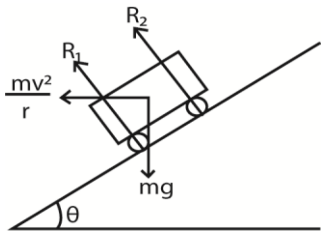
UACE Physics paper 1 set9 guide

1. (a) Define the following terms
   (i) Uniform acceleration (01mark)
   Uniform acceleration is a constant rate of change of velocity
   (ii) Angular velocity (01mark)
   Angular velocity is the rate of change of angular displacement

   (b) (i) What is meant by banking a track? (01mark)

   Banking the road is the rising of the road outwards from the centre of circular path

   (ii) Derive an expression for the angle of banking θ for a car of mass, m, moving at speed, v, round a banked tract of radius, r. (04marks)



Resolving horizontally: $(R_1 + R_2)\sin\theta = \frac{mv^2}{r}$ ………………….. (i)

Resolving vertically: $(R_1 + R_2)\cos\theta = mg$ ……………………….(ii)

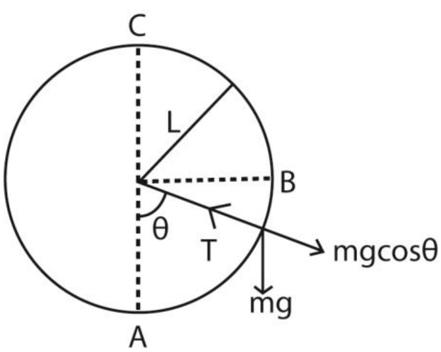
Eqn. (i) and Eqn. (ii);

$\tan\theta = \frac{v^2}{rg}$

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

   (c) A bob of mass, m is tied to an inelastic thread of length, L, and whirled with constant speed in a vertical circle

   (i) With the aid of a sketch diagram, explain the variation of tension in the string along the circle. (05 marks)



At A, θ = 0

=> T = $\frac{mv^2}{L}$ + mg

At B, θ = 90^0

=> T = $\frac{mv^2}{L}$

At C, θ = 1800

=> T = $\frac{mv^2}{L}$ - mg

(ii) If the string breaks at one point along the circle, state the most likely position and explain the subsequent motion of the bob.

The string breaks at the lowest point, A of the circle because tension the string is highest. Motion is tangential to the circle and when the string breaks, the bob follows a parabolic path.

(d) A body of mass 15kg is moved from earth's surface to a point 1.8x 10^6m above the earth. If the radius of the earth is 6.4 x 10^6m and the mass of the earth is 6.0 x 10^{24}kg; calculate the work done in taking the body to that point (06marks)

On earth, $P.E_1 = \frac{-GmM}{R_S}$

Above the earth P.E2 = $\frac{-GmM}{r}$, r = ((6.4 + 1.8) x 10^6) = 8.2 x 10^6m

Work done = $GmM\left(\frac{1}{R_S} - \frac{1}{r}\right)$

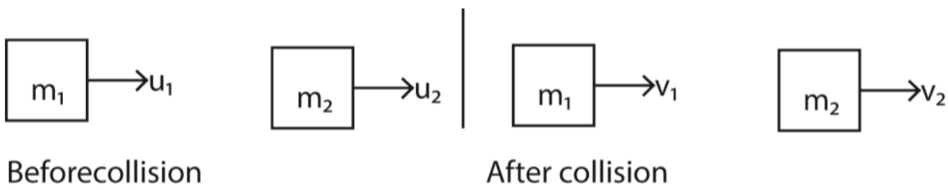
$= 6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times 15\left(\frac{1}{6.4 \times 10^6} - \frac{1}{8.2 \times 10^6}\right)$

= 2.06x 10^8J

2. (a) State Newton's laws of motion. (03marks)

- 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 of a body is directly proportional to applied force and takes place in the direction of the force
- For every action, there is an equal and opposite reaction

(b) Use Newton's laws of motion to show that when two bodies collide their momentum is conserved. (04marks)



During collision, each body exerts a force of impact on each other according to Newton's second law of motion.

Let I be the I impulse on A, then the impulse on B = -I.

