line on the cardboard suspended from other holes. The intersection of the outlines is the centre of gravity of the sheet.

4. a) (i) No external force should act on the system of colliding objects.

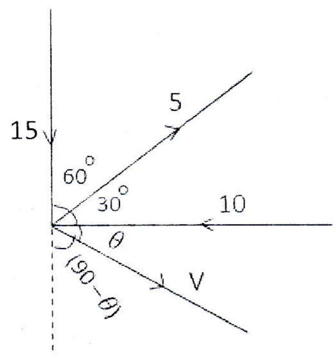
(ii) There should be a conservative force field.

b) (i) Every body continues to be in state of rest or uniform motion in a straight line unless compelled to change that state by an external force.

The rate of change of momentum of a body is proportional to the applied force and takes place in the direction of the force.

To every action there is equal and opposite reaction.

(ii)



Resolving momentum horizontally

$10x0.1 = 5x0.1\cos30 + 0.2V\cos\theta$

$0.2V\cos\theta = 0.567$ .... (i)

Resolving vertically

$15x0.2 = 0.2V\sin\theta - 0.5\sin30$

$0.2V\sin\theta = 3.25$ .... (ii)

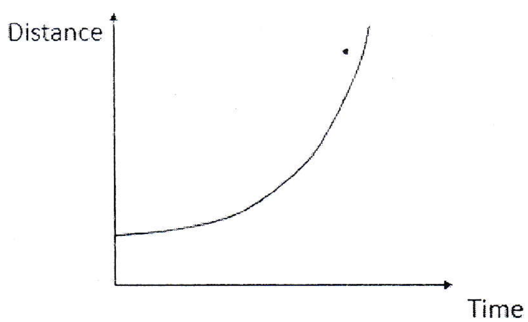
Dividing (ii) by (i)

$\tan\theta = 5.73 \quad \therefore \theta \approx 80^o$

From (i) $V = \dfrac{0.567}{0.2\cos80} = 16.5ms^{-1}$

c) (i) Uniform acceleration is when the velocity of a body changes by the same magnitude per unit time.

(ii)



d) From $h = ut - \frac{1}{2}gt^2$

$-980 = 49t - \frac{1}{2}9.81t^2$

$4.905t^2 - 49t - 980 = 0$

$t = -10$ or 20

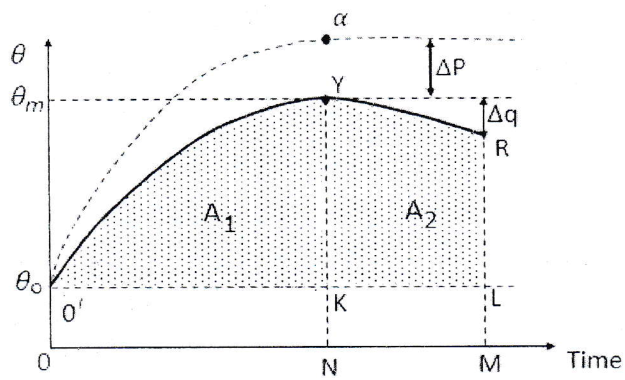
$\therefore t = 20s$

5. a) (i) Under forced convection the rate at which a body loses heat is proportional to the difference in temperature between the body and the surroundings.

(ii) Read and record the room temperature, θ_R. Heat water in a beaker until temperature is steady. Switch off the heater. Record the temperature of the water as it cools at suitable, interval of time until when the temperature is almost constant. As you record gently stir the water with the bulb of thermometer. Plot a graph of temperature against time to obtain the cooling curve. From the graph determine the rate of temperature fall at different times. Obtain the excess temperature, θ.from $\theta =$

$\theta_1 - \theta_R$ for each rate. Where θ_1 is temperature at any time, t. plot a graph of rate of fall of temperature$\frac{d\theta_1}{dt}$ against θ. it is a straight line $\rightarrow \frac{d\theta_1}{dt} \propto \theta$.
Hence Newton's law of cooling.

b) (i) A cooling correction is temperature when added to the observed maximum temperature gives the estimated maximum temperature if there were no heat losses.
(ii)



Ordinate YN is drawn through the peak X or Y. ensure OM is at least twice ON, another ordinate RM is drawn. The abscissci O'KLM is drawn through room temperature θ_o. Areas A_1 and A_2 are estimated by counting squares of the graph paper.
Then $\frac{\Delta p}{\Delta q} = A_1 / A_2$.
$\rightarrow \Delta p = \Delta q(A_1 / A_2)$ and Δp *is added to* θ_m

c) (i) it is the amount of heat required to convert 1kg of ice to its melting point into water at 0^0C.

