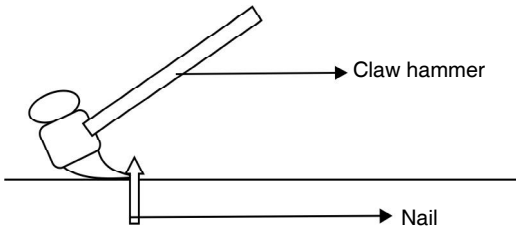
PHYSICS – Paper 2019 (Solved)

SECTION I (40 Marks)

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

Question 1

(a) The diagram alongside shows a claw hammer used to remove a nail : [2]



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

(ii) Give one more example of the **same class** of lever mentioned by you in (i) for which the **mechanical advantage is greater than one**.

Ans. (i) Class I lever. (ii) Shears (used to cut metal sheets).

(b) Two bodies A and B have masses in the ratio 5 : 1 and their kinetic energies are in the ratio 125 : 9. Find the ratio of their velocities. [2]

Ans. Given $\frac{m_A}{m_B} = \frac{5}{1}, \frac{K_A}{K_B} = \frac{125}{9}$

Since $\frac{K_A}{K_B} = \frac{\frac{1}{2}m_A V_A^2}{\frac{1}{2}m_B V_B^2} = \left(\frac{m_A}{m_B}\right)\cdot\frac{V_A^2}{V_B^2}$

$\frac{125}{9} = \frac{5}{1}\cdot\frac{V_A^2}{V_B^2}$

or $\frac{V_A}{V_B} = \sqrt{\frac{25}{9}} = \frac{5}{3}$

Ratio of velocities of A and B is 5 : 3.

(c) (i) Name the physical quantity which is measured in calories.

(ii) How is calorie related to the S.I. unit of that quantity ? [2]

Ans. (i) Heat energy.

(ii) 1 cal = 4·2 J

(d) (i) Define couple.

(ii) State the S.I. unit of moment of couple. [2]

Ans. (i) Two equal and opposite parallel forces, not acting along the same line, form a couple.

(ii) Newton × meter or Nm.

(e) (i) Define critical angle.

(ii) State one important factor which affects the critical angle of a given medium. [2]

Ans. (i) Critical angle is the angle of incidence in the denser medium corresponding to which the angle of refraction in the rarer medium is 90°.

(ii) The refractive index of the medium.

Question 2

(a) An electromagnetic radiation is used for photography in fog. [2]

(i) Identify the radiation.

(ii) Why is this radiation mentioned by you, ideal for this purpose ?

Ans. (i) Infra-red radiation.

(ii) Because of its larger wavelength, it is scattered least among visible radiations and thus have deep penetvation even in the fog.

(b) (i) What is the relation between the refractive index of water with respect to air ($_a\mu_w$) and the refractive index of air with respect to water ($_w\mu_a$).

(ii) If the refractive index of water with respect to air ($_a\mu_w$) is $\frac{5}{3}$, calculate the refractive index of air with respect to water ($_w\mu_a$). **[2]**

Ans. (i) $_a\mu_w = \frac{1}{_w\mu_a}$ *i.e.* they are inverse of each other.

(ii) Given $_a\mu_w = \frac{5}{3}$

$\therefore \ _w\mu_a = \frac{3}{5} = 0{\cdot}6$

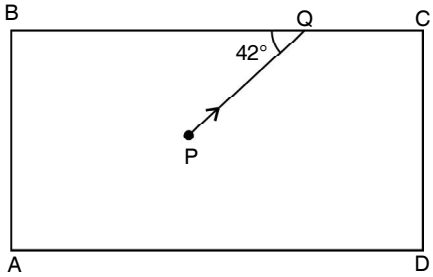
(c) The specific heat capacity of a substance A is 3,800 $Jkg^{-1}K^{-1}$ and that of a substance B is 400 $Jkg^{-1}K^{-1}$. Which of the two substances is a good conductor of heat ? Give a reason for your answer. **[2]**

Ans. Substance B is a good conductor of heat. The reason is that the substance B due to its lower heat capacity soon acquires the higher temperature as compared to A. Now B being at high temperature conducts heat to surroundings rapidly.