$I = M_1v_1 - m_1u_1$ ……………. (i)

$-I = m_2v_2 - m_2u_2$ ……………. (ii)

Equation (i) + equation (ii)

$0 = M_1v_1 - m_1u_1 + m_2v_2 - m_2u_2$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

(c) Two balls P and Q travelling in the same line in opposite directions with speeds of $6ms^{-1}$ and $15ms^{-1}$ respectively make a perfect collision. If the masses of P and Q are 8kg and 5kg respectively, find the

(i) final velocity of P, (04marks)

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

$-8 \times 6 + 5 \times 15 = (8 + 5)v$

$v = - 2.08ms^{-1}$ in the same direction as that of Q

(ii) change in kinetic energy. (04marks)

Change in kinetic energy = initial K.E – Final K.E

$= \left(\frac{1}{2}\ x\ 8\ x\ 6^2 - \frac{1}{2}\ x\ 5\ x\ 15^2\right) - \frac{1}{2}\ x\ 13\ x\ 2.08^2$

= 678 .38J

(d) (i) What is an impulse of a force? (01marks)

An impulse is a product of force and time of action of force

(ii) Explain why a long jumper should normally land on sand. (04marks)

By landing on sand, the time take to come to rest is increased and hence the rate of change of momentum is reduced. Therefore the force on the jumpers legs is reduced thus less pain in the legs.

3. (a) (i) What is meant by viscosity. (01mark)

Viscosity is the frictional force per unit area of a liquid where the velocity gradient is unity.

(ii) Explain the effect of temperature on viscosity of a liquid. (03marks)

Increase in temperature of a liquid increases the separation between the molecules and reduce the intermolecular attraction leading to a decrease in viscosity.

(b) Derive an expression for terminal velocity of a sphere of radius, a, falling in a liquid of viscosity, η. (04marks)

At terminal velocity, mg = U + Fv

⇨ $\frac{4}{3}\pi a^3\sigma g = \frac{4}{3}\pi a^3\rho g - 6\pi a\eta v_0$

$v_0 = \frac{2ga^2(\sigma - \rho)}{9\eta}$ where;

σ = density of the sphere

ρ = density of the liquid

η = viscosity of the fluid

g = acceleration due to gravity

(c) Explain why velocity of a liquid at a wide part of a tube is less than that at a narrow part. (02marks)

Volume flow per second is constant, so by the equation of continuity AV = constant', the velocity is inversely proportional to cross section area.

(d) A solid weighs 237.5g in air and 12.5g when totally immersed in a fluid of density 9.0 x 10^2kgm^{-3}. Calculate the density of the liquid in which the sold would float with one fifth of its volume exposed above the liquid surface.

Up thrust = $\frac{(237.5-12.5)}{1000}$ = 0.225kg

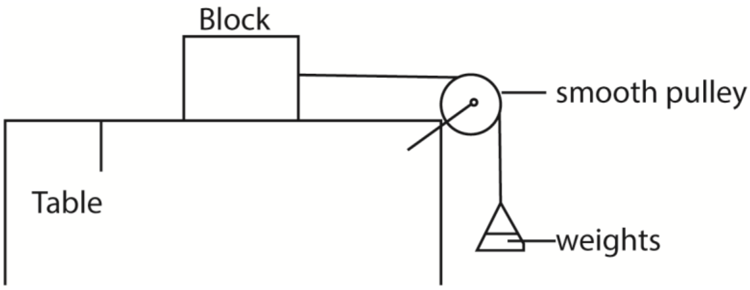
Volume = $\frac{0.225}{900}$

Volume the liquid displaced = $\frac{4}{5}\ x\ \frac{0.225}{900}$

The $\frac{4}{5}\ x\ \frac{0.225}{900}\rho = 237.5$

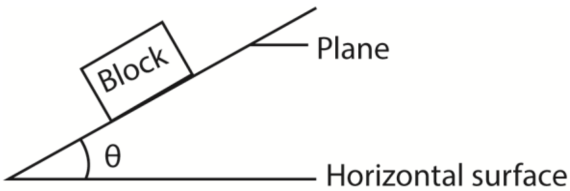
ρ = 1187.5kgm^{-3}

(e) Describe an experiment to measure the coefficient of static friction between a rectangular block of wood and a plane surface. (04marks)



- A block of mass m is placed on a flat table and connected to a scale pan as shown in the diagram above.
- Small weights are added in bits on to the scale pan until the block just starts to move. The total weight of the scale pan and weights added is obtained, W_f.
- The coefficient of static friction, μ = $\frac{W_f}{mg}$

Alternative method



- A block is placed on horizontal plane. The plane is tilted gently until the block just start to slide
- The angle of tilt θ is measured
- The coefficient of static friction, μ = tanθ

4. (a) (i) What is meant by simple harmonic motion? (01mark)

Simple harmonic motion is the periodic motion of a body whose acceleration id proportional to the displacement from a fixed point and directed towards the fixed point.