(ii)

Heat loss by solid cooling from 90°C to 10°C	=	Heat gained by ice melting at 0°C	+	Heat gained by melted ice and water warming from 0°C to 10°C

Let M be the mass of melted ice

$M_s C_s (\theta 2 - \theta 1) = M l + (M+0.1)\, C_w (\theta 2 - 0)$

$0.5 \times 4 \times 10^2 (90 - 10) = 3.36 \times 10^5\, M + (M+0.1)\, 4.2 \times 10^3 \times 10$

$2 \times 10^2 \times 80 = 3.36 \times 10^5 M + 4.2 \times 10^4 M + 4.2 \times 10^3$

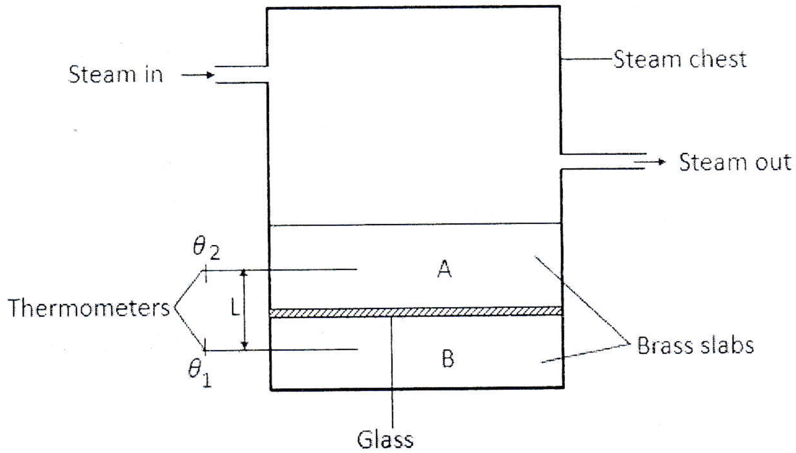
$16 \times 10^3 - 4.2 \times 10^3 = 3.78 \times 10^5 M$

$\therefore\ M = 3.12 \times 10^{-2}$ kg

6. a) (i) Is the rate of heat flow through a material per unit cross-sectional area per unit temperature gradient.
(ii) Is a resistance to the heat flow per unit cross-sectional area.

b) Should be very long and small cross-sectional area. The bar should be well lagged.

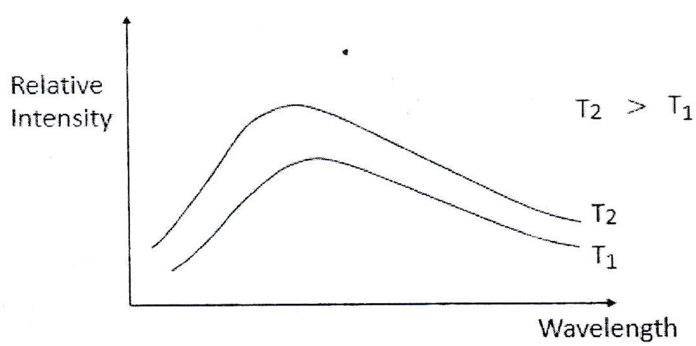
c)



Steam is passed through the steam chest until steady temperatures are attained and the readings of the thermometers θ_1 and θ_2 are recorded. The glass is removed and brass base heated directly from steam chest until its temperature rises by about 10^0C above θ_1 . Steam chest is removed and the top part of B is again covered with the glass. At suitable intervals of time, temperature of B are recorded. A graph of temperature against time is plotted. Slope to the curve at temperature θ_1 is calculated. The diameter of the glass is measured and the cross-sectional area A calculated. The thickness, l of the glass is measured using a micrometer screw gauge. If m and c are mass and specific heat capacity of B, then

$$K = \frac{mscl}{A(\theta_2 - \theta_1)}$$

d) (i) A body that absorbs all the radiation falling on it reflects and transmits none.



