WAKISSHA JOINT MOCK EXAMINATIONS
MARKING GUIDE
Uganda Advanced Certificate of Education
UACE August 2019
PHYSICS P510/1

SECTION A

1. (a) (i) - A body continues in its state of rest or uniform motion in a straight line unless acted upon by an external force.
- The rate of change of momentum is directly proportional to the applied force and takes place in the direction of the force.
- For every action, there is an equal and opposite reaction. ***(03 marks)***

(ii) Consider a body of mass M, initially moving at a vel. U, and is acted upon by a force F so that after time t, its vel. Changes to v.
From Newton's 2nd law of motion;

$$F \propto \frac{mv - mu}{t} \Rightarrow F \propto m\left(\frac{v-u}{t}\right)$$

But $\frac{v-u}{t} = a \Rightarrow F \propto ma$ or $F = kma$

When $F = 1N, m = 1kg$ and $a = 1ms^{-2}$, $k = 1$

$$\Rightarrow F = ma$$

- The newton is the force that acts on a body of mass 1kg to produce an acceleration of $1ms^{-2}$ ***(03 marks)***

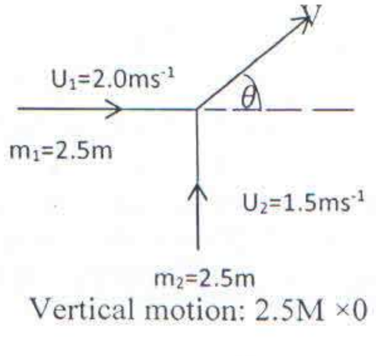
(b) (i) A perfectly inelastic collision is a collision in which some k.e is lost and the bodies stick together after collision; ie move with a common vel. ***(01 mark)***

(ii) Examples of perfectly inelastic collisions:
- Car crash during, say, a head-on collision in which cars stick together after.
- Soft mud thrown onto a wall and sticks on it. ***(02 marks)***
- A bullet shot into a suspended block of wood and gets embedded into it and the two swing together after impact.

(Any two examples @ 1 mark)

N.B Mark the first two answers only

(iii)



Horizontal motion;

$m_1 u_1 + m_2 u_2 = (m_1 + m_2) V \cos\theta$

$\therefore 2.5M \times 2.0 + 2.5M \times 0 = 5.0MV \cos\theta$

$\Rightarrow 5.0M = 5.0MV \cos\theta$

Or $\cos\theta = \frac{1}{v}$ .... (i)

Vertical motion: $2.5M \times 0 + 2.5M \times 1.2 = 5.0M\ V\sin\theta$

$$\Rightarrow 3.75M = 5.0?? MV \sin\theta$$

$$\Rightarrow \sin\theta = \frac{0.75}{v} \quad \ldots\ldots\ldots\ldots\ldots\ (ii)$$

But $\sin^2\theta + \cos^2\theta = 1 \Rightarrow \left(\frac{0.75}{v}\right)^2 + \left(\frac{1}{v}\right)^2 = 1$

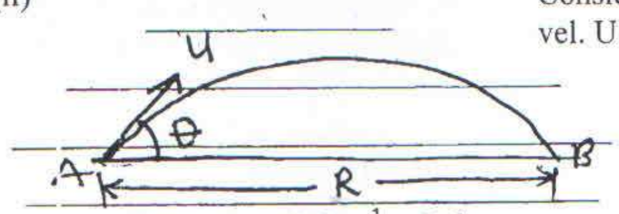
From which $v = 1.25ms^{-1}$

In the direction $\theta = \sin^{-1}\left(\frac{0.75}{v}\right) = 36.9^0$ ***(05 marks)***

(c) (i) Time of flight is the time taken by a projectile to cover its Trajectory through the point of projection.

(01 mark)

(ii) Consider a body projected a vel. U at an angle θ to the horizontal .



From $y = ut\sin\theta - \frac{1}{2}\, of\ t^2$

At B; $O = u\sin\theta.T - \frac{1}{2}gT^2$, where T = time of flight.

$$\Rightarrow T = \frac{2u\sin\theta}{g} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (i)$$

The Range, $R = u\cos\theta.T$ .... (ii)

Dividing (i) by (2) gives: $\frac{T}{R} = \frac{2\tan\theta}{gT}$

$$\Rightarrow T = \left(\frac{2R\tan\theta}{g}\right)^{\frac{1}{2}}$$

(03 marks)

(iii) Range, $R = \frac{gT^2}{2\tan\theta}$; R is max. when $\theta = 45^o \Rightarrow \tan\theta = 1$

$$\therefore R\max = \frac{gT^2}{2} = \frac{9.81\times(3.5)^2}{2}$$

$$= 60.09m$$

(02marks)

Total = 20 marks

2. (a) (i) Static friction is the force that opposes relative motion of two surfaces in contact, which are at rest, but have a tendency to move.