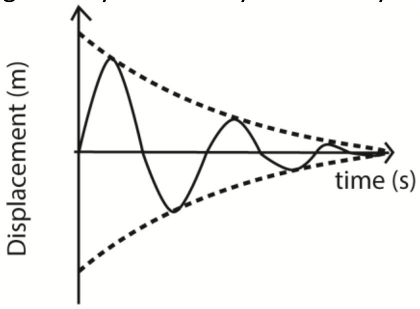
(ii) State two practical examples of simple harmonic motion. (01mark)

- Motion of pistons in an engine
- Motion of balance wheel of a pendulum clock

(iii) Using graphical illustrations, distinguish between under damped and critically damped oscillations (04marks)

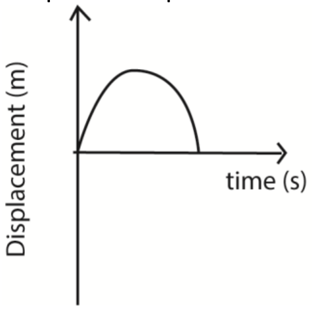
(i) Under damped oscillation

These are oscillations in which the system experiences low resistance/dissipative forces such that it loses energy gradually and amplitude of oscillations decrease gradually until the system finally comes to rest.

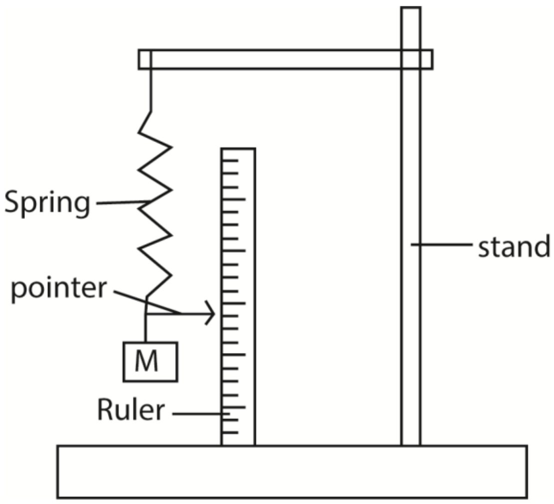


(ii) Critically damped

These are oscillation which occur when a system is displaced but does not oscillate and return to equilibrium position in the minimum possible time. The magnitude of resistive forces is such that they do not allow the system to vibrate past this equilibrium position.



(b) (i) Describe an experiment to measure acceleration due to gravity using a spiral spring (06marks)



- Clamp the spring on a retort stand

- Fix a horizontal pin at free end of the spring to act as a pointer.
- Place a vertical meter rule next the pointer and note the initial pointer position, P_1.
- Suspend a known mass, M, to the free end of the spring, note and record the new position of the pointer, P_2.
- Calculate extension, $e = P_2 – P_1$.
- Find the extensions for different masses
- Plot a graph of e against M
- Calculate the slope, S of the graph
- Calculate the acceleration due to gravity, g = kS (k = force constant)

(ii)State two limitations to the accuracy of the value obtained in (b)(i).

- Upthust
- Accurate reading of initial and final pointer position

(c) A horizontal spring of force constant $200Nm^{-1}$ fixed at one end has a mass of 2kg attached to the free end and resting on a smooth horizontal surface. The mass is pulled through a distance of 40.0cm and released.

Calculate the

(i) Angular speed

From $T = 2\pi\sqrt{\frac{m}{K}}$

$T = 2\pi\sqrt{\frac{2}{200}} = 0.628s$

But $\omega = \frac{2\pi}{T} = \frac{2\pi}{0.628} = 10rads^{-1}$

(ii) Maximum velocity attained by a vibrating body. (02marks)

$v_{max} = \omega A$

$= 10 \times 4 \times 10^{-2} = 0.4ms^{-1}$

(iii) Acceleration when the body is half way towards the centre from its initial position (02marks)

$a = -\omega^2 x$ but $x = \frac{0.04}{2}$ - 0.02m

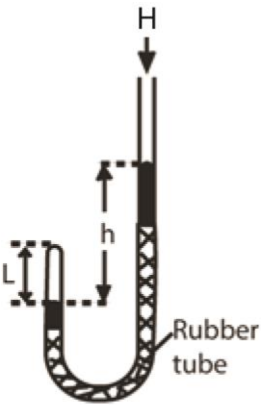
$a = -10^2 \times 0.02 = 2ms^{-2}$

SECTION B

5. (a)(i) State Boyles law (01mark)

Boyles law states that for a fixed mass of a gas at constant temperature, pressure is inversely proportional to volume.

(ii) Describe an experiment to verify Boyles' law (06mark)



- air in the closed limb of a U-tube barometer as shown above
- mercury is poured to a height, h, and the length of the air column, L is noted.
- the length h is varied to obtain different sets of values of h and L
- Pressure of the gas is calculated from $P = (H + h)\rho g$ where H= height of barometer corresponding to atmospheric pressure, ρ = density of mercury, g = acceleration due to gravity. Note that h can be positive or negative.
- If A is the cross section area, V =AL
- Values of h, L, P, V and 1/V are tabulated
- A plot of P against 1/V gives a straight line through the origin which verifies Boyle's law.