(iii) The body changes from its colour to red hot (λ_{max} in red region) yellow hot to white hot (λ_{max} at middle of spectrum). At this point different colours of radiations are emitted, they mix up and form white light.

e). P = $4\pi r^2 \varepsilon(T^4 - T_0{}^4)$ .... (i) P = $\frac{m}{t}$ C$\Delta\theta = \frac{4}{3}\pi r^3 \rho c$

$$\frac{\Delta\theta}{t} = \frac{3\sigma\varepsilon(T^4 - T_0{}^4)}{\rho c r} = \frac{3\times5.57\times10^{-8}\times0.65(300^4 - 253^4)}{8300\times400\times20\times10^{-3}}$$

$$= 6.5 \times 10^{-3}\ Ks^{-1}$$

7. a) (i) Molecules are of appreciable volume so their volumes cannot be neglected. Intermolecular forces of attraction are appreciable no collisions are not elastic.
(ii) Let a cube of side l above N molecules each of mas m moving with velocities $u_1, u_2, \ldots\ldots\ldots\ldots u_N$ in the x- direction. For one molecule, momentum change = $mu_1 - (-mu_1)$ = $2mu_1$. Time taken to move from one side to an opposite side and back $= \frac{2l}{u_1}$.

Rate of change of momentum = $2mu_1 \div \frac{2l}{u_1} = mu_1^2$ by 2nd law: $F = \frac{mu^2}{l}$, $A = l^2$ and pressure $= \frac{F}{A} = \frac{mu_1^2}{l^3}$.

For N molecules in x- direction

$$P = \frac{m}{l^3}(u_1^2 + u_2^2 + \ldots\ldots\ldots\ldots + u_N^2)$$

But $\overline{u^2} = \frac{u_1^2 + u_2^2 + \cdots\ldots\ldots + u_N^2}{N}$ and $\frac{M}{l^3} = \rho$

$P = \rho\,\overline{u^2}$. if c is the mean speed in x, y and z direction and u, v and w are x, y, z components of velocities then,

$$c^2 = u^2 + v^2 + w^2 \quad \Rightarrow \quad \overline{c^2} = \overline{v^2} = \overline{w^2}$$

For large number of molecules moving randomly,

$$\overline{u^2} = \overline{v^2} = \overline{w^2} \quad \Rightarrow \quad \overline{c^2} = 3\overline{u^2}$$

$$\therefore \overline{u^2} = \tfrac{1}{3}\overline{c^2}$$

$$\Rightarrow \quad p = \tfrac{1}{3}\rho\,\overline{c^2}$$

b) (i) is a pressure of the vapour which is in equilibrium with its own liquid.

(ii). Let the atmospheric pressure be H

$P_1 = (H - 4\times 10^3)$, $V_1 = 10A$, $T_1 = 273+27 = 300$

$P_2 = (H - 62\times 10^3)$, $V_2 = 30A$, $T_2 = 273+87 = 360$

From $\frac{PV}{T}$ = a constant

$$\frac{(H - 4\times 10^3)10A}{300} = \frac{(H - 62\times 10^3)30A}{360}$$

$$H = 1.01\times 10^5 \text{ Pa}$$

c) (i) Quantity of heat supplies to a substance goes in to increase internal energy of the substance thereby making it do work by expanding against atmosphere. Or

$Q = \Delta u + \Delta w$ (with definitions of symbols)

(ii) Isothermal change is change in volume of a gas at constant temperature.

Adiabatic change is change in volume of a gas in which no heat enters or leaves the gas.

(iii) State AB; $P_1^{1-\gamma}T_1^{\gamma} = P_2^{1-\gamma}T_2^{\gamma} \quad \Rightarrow \quad \frac{T2}{T1} = \left[\frac{P2}{P1}\right]^{1-\gamma}$ .... (i)

