SECTION A

1. (a) (i) Define **linear momentum**. (01 mark)

(ii) State the **law of conservation of linear momentum**. (01 mark)

(iii) Show that the law of conservation in (a) (ii) above follows from Newton's laws of motion. (04 marks)

(b) A man whose weight is 490.5 N, jumps onto the ground from a 2.5 m high wall.

(i) Explain why he has to bend his knees when landing on the ground. (02 marks)

(ii) Calculate the force with which his legs hit the ground if his body comes to rest in 0.5 s on reaching the ground. (04 marks)

(c) (i) Distinguish between **perfectly elastic** and **perfectly inelastic** collisions, and give **one** example of each. (03 marks)

(ii) Two bodies each of mass m_1 and m_2 initially moving with velocities u_1 and u_2 respectively collide perfectly inelastically. Show that the loss in kinetic energy is given by the expression:

$$\frac{m_1 m_2 (u_1 - u_2)^2}{2(m_1 + m_2)}$$

(04 marks)

(iii) State any **two** applications of the law of conservation of linear momentum. (01 mark)

2. (a) Define the following terms as applied to circular motion:

(i) **centripetal acceleration**. (01 mark)

(ii) **angular velocity**. (01 mark)

(b) (i) What is the purpose of banking a track? (01 mark)

(ii) Derive an expression for the angle of banking for a case of a car of mass **M** moving with a speed v round a banked track of radius **r**. (04 marks)

(iii) A car moves round a circular track of radius 65 m which is banked at an angle $\tan^{-1} 5/12$ to the horizontal. Find the speed at which the car should be driven for no tendency to slip. (03 marks)

(c) (i) State **Kepler's laws** of gravitation. (03 marks)

(ii) Describe an experiment you would carry out in the laboratory to determine the universal gravitational constant. (05 marks)

(iii) A body of mass 10 kg is first weighed on a balance at the top of a tower 30m high and later transferred to the ground and is reweighed. Calculate the difference in the weights of the body. (02 marks)

3. (a) (i) Define **surface tension**. (01 mark)

(ii) Briefly describe an experiment you would use to show that surface tension of a liquid decreases with increase in temperature. (03 marks)

(iii) State how **one** other factor affects surface tension of a liquid. (02 marks)

(b) (i) Derive an expression for pressure difference across a soap bubble in air. (04 marks)

(ii) Two soap bubbles of radii 1.5 cm and 3.0 cm respectively coalesce to form a single bubble under isothermal conditions. Calculate the excess pressure inside the resulting soap bubble. (03 marks)

(c) (i) Define **coefficient of viscosity**. (01 mark)

(ii) Explain briefly how temperature affects viscosity of a liquid. (03 marks)

(d) A liquid of negligible viscosity flows steadily through a pipe whose cross sectional area at one point is 15 cm^2 at a velocity of 0.5 ms^{-1}. Find the pressure difference between this point and another point whose cross sectional area is 3.0 cm^{-2}. (03 marks)

4. (a) What is meant by the following terms as applied to mechanical properties of materials?

(i) **elasticity**. (01 mark)

(ii) **force constant**. (01 mark)

(b) A wire of length l and cross sectional area **A** has a force constant **k**. The wire is stretched to a length $l + x$ by a constant force **F**. Show that:

(i) the force constant $k = EA/l$, where E is Young's modulus of the material of the wire. (03 marks)

(ii) the energy stored per unit volume is $\frac{1}{2} E(x/l)^2$. (03 marks)

(c) One end of a copper wire of length 1.0m and diameter 0.5mm is welded to a steel wire of length 0.5m and diameter 0.8mm, while its other end is fixed onto a rigid support. If a load of 12kg is suspended from the free end of the steel wire, calculate the:

(i) extension which results. (04 marks)

(ii) energy stored in the compound wire. (03 marks)

(d) (i) State **Bernoulli's principle**. (01 mark)

(ii) Explain why the roof of a building is likely to be blown off when a strong wind blows over it. (04 marks)

SECTION B

5. (a) Define the following terms as applied to heat:

   (i) **Heat capacity.** (01 mark)

   (ii) **Cooling correction.** (01 mark)

   (b) (i) Describe an experiment to determine the specific heat capacity of a liquid using the continuous – flow method. (05 marks)

   (ii) In the above experiment, state why the temperature differences are kept constant. (01 mark)

   (ii) State **three advantages** of the continuous flow method over the method of mixtures. (03 marks)

   (c) In a continuous – flow experiment, a steady difference of temperature of 2.0 ^0C is a maintained when the rate of liquid flow is 20 gs^{-1} and the power of the electrical heater is 40 W. When the liquid flow rate is adjusted to 75 gs^{-1}, 80 W of electrical power is required to maintain the same temperature difference.

   Calculate the total heat energy lost in 5 minutes. (05 marks)

   (d) (i) What is meant by **latent heat of fusion of ice**? (01 mark)

   (ii) Explain briefly why ice tends to stick onto a sweaty hand. (03 marks)

6. (a) (i) Distinguish between an **isothermal** and **adiabatic** changes. (01 mark)

   (ii) State **two conditions** for an adiabatic process to take place. (02marks)

   (iii) State **two examples** of an adiabatic process. (02 marks)

   (b) An ideal gas is expanded adiabatically to a final pressure of 1.0×10^7 Pa, when originally it had a pressure of 2.0×10^6 Pa and volume of 3.0 litres at a temperature of 50^0C.

   Calculate the:

   (i) number of moles of the gas. (03 marks)

   (ii) final temperature of the gas. (04 marks)

   (Take ratio of the specific heat capacity at constant pressure to that at constant volume to be 1.4).