(iii) Explain why the pressure of a fixed mass of a gas rises if its temperature is increased. (02marks)

When the temperature of a fixed mass of a gas is increased, at constant volume, the velocities and kinetic energy of molecules is increased. They bombard the walls of the container more frequently with increased force. This increases pressure since pressure is proportional to force.

(b) (i) Define the term thermometric property and give four examples (03marks)

Thermometric property is a physical property whose value varies uniformly and continuously with change in temperature.

Examples

- Volume of constant mass of a gas at constant pressure
- Pressure of a gas at constant volume
- Electrical resistance of a platinum wire
- e.m.f of a thermocouple
-

(ii) State two qualities of a good thermometric property. (01mark)

- Should vary linearly and continuously with temperature
- Should be sensitive to temperature change
- Should vary over a wide range of temperature.

(c) (i) With reference to a liquid in glass thermometer, describe the step involved in setting up a Kelvin scale of temperature (03marks)

Length l_{tr} of a liquid column is measured at the triple point of water
Length l_T of liquid column is measured at unknown temperature, T

$T = \frac{l_T}{l_{tr}} x\ 273.16K$

(ii) State one advantage and one disadvantage of the resistance thermometer. (01mark)

Advantage

- measures a wide range of temperatures
- very accurate

Disadvantage

- unsuitable for rapidly changing temperatures
- Cannot measure temperature at a point
- Does not give direct readings

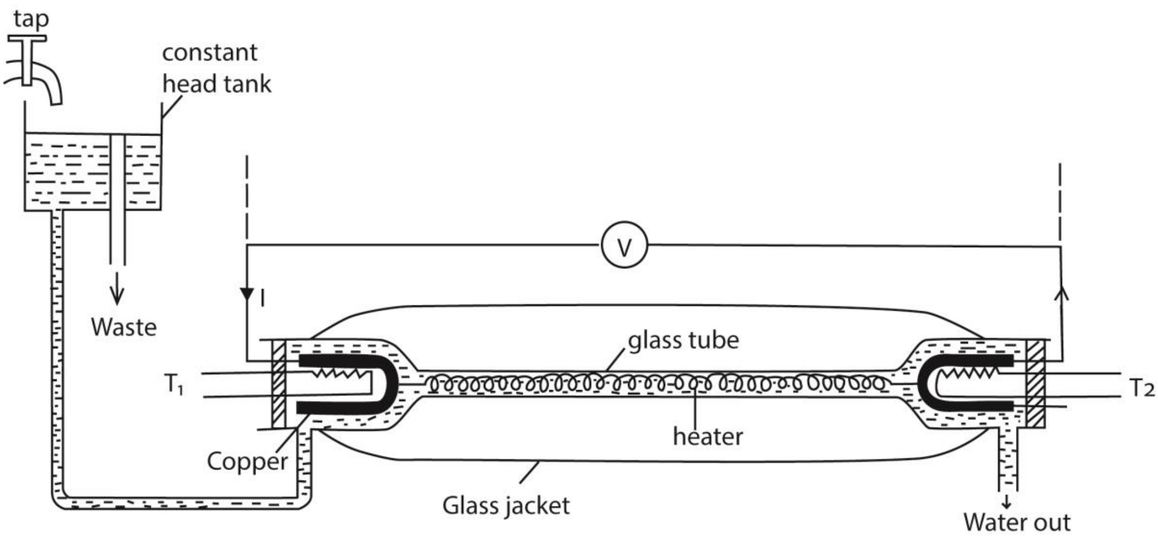
(d) A resistance thermometer has resistance of 21.42Ω at the ice point, 29.10Ω at steam point and 28.11Ω at some unknown temperature θ. Calculate θ on the scale of this thermometer. (03marks)

$\theta = \frac{R_\theta - R_0}{R_{100} - R_0} x\ 100^0C = \frac{28.11-21.42}{29.10-21.42}\ x\ 100^0C$ = 87.11^0C

6. (a) Define specific heat capacity of a substance and state its units (02marks)

Specific heat capacity is the amount of heat required to raise the temperature of 1kg mass of a substance by 1K of 1^0C. Units $JKg^{-1}K^{-1}$.

