PHYSICS – Paper 2018 (Solved)

SECTION I (40 Marks)

*Attempt **all** questions from this section*

Question 1

(a) (i) State and define the S.I. unit of power.

(ii) How is the unit horse power related to the S.I. unit of power ? **[2]**

Ans. (i) The S.I. unit of power is watt.

It is defined as the power spent when 1 joule work is done for 1 second.

(ii) 1 horse power = 746 watt.

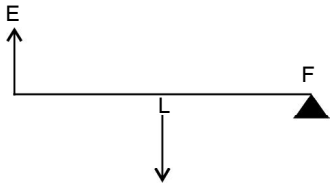
(b) State the energy changes in the following cases while in use : **[2]**

(i) An electric iron. (ii) A ceiling fan.

Ans. (i) The electric energy changes into heat energy.

(ii) The electrical energy changes into mechanical energy.

(c) The diagram alongside shows a lever in use : **[2]**



(i) To which class of levers does it belong ?

(ii) Without changing the dimensions of the lever, if the load is shifted towards the fulcrum what happens to the mechanical advantage of the lever ?

Ans. (i) It belongs to second class lever.

(ii) The mechanical advantage of the lever will increase when load is shifted towards the fulcrum.

(d) (i) Why is the ratio of the velocities of light of wavelengths 4000Å and 8000Å in vacuum 1 : 1 ?

(ii) Which of the above wavelengths has a higher frequency ? **[2]**

Ans. (i) In vacuum the light of each wavelength travels with the same speed *i.e.*, the speed of light of wavelength of 4000Å is same as that of light of wavelength 8000Å.

(ii) The light of wavelength 4000Å will have higher frequency.

(e) (i) Why is the motion of a body moving with a constant speed around a circular path said to be accelerated ?

(ii) Name the unit of physical quantity obtained by the formula $\frac{2K}{V^2}$. **[2]**

Ans. (i) The motion of a body moving with a constant speed around a circular path is said to be accelerated because as the direction keeps changing the velocity changes and therefore it's an accelerated motion.

(ii) $\frac{2K}{V^2} = \frac{2\times\left(\frac{1}{2}mV^2\right)}{V^2} = m$. Therefore the quantity. $\frac{2K}{V^2}$ will have the unit of mass m which is kilogram (kg.)

Question 2

(a) The power of a lens is –5D. **[2]**

(i) Find its focal length. (ii) Name the type of lens.

Ans. (i) Given, P = –5D

Focal length $f = \frac{1}{P} = \frac{1}{-5} = -0{\cdot}2$ m = –20 cm

(ii) The lens is concave.

(b) State the position of the object in front of a converging lens if : [2]

(i) It produces a real and same size image of the object.

(ii) It is used as a magnifying lens.

Ans. (i) At a distance of $2f$ in front of the lens.

(ii) Between optical centre and focus of the lens.

(c) (i) State the relation between the critical angle and the absolute refractive index of a medium.

(ii) Which colour of light has a higher critical angle ? Red light or Green light. [2]

Ans. (i) Critical angle $i_c = \sin^{-1}\left(\frac{1}{\mu}\right)$ or $\sin i_c = \frac{1}{\mu}$.

(ii) The critical angle of Red light is higher than that of green light.

(d) (i) Define scattering. [2]

(ii) The smoke from a fire looks white. Which of the following statements is true ?

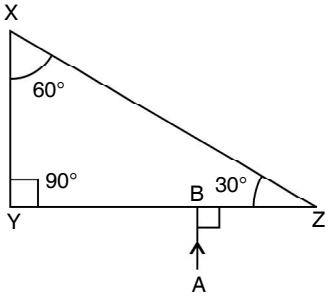
1. Molecules of the smoke are bigger than the wavelength of light.