   (c) (i) Define **molar heat capacity at constant pressure**. (01 mark)

   (ii) Derive the expression for the difference between the molar heat capacity at constant pressure and that at constant volume for one mole of an ideal gas. (05 marks)

   (d) Explain briefly why a gas heats up when it is compressed. (02 marks)

7. (a) (i) What is meant by a **black body**? (01 mark)

(ii) State the **laws of black body radiation**. (02 marks)

(b) Using the same axes, sketch graphs to show the distribution of energy in the spectrum of radiation from a black body at three different temperatures, and explain their features. (05 marks)

(c) The tungsten filament of a lamp has an operating temperature of 3500^0C. If the effective surface area of the filament is $0.42\ cm^2$ and assuming that the energy radiated is 29 % that from a black body in similar conditions, calculate the:

(i) power of the lamp. (03 marks)

(ii) calculate the frequency of radiation emitted with maximum intensity. (03 marks)

(d) (i) Explain, using **molecular theory of matter**, the mechanism of thermal conduction in insulators. (03 marks)

(ii) Briefly account for the fact that metals are better conductors of heat than insulators. (03 marks)

SECTION C

8. (a) Define the following terms:

(i) **Photoelectric emission.** (01 mark)

(ii) **stopping potential.** (01 mark)

(b) Describe an experiment to determine the stopping potential of a given metal surface. (05 marks)

(c) A certain metal is illuminated by radiation of wavelength 145 nm. If it has a work function of 2.0 eV, calculate the:

(i) maximum speed of the photoelectrons. (03 marks)

(ii) threshold frequency. (02 marks)

(d) (i) What are **x – rays**? (01 mark)

(ii) Sketch a graph of intensity against wavelength of x – rays from an x – ray tube and describe its main features. (04 marks)

(iii) Calculate the maximum frequency of x – rays emitted by an x – ray tube with an operating voltage of 40 kV. (03 marks)

9. (a) (i) Define **background radiation.** (01 mark)

(ii) State the **three main sources** of background radiation. (02 marks)

(iii) Give **two examples** of background radiation. (01 mark)

Turn Over

(b) (i) State the **law of radioactive decay**. (01 mark)

(ii) Show that the half – life $T_{½}$ of a radioactive material is related to the decay constant λ by the expression $\lambda T_{½} = \ln 2$. (02 marks)

(iii) A radioisotope of strontium of half – life 28 years providing a source of beta particles has been in use for some time. If originally 5 μg of strontium were present, find the number of atoms remaining after 15 years of use. (04 marks)

(c) (i) Describe the structure and mode of operation of the **scintillation counter**. (05 marks)

(ii) State **two advantages** of the scintillation counter over the Geiger – Muller tube. (02 marks)

(d) State **one industrial** use and **one medical** use of radioactivity. (02 marks)

10. (a) (i) Define **mass defect**. (01 mark)

(ii) State the mathematical relation between **mass defect** and **binding energy**. (01 mark)

(b) (i) Distinguish between **nuclear fusion** and **nuclear fission**. (02 marks)

(ii) State and explain **two** conditions necessary for nuclear fusion to occur. (04 marks)

(iii) Sketch a graph of binding energy per nucleon against mass number, showing its key features. (02 marks)

(c) Calculate the binding energy per nucleon in joules of boron ${}^{10}_{5}B$ given that:

Mass of a proton = 1.0080 U

Mass of a neutron = 1.5087 U

Mass of ${}^{10}_{5}B$ = 10.0129 U

1 U = 1.66×10^{-27} kg (05 marks)

(d) (i) State **Bohr's postulates** of the atom. (02 marks)

(ii) Explain the occurrence of the emission line spectrum. (03 marks)

END

WAKISSHA JOINT MOCK EXAMINATIONS
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PHYSICS P510/1

SECTION A

1. (a) (i) Linear momentum is the product of mass and velocity of a body. moving **(01 mark)**

(ii) The total momentum of any two or more bodies interacting is constant in a straight line provided there are no external forces acting. **(01 mark)**

(iii) Consider two bodies each mass m_1 and M_2 moving in the same direction at velocities V_1 and V_2 ($u_1 > u_2$). Suppose the two bodies collide and after each moves with velocity. V_1 and V_2 respectively in the same direction.
(In accordance with Newton's first law of motion)'

The force exerted by M_1 on M_2 = , F_{12} $\dfrac{m_1(v_1 - u_1)}{t}$ and force exerted by m_2 on m_1, $F_{21} = \dfrac{m_2(v_2 - u_2)}{t}$ where t = time of impact

(In accordance with Newton's 2nd law of motion).
But $F_{12} = -F_{21}$(Newton's 3rd law)

$$\Rightarrow \frac{m_1(v_1 - u_1)}{t} = \frac{-m_2(v_2 - u_2)}{t}$$

$$\Rightarrow m_1v_1 + m_2v_2 = m_2u_2 + m_1u_1$$

Rearranging gives $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ which is the law of conservation of linear momentum .

(04 marks)

(b) (i) Bending his knees when landing on the ground increases the time during which his body comes to rest.
The rate of change of momentum of his body reduces; and the force with which his legs hit the ground reduces; leading to a reduced pain on his legs.

(02 marks)

(ii) $W = mg = 490.5 \Rightarrow \dfrac{490.5}{9.81} = 50kg$

From $\dfrac{1}{2}mv^2 = mgh \Rightarrow v = \sqrt{2gh}$

$$\sqrt{2 \times 9.81 \times 2.5}$$
$$= 7.0$$

Force F $= \dfrac{m(v-u)}{t} = \dfrac{50(7.0-0)}{0.5}$
$= 700$ N

(c) (i)

Perfectly elastic collision	perfectly inelastic collision
• Kinetic energy is conserved.	• Kinetic energy is not conserved ie. Some is lost.
• Bodes move at different velocities(or separate)	• Bodies move with a common velocity (or stick together after collision.
• Examples collision between Molecules of an ideal gas.	• Collision between two vehicles that stick together after impact.