(b) (i) Describe how specific heat capacity of a liquid can be obtained by continuous flow method. (07marks)



- A liquid is allowed to flow at constant rate
- Power is switched on and the liquid is heated until temperatures registered by T_1 and T_2 are steady and the values θ_1 and θ_2 respectively are recorded.
- The p.d V and current I are recorded from the voltmeter and ammeter respectively
- The mass, m of a liquid collected in time t is recorded
- At steady state; $VIt = mc(\theta_2 – \theta_1) + h$ …………. (i)
  where h is heat lost to the surrounding
- The rate of flow is changed and the voltage and current are adjusted until the steady readings of T_1 and T_2 are θ_1 and θ_2 respectively

- If m_1, V_1 and I_1 are the values mass of liquid collected in time t, voltmeter and ammeter readings respectively, then
  $V_1I_1t = m_1c(\theta_2 - \theta_1) + h$ …………. (ii)
  Subtracting (ii) from (i)
  $c = \frac{(VI - V_1I_1)t}{(m - m_1)(\theta - \theta_1)}$

(ii) State one disadvantage of this method. (01mark)
- A large quantity of liquid is required
- Not suitable for all liquids

(c) An electric kettle rated 1000W, 240V is used on 220V mains to boil 0.52kg of water. If the heat capacity of the kettle is $400JK^{-1}$ and the initial temperature of water is 20^0C, how long will the water take to boil? (04marks)

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

=> $1000 = \frac{240^2}{R}$; R = 57.6Ω

$P \times t = mc\theta + C\theta$

$$\frac{220^2}{57.6} = 0.52\ x\ 4200(100 - 20) + 400(100 - 20)$$

$t = 246s$

(d) (i) Distinguish between isothermal and adiabatic changes (02marks)

Isothermal change is a process which takes place at constant temperature while adiabatic change is a change which takes place in such a way that no heat enters or leaves the system

(ii) An ideal gas at 18^0C is compressed adiabatically until the volume is halved. Calculate the final temperature of the gas. [Assume specific heat capacities of the gas at constant pressure and volume are $2100Jkg^{-1}K^{-1}$ and $1500Jkg^{-1}K^{-1}$] respectively. (04marks)

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

$$\gamma = \frac{2100}{1500} = 1.40$$

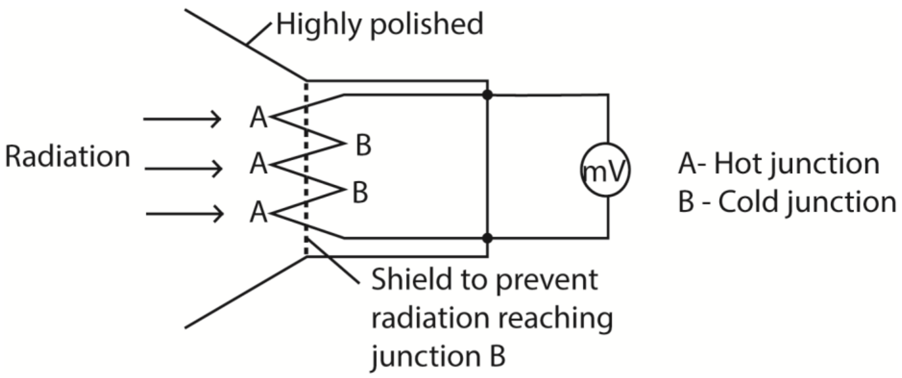
⇨ $291(V)^{1.4-1} = T_2\left(\frac{V}{2}\right)^{1.4-1}$

$T_2 = 384K$

7. (a) State Stefan's law of black body radiation. (01marks)

Stefan's law states that the energy radiated per second per unit area of black body is proportional to the fourth power of the temperature of the body in Kelvin.

(b) Briefly describe how a thermopile can be used to detect thermal radiation. (05marks)



Radiation falling on junction A is absorbed and temperature rises above that of junction B. An e.m.f is generated and is measured by millivolt meter which deflects as a result.

(c) Explain the temperature distribution along

(i) a perfectly lagged metal bar (02marks)

When a metal is fully lagged, no heat is lost to the surroundings. The rate of heat flow along the metal bar is the same making the fall in temperature along the bar is uniform,

(ii) an unlagged metal bar. (02marks)

For a fully unlagged metal, heat lost to the surroundings. The rate of heat flow along the bar is not the same. Hence temperature gradient along the bar decreases with distance from the hot end to the cold end.

(d) The wall of a furnace is constructed with two layers. The inner layer is made of bricks of thickness 10.0cm and thermal conductivity 0.8 $Wm^{-1}K^{-1}$ and the outer layer is made of material of thickness 10.0 cm and thermal conductivity 1.6 $Wm^{-1}K^{-1}$.

The temperatures of the inner and outer surfaces ate 600^0C and 460^0C respectively.

(i) Explain why in steady state, the rate of thermal energy transfer must be the same in both layers. (01mark)

Rate of the thermal energy transfer is the same because no heat is lost transverse to the direction of heat flow.