2. Molecules of the smoke are smaller than the wavelength of light.

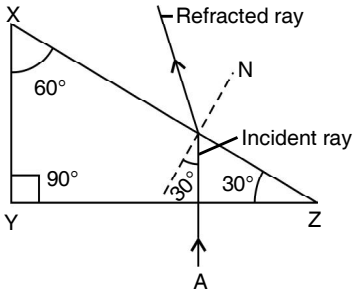
Ans. (i) Scattering of light is the process of absorption and reemission of light energy by the dust particle and air molecules present in the atmosphere.

(ii) Statement 1 is true.

(e) The following diagram shows a 60°, 30°, 90° glass prism of critical angle 42°. Copy the diagram and complete the path of incident ray AB emerging out of the prism marking the angle of incidence on each surface. [2]

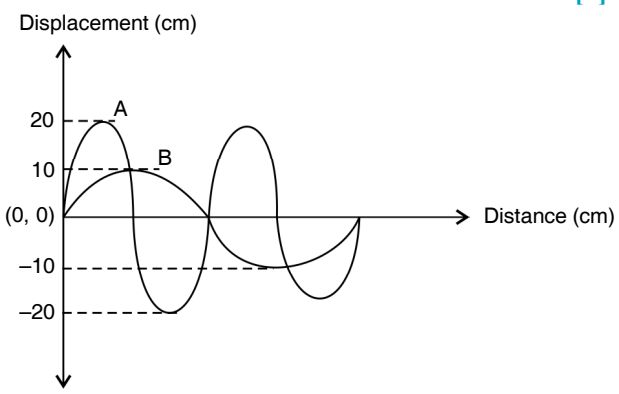


Ans. The completed diagram is given below.



Question 3

(a) Displacement distance graph of two sound waves A and B, travelling in a medium, are as shown in the diagram below. [2]



Study the two sound waves and compare their :

(i) Amplitudes (ii) Wavelengths

Ans. (i) From figure, amplitude of wave A = 20 cm and amplitude of wave B = 10 cm.

Therefore $= \frac{\text{Amplitude of wave A}}{\text{Amplitude of wave B}} = \frac{20}{10} = 2 : 1$

(ii) Wavelength of A = x and wavelength of B = $2x$

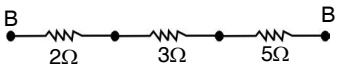
Therefore $= \frac{\text{Wavelength of wave A}}{\text{Wavelength of wave B}} = \frac{x}{2x} = 1 : 2$

(b) You have three resistors of values 2Ω, 3Ω and 5Ω. How will you join them so that the total resistance is more than 7Ω ? **[2]**

(i) Draw a diagram for the arranegment.

(ii) Calculate the equivalent resistance.

Ans. (i) The three resistors are joined in series as below.



(ii) The equivalent resistance $R = R_1 + R_2 + R_3$

$R = 2 + 3 + 5$

$R = 10\Omega$

(c) (i) What do you understand by the term nuclear fusion ? **[2]**

(ii) Nuclear power plants use the **nuclear fission** reaction to produce electricity. What is the advantage of producing electricity by **fusion** reaction ?

Ans. (i) The combining of two or more light nucleii at very high temperature and pressure, to form one nucleus is called nuclear fusion.

(ii) The energy released in nuclear fusion will be more than in nuclear fission for the same mass.

(d) (i) What do you understand by free vibrations of a body ? **[2]**

(ii) Why does the amplitude of a vibrating body continuously decrease during damped vibrations ?

Ans. (i) The periodic vibrations of constant amplitude and frequency in absence of any external medium, are called free vibrations.

(ii) The amplitude of vibrations continuously decreases due to loss of energy against the damping forces such as air friction etc.

(e) (i) How is the e.m.f. across primary and secondary coils of a transformer related with the number of turns of coil in them ? **[2]**

(ii) On which type of current do transformers work ?

Ans. (i) $\dfrac{\text{e.m.f. across the primary coil}}{\text{e.m.f. across the secondary coil}} = \dfrac{\text{number of turns in the primary coil}}{\text{number of turns in the secondary coil}}$

(ii) Transformer works only with alternating current.