(03 marks)

(ii) For perfectly inelastic collision:

$m_1u_1+m_2u_2 = (m_1+m_2)V$

where V= common velocity.

$$\Rightarrow v = \frac{m_1u_1+m_2u_2}{m_1+m_2} \quad \text{(i)}$$

Loss in k.e = Total k.e Before coil - Total k.e after coil.

$$= \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \frac{1}{2}(m_1+m_2)V^2$$

$$= \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \frac{1}{2}(m_1+m_2)\left(\frac{m_1u_1+m_2u_2}{m_{1+m_2}}\right)^2$$

$$= \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \frac{1}{2}\left(\frac{m_1^2u_1^2+2m_1m_2u_1u_2+m_2^2u_2^2}{m_1+m_2}\right)$$

$$= \frac{1}{2}m_1m_2\left(\frac{u_1^2-2u_1u_2+u_2^2}{m_1+m_2}\right)$$

$$= \frac{m_1m_2(u_1-u_2)^2}{2(m_1+m_2)}$$

(04 marks)

(iii) - Launch of rockets (rockets propulsion)
- Jet engine operation.
- Recoil of a gun.
- Motion of motor boats.

any 2 @ ½

(01 mark)

TOTAL MARKS = 20

2. (a) (i) Centripetal acceleration is the rate of change of velocity of a body moving in a circular path and is directed towards the Centre of the path.

(01 mark)

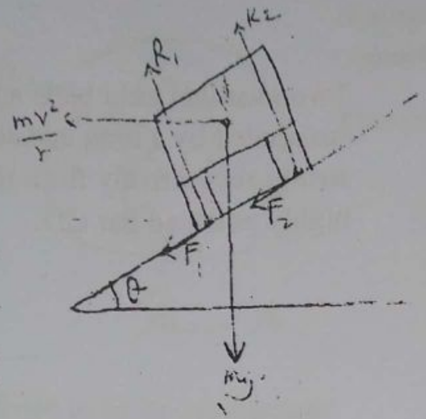
(ii) Angular velocity is the rate of change of angular displacement of a body moving in a circular path.

(01 mark)

(b) (i) Banking a track help to increase the forces that provide the centripetal force, ie. The horizontal components of the normal reaction and friction; thereby increasing the speed at which a car moves around the bend without skidding or toppling.

(01 mark)

(ii)



$F_1 = \mu R_1$, $F_2 = \mu R_2$

$$(R_1\sin\theta + R_2\sin\theta) + (F_1\cos\theta + F_2\cos\theta) = \frac{mv^2}{r}$$

$$\Rightarrow (R_1 + R_2)(\sin\theta + \mu\cos\theta) = \frac{mv^2}{r} \quad \text{———— (i)}$$

Also; $(R_1\cos\theta + R_2\cos\theta - (F_1\sin\theta + F_2\sin\theta) = mg$

$$\Rightarrow (R_1 + R_2)(\cos - \mu\sin\theta) = mg \quad \text{———— (ii)}$$

Dividing (i) by (ii) gives

$$\frac{\sin\theta + \mu\cos\theta}{\cos\theta - \mu\sin\theta} = \frac{v^2}{rg}$$

Dividing this by $\cos\theta =$

$$\frac{\tan\theta + \mu}{1 - \mu\tan\theta} = \frac{v^2}{rg}$$

From which;

$$\theta = \tan^{-1}\left(\frac{v^2 - \mu rg}{v^2\mu + rg}\right)$$

(04 marks)

(iii) r=65m, $\theta = \tan^{-1}\left(\frac{5}{12}\right) = 22.6^0$, V=?

For no tendarney to slip, these will be no friction.

$$\therefore v = \sqrt{rg\tan\theta}$$

$$= \sqrt{65 \times 9.81 \times \tan 22.6}$$

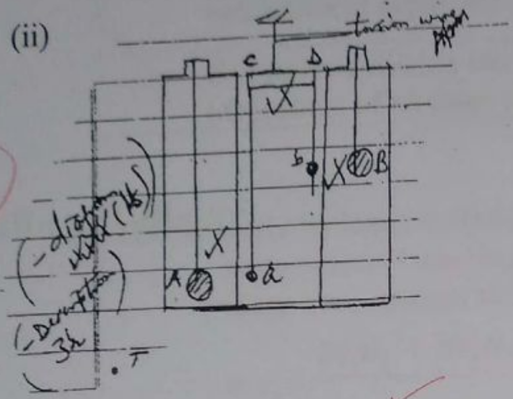
$= 16.29ms^{-1}$

(03 marks)

(c) (i)
- Planets describe elliptical orbit about the sun as one focus.
- The imaginary line joining a planet to the sun sweeps out equal areas in equal time intervals.
- The squares of the period of revolutions of planets about the sum is directly proportional to the cubes of their mean distances from the sun.

(03 marks)

(ii)



Two identical gold balls a and b are suspended by a long and short fine quarts strings respectively from the end of a highly polished bar CD.

1½

- Two large lead spheres A and B are brought into position near a and b as shown.
- The deflection θ of the bar CD is measured and noted by a lamp and seale method.
- The distance d between A and a or B and b is noted.
- The mass m and M of a and A respectively is also measured and recorded.
- The gravitational constant G is the obtained from; $G = \dfrac{c\theta d^2}{MmCD}$

where C= obtained constant of the wire.

(05 marks)

(c) (iii) m = 10 kg, h=30m.