(ii) Calculate the rate of heat flow per square meter through the wall. (05marks)

$$\frac{Q}{t} = kA\left(\frac{\theta_2 - \theta_1}{l}\right)$$

$$\frac{0.8A(600-\theta)}{10 \ x\ 10^{-2}} = \frac{1.6A(\theta-460)}{10\ x\ 10^{-2}}$$

$$\theta = 506.7^0$$

$$\frac{QIt}{A} = \frac{0.8A(600-506.7)}{10\ x\ 10^{-2}} = 746.4Wm^{-2}$$

(e) Explain the greenhouse effect and how it is related to global warming. (04marks)

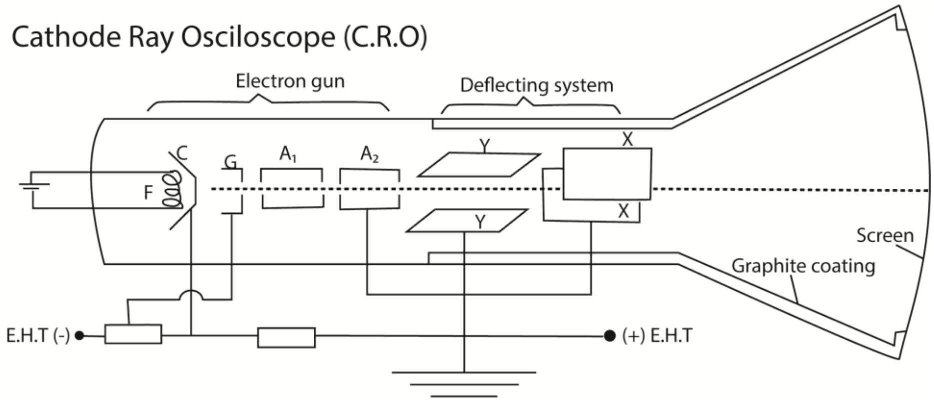
Short wavelength radiation from the sun passes through glass of green house. This is absorbed by plants and soil leading to increase in temperature. Plants and soil reradiate long wavelength radiations which cannot penetrate the glass and trapped in the greenhouse leading to higher temperature inside the greenhouse.

Water vapour, carbon dioxide, CFC and other greenhouse gases exhibit the same selective absorption effect in the temperature, making the earth to high temperature by absorbing short wavelength radiation.

The earth reradiates long wavelength radiation which is absorbed by the layers of greenhouse gases. This leads to increased temperature over the earth and after a long time may lead to global warming.

SECTION C

8. (a) (i) Describe with the aid of a well labelled diagram, the structure and mode of operation of a C.R.O (06marks)



The cathode ray oscilloscope consists of

- cathode C (Electron gun) produces electron by thermionic emission
- Grid G controls number of electrons reaching the screen
- Anodes, A accelerate electrons
- Y and X- plates deflect electrons vertically and horizontally respectively
- The screen is coated with zinc sulphide to glow when hit by electron
- Time base is connected to X- plates and provides a saw tooth p.d that sweep the electron spot from left to right of the screen at steady speed

(ii) State the advantages of C.R.O over a moving coil voltmeter. (02marks)

- draws very little current
- measures both alternating and direct voltages
- has no coil to burn out
- gives instantaneous response

(b) In the determination of the electron charge by Millikan's method, a potential difference of 1.5kV is applied between horizontal metal plates, 12mm apart. With the field switched off, a drop of oil of mass 1.0×10^{-14} kg is observes to fall with constant velocity, $4 \times 10^{-4} ms^{-1}$ between two metal plates. When a potential difference of 1.5kV is applied across the plates, the drop rises with constant velocity of $8.0 \times 10^{-5} ms^{-1}$.

How many electron charges are there on the drop? (Assume air resistance is proportional to the velocity of the drop and neglect air buoyancy.

$mg = kv_1$

$k = \frac{9.81 x 10^{-14}}{4 x 10^{-4}}$

EQ-mf= kv₂ But E = $\frac{V}{d} = \frac{1.5 \, x \, 10^3}{12 \, x \, 10^{-3}}$

=> $\frac{1.5 \, x \, 10^3}{12 \, x \, 10^{-3}} Q - 9.81 \, x \, 10^{-14} = \frac{9.81 \, x \, 10^{-14}}{4 \, x \, 10^{-4}} \, x \, 8.0 \, x \, 10^{-5}$

Q = 9.4176 x 10^{-19}C

But Q =ne

n = $\frac{9.4176 \, x \, 10^{-19}}{1.6 \, x \, 10^{-19}} = 6$

(c) Explain why

(i) the apparatus in Millikan's experiment is surrounded with a constant temperature enclosure, (03marks)

- to keep the density oil and air constant
- to eliminate conventional currents

(ii) low vapor-pressure oil is used. (02marks)

- to maintain the size of the drop by minimizing evaporation

(d) In Millikan's experiment, the radius, r, of the drop is calculated from

r = $\sqrt{\frac{9\eta v}{2\rho g}}$

where η is the viscosity of air and ρ is the density of oil.