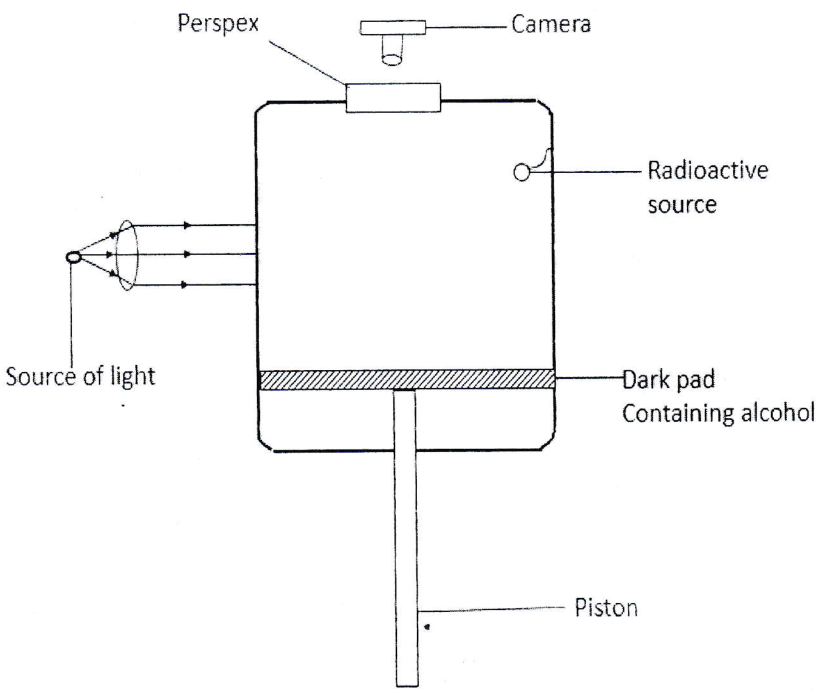
$$\frac{P_2}{T_2} = \frac{P_3}{T_1} \quad \Rightarrow \quad \frac{T_2}{T_1} = \frac{P_2}{P_3} \;\ldots\ldots\ldots\ldots \text{(ii)} \qquad \left[\frac{P_2}{P_3}\right]^{\gamma} = \frac{P_1}{P_2}\left[\frac{P_2}{T_1}\right]^{\gamma}$$

$$\therefore \left[\frac{P_1}{P_3}\right]^{\gamma} = \left[\frac{P_1}{P_2}\right]$$

8. a)

Alpha particles	Beta particles
Positively charged	Negatively charged
Least penetrating	More penetrating
More ionising	Less ionising
Less deviated by electric or magnetic field.	More easily deviated by electric or magnetic fields.

(b)



Liquid alcohol is placed on a dark pad on piston. The piston is quickly pulled down and air inside undergoes an adiabatic expansion and cools. Dust particles are carried away by drops forming on them. The dust free air is subjected to a controlled adiabatic expansion making the air supersaturated. Simultaneously the air is exposed to an ionising radiation. Water droplets collect around the ions produced which acts as centres of formation. The drops are illuminated and photographed by the light scattered from them.

If the tracks are thick and straight, the source is emitting alpha particles. If they are thin, β particles. For faint thin tracks, γ-rays.

c) Uses; checking thickness of paper, detecting leakages, treatment of cancer, detecting brain tumours. Hazards; causes leukaemia, eye cataracts, genetic mutation.

d) (i) $\lambda = \frac{ln2}{t_{1/2}} = \frac{ln2}{12\times60\times60} = 1.6\times 10^{-5}s^{-1}$

$\frac{dN}{dt} = \lambda N = 1.6\times 10^{-5} \times 10^{20} = 1.6\times 10^{15}s^{-1}$

(ii) $N = N_0 e^{-\lambda t} = 10^{20}e^{-1.6\times10^{-5}\times3600} = 9.44\times 10^{20}$atoms

9. a) (i) When white light passes through a hot gas, the atoms of the gas will absorb some photons whose frequency is sufficient to excite the atoms. The intensity of incident radiation will be reduced and a dark line absorption spectrum is observed against a white background.

(ii) Ionization energy is the energy required to remove the most loosely bound electron from the ground state of an atom.

b (i) $E_n = \dfrac{-2.16\times 10^{-18}}{n^2}$ $\Rightarrow E_1 = -2.16\times 10^{-18}$, $E_\infty = 0$

Ionisation energy $= E_\infty - E_1 = 0 - (-2.16\times 10^{-18}) = 2.16\times 10^{-18}$ J

(ii) $E_3 = \dfrac{-2.16\times 10^{-18}}{3^2} = -2.4\times 10^{-19}$, $E_3 = \dfrac{-2.16\times 10^{-18}}{2^2} = -5.4\times 10^{-19}$

$E_3 - E_2 = \dfrac{hc}{\lambda}$ $\Rightarrow -2.4\times 10^{-19} + 5.4\times 10^{-19} = \dfrac{6.6\times 10^{-34}\times 3\times 10^{8}}{\lambda}$