Difference in the weight

$$= GMm\left(\frac{1}{re^2} - \frac{1}{(re+h)^2}\right)$$

$$= 6.67\times10^{-11}\times Me\times10\left(\frac{1}{(6.4\times10^6)^2} - \frac{1}{(6.4\times10^6+30)^2}\right)$$

$= \cancel{1.34 = 1.34\times10^{-2a}\,Me}$ $9.114\times10^{-4}N$

(02 marks)

TOTAL MARKS = 20

3. (a) (i) Surface tension is the tangential force per meter that its perpendicularly to one side of an **imaginary** line drawn on a liquid surface. **(01 mark)**

(ii)
- Some lycopodium powder or light dust in sprinkled on the surface of clean water standing in a flat metal dish.
- One side of the dish is then gently heated with a candle or bursen flame.

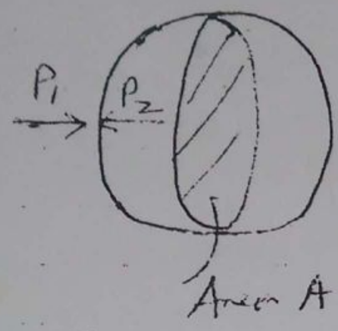
- It will be noted that the particles of the powder will be swept away from the heated portion, implying that the surface tension force can no longer hold the particles of the powder in their previous positions.

(03 marks)

(iii) The other factor is **presence of impurities** in the liquid; which **reduces** surface tension force of the liquid.

(02marks)

(b) (i)



A soap bubble in air has two liquid surface in contact with air.

This surface tensional forces $= 2 \times 2\pi r \gamma = 4\pi r \gamma$

For the bubble to be in equilibrium:

force due to external pressure P_1 + force due to surface tension. = force due to internal Press P_2

ie. $P_1 . A + 4\pi r \gamma = P_2 . A$

where A = area of cross – section of the bubble

$= \pi r^2$

$$\Rightarrow p_1 . \pi r^2 + 4\pi r \gamma = p_2 . \pi r^2$$

$$\text{or } (p_2 - p_1)\pi r^2 = 4\pi r \gamma$$

$$\Rightarrow \text{pressure diff } (P_2 - P_1) = \frac{4\gamma}{r}$$

(04 marks)

(ii) $r_1 = 1.5$cm, $r_2 = 30$cm, excess pressure =?

Pressure difference, $P = \frac{4\gamma}{r}$

Where $r = \sqrt{r_1^2 + r_2^2}$

$$\therefore p \frac{4}{\sqrt{r_1^2 + r_2^2}} = \frac{4 \times 2.0 \times 10^{-2}}{\sqrt{(0.015)^2 + (0.03)^2}}$$

$= 2.38 \text{ Nm}^{-2}$

(03marks)

(c) (i) Coefficient of viscosity is the tangential force acting on an area of $1m^2$ of fluid which resists the motion of one layer over another when the velocity gradient is $1s^{-1}$. (or tangential force per unit area of surface between two fluid layers in contact per unit velocity. Gradiant)

(01 mark)

(ii) - In liquids, viscosity is due to the existence of intermolecular forces of attraction. When temperature is increased, the molecules move further apart with increased k.e

MI

- Thus the internal. Force area weakened; leading to a decrease in viscosity of the liquid. **(03 marks)**

intermolecular forces are

(d) $A_1 = 15cm^2 = 15\times10^{-4}m^2, V_1 = 0.5ms^{-1}$

$A_2 = 3.0cm^2 = 3.0\times10^{-4}m^2, V_2e$

from $A_1V_1 = A_2V_2$

$\Rightarrow 15\times10^{-4}\times0.5 = 3.0\times10^{-4}\times V_2$

$V_2 = 2.5ms^{-1}$

Pressure difference, $\Delta P = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right)$

Where ρ = density of the liquid.

$\therefore P = \frac{1}{2}\rho\left(2.5^2 - 0.5^2\right)$

$= 3\rho \, Nm^{-2}$ **(03 marks)**

TOTAL 20 MARKS

4. (a) (i) Elasticity is the property of a material to regain its original shape (size or length) if the deforming force has been removed. **(01 mark)**

(ii) Force constant is the ratio of force to extension of an elastic material. Or the amount of force that causes a unit extension of a material. **(01 mark)**

(b) Original length =l, x-sectional area =A, force constant =k new length = l+x, stretching force =F.

(i) Young's modulus, $E = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{x/l}$

$\therefore E = \frac{Fl}{Ax}$

from which $F = \frac{EAx}{l}$

But $F = kx$

$\Rightarrow F = \frac{EAx}{l} = kx$

$\therefore k = EA/l$

(03 marks)

(ii) Energy stored in the wire = work done to stretch material ie.

W= average force × extension.

$= F/2 \times x = \frac{1}{2}Fx$

Since F =kx.

$\Rightarrow w = \frac{1}{2}kx^2$

But $K = \dfrac{EA}{l}$

$$\therefore W = \frac{1}{2}\frac{EA}{l}x^2$$

Also ; energy stored per unit vol $= {}^{W}/_{Al} = \frac{1}{2}\,{}^{EAx^2}/_{Al}$
$= \frac{1}{2}E({}^{x}/_{l})^2$ **(03 marks)**

4. (c) $lc = 1.0m$, dc = 0.5mm $= 0.5 \times 10^{-3}$m

$ls = 0.5m, ds = 0.8m = 0.8 \times 10^{-3}\,m$

$M = 12\text{kg};\ W = 12 \times 9.81 = 117.72\text{N}$

(i) From extension $x = \dfrac{Fl}{EA}$

For copper, $xc = \dfrac{Flc}{EcAc} = \dfrac{12 \times 9.81 \times 1.0}{Ec \times 3.14 \times \left(\frac{0.5 \times 10^{-3}}{2}\right)^2}$

$$= \frac{\cancel{1.49} \times 10^8}{Ec} \quad \frac{6.0 \times 10^8}{Ec}$$

For steel, $x_s = \dfrac{Fl_s}{E_sA_s} = \dfrac{12 \times 9.81 \times \cancel{1.0}\ 0.5}{Es \times 3.14 \times (0.\cancel{8}4 \times 10^{-3})^2}$