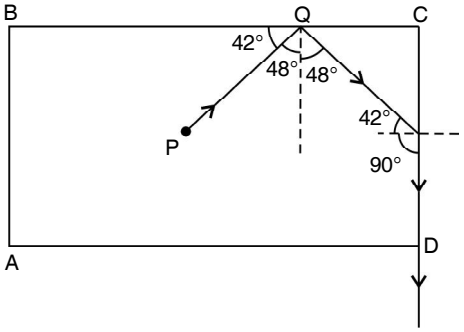
(d) A man playing a flute is able to produce notes of different frequencies. If he closes the holes near his mouth, will the pitch of the note produced, increase or decrease ? Give a reason. **[2]**

Ans. When the holes near the month are closed, the effective length of air column increases so the pitch of sound decreases as the frequency of note produced is inversly proportional to the length of air column.

(e) The diagram alongside shows a light source P embedded in a rectangular glass block ABCD of critical angle 42°. Complete the path of the ray PQ till it emerges out of the block. [Write necessary angles.] **[2]**



Ans.



Question 3

(a) (i) If the lens is placed in water instead of air, how does its focal length change ?

(ii) Which lens, thick or thin has greater focal length ?

Ans. (i) Focal length of lens increases.

(ii) A thin lens has greater focal length as compared to a thick lens.

(b) Two waves of the same pitch have amplitudes in the ratio 1 : 3. What will be the ratio of their : **[2]**

(i) intensities and (ii) frequencies ?

Ans. (i) Ratio of intensities is 1 : 9.

(ii) Ratio of frequencies is 1 : 1. (same frequency)

(c) How does an increase in the temperature affect the specific resistance of a : **[2]**

(i) Metal and (ii) Semiconductor ?

Ans. (i) Specific resistance of a metal increases. (ii) Specific resistance of a semiconductor decreases.

(d) (i) Define resonant vibrations. **[2]**

(ii) Which characteristic of sound, makes it possible to recognize a person by his voice without seeing him ?

Ans. (i) Resonant vibvibrations are vibrations of high amplitude which are produced when the natural frequency of virbation of the vibrating body is equal to the frequency of forced vibration imposed on it.

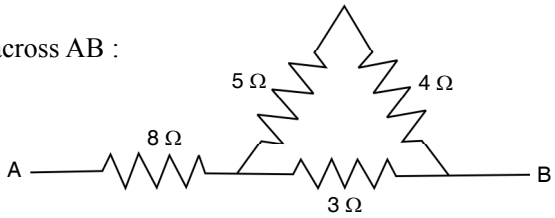
(ii) The 'quality' of sound which is different for different persons.

(e) Is it possible for a hydrogen ($^1_1$H) nucleus to emit an alpha particle ? Give a reason for your answer. **[2]**

Ans. No, hydrogen nucleus is just a proton which obviosly can not give out an alpha particle made of two protons and two neutrons.

Question 4

(a) Calculate the effective resistance across AB : **[2]**



Ans. Resistance of 3 Ω is in parallel to series combination of 4 Ω and 5 Ω resistance, therefore sum of series resistance $R_{45} = 4 + 5 = 9\ \Omega$