$\therefore \lambda = 6.6\times 10^{-7}$ visible spectrum

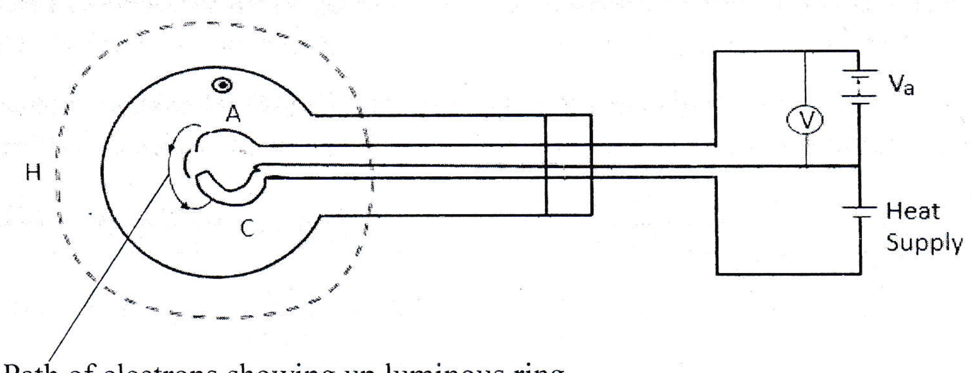
c) (i) most alpha particles pass through un deflected because most space in the atom is empty. A few are deflected at angles less than 90^0 because of repulsion from nucleus very few are deflected through angles greater than 90 because the nucleus occupy a small space.

(ii) From $\frac{1}{2} m u^2 = \dfrac{Q_1 Q_2}{4\pi\epsilon_0 d}$ $Q_1 = 2e$, $Q_2 = 79e$

$\frac{1}{2} m u^2 = \dfrac{79\times 2\times e^2}{4\pi\epsilon_0 d}$ $\Rightarrow d = \dfrac{158(1.6\times 10^{-19})^2\times 9\times 10^9\times 2}{17\times 10^{-27}(2\times 10^7)^2} = 2.6\times 10^{-14}$

d) For a given metal there is a minimum frequency (threshold frequency) below which no photoelectric emission takes place.
There is no time lag between irradiation and emission of photoelectrons.
The number of photoelectrons emitted per second is proportional to intensity of incident radiation.
The maximum Kinetic energy of photoelectrons is proportional to the frequency of incident radiation.

10. a) (i) Specific charge is the charge to mass ratio of an electron.



Path of electrons showing up luminous ring.

H – a pair of Helmholtz coils for producing a uniform magnetic field.

A – conical anode

C – Heated cathode

V_a – accelerating voltage between A and C. the cathode is heated and it emits electrons by thermionic emission. The electrons are accelerated by a high p.d V_a to a velocity of V_1 on reaching the anode and emerge as narrow beam from a small hole at the apex of the anode into a region of a uniform magnetic field B

Work done by p.d V_a = gain in k.e of the electrons

$eV_a = \frac{1}{2} mV_1^2$ .... (i)

e and m are charge and mass of electrons respectively. The diameter of the luminous circular ring is measured and the radius r calculated.

$BeV = \frac{mV_1^2}{r}$ ....(ii)

$V_1^2 = \frac{B^2e^2r^2}{m^2}$ $\Rightarrow$ $eVa = \frac{1}{2} m \left[\frac{B^2e^2r^2}{m^2}\right]$

$\therefore \frac{e}{m^2} = \frac{2Va}{B^2r^2}$

b) (i) $\frac{1}{2} m u^2 = eV$ $\Rightarrow$ $u = \frac{\sqrt{2eV}}{m} = \sqrt{2 \times 10^{11} \times 1.7 \times 1.6 \times 10^3}$

$= 1.84 \times 10^7 ms^{-1}$

(ii) $Beu = \frac{mu^2}{r}$ $\Rightarrow$ $r = \frac{mu}{Be} = \frac{1}{10^{-3}} \left[\frac{1}{1.7 \times 10^{11}}\right] 1.84 \times 10^7$

$= 0.108$ m

(c) (i) thermionic emission is a process by which electrons are emitted from a metal surface when heated.

(ii) Metals have free electrons. These electrons move randomly throughout the metal lattice. When a metal is heated, the electrons gain energy. If this energy is sufficient enough to overcome the attraction of the positive ion, the electrons escape from the metal surface

d) Use non-volatile oil.

Enclose the apparatus in a constant temperature water bath

END