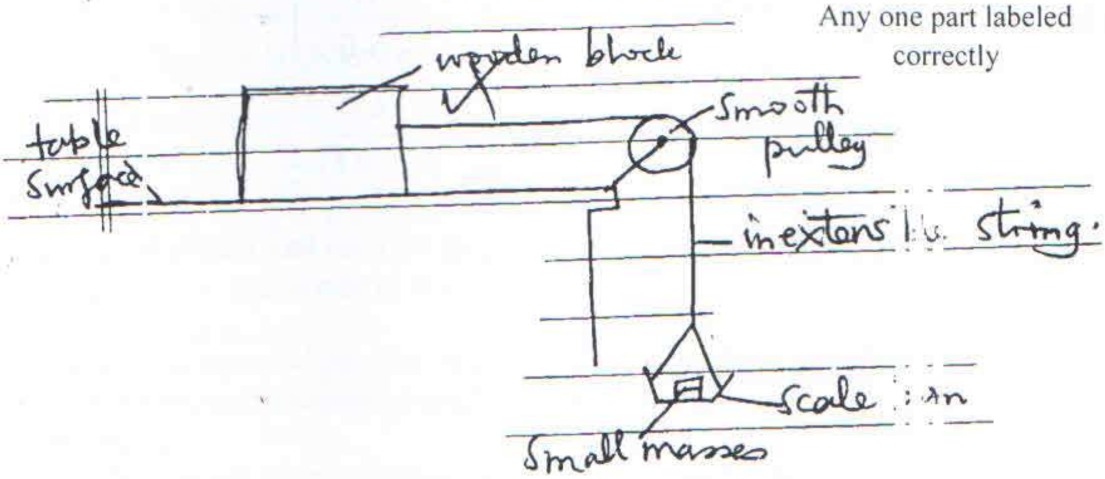
(ii) - Solid surfaces have irregular molecular projections which form welded joints when two surfaces are placed into contact with each other.

- When the normal reaction is increased, the pressure at the welded joints increases.

- This leads to increased degree of interlocking of the irregular projections; and hence a bigger force (frictional) is required to cause motion of one surface relative to the other. *(03 marks)*

(b)

Any one part labeled correctly



- Small masses are added one at a time in the scale pan, and each time, the wooden block is given a slight push, until it moves at a constant velocity.
- The total mass m of the scale pan and its contents and the mass M of the wooden block are determined by measurement.
- The coefficient of kinetic friction μ is then obtained from: $\mu = \frac{m}{M}$

Limitation:

- Difficulty in knowing whether wooden block is moving at constant velocity. *(04 marks)*

(c) (i) Work – energy equation is $W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Where W = work done by a force

m = mass of the body

v = final velocity

u = initial velocity of the body.

- Suppose a body of mass m initially moving with speed u is subjected to an accelerating force F such that its speed is increased to v in a distance s;

Then $S = \frac{v^2 - u^2}{2a}$, where a = acceleration.

- Work done by the force W = Fs

$$= F \times \frac{v^2 - u^2}{2a}$$

But F = ma

$$\Rightarrow W = ma.\frac{v^2 - u^2}{2a}$$

$$= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$ *(03 marks)*

(ii) $u = 4.0ms^{-1}$; s = 6.0m, m = 3.0kg; v = 0

The retarding force F = -ma $= -m\left(\frac{v^2-u^2}{2s}\right)$

$$= -3.0\left(\frac{o^2-4.0^2}{2\times 6.0}\right) = 4N$$

But $F = \mu R = \mu mg \Rightarrow \mu = \frac{F}{mg} = \frac{4}{3.0\times 9.81}$

$= 0.136$ *(04 marks)*

(d) (i) Viscosity; - Is the friction force that opposes the relative motion between two fluid layers in contact.

<u>Velocity gradient;</u> - Is the change in velocity between molecular layers if the fluid layers separated by one metre.

(02 marks)

(ii) - Viscosity in gases is due to momentum transfer between the neighbouring layers of gases.

- The viscosity is directly proportional to the average speed of the gas mols. And since the average speed of the gas mols increases with temp, ⇒ viscosity in a gas increases with increase in temp.

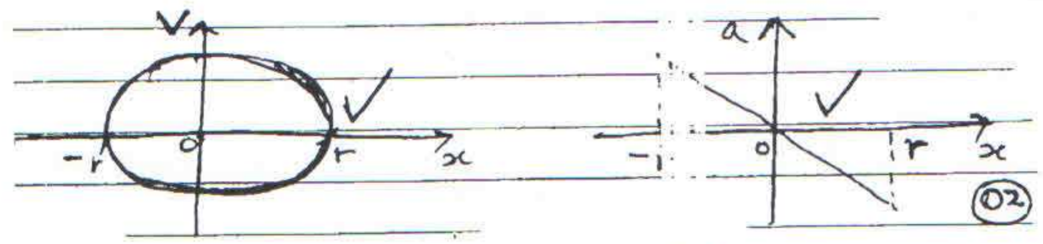
(03 marks)

Total = 20 marks.

3. (a) (i) Simple harmonic motion is the to and fro periodic motion of a body whose acceleration is directly proportional to its displacement from a fixed point, and is always directed towards the fixed point.

(01 mark)

(ii)



½ for labeling axes

½ for shape of the graph

(b) (i) - The helical spring is clamped vertically by using the retort stand and a clamp.