Question 4

(a) (i) How can a temperature in degree Celsius be converted into S.I. unit of temperature ? **[2]**

(ii) A liquid X has the maximum specific heat capacity and is used as a coolant in Car radiators. Name the liquid X.

Ans. (i) The temperature in degree Celsius (t) can be converted to S.I. unit Kelvin (T) by adding 273 to it.

$T(K) = (273 + t)\ °C$.

(ii) Water.

(b) A solid metal of mass 150 g melts at its melting point of 800°C by providing heat at the rate of 100 W. The time taken for it to completely melt at the same temperature is 4 min. What is the specific latent heat of fusion of the metal ? **[2]**

Ans. Given, mass $m = 150\ g = 0{\cdot}15\ kg$, power $P = 100\ W$, time $t = 4\ min = 4 \times 60 = 240\ s$

energy supplied Q = power × time $= 100 \times 240 = 24000\ J$

specific latent heat $L = \dfrac{Q}{m} = \dfrac{24000}{0{\cdot}15} = 1{\cdot}6 \times 10^5\ J\ kg^{-1}$.

(c) Identify the following wires used in a household circuit : **[2]**

(i) The wire is also called as the phase wire.

(ii) The wire is connected to the top terminal of a three pin socket.

Ans. (i) Live wire (ii) Earth wire

(d) (i) What are isobars ? **[2]**

(ii) Give one example of isobars.

Ans. (i) Isobars are the atoms of same mass number but different atomic number.

(ii) $^{23}_{11}Na$ and $^{23}_{12}Mg$ are isobars.

(e) State any two advantages of electromagnets over permanent magnets. **[2]**

Ans. (i) An electromagnet can be made to produce a strong magnetic field (increasing the number of turns in the coil).

(ii) The polarity of the electromagnet can be reversed.

SECTION II (40 Marks)

*Attempt any **four** questions from this section*

Question 5

(a) (i) Derive a relationship between S.I. and C.G.S. unit of work. **[2]**

(ii) A force acts on a body and displaces it by a distance S in a direction at an angle θ with the direction of force. What should be the value of θ to get the maximum positive work ?

Ans. (i) S.I. unit of work is joule and C.G.S. unit is erg

Since work = Force × displacement

1 joule = 1 newton × 1 metre

$= 10^5$ dyne × 100 cm

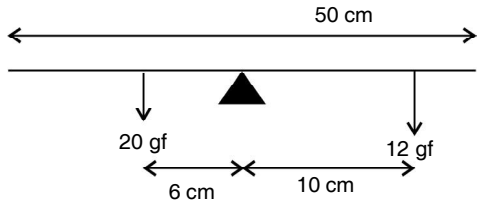
$= 10^7$ dyne × cm = 10^7 erg

1 joule = 10^7 erg

(ii) Work W = F.S. cos θ

For maximum work, cos θ = 1 or θ = 0°

(b) A half metre rod is pivoted at the centre with two weights of 20 gf and 12 gf suspended at a perpendicular distance of 6 cm and 10 cm from the pivot respectively as shown below. **[3]**



(i) Which of the two forces acting on the rigid rod causes clockwise moment?

(ii) Is the rod in equilibrium ?

(iii) The direction of 20 gf force is reversed. What is the magnitude of the resultant moment of the forces on the rod ?

Ans. (i) The force 12 gf rotates the rod clockwise.

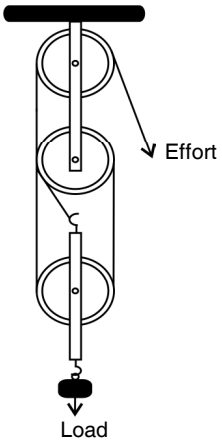
(ii) Since the clockwise moment (= 20 gf × 6 cm = 120 gf cm) is equal to the anticlockwise moment (= 12 gf × 10 cm = 120 gf cm), the rod is in equilibrium.

(iii) On reversing the direction of force, 20 gf will also produce clockwise moment, total clockwise moment will then be (20 gf × 6 cm + 12 gf × 10 cm) = 240 gf × cm.