For parallel combination of it with 3 Ω resistance,

$$\frac{1}{R_p} = \frac{1}{R_3} + \frac{1}{R_{4,5}}$$

$$\therefore \quad \frac{1}{R_p} = \frac{1}{3} + \frac{1}{9} = \frac{4}{9}$$

$$\therefore \quad R_p = \frac{9}{4} = 2{\cdot}25\ \Omega$$

$\therefore$ Total resistance between A and B is give by

$R_{AB} = 8 + R_p = 8 + 2{\cdot}25 = 10{\cdot}25\ \Omega$

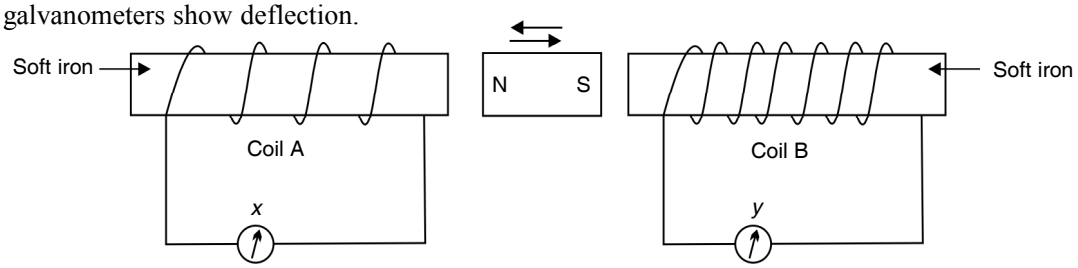
(b) (i) State whether the specific heat capacity of a substance remains the same when its state changes from solid to liquid. **[2]**

(ii) Give one example to support your answer.

Ans. (i) The specific heat capacity of a substance changes when its state changes.

(ii) The specific heat capacity of water is 4·2 J/g°C while that of ice (frozon water) is 2·1 J/g°C.

(c) A magnet kept at the centre of two coils A and B is moved to and fro as shown in the diagram. The two galvanometers show deflection. **[2]**



State with a **reason** whether :

$x > y$ or $x < y$ [x and y are magnitudes of deflection]

Ans. $x < y$

Since the coil A has less number of turns, therefore the e.m.f. generated in this coil will be less; hence the galvanometer x connected to this coil shows less deffection *i.e.* $x < y$.

(d) (i) Why is a nuclear fusion reaction called a thermo nuclear reaction ? **[2]**

(ii) Complete the reaction : $^3He_2 + {}^2H_1 \longrightarrow {}^4He_2 +$ ..... + Energy.

Ans. (i) Since the nuclear fusion reaction takes place at a temperature of nearly 10^7 K (10 million), it is termed as thermo-nuclear reaction.

(ii) $^3He_2 + {}^2H_1 \longrightarrow {}^4He_2 + {}^1H_1 +$ Energy.

(e) State two ways to increase the speed rotation of a D.C. motor. **[2]**

(i) By increasing the strength of current through the coil.

(ii) By increasing the number of turns in the coil.

SECTION II (40 Marks)

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

Question 5

(a) A body of mass 10 Kg is kept at a height of 5 m. It is allowed to fall and reach the ground. **[3]**

(i) What is the total mechanical energy possessed by the body at the height of 2 m assuming it is a frictionless medium ?

(ii) What is the kinetic energy possessed by the body just before hitting the ground ? Take $g = 10$ m/s^2.

Ans. (i) The speed of body when at a height of 2m above the ground *i.e.* after falling through 3 m is :

$$V^2 = U^2 + 2gh = 0 + 2 \times 10 \times 3$$

$$\therefore \quad V = \sqrt{60} \text{ ms}^{-1}$$

$$\therefore \quad \text{Mechanical energy at 2 m height} = \text{P.E.} + \text{K.E.} = mgh + \frac{1}{2} mv^2$$

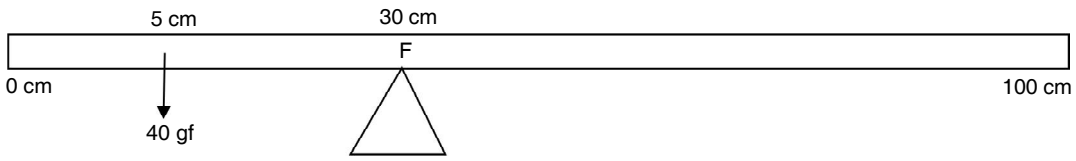
$$= 10 \times 10 \times 2 + \frac{1}{2} \times 10 \times 60 = 500 \text{ J}$$

(ii) The kinetic energy on reaching the ground will be same as was on its highest point from which it started falling.

$$\therefore \quad \text{Mechanical energy} = \text{Intial potential energy}$$

$$= m \times g \times h = 10 \times 10 \times 5 = 500 \text{ J}$$

(b) A uniform meter scale is in equilibrium as shown in the diagram : **[3]**



(i) Calculate the weight of the meter scale.

(ii) Which of the following options is correct to keep the ruler in equilibrium when 40 gf wt is shifted to 0 cm mark ?