- A known mass m is attached to the free end of the spring and is pulled downwards through a small distance and is released to oscillate.
- The time for 20 oscillations is obtained, and the time for one oscillations, T is determined.
- The expt. Is repeated for different values of m; and results tabulated to include T^2. 04
- A graph of T^2 against M is plotted and its slope s is calculated.
- The force constant k is then obtained from $K = \frac{4\pi^2}{5}$

(ii) – The mass of the spring not being negligible.
- Improper clamping of the spring at the point of suspension.
- Presence of viscosity or dissipative forces due to air.
- Swinging movement o the position of point of suspension or the stand not being firm.

(Any three @ 1 mark)

(c) m = 2kg, k = $100Nm^{-1}$, r = 4cm = 0.04m

(i) Vmax = rw; = $\sqrt{\frac{k}{m}}$

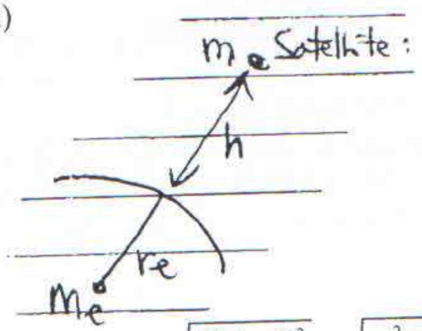
$$\therefore V\max = r\sqrt{\frac{k}{m}} = 0.04\times\sqrt{\frac{100}{2}} = 0.28ms^{-1}$$ ***(03 marks)***

(ii) When x = 2cm = 0.02m;

$$a = -w^2x$$
$$= -\left(\frac{k}{m}\right)\times 0.02 = -\frac{100}{2}\times 0.02$$
$$= -1.0ms^{-2}$$ ***(02 marks)***

(d) (i) Geostationary orbit is a path in space of a satellite in which it has a period of 24 hours and appears to be at the same position relative to an observer on the earth's surface. ***(01 mark)***

(ii)



$$F = \frac{GM_em}{r^2} = \frac{mv^2}{r};$$
$$v = rw = r.\frac{2\pi}{T}$$
$$\therefore \frac{GM_em}{r^2} = \frac{4\pi^2 mr}{T^2}$$

Or $r = \sqrt[3]{\frac{GM_emT^2}{4\pi^2}} = \sqrt{\frac{re^2 g.T^2}{4\pi^2}}$

$$= \sqrt[3]{\frac{(6.4\times10^6)^2\times9.81\times(24\times3600)^2}{4\times(3.14)^2}}$$
$$= 4.24\times10^7 m$$
$$\therefore h = r - r_e$$
$$= 4.24\times10^7 - 6.4\times10^6$$
$$= 3.6\times10^7 m$$ *(04 marks)*

Total = 20 marks

4. (a) (i) Rel. density is the ratio of the density of a substance to the density of water.
Or It is the ratio of the mass (weight) of any given volume of a substance to the mass (weight) of an equal volume of water.

(ii) - The weight of a solid object is measured in air using a spring balance and recorded as W_1.

- The object is completely in the immersed in water and its weight is recorded as W_2 and is immersed completely in the liquid whose rel. density is required and its weight W_3 is recorded.
- The rel. density of the $Liq. = \frac{W_1 - W_3}{W_1 - W_2}$. *(03 marks)*

(b) Mass of displaced water $= \ell_w V_w = 1000 \times 40 \times 10^{-4} \times x = 0.2$

Where x is the depth of which the solid floats.

$$\Rightarrow x = \frac{0.2}{1000 \times 40 \times 10^{-4}} = 0.05m$$

Mass of displaced mixture of Liq.

$= \ell_m V_m = \ell_m \times 40 \times 10^{-4} \times x = 0.3$

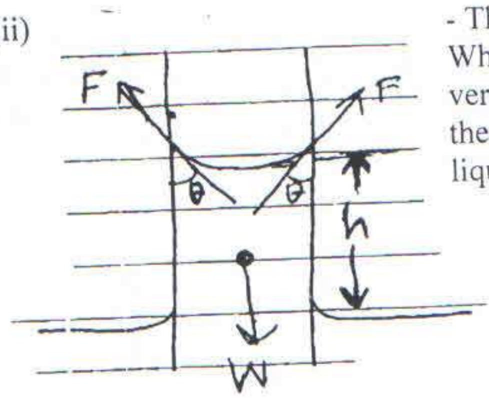
$\Rightarrow \ell_m \times 40 \times 10^{-4} \times 0.05 = 0.3$

From which $\ell_m = 1500 kgm^{-3}$ *(04 marks)*

(c) (i) Surface tension; - Is the tangential force per metre that acts perpendicularly to one side of an imaginary line drawn on a liquid surface.