(c) (i) Draw a diagram to show a block and tackle pulley system having a velocity ratio of 3 marking the direction of load (L), effort (E) and tension (T). **[4]**

(ii) The pulley system drawn lifts a load of 150 N when an effort of 60 N is applied. Find its mechanical advantage.

(iii) Is the above pulley system an ideal machine or not ?



Ans. (i) The block and tackle pulley system with velocity ratio 3 is shown below in which the direction of load (L), effort (E) and tension (T) has been marked.

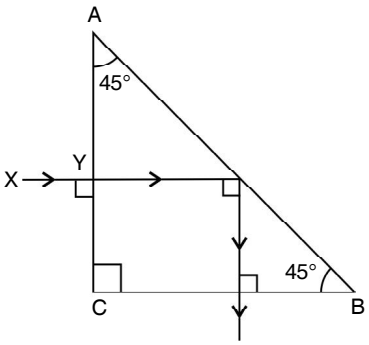
(ii) Given L = 150 N, E = 60 N

Mechanical advantage M.A. $= \frac{L}{E} = \frac{150\ N}{60\ N} = 2{\cdot}5$

(iii) This pulley system is not ideal.

Question 6

(a) A ray of light XY passes through a right angled isosceles prism as shown alongside. **[3]**



(i) What is the angle through which the incident ray deviates and emerges out of the prism ?

(ii) Name the instrument where this action of prism is put into use.

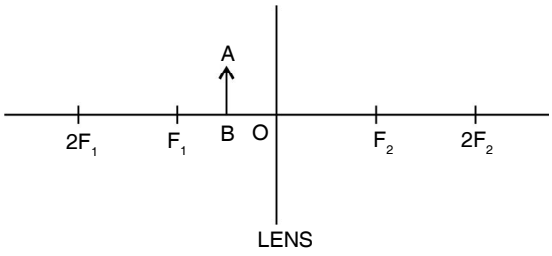
(iii) Which prism surface will behave as a mirror ?

Ans. (i) Angle of deviation = the angle which the emergent makes with the incident ray XY = 90°

(ii) Periscope.

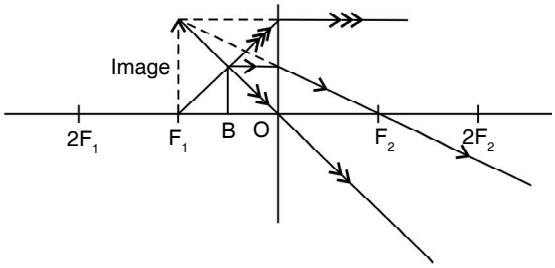
(iii) The surface AB of the prism behaves as the mirror.

(b) An object AB is placed between O and F_1 on the principal axis of a converging lens as shown in the diagram. **[3]**



Copy the diagram and by using three standard rays starting from point A, obtain an image of the object AB.

Ans. The completed diagram is given below



(c) An object is placed at a distance of 12 cm from a convex lens of focal length 8 cm. Find : **[4]**

(i) the position of the image (ii) nature of the image

Ans. (i) Given $u = 12$ cm (– negative), $f = 8$ cm (positive)

From lens formula $\frac{1}{v} - \frac{1}{v} = \frac{1}{f}$

We get $\frac{1}{v} - \frac{1}{-12} = \frac{1}{8}$

or $\frac{1}{v} = \frac{1}{8} - \frac{1}{12}$

$\frac{1}{v} = \frac{1}{24}$

$v = 24$ cm

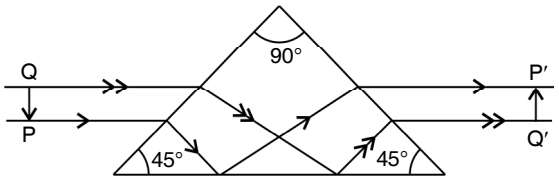
The image will be formed at a distance 24 cm behind the lens.

(ii) The image will be real, inverted and magnified.