$E_{Cu} = 1.2 \times 10^{11}$

$$= \frac{\cancel{2.93 \times 10^8}}{Es} \quad \frac{1.17 \times 10^8}{Es}$$

$E_{steel} = 2.0 \times 10^{11}$

$\therefore$ Total extension, $x = xc + xs$

$$= \frac{\cancel{1.49} \times 10^8}{Ec} + \frac{\cancel{2.93}\ 1.17 \times 10^8}{Es}$$

$$= 10^8\left(\frac{\cancel{14.9}}{Ec} + \frac{\cancel{2.93}}{Es}\right) \quad 10^8\left(\frac{6.0}{Ec} + \frac{1.17}{Es}\right)$$

(04 marks)

(ii) Energy stored in the compound wire

$$W = \tfrac{1}{2}Fx_1 + \frac{1}{2}Fx_2 = \frac{1}{2}Fx$$

$$= \frac{1}{2} \times 12 \times 9.81 \times 10^8\left(\frac{\cancel{14.9}\ 6.0}{Ec} + \frac{\cancel{2.93}\ 1.17}{Es}\right)$$

$$= 5.89 \times 10^9\left(\frac{\cancel{14.9}\ 6.0}{Ec} + \frac{\cancel{2.93}\ 1.17}{Es}\right)\text{J}$$

(03marks)

(d) (i) Bernorth's principle states that in an **incompressible non-viscons** fluid

No 8 b) i

undergoing a steamline flow, the sum of the pressure at any point, the k.e per unit vol. and the p.e per unit vol. is constant. **(01 mark)**

(ii)

- A strong wind above the roof causes a faster flow of air above it than below, where the air is almost stationary.
- By Bernotth's principle the ~~presence~~ pressure under neath is greater than that above the roof.
- The pressure difference ~~this~~ thus produces an upward resultant force on the roof which consequently lift it and is blown off.

(04marks)

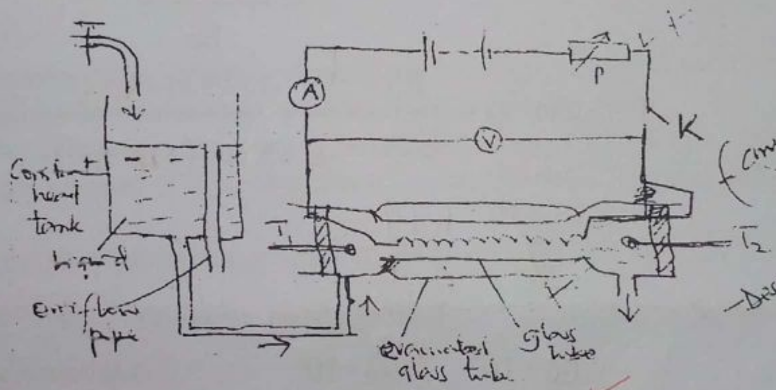
TOTAL MARKS 20

SECTION B

5. (a) (i) Heat capacity is the heat required the raise the temperature of any mass of a substance by 1K **(01 mark)**

(ii) Cooling correction is the temperature that has to be added to the observed maximum temp of a mixture to cater for heat losses to the surroundings. **(01 mark)**

(b) (i)



(any two points) (1 marks)

— Description 4 marks

- A steady flow of the liquid is set at a constant rate.
- K is closed and liquid is heated as it flows through the tube until the thermometer readings indicated by T_1 and T_2 are constant; and their readings θ_1 and θ_2 are noted.
- The ammeter and voltmeter readings I_1 and V_1 respectively are noted.
- The liquid is collected in a measured time and its mass per second M_1 collected is determined.
- The experiment is repeated by adjusting the flow rate of the liquid to a new value; P is adjusted until the ~~therm~~ thermometer readings indicated by T_1 and T_2 are the same as before i.e. θ_1 and θ_2.
- ~~and θ_2.~~
- The new ammeter and voltmeter readings I_2 and V_2 and the mass per second m_2 of the liquid collected in the same time are noted.

Deny all marks if the switch is not closed.

The s.h.c of the liquid is then obtained from; $C = \dfrac{I_2V_2 - I_1V_1}{(m_2 - m_1)(\theta_2 - \theta_1)}$

(05 marks)

(ii)This is to maintain the same rate of heat loss to the surrounding in the two parts of the experiment. **(01 mark**

(iii) Heat capacity of the apparatus is not required.

Any three

- Cooling correction is not required.
- Heat losses to the surroudings can be accounted for by repeating the experiment
- Heat losses are minimized by use of a vacuum.
- Readings can be recorded at leisure.

(03 marks

(c) $\theta = 2.0^0 C$, $m_1 = 20gs^{-1} = 0.02kgs^{-1}$, $P_1 = 40W$

$m_2 = 75gs^{-1} = 0.075kgs^{-1}$, $P_2 = 80W$

from $P = mc\theta + h$,

$40 = 0.02\,C \times 2.0 + h$

$\Rightarrow 40 = 0.04C + h$ ________ (i)

Also $80 = 0.075\,C \times 2.0 + h$

$\Rightarrow 80 = 0.150\,C + h$ ________ (ii)

Solving (i) and (ii) gives: $h = 25.45W$

$\therefore$ heat lost in 5 minutes $= 25.45 \times 5 \times 60$

$= 7635\ J$

or $= 7.635 \times 10^3 J$

(05 marks)

(d) (i) Latent heat of fusion of ice is the heat required to change the state any given mass of ice into water at its melting point. constant temperature.