Work done to stretch a liquid surface by 1m under isothermal conditions *(01 mark)*

(ii)



- The liquid stops rising in the cap. Tube When the weight of the raised column acting vertically downwards = vertical component of the upward forces exerted by the tube on the liquid.

ie. $F\cos\theta = W$, where F = $\frac{surface}{tension\ force}$

But $F = 2\pi r\gamma$ and $W = \pi r^2 h \rho g$

$\therefore 2\pi r\gamma \cos\theta = \pi r^2 h \rho g$

$$h = \frac{2\gamma cos\theta}{\rho r g}$$

(04 marks)

(d) r = 0.5cm, r = 1.0mm; $\delta = 7.0 \times 10^{-2} Nm^{-1}$

Vol. of big drop $= \frac{4\pi r^3}{3} = \frac{4 \times 3.14 \times (5.0 \times 10^{-3})^3}{3}$

$= 5.23 \times 10^{-7} m^3$

Vol. of small droplet $= \frac{4\pi r'^3}{3} = \frac{4 \times 3.14 \times (1.0 \times 10^{-3})^3}{3}$

$$= 4.0\times10^{-9}\,m^3$$

$\therefore$ no of droplets formed; $n = \dfrac{5.23\times10^{-7}}{4.0\times10^{-9}} = 125$

Surface area of big drop $= 4\pi r^2 = 4\times3.14\times\left(5.0\times10^{-3}\right)^2$

$$= 3.14\times10^{-4}\,m^2$$

Surface area of the 125 droplets $= 125\times4\pi r'^2$

$$= 125\times4\times3.14\times\left(1.0\times10^{-3}\right)^3$$

$$= 0.01257\,m^2$$

$\therefore$ Change in area $= 0.01257 - 3.14\times10^{-4}$

$$= 1.23\times10^{-2}\,m^2$$

$\therefore$ Work done $= \gamma$ x Change in area

$$= 7.0\times10^{-2}\times1.23\times10^{-2}$$

$$= 8.6\times10^{-4}\,J$$

(04 marks)

(e) - Introducing soap at the spot where the water surface is touched reduces the surface tension there.
- The resultant force is thus away from the spot and the powder is carried away from the spot towards the sides of the vessel.

(03 marks)

Total = 20 marks

SECTION B

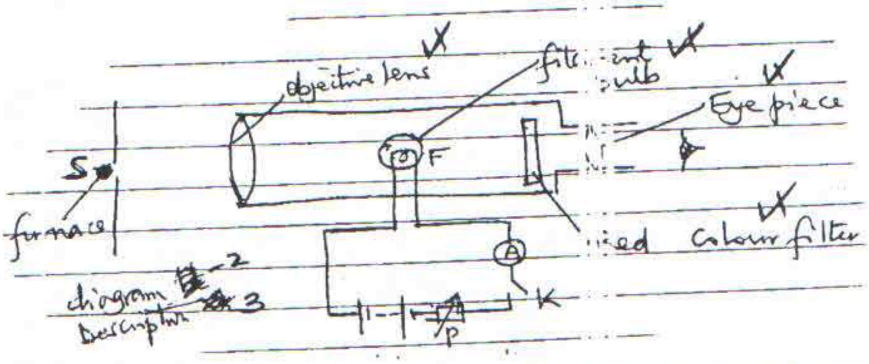
5. (a) (i) Thermometric property is a physical property of a substance which varies linearly and continuously with temp. ***(01 mark)***
- Vol. of a fixed mass of gas at constant pressure.
- Pressure of a fixed mass of gas at constant vol.
- Emf of a thermo couple
- Length of a liquid column in a cap. Tube
- Electrical resistance of a platinum wire. ***(02 mark)***

(Any two @ 1 mark)

Mark only the first 2 answers

(ii) Absolute zero (OK); and is obtained when molecular motion of mols. Of a substance has ceased.

(b) (i)



Mark any four parts labeled correctly.

- On closing the switch K, the eye piece E is focused at the filament F of the bulb.
- The telescope is then directed to focus the furnace S and light from it is focused by the objective lens on to the filament F.

- The current through the filament is adjusted by using the rheostat P, until the brightness of the filament merges with that of the furnace; ie F becomes indistinguishable from the furnace.
- The temp. of the furnace is then read from the ammeter A, previously calibrated in Kelvin.

(05 marks)

(ii) Advantage
- Can measure high temps (>1500°C)
- Direct reading

Disadvantage
- Cannot measure low temps. *(02 marks)*

(c) (i) Specific latent Heat of fusion of a substance is the Heat required to change the state of 1kg mass of a solid in to liquid at constant temp. *(01 mark)*

(ii) Latent Heat of fusion is used in only weakening the strong inter molecular forces in the crystalline structure of the solid and some small work done against the atmosphere due to small increase in vol. whereas latent Lt of vaporization separates the molecular further, increasing the p.e of the molecules and energy is used to o work during the appreciable expansion against atmosphere pressure by the vapour. ***(03 marks)***

(d) $m_w = 2kg$: $p = 98.5k\ Pa = 98.5\times10^3 Pa$

$$\vartheta_s = 0.60kgm^{-3}; l_v = 2.3\times10^3 kJkg^{-1}$$

$$= 2.3\times10^6 Jkg^{-1}$$

Vol. of water, $V_1 = \frac{mass\ of\ water}{density\ of\ water} = \frac{2}{1000} = 0.002m^3$