F is shifted towards 0 cm.

or

F is shifted towards 100 cm.

Ans. (i) Let W gf be the weight of metre rule which acts downwards from 50 cm mark

In equilibrium position, taking moments about fulcrum,

Anticlockwise moment = 40 × (30 – 5) = 1000 gf cm

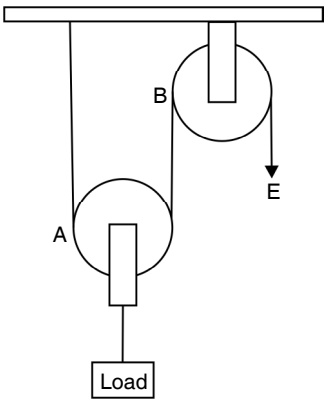
Clockwise moment = W (50 – 30) = 20 W gf cm

∴ Using principle of moments, 20 W = 1000

∴ Wt. of metre scale W = 50 gf

(ii) F is to be shifted towards 0 cm mark.

(c) The diagram alongside shows a pulley arrangement : **[4]**



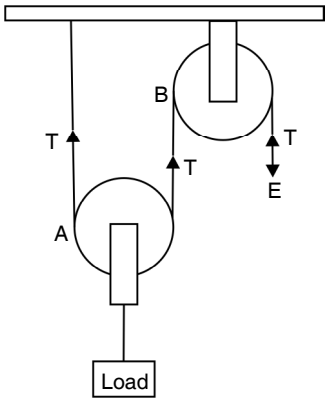
(i) Copy the diagram and mark the direction of tension on each strand of the string.

(ii) What is the velocity ratio of the arrangement ?

(iii) If the tension acting on the string is T, then what is the relationship between T and effort E ?

(iv) If the free end of the string moves through a distance x, find the distance by which the load is raised.

Ans. (i) The direction of tension (T) is marked in the diagram.



(ii) V.R. = $\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$ = 2.

(iii) T = E.

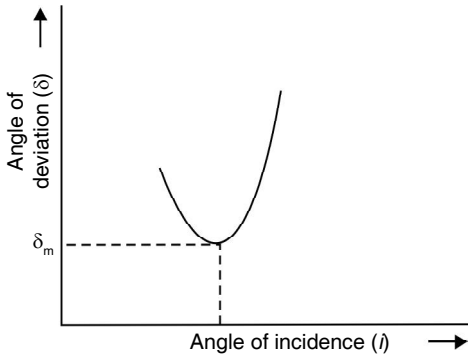
(iv) Distance moved by load = $\frac{1}{2}x$.

Question 6

(a) How does the angle of deviation formed by a prism change with the increase in the angle of incidence ? Draw a graph showing the variation in the angle of deviation with the angle of incidence at a prism surface. **[3]**

Ans. The angle of deivation (δ) produced by a prism first decreases with the increase in angle of incidence (i) and reaches to a minimum value at a eartain angle of incidence. With further increase in angle of incidence, angle of deviation also increases.

The figure alongside shows the variation of angle of deviation with angle of incidence.



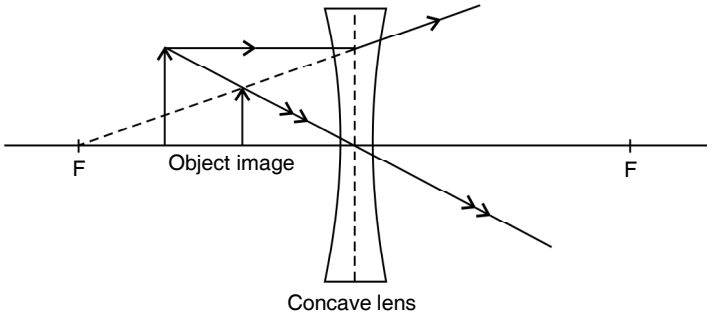
(b) A virtual, diminished image is formed when an object is placed between the optical centre and the principal focus of a lens. **[3]**

(i) Name the type of lens which forms the above image.

(ii) Draw a ray diagram to show the formation of the image with the above stated characteristics.

Ans. (i) Concave lens.

(ii) Image formation is shown in the diagram.