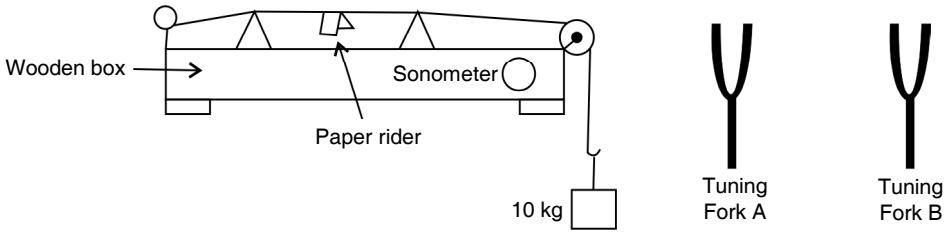
Question 7

(a) Draw a diagram of a right angled isoscles prism which is used to make an inverted image erect. **[3]**

Ans.



(b) The diagram below shows a wire stretched over a sonometer. Stems of two vibrating tuning forks A and B are touched in turn to the wooden box of the sonometer. It is observed that the paper rider (a small piece of paper folded at the centre) present on the wire flies off when the stem of vibrating tuning fork B is touched to the wooden box but the paper just vibrates when the stem of vibrating tuning fork A is touched to the wooden box. **[3]**



(i) Name the phenomenon when the paper rider just vibrates.

(ii) Name the phenomenon when the paper rider flies off.

(iii) Why does the paper rider fly off when the stem of tuning fork B is touched to the box ?

Ans. (i) The tuning fork A produces **forced vibrations** in the wire due to which rider vibrates.

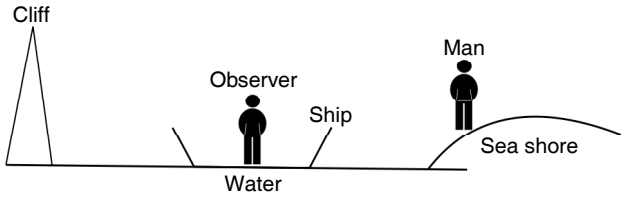
(ii) The tuning fork B produces **resonant vibration** in the wire due to which the rider flies off.

(iii) The frequency of tuning fork B is equal to the natural frequency of wire, so the wire vibrates with a large amplitude and rider flies off.

(c) A person is standing at the sea shore. An observer on the ship which is anchored in between a vertical cliff and the person on the shore fires a gun. the person on the shore hears two sounds, 2 seconds and 3 seconds after seeing the smoke of the fired gun. If the speed of sound in the air is 320 ms^{-1}, then calculate : **[4]**

(i) the distance between the observer on the ship and the person on the shore.

(ii) the distance between the cliff and the observer on the ship.



Ans. (i) Let d_1 be the distance between the observer on ship and person on shore. The first sound heard by the person at shore after $t_1 = 2$ s will be the direct sound of the fire. From relation $v = \frac{d}{t}$, $320 = \frac{d_1}{2}$ or $d_1 = 640$ m.

(ii) The second sound heard by the person at shore will be the echo heard after reflection from the cliff. Since sound takes 2 s to reach from the observer to the person, so the time taken by the echo of fire to reach the observer will be $t_2 = 3 - 2 = 1$ s.

Let d_2 be the distance between the observer and cliff. Then $\frac{2d_2}{t_2} = \text{V}$ or $d_2 = \frac{\text{V}t_2}{2} = \frac{320 \times 1}{2} = 160$ m.

Question 8

(a) (i) A fuse is rated 8A. Can it be used with an electrical appliance rated 5 KW, 200 V ? Give a reason. **[3]**

(ii) Name two safety devices which are connected to the live wire of a household electric circuit.