Vol. of steam $V_2 = \frac{mass\ of\ water}{density\ of\ steam} = \frac{2}{0.60} = 3.333m^3$

But $W = P(V_2 - V_1) = 98.5 \times 10^3(3.333 - 0.002$

$= 3.28 \times 10^5 J$ ***(04 marks)***

Total = 20 marks

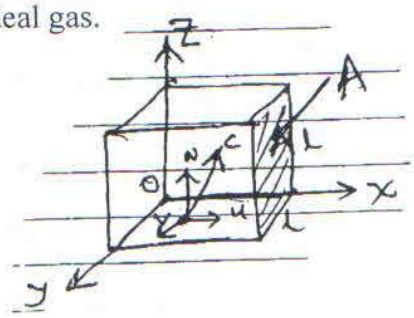
6. (a) (i) An ideal gas is a gas in which inter molecular forces are negligible, and obeys Boyle's law perfectly. ***(01 mark)***

(ii) - At high temp – the average k.e.s of the mols is high and this minimizes the inter molecular forces, and thus the forces become negligible ⇒ gas behaves like an ideal gas.

- At low pressure – at a given temp; the number of mols colliding with a container is low, so mols will be spaced and their volume will be negligible compared to the volume of the vessel. Hence the gas will behave like an ideal gas.

(03 marks)

(b)



Suppose a gas enclose in a cube of side l contains N molecules each of mass m.

Taking one mol. moving at a vel. C; which can be resolved into component u, v and w in the directions OX, OY and OZ directions respectively.

OX – direction:

Initial momentum = mu, and

Final momentum = -mu

$\therefore \Delta$ mom = mu – (-mu) = 2mu

Time of flight = $2l/_u$

$\therefore$ Rate of change of mom = $\frac{2mu}{2l/_u} = \frac{mu^2}{l}$ = force on A.

Total force due to the N molecules:

$$F = \frac{mu_1^{\ 2}}{l} + \frac{mu_2^{\ 2}}{l} + ... + \frac{mu_N^{\ 2}}{l}$$

$$= \frac{m}{l}\left(u_1^{\ 2} + u_2^{\ 2} + ... + \frac{u_N^{\ 2}}{l}\right)$$

$\therefore$ Pressure on $A = \frac{F}{A} = \frac{m}{l^3}\left(u_1^{\ 2} + u_2^{\ 2} + ... + u_N^{\ 2}\right)$

Let $\bar{u^2} = \frac{u_1^{\ 2} + u_2^{\ 2} + ... + u_N^{\ 2}}{N} \Rightarrow u_1^{\ 2} + u_2^{\ 2} + ... + u_N^{\ 2} = N\bar{u^2}$

$$\therefore P = \frac{mN\bar{u^2}}{l^3}$$

For each mol; $c^2 = u^2 + v^2 + w^2 \Rightarrow \bar{c^2} = \bar{u^2} + \bar{v^2} + \bar{w^2}$

But $\bar{u^2} = \bar{v^2} = \bar{w^2} \Rightarrow \bar{c^2} = \bar{u^2} + \bar{u^2} + \bar{u^2} = 3\bar{u^2}$

$$\therefore \bar{u^2} = \frac{1}{3}\bar{c^2}$$

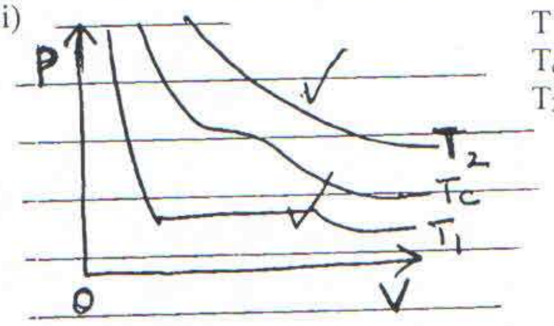
$\therefore P = \frac{mN}{l^3}.\frac{1}{3}\bar{c^2} = \frac{1}{3}\frac{mN}{l^3}\bar{c^2}$

But $\frac{Nm}{l^3} = \rho \Longrightarrow \frac{1}{3}\rho c^{-2}$

(06 marks)

(c) (i) Critical temp. is the temp. above which a gas cannot be liquidified however high the pressure is. ***(01 mark)***

(ii)



T_1 - Below critical temp.

T_c - Critical temp

T_2 - Above critical temp.

(02 marks)

(d) $M_h = 1.66 \times 10^{-27}$kg, $M_o = 2.66 \times 10^{-26}$kg

From PV = $^1/_3 M\overline{c^2} = RT$ for 1 mole

$$\Rightarrow \sqrt{\bar{c^2}} = \sqrt{\frac{3RT}{M}}$$

$$\therefore \sqrt{\bar{c_h^2}} = \sqrt{\frac{3RT}{M_h}} and \sqrt{\bar{c_o^2}} = \sqrt{\frac{3RT}{M_o}}$$

$$\Rightarrow \frac{\sqrt{\bar{c_h^2}}}{\sqrt{\bar{c_o^2}}} = \sqrt{\frac{M_o}{M_h}} = \sqrt{\frac{2.66\times10^{-26}}{1.66\times10^{-27}}}$$

$$= 4:1$$

(04 marks)

(e) - When the temp. of a liquid is increased, the average k.e of its molecules increases.
- More molecules are able to escape and so the rate of evaporation increases
- The density of the vapour increases and this leads to an increase in the rate of condensation
- Equilibrium and saturation are re-established at a greater saturated vapour pressure. *(03 marks)*

Total = 20 marks

7. (a) (i) Coefficient of thermal conductivity is the rate of heat flow through a material per unit cross sectional area per unit temp. gradient.