(c) An object is placed at a distance 24 cm in front of a convex lens of focal length 8 cm. **[4]**

(i) What is the nature of the image so formed ?

(ii) Calculate the distance of the image from the lens.

(iii) Calculate the magnification of the image.

Ans. Given, u = 24 cm (*–ve*), f = 8 cm (*+ve*)

(i) Image formed is real, inverted and diminished.

(ii) Let v be the distance of image from optical centre. From the relation $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

We have : $\frac{1}{v} + \frac{1}{24} = \frac{1}{8}$, or v = 12 cm

$\therefore$ The distance of image from the lens = 12 cm.

(iii) Magnification, $m = \frac{v}{u} = \frac{12}{24} = 0{\cdot}5$.

Question 7

(a) It is observed that during march-past we hear a base drum distinctly from a distance compared to the side drums. **[3]**

(i) Name the characteristic of sound associated with the above observation.

(ii) Give a reason for the above observation.

Ans. (i) The sound from the two types of drums have different pitch and amplitude, so they can be easily distinguished at a distance due to their different pitch and loudness.

(ii) The sound from base drum is of large amplitude but of grave note (having low frequency), while the sound from side drums have high pitch (high frequency).

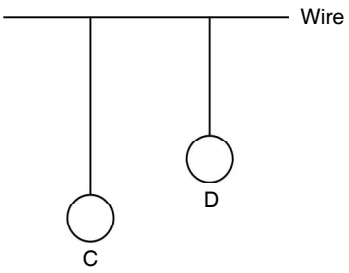
(b) A pendulum has a frequency of 4 vibrations per second. An observer starts the pendulum and fires a gun simultaneously. He hears the echo from the cliff after 6 vibrations of the pendulum. If the velocity of sound in air is 340 m/s, find the distance between the cliff and the observer. **[3]**

Ans. Echo is heard after 6 vibrations of pendulum. Since frequency of pendulum is 4 vib./sec, so the time taken for echo to be heard is $t = \frac{6}{4} = 1{\cdot}5$ s.

If d is the distance between the cliff and the observer, then velocity of sound V = $\frac{2d}{t}$.

$\therefore$ Distance between the cliff the observer = $\frac{v{\cdot}t}{2} = \frac{340 \times 1{\cdot}5}{2} = 255$ m.

(c) Two pendulums C and D are suspended from a wire as shown in the figure given below. Pendulum C is made to oscillate by displacing it from its mean position. It is seen that D also starts oscillating. **[4]**



(i) Name the type of oscillation, C will execute.

(ii) Name the type of oscillation, D will execute.

(iii) If the length of D is made equal to C then what difference will you notice in the oscillations of D ?

(iv) What is the name of the phenomenon when the length of D is made equal to C ?

Ans. (i) C executes free vibrations (damped if medium is present).

(ii) Forced vibration.

(iii) The amplitude of vibration of pendulum D increases substantially.

(iv) The phenomenon is called resonance.

Question 8

(a) (i) Write one advantage of connecting electrical appliances in parallel combination. **[3]**

(ii) What characteristics should a fuse wire have ?

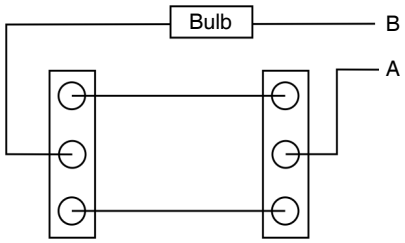
(iii) Which wire in a power circuit is connected to the metallic body of the appliance ?

Ans. (i) In parallel connection, each appliance works independently *i.e.* any change in one appliance does not affect the other appliance(s).

(ii) It should have high specific resistance and low melting point.

(iii) Earth wire.

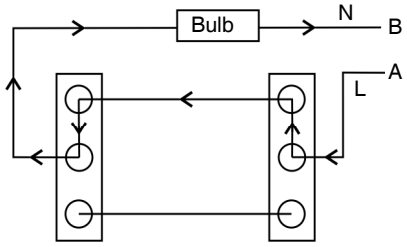
(b) The diagram alongside shows a dual control switch circuit connected to a bulb. **[3]**



(i) Copy the diagram and complete it so that the bulb is switched ON.