(01 mark)

(ii) When the cold ice comes into contact with one's hand heat is lost from the hand to the ice, causing a thin layer of water to form on ice due to melting.
This thin layer of water together with the sweat in the hand will freeze into the tiny indentations in the surface of the hand.
The oxygen and hydrogen atoms in the water molecules in the ice will form strong bonds with the hydrogen and oxygen atoms respectively in the sweat.
This strong bond will give the "sticking" feeling in the hand.

(03 marks)

TOTAL 20 MARKS

6. (a) (i) Isothermal change is the expansion or contraction of a gas that takes place at constant temperature. while
Achiabatic change is the expansion or contraction of a gas that takes place at constant heat.

(01 mark)

(ii) The expansion or contraction of the gas must take place rapidly to give little time for heat to escape or enter the system.
- The walls of the container of the gas must be thick walled and of poor conducting materials.
A light frictionless piston is used.

(02 marks)

(iii)Transmission of sound waves through air.

- Rapid expansion of air during a tyre burst. **(02 marks)**

- An inflated tyre

(b) $P_1 = 2.0\times10^6$ Pa, $V_1=3.0l = 3.0\times10^{-3}m^3$, $T_1=50^0C =323k$

$P_2 = 1.0\times10^7$ Pa.

(i) From $n = \frac{P_1V_1}{RT_1} = \frac{2.0\times10^6\times3.0\times10^{-3}}{8.31\times323}$

$= 2.24$ moles **(03 marks)**

(ii) $T_2 = ?$ from $P_1V_1^{\gamma}= P_2V_2^{\gamma}$

1.4

$V_2 = \frac{P_1}{P_2}.V_1 = \frac{2.0\times10^6}{1.0\times10^7}\times\left(3.0\times10^{-3}\right)^{1.4}$

From $V_2 =9.5\times10^{-4}m^3$

Also $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$\Rightarrow T_2 = \left(\frac{v_1}{v_2}\right)^{\gamma-1}\times T_1$

$= \left(\frac{3.0\times10^{-3}}{9.5\times10^{-4}}\right)^{1.40-1}\times323$

$= 511.63K$ **(04 marks)**

(c) (i) Molar heat capacity at constant pressure is defined as the heat required to raise the temperature of one mole of a gas by 1K when its pressure is constant. **(01 mark)**

(ii) If 1 mole of a gas is heated through ΔT at constant vol; $\Delta Q = CV\Delta T$.

Where CV = Molar heat capacity at constant vol.

Since $\Delta V= 0 \Rightarrow \Delta w = 0$

from $\Delta Q = \Delta u + \Delta w$

$\Rightarrow \Delta Q = \Delta u = Cv\Delta T$

If the same gas of 1 mole is heated through ΔT at constant pressure;

$\Delta Q = Cp\Delta T$

Where Cp = molar ht capacity at constant pressure.

$\Rightarrow \Delta Q = Cp\Delta T=\Delta u+\Delta w$

$\therefore Cp\Delta T = Cv\Delta T+P\Delta V$ ---- *

But for 1 mole: PV = RT ________ (i)

And $P(V+\Delta V) = R(T+\Delta T)$ ____ (ii) for constant pressure.

from (i) and (ii): $P\Delta V = R\Delta T$

Substituting $\therefore$ In(*)$Cp\Delta T=Cv\Delta T+R\Delta T$

from which Cp = Cv +R or Cp –Cv =R **(05 marks)**

(d)

- When a gas is composed in a vessel ,its molecules bounce off the wall with increased speed.

No 8 60 ?

- The frequency of collisions between the molecules also increases and this increases the mean k.e of the molecules.
- Since mean k.e of the ~~moles is~~ molecules is portional to absolute temperature, $\Rightarrow$ temp. of the gas increases.

(02 marks)

TOTAL = 20 MARKS

7. (a) (i) A black body is a body which absorbs all the radiations of every wave length falling on it and transmits none.

(01 mark)

(ii) Stefan's law- the energy radiated per second per unit surface area of a black body is directly proportional to the fourth absolute temperature of the body.
(or $\frac{P}{A} \alpha T^4$ – with P and T defined)

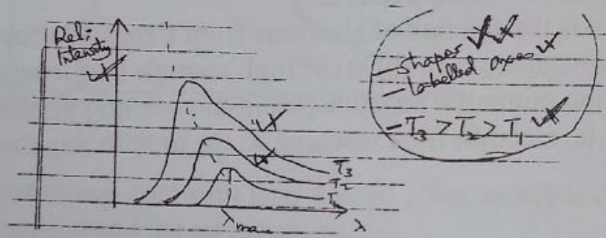
(01 mark)

Wien's displacement law the wave length at which intensity of energy emitted by a black body is max inversely prop to its absolute temperature.

(01 mark)

(or $\lambda_{max}\ \alpha\ \dfrac{1}{T}$ with λ_{max} and T defined

(d)



(02 marks)

- As the temperature of the body increases, the intensities of every wave length increases, the intensities of the shorter wave lengths increase more rapidly.
- At each temp; there is max. intensity which occurs at a particular wave length λ_{max} which decreases with increasing temp.