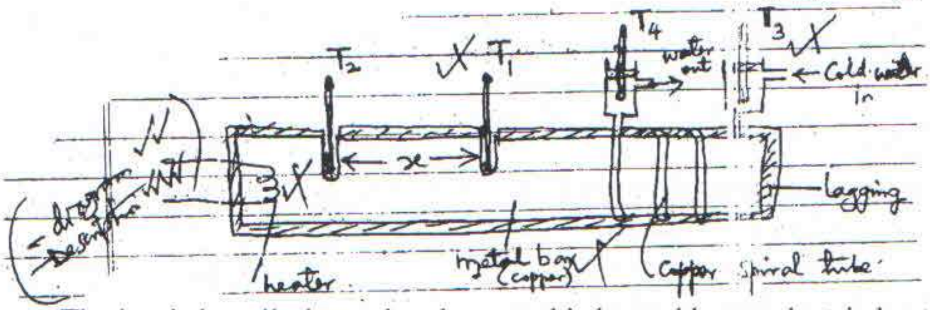
(ii) - When one end of glasss is heated, the atoms therer gain thermal energy and vibrate with increased amplitudes; they will then collide with their neighbouring atoms and pass on some of their vibrational energy to these atoms.
- This will result into increase in amplitude of vibration of the atoms; they will in turn collide with the neighbouring atoms and pan on their energy. In this way, heat energy is propagated along the glass towards the colder end. *(03 marks)*

(iii) Rate of heat transfer depends on:
- Length of the conductor
- Cross – sectional area
- Temp. difference btn the ends
- Nature of the material (conductivity)

Mark only the first two answers, each takes ½

(01 mark)
(any two @ 1 mark)

(b)



Mark any four parts labeled correctly

- The bar is heavily lagged and one end is heated by an electric heater.
- Cold water is then passed through the copper spiral tube at a constant rate.
- Two temperature T_3 and T_4 record the entrance and exit temps. θ_3 and θ_4 respectively of the water.

- The thermometer T_1 and T_2 giving temps. θ_1 and θ_2 at a known separation x on the bar are inserted in holes containing mercury.
- The expt is made to run until the four thermometer readings are constant.
- They are read and recorded.
- The mass m of water flowing through the tube in time t is measured.
- The thermal conductivity K of copper is then obtained from:

$$K = \frac{xmc(\theta_4 - \theta_3)}{tA(\theta_2 - \theta_1)}$$

Where A = area of cross section of the Bar, obtained from $A = \frac{\pi d^2}{4}$,

Where d = diameter of the bar c = s.h.c. of the water. ***(06 marks)***

(c) $K_c = 385 Wm^{-1}K^{-1}$, $K_b = 108 Wm^{-1}K^{-1}$, $K_s = 50\ Wm^{-1}K^{-1}$

Let θ = temp. of junction

(i) From $Q_c = Q_b + Q_s$

$$\Rightarrow \frac{K_c A(100-\theta)}{l_c} = \frac{K_b A(\theta - 0)}{l_b} + \frac{K_s A(\theta - 0)}{l_s}$$

$$\Rightarrow \frac{385A(100-\theta)}{0.40} = \frac{108A(\theta)}{0.10} + \frac{50A(\theta)}{0.15}$$

$$\Rightarrow 962.5(100-\theta) = 1080\theta + 333.3\theta$$

$$= 1413.3\theta$$

From which $\theta = 40.5^{\circ}C$ ***(05 marks)***

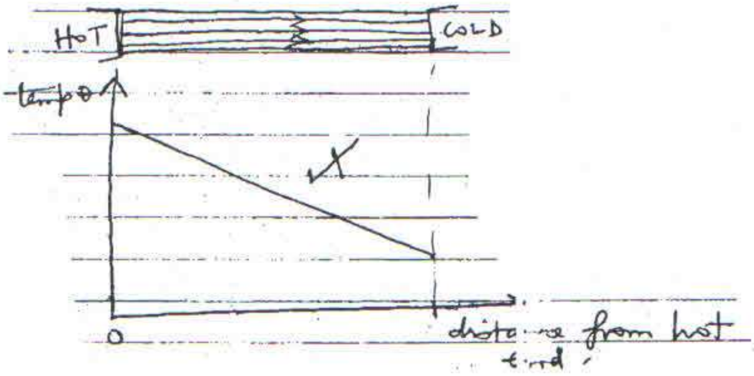
(ii) Heat current in the copper rod = rate of Lt flow

$$= \frac{K_c A(100-\theta)}{l_c}$$

$$= \frac{385 \times 2 \times 10^{-4} \times (100 - 40.5)}{0.4}$$ ***(02 marks)***

$$= 11.5 Js^{-1}$$

(d)



- The temp. falls steadily or uniformly from the hot end.
- The heat loss from the sides is negligible and the same all along the bar.
- The lines of heat are parallel. *(02 marks)*

Total = 20 marks

SECTION C

8. (a) (i) X-rays are electromagnetic rod of short wave length (or high freq.) produced when fast moving electrons are stopped by matter.