Identify the symbol v and describe briefly how it is measured. (02mark)

v = terminal velocity; it is measure by measuring the time t taken by the drop to fall through a known distance S. then v = $\frac{S}{t}$.

9. (a) (i) Explain how X-rays are produced in an X-ray tube (04 marks)
   - The cathode is heated and electrons emitted by thermionic emission.
   - The electrons are accelerated by tube voltage towards the metal target.
   - When the high energy electrons strike the metal target X-rays are produced with liberation of heat

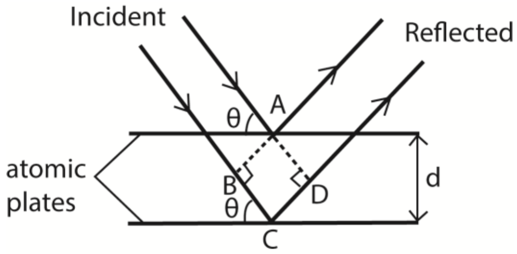
(ii) Explain the emission of X-ray characteristic spectra. (03 marks)

When an energetic electron strikes the metal target, it dislodges electrons from the innermost shell of the atom of the metal target. This creates vacancies in the inner shell making the atom unstable.

When electrons fall back to occupy the vacant orbits left, X-rays are produced of definite frequency characteristic of the atoms of target metal.

(iii) Derive the Bragg X-ray diffraction equation (04marks)

- A parallel beam of monochromatic X-rays incident on a crystal is reflected from successive atomic planes and super-imposed, forming an interference pattern.



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For constructive interference to occur, the path difference is equal to the whole number of wavelength

Thus BC + CD = nλ

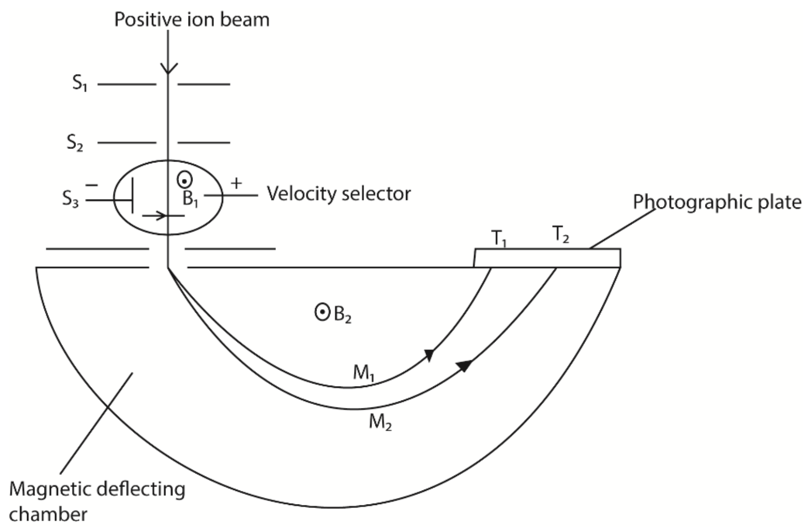
⇨ dsinθ + dsinθ = nλ

or 2dsinθ = nλ where n = 1, 2, 3, 4 …

(iv) Under what conditions does X-ray diffraction occurs? (02marks)

- Wavelength of X-ray must be of the same order as the interplanar spacing.
- Parallel beam of X-ray must be incident on the planes

(b) With the aid of a labelled diagram, describe how a Bainbridge mass spectrometer is used to measure specific charge. (07marks)



T_1 and T_2 are tracers on photographic plate, S_1, S_2 and S_3 are slits

Mode of Action

- Positive ions are produced in a discharge tube and admitted as a beam through slits S_1 and S_2.
- The beam then passes between insulated plates P, Q, connected to a battery, which create an electric field of intensity E.
- A uniform magnetic field B_1, perpendicular to E is applied over the region of the plates and all ions, charge e with the same velocity, v given by $B_1ev = Ee$ will then pass undeflected through the plates and through a slit S_3.
- The selected ions are deflected in a circular path of radius r by a uniform perpendicular magnetic field B_2 and an image is produced on a photographic plate as shown.