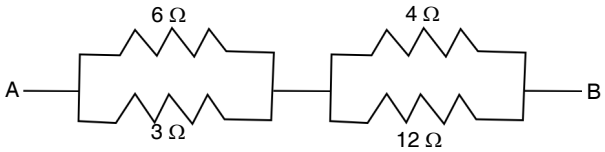
Ans. (i) Given P = 5 KW = 5000 W, V = 200 V

Current drawn $i = \frac{\text{P}}{\text{V}} = \frac{5000\ \text{W}}{200\ \text{V}} = 25\text{A}$

Since the appliance when in use will draw 25 A current, the fuse rated 8 A cannot be used because it will blow off as the current will exceed 8A and the circuit will break.

(ii) Switch and fuse.

(b) (i) Find the equivalent resistance between A and B. **[3]**



(ii) State whether the resistivity of a wire changes with the change in the thickness of the wire.

Ans. (i) In figure, a parallel combination of resistors 6 Ω and 3 Ω is connected in series with another parallel combination of resistors 4 Ω and 12 Ω between the terminals A and B. The equivalent resistance of parallel combination of resistors 3 Ω and 6 Ω is

$$\frac{1}{\text{R}_1} = \frac{1}{3} + \frac{1}{6} \quad \text{or} \quad \frac{1}{\text{R}_2} = \frac{1}{2} \quad \text{or} \quad \text{R}_1 = 2\ \Omega$$

the equivalent resistance of parallel combination of resistors 4 W and 12 Ω is

$$\frac{1}{\text{R}_2} = \frac{1}{4} + \frac{1}{12} \quad \text{or} \quad \frac{1}{\text{R}_2} = \frac{1}{3} \quad \text{or} \quad \text{R}_2 = 3\ \Omega$$

the total equivalent resistance between the terminals A and B is $\text{R} = \text{R}_1 + \text{R}_2 = 2 + 3 = 5\ \Omega$.

(ii) The resistivity of a wire does not change with the change in the thickness of the wire.

(c) An electric iron is rated 220 V, 2 kW [4]

(i) If the iron is used for 3h daily find the cost of running it for one week if it costs ₹ 4.25 per kWh.

(ii) Why is the fuse absolutely necessary in a power circuit ?

Ans. (i) Given power P = 2 kW, time t = 2h, number of days = 7 and costs = ₹ 4.25 per kWh

Electrical energy consumed = Power × total time

= 2 kW × (2 × 7) h

= 28 kWh

Cost = 28 × 4.25 = ₹ 119

(ii) The fuse is absolutely necessary in a power circuit because if somehow the circuit is overloaded (*i.e.*, the total power of appliances connected in the circuit exceeds the power limit of the circuit) an excessive current will flow in the circuit and the line wire or appliances may get damaged. The use of fuse in the circuit will safeguard the appliances from any such mishap.

Question 9

(a) (i) Heat supplied to a solid changes it into liquid. What is this change in phase called ? [3]

(ii) During the phase change does the average kinetic energy of the molecules of the substance increase ?

(iii) What is the energy absorbed during the phase change called ?

Ans. (i) Melting

(ii) No, the average kinetic energy of the molecules does not change during the change of phase.

(iii) Latent heat.

(b) (i) State two differences between "Heat Capacity" and "Specific Heat Capacity" [3]

(ii) Give a mathematical relation between Heat Capacity and Specific Heat.

Ans. (i) (1) Heat capacity is the amount of heat energy required to raise the temperature of entire body by 1°C, but specific heat capacity is the amount of heat energy required to raise the temperature of unit mass of the body by 1°C.

(2) The S.I. unit of heat capacity is JK^{-1}, but the S.I. unit of specific heat capacity is J kg^{-1} K^{-1}.

(ii) Heat capacity = mass × specific heat capacity.