(01 mark)

(ii) - X-rays are produced when fast moving electrons are stopped suddenly by matter whereas ɤ-rays are produced when the molecules of an atom under go nuclear fusion or fission.

- X-rays have relatively longer wave length than for ɤ-rays.

(02 marks)

(b) (i) Shows - A line spectrum consisting of K- and L- series occurring at wavelengths of 0.500×10^{-10}m and 0.600×10^{-10}m respectively.

- A continuous spectrum with a definite cut-off wave length at 0.313×10^{-10}m.

(02 marks)

(ii) From $\frac{hc}{\lambda \min} = eVa \Rightarrow h/_e = \frac{\lambda \min Va}{c}$

$$= \frac{0.313\times10^{-10}\times40\times10^{3}}{3.0\times10^{8}}$$

(03 marks)

$$= 4.17\times10^{-15} JsC^{-1}$$

(iii) Increasing energy of the bombarding electrons leads to:

- A decrease in the cut-off wave length
- More characteristics lines like K_β, K_α and $L_\beta, \mathrm{L}_\alpha$ appearing as the tube voltage is increased.

(02 marks)

(c) Va = 35kV = 35 × 10^3V, I = 10m A = 10 × 10^3A

(i) $I = ne \Rightarrow n = \frac{I}{e} = \frac{10\times10^{-3}}{1.6\times10^{-19}} = 6.25\times10^{1.6} S^{-1}$

(03 marks)

(ii) Rate of production of heat

$$= \frac{90}{100}\times n\times eVa$$

$$= \frac{90}{100}\times6.25\times10^{16}\times1.6\times10^{-19}\times35\times10^{3}$$

$$= 3.15\times10^{2} W$$

Or = $\frac{90}{100}$ x Ivt = 0.9 x 35x1000x10^{-2}

= 315 W

(03 marks)

(d) (i) Millikan's apparatus is surrounded in a constant – temp. bath in order:

- To maintain the density of the air so that the up thrust on the oil drops remains constant
- Changes in temp. may affect density of oil and so weight may change.

(02 marks)

(ii) - Since separation of plates is small, large drops may strike the lower plate without attaining terminal velocity.

- Large drops require high voltage or p.d.s to be kept stationary.

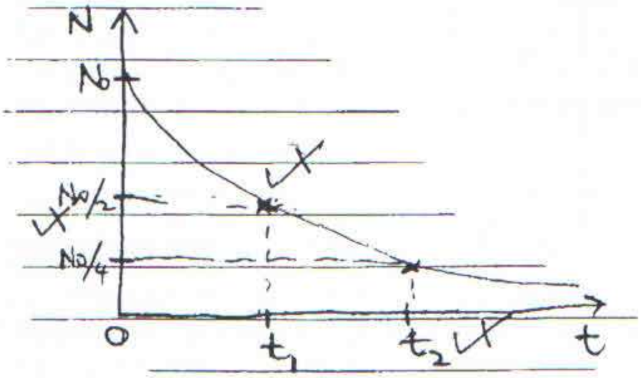
(02 marks)

9. (a) (i) Radioactive decay – Is the spontaneous disintegration of unstable nuclei of atoms accompanied by emission of α, β- particles and γ-rays or energy. ***(01 mark)***

(ii) Half-life – Is the time taken for half the number of radioactive atoms to decay or it is the time taken for the activity of a source to reduce to half of its original value. ***(01 mark)***

(iii) Decay constant – Is the fractional number of radioactive atoms that decay per second. ***(01 mark)***

(b)



- Horizontal lines parallel to the time- axis are drawn at points $^{No}/_2$ and $^{No}/_4$ and the corresponding times t_1 and t_2 where the curve is cut are noted.
- The half-life t_1 is then calculated from: $t_{\frac{1}{2}} = \dfrac{t_1 + (t_2 - t_1)}{2}$
- Decay constant $\lambda = \dfrac{0.693}{t_{\frac{1}{2}}}$ ***(04 marks)***

(c) $t_{\frac{1}{2}} = 60$ days; No $= 1.0 \times 10^{20}$ atoms; $E_o = 8.0 \times 10^{-13}$J

(i) $A = \lambda N = \dfrac{0.693}{t_{\frac{1}{2}}} N_o e^{-\lambda t}$

$= \dfrac{0.693}{60} \times 1.0 \times 10^{20} e^{-\left(\frac{0.693}{60}\right) \times 120}$

$= 2.89 \times 10^{17} day^{-1}$ or $3.34 \times 10^{12}\ s^{-1}$

(04 marks)