  In this case

  $$\frac{mv^2}{r} = B_2ev$$

$\therefore \frac{m}{e} = \frac{rB_2}{v}$

But for the ions selected v = $\frac{E}{B_1}$ from above

Specific charge, $\frac{e}{m} = \frac{E}{rB_2B_1}$

10. (a) What is meant by unified atomic mass unit? (01mark)
    Unified atomic unit is one twelfth the mass of one atom of carbon-12

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

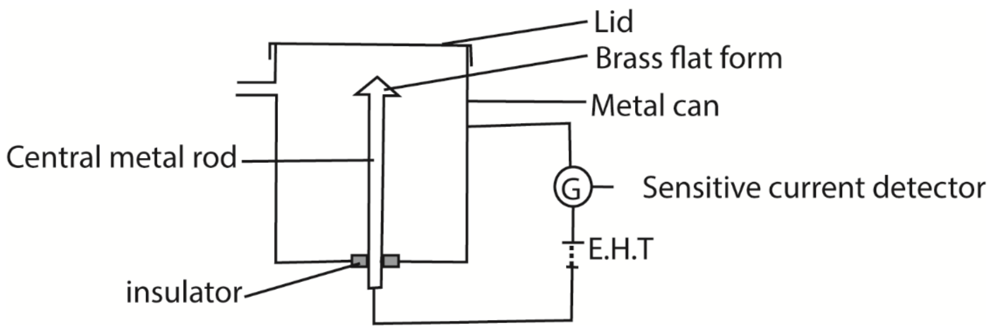
Nuclear fusion is the process where two light nuclei combine to form a heavier nuclei accompanied by release of energy

Nuclear fission is a process where a heavy nucleus splits into two lighter nuclei accompanied by release of energy.

(ii) State the conditions necessary for each of the nuclear reaction in (b) (i) to occur. (02marks)

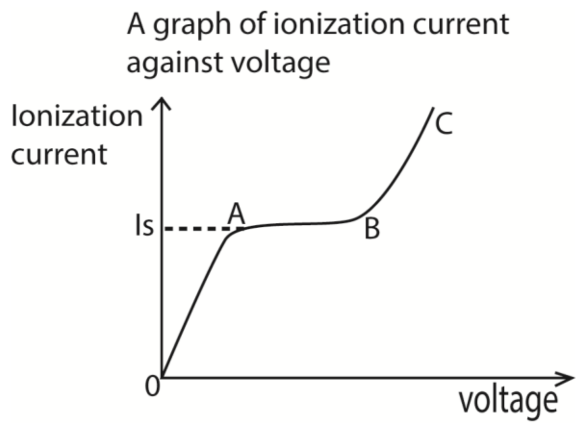
- Fusion requires very high temperature
- Fission requires energetic bombarding particles or heavy unstable nuclei.

(c) (i) With the aid of a labelled diagram, describe the operation of an ionization chamber. (06marks)



- A radiation source on the brass flat form causes ionization of air in the chamber producing electrons and positive ions.
- The electrons move to the metal can and positive ions drift to the central metal rod.
- Movement of the ions to the electrodes causes discharge and current pulse flows in external circuit.
- The current sensitive detector detects current.
- The magnitude of current detected shows the extent to which ionization takes place.

(ii) Sketch the curve of ionization current against applied p.d and explain its main features. (04marks)



Region OA:

Current detected increases gradually but p.d is not large enough to prevent recombination of the ions.

Region AB. (saturation region)

Current is almost constant, all ions reach the electrode before recombination but there is no secondary ionization.

Region BC (gas amplification)

Current increases rapidly for small increase (change) in p.d. because secondary ionization takes place due to primary ions being produced. This implies many ion pairs, thus a larger current detected.

(d) A typical nuclear reaction is given by:

$${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{95}_{42}Mo + {}^{139}_{57}La + 2{}^{1}_{0}n + {}_{7-1}^{\;\;0}e$$

Calculate the total energy released by 1g of uranium. (05marks)

Mass of ${}^{1}_{0}n = 1.009\mu$

${}^{0}_{-1}e = 0.00055\mu$

${}^{95}_{42}Mo = 94.906\mu$

${}^{139}_{57}La = 138.906\mu$

${}^{235}_{92}U = 235.044\mu$

$1\mu = 1.66 \; x \; 10^{-27} kg$

Solution

Total mass on the left hand side= 235.044 +1.009 = 236.053U

Total mass on the right hand side = (94.906 +138.906 +2 x 1.009 + 0.00055)U=235.83385U

Mass defect = 236.053 – 235.83385 = 0.21915U

Energy released = mc^2 = 0.21915 x 1.66 x 20^{-27} x $(3 \times 10^8)^2$ = 3.274 x 10^{-11}J

Number of atoms in 1g of uranium = $\frac{1}{235}\ x\ 6.02\ x\ 10^{23}$

Total energy released = $\frac{1}{235}\ x\ 6.02\ x\ 10^{23} x\ 3.274\ x\ 10^{-11} = 8.387\ x\ 10^{10} J$

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