(c) The temperature of 170 g of water at 50°C is lowered to 5°C by adding certain amount of ice to it. Find the mass of ice added. Given : Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$ and Specific latent heat of ice = 336000 J kg^{-1}. [4]

Ans. Given : mass of water m =170 g = 1·17 kg, initial temperature = 50°C, final temperature = 5°c

$\therefore$ Fall in temperature = Δt = (50 – 5) = 45°C = 45 K

Heat lost by water = $mc\ \Delta t$

= 0·17 × 4200 × 45

= 3·213 × 10^4 J

If m' kg ice is added, heat gained by it to melt to 0°C = m'L

= m' × 3·36 × 10^5 J

Heat gained by it to raise temperature by 5°C = m'C Δt

= m' × 4200 × 5

= m' × 2·1 × 10^4 J

Total heat gained by ice $= 3{\cdot}36 \times 10^5\ m' + 2{\cdot}1 \times 10^4\ m'$

$= 3{\cdot}57 \times 10^5\ m'$ J

By the principle of method of mixtures

heat lost by water = heat gained by ice

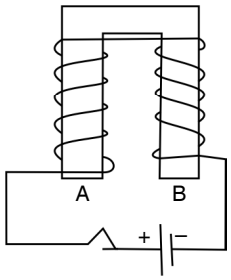
$3{\cdot}213 \times 10^4 = 3{\cdot}57 \times 10^5\ m'$

$$m' = \frac{3{\cdot}213 \times 10^4}{3{\cdot}57 \times 10^5}$$

$= 0{\cdot}09$ kg (90 g)

Question 10

(a) The diagram shows a coil wound around a U shape soft iron bar AB. **[3]**



(i) What is the polarity induced at the ends A and B when the switch is pressed ?

(ii) Suggest one way to strengthen the magnetic field in the electromagnet.

(iii) What will be the polarities at A and B if the direction of current is reversed in the circuit ?

Ans. (i) The polarity induced at the end A is North and at the end B is South.

(ii) To strengthen the magnetic field in the electromagnet, the current flowing in it is increased.

(iii) On reversing the direction of current, the end A will be south pole and the end B will be the north pole.

(b) The ore of Uranium found in nature contains $^{238}_{92}U$ and $^{235}_{92}U$. Although both the isotopes are fissionable, it is found out experimentally that one of the two isotopes is more easily fissionable. **[3]**

(i) Name the isotope of Uranium which is easily fissionable.

(ii) Give a reason for your answer.

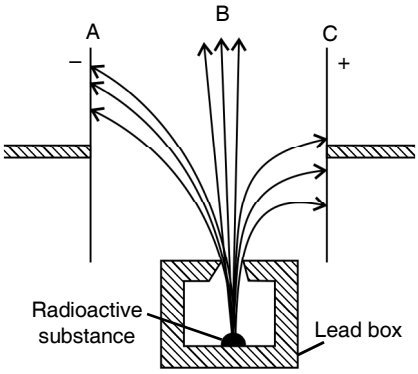
(iii) Write a nuclear reaction when Uranium 238 emits an alpha particle to form a Thorium (Th) nucleus.

Ans. (i) $^{235}_{92}U$ is easily fissionable.

(ii) The reason is that the fission of $^{238}_{92}U$ nucleus is possible only by the fast neutrons, while the fission of $^{235}_{92}U$ nucleus can be even done by the slow neutrons.

(iii) $\underset{\text{(Uranium)}}{^{238}_{92}U} \rightarrow \underset{\text{(Thorium)}}{^{234}_{90}Th} + \underset{\text{(α-particle)}}{^{4}_{2}He}$

(c) Radiations given out from a source when subjected to an electric field in a direction perpendicular to their path are shown below in the diagram. The arrows show the path of the radiation A, B and C. Answer the following question in terms of A, B and C. **[3]**



(i) Name the radiation B which is unaffected by the electrostatic field.

(ii) Why does the radiation C deflect more than A?

(iii) Which among the three causes the least biological damage extremlly?

(iv) Name the radiation which is used in carbon dating.

Ans. (i) The radiation B *i.e.*, Gamma (γ) radiation unaffected.

(ii) The radiation C is the Beta (β) radiation which is lighter than radiation A (alpha radiation (α))

(iii) The radiation A (*i.e.* Alpha) causes the least biological damage.

(iv) The radiation C (*i.e.* Beta radiation) is used in carbon dating.