(ii) Total energy E = no decayed $\times E_o$

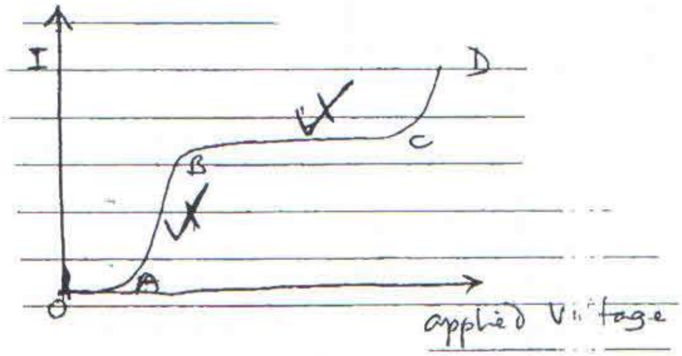
$$\therefore E = 1.0\times10^{20}\left(1-e^{\frac{-0.693}{60}\times120}\right)\times8.0\times10^{-13}$$

$$= 6.0\times10^{7}J$$ ***(03 marks)***

(d) (i) - Space charge – Is the large number of electrons that gather close to the cathode as an almost station any cloud of negative charge due to lack of sufficient energy to enable them reach the anode. ***(01 mark)***

- Avalamche – Is a collection of large number of moving ion-pairs as a result of violent collisions btn electrons and atoms as the former is accelerated towards the anode and a large no of electrons collects all along the anode wire. *(02 marks)*

(ii)



- Along OA, the applied voltage is less than the threshold voltage and there is insufficient gas amplication (there is recombination of ions-pairs) so no current pulses are detected
- Along AB, the magnitude of any particular pulse depends on the strength of the initial ionization; some ion pairs re-combine and current increase with applied voltage.
- Along BC; all ion-pair reach their respective destinations; no recombination occurs and current produced have the same amplitude or some current pulses are detected.
- Beyond C, quenching process is less and less effective and current increases uncontrollably. ***(03 marks)***

Total = 20 marks

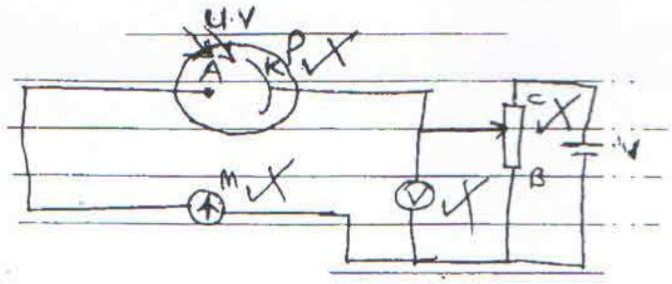
10. (a) (i) - Threshold freq – Is the frequency below which no photoelectric emission occurs however intense the incident radiation is.

- Work function – Is the minimum energy required to liberate an electron from a metal surface. ***(02 marks)***

(ii) - When a metal surface is irradiated by an electromagnetic radiation of high enough frequency, the electrons there absorbs the energy from the radiation as internal energy.

- If it is sufficient enough, they overcome the inward attraction by the atoms and are ejected as photo electrons. ***(03 marks)***

(b)



Mark any 4 correctly labeled parts including the terminal connections

- Monochromatic light (u.v) is made to illuminate the cathode k of a photocell P.
- The cathode is made positive with respect to the anode A.
- The p.d btn A and K is varied until the micro ammeter A reads zero.
- The voltmeter reading taken from the voltmeter is the stopping potential.

(05 marks)

(c) (i) When u.v falls on the zinc plate, the leaf falls . This is because the electrons from the zinc plate are lost through photo electric emission; and the negative charge (electrons) will move from the leaf to the cap and to the zinc to replace the emitted electrons, thus no of electrons down the GLE reduces thus reduces the force of repulsion btn the leaf and the zinc metal plate, then leaf falls.

(02 marks)

(ii) No effect is observed if infrared radiation falls on the zinc plate This is because infrared radiation has a frequency below the threshold required for photoelectric emission. ***(02 marks)***

(iii) If u.v falls on the zinc plate connected to a positively charged plate, there will be no change in divergence of the leaf. This is because the electrons emitted by photoelectric emission are attracted back by the positively charged zinc plate. ***(02 marks)***

(d) $\lambda_1 = 6.0\times10^{-7}m$ $\qquad \frac{1}{2}mv^2 \max = 4.0\times10^{-20}J$

$\lambda_2 = 5.5\times10^{-7}m$

From $hf = \frac{hc}{\lambda} = w_o + \frac{1}{2}mv^2;$

$$\frac{hc}{6.0\times10^{-7}} = w_o$$

Also; $\frac{hc}{5.5\times10^{-7}} = w_o + 4.0\times10^{-20}$

$$\Rightarrow \frac{hc}{5.5\times10^{-7}} = \frac{hc}{6.0\times10^{-7}} + 4.0\times10^{-20}$$

(04 marks)

$$\Rightarrow h = 8.89\times10^{-34}Js$$

Total = 20 marks

END