(03 marks)

7. (c) $T = 3500^0C = 3773K$, $A = 0.42cm^2 = 0.42\times10^{-4}m^2$

(i) $P = 0.29\sigma AT^4$

$= 0.29\times 5.67\times10^{-8}\times0.42\times10^{-4}\times(3773)^4$

$= 140W$

(03 marks)

(ii) $\lambda_{max}T = 2.90\times10^{-3}$

But $\lambda_{max} = {}^{c}/_{f}$

$$\Rightarrow \frac{c}{f}.T = 2.90\times10^{-3}$$

$$\therefore f = \frac{CT}{2.90\times10^{-3}} = \frac{3.0\times10^{8}\times3773}{2.90\times10^{-3}}$$

$= 3.9\times10^{14}Hz$

(03 marks)

(d) (i)

- Atoms in a solid are closely packed together.
- When one end of the solid is heated, the atoms there absorb the heat energy and begin to vibrate with increased amplitudes about their fixed positions.
- Since they are coupled by interatomic bonds to the neighboring atoms , they pass on their vibrational energy to them; which in turn pass on the energy to their neighbors, causing heat energy to be transmitted to the colder end.

(03 marks)

(ii)

- Metals have free electrons in their lathice that move with high or increased velocities once they gain heat energy from the heated end unlike in insulators.
- Also, owning to the fact they are higher, they carry the heat energy which the pass on to the positive nucleus of atoms due to collisions in the metal lathice.This makes heat transfer faster unlike in insulators where heat transfer is due to atomic vibrations only.

(03 marks)

TOTAL 20 MARKS

SECTION C

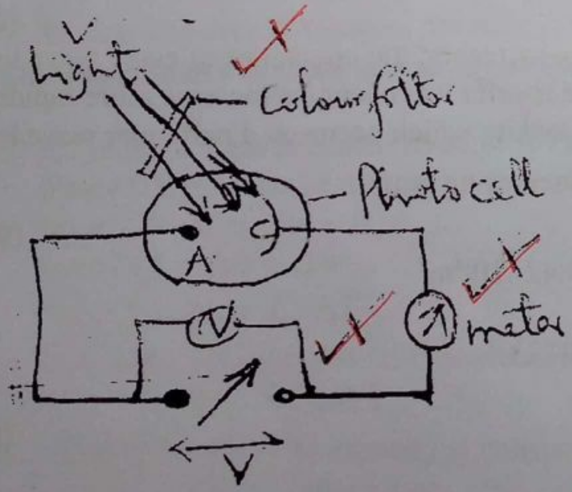
8. (a) (i) Photoelectric emission – is the ejection of electrons from a metal surface when irradiated by an electromagnetic radn (light) of high enough frequency.

(ii) Stopping potential – Is the minimum negative potential (voltage) applied to the anode to stop the most energetic electron from reaching it. (or to reducing the photo current to zero).

(01 mark)

(b)

Any four points (1 marks)



- An evaluated photo cell that has a photo emissive cathode C of large surface area and an amode A is used.
- Circuit is connected across a variable potential.

– Monochromatic radiation is made incident on to the cathode

- A is made negative in potential relative to C
- The p.d V is increased negatively until the photo current registered by the meter is zero.
- The p.d Vs is then noted from the voltmeter V and is the stopping potential.

(05 marks)

(c) $\lambda = 145nm = 145\times10^{-9}m$, $w_o = 2eV$

(i) $\frac{1}{2} m V_{max}^2 = \frac{hc}{\lambda} - w_o$

$$\Rightarrow \frac{1}{2}\times 9.11\times10^{-31}\times V_{max}^2 = \frac{6.6\times10^{-34}\times3.0\times10^{8}}{145\times10^{-9}} - 2\times1.6\times10^{-19}$$

$\therefore V_{max} = \cancel{4.81\times10^{6}\ ms^{-1}}$ $1.515\times10^{6}\ ms^{-1}$

(03 marks

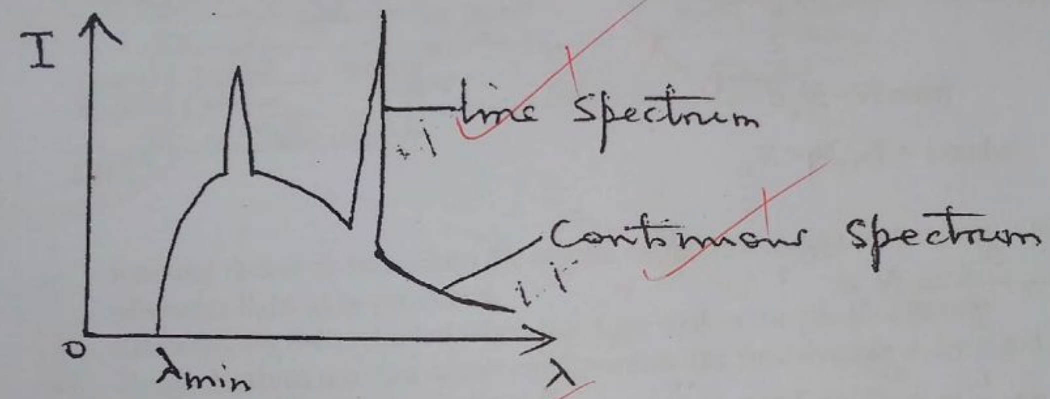
(iii) $hf_o = w_o \Rightarrow f_o = \frac{w_o}{h} = \frac{2\times1.6\times10^{-19}}{6.6\times10^{-34}} = 4.85\times10^{14}Hz$

(02 marks

(d) (i) X-rays are electromagnetic radiations of very high frequency and short wave length emitted or produced when fast moving electrons are stopped by matter.

(01 mark

(ii)



- Continuous spectrum is produced when multiple collision occur between the energetic electrons and the target atoms.
- At each collision, X-rays photons of different wave lengths are emitted since each electron gives up a different amount of its k.e.
- Line spectrum is produced when a highly energetic electron penetrates deeper into an atom of the target metal and knocks out an electron from the inner most shell. The electron transition to the vacancies left results and leads to emission of X-rays of definite wave length seen as line spectrum.
- When an electron gives up all its k.e in a single collision, a highly energetic X-ray photon of max. frequency and min wave length λ_{min} is emitted.

(04 marks)

(iii) $f_{max} = \frac{eVa}{h} = \frac{1.6\times10^{-19}\times40\times10^{3}}{6.6\times10^{-34}} = 9.69\times10^{18}\ Hz$

(03 marks)

Total:20 marks

9. (a) (i) Backgroud radiation – is the natural ionizing radiation present in the environment, emitted from a variety of source to which all humans are exposed to.

(01 marks)

(ii) Main sources.

- Cosmic radiation.
- Terrestrial radiation.

CONT.

(02 marks)

- Inhalation/ingestion radiation.

(iii) Examples of background radiation:

- Cosmic rays from the sun.
- Gaseous radon.

(01 mark)

(b) (i) The law of radioactive decay states that ~~of~~ at a particular time, the rate of radioactive disintegration is directly proportional to the number of nuclear of the element present at that time.

(or $dN/dt \propto N$ – with symbols defined)

(01 mark)

(ii) To show that $\lambda T_{\frac{1}{2}}$ In2.

from N= $N_o e^{-\lambda t}$ 01

when t = T½ ,N= $\frac{N_o}{2}$

$$\Rightarrow \frac{N_o}{2} = N_o e^{-\lambda T\frac{1}{2}}$$ 01

$$\Rightarrow \frac{1}{2} = e^{-\lambda T\frac{1}{2}} \text{ or } 2 = e^{\lambda T\frac{1}{2}}$$

Taking log$_e$ of both sides;

$$\ln e^{\lambda T\frac{1}{2}} = \ln 2$$ 01

$$\Rightarrow \lambda T\frac{1}{2} = \ln 2$$ 01

(04 marks)

9. (b) (iii) $T\frac{1}{2}$= 28yrs, t =15 yrs

$$\lambda = \frac{0.693}{T_{\frac{1}{2}}} = \frac{0.693}{28} = 0.0248\,yr^{-1}$$ 01 01

Original no. of atoms, $N_o = \frac{N_A}{M}.m_o = \left(\frac{N_A}{M} \times 5\times10^{-6}\right)$ 01

where N_A = Avogadro no.

M = molar mass of strontium.

from $N = N_o\, e^{-\lambda t}$, $N = \left(\frac{N_A}{M} \times 5.0\times10^{-6}\right) e^{-(0.0248\times15)}$

$$= \left(3.45 \times 10^{-6}\frac{N_A}{M}\right) \text{atoms}$$

$= 3.45\times10^{-6} \times \frac{6.02\times10^{23}}{M}$

$= \frac{2.076\times10^{18}}{M}$ atoms

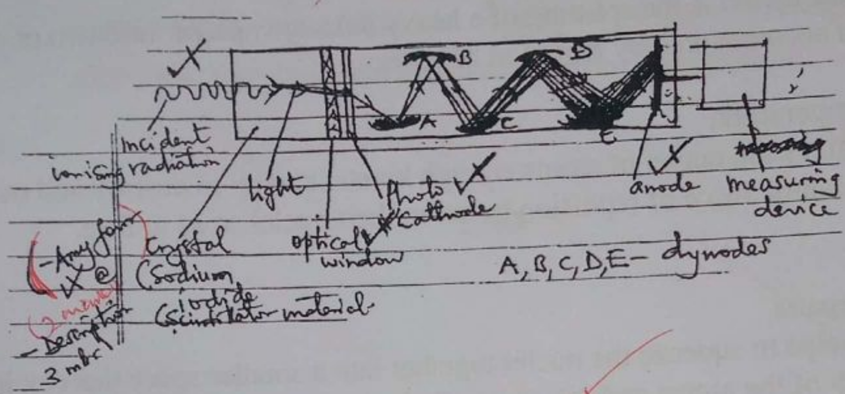
$\therefore$ mass remaining in the N atoms.

$$= \left(3.45\times10^{-6}\frac{N_A}{M}\right)\times\frac{M}{N_A}$$

$= 3.45\times10^{-6}$ g or 3.45ng.

02 **(04 marks)**

(c) (i)



- Ionizing radiation enters into the crystal of sodium iodide and causes a photon of visible light to be produced.
- Electrons are then released when this light strikes the photocathrode.
- These electrons are then accelerated towards the first dynode A by a p.d, high enough to release electrons from A.
- These electrons are attracted towards the second dynode B, and more ebetrons are released.
- Each dynode impact release more electrons producing a current amplifying effect at each dynode stage.
- At the find dynode, sufficient electrons are available to produce pulse of current which can be analyzed by the measuring device.

(05 marks)

(ii) Two advantages of the scihtillator counter over the GM tube;

- Its counting rate is very fast;
- It can also be used to detect x-rays.
- It is more sensitive compared to the GM tube
- It can detect lower levels of radiation.

(02 marks)

(d) Industrial use

- In tracers to monitor fluid flow
- Detection of leaks.
- Ganging engine wear and corrosion
- Monitoring thickness of metal sheets during manufacture.

Any one

Medical use

- In therapy to treat cancer.
- In diagrosis of tumours and other maligrat growths in the body.

Any one.

(02 marks)
Total :20 marks

- When electron makes a transition from one orbit to another of lower energy, a photon is emitted equal to the energy difference between the two states.

(02Marks)

(ii)

- When an atom is involved in a violent collision, an electron may gain energy and move from its normal orbit to one of a higher energy level.
- This makes the atom excited but soon the electron returns to its original orbit.
- This electron transition is accomplished by emission of energy in form of light.
- The wave length of the emitted light is dependent on the two orbits involved.
- Light of a number of different λ_s may be produced corresponding to the electronic transition and this constitute the line spectrum.

(03 marks)

TOTAL 20 MARKS

END