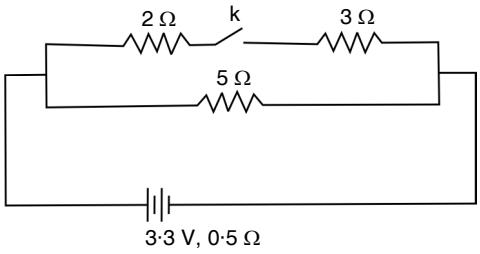
(ii) Out of A and B which one is the live wire and which one is the neutral wire ?

Ans. (i) The following figure shows the completed diagram.



(ii) Wire A is the live wire while wire B is the neutral wire.

(c) The diagram alongside shows a circuit with the key *k* open. Calculate : **[3]**



(i) the resistance of the circuit when the key *k* is open.

(ii) the current drawn from the celi when the key *k* is open.

(iii) the resistance of the circuit when the key *k* is closed.

(iv) the current drawn from the cell when the key *k* is closed.

Ans. (i) When *k* is open, resistance is $5 + 0{\cdot}5 = 5{\cdot}5\ \Omega$.

(ii) Current drawn $I = \frac{V}{R} = \frac{3{\cdot}3}{5{\cdot}5} = 0{\cdot}6$ A.

(iii) When k is closed, the resistance 2 Ω and 3 Ω are in series, therefore their total resistance is 5 Ω. Now since 5 Ω resistance is in parallel to it,

$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{5} = \frac{2}{5}$ $\quad \therefore R_p = 2{\cdot}5\ \Omega$

So now the resistance of circuit is = 2·5 + 0·5 = 3 Ω

(iv) Current drawn $I = \frac{V}{R} = \frac{3{\cdot}3}{3} = 1{\cdot}1$ A.

Question 9

(a) (i) Define chlorimetry. **[3]**

(ii) Name the material used for making a calorimeter.

(iii) Why is a calorimeter made up of thin sheets of the above material answered in (ii) ?

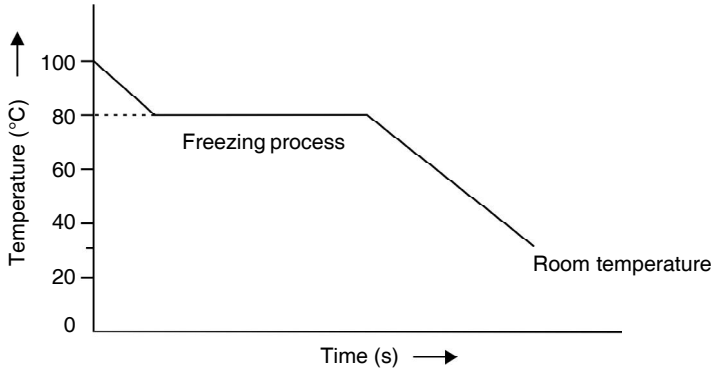
Ans. (i) The science of measuirng the amount of heat exchanged by the system with its surrounding is called calorimetry.

(ii) A copper sheet is used to make a calorimeter.

(iii) It is because copper is a good conductor of heat so that it soon acquires the temperature of its contents and a thin copper sheet has low heat capacity, so that it takes only a small amount of heat from its contents.

(b) The melting point of naphthalene is 80°C and the room temperature is 30°C. A sample of liquid naphthalene at 100°C is cooled down to the room temperature. Draw a temperature time graph to represent this cooling. In the graph, mark the region which corresponds to the freezing process. **[3]**

Ans. The figure below shows the cooling curve for naphthalene.



(c) 104 g of water at 30°C is taken in a calorimeter made of copper of mass 42 g. When a certain mass of ice at 0°C is added to it, the final steady temperature of the mixture after the ice has melted, was found to be 10°C. Find the mass of ice added. [Specific heat capacity of water = 4·2 $Jg^{-1}°C^{-1}$; Specific latent heat of fusion of ice = 336 Jg^{-1}; Specific heat capacity of copper = 0·4 $Jg^{-1}°C^{-1}$]. **[4]**

Ans. The Final temperature of mixture is 10°C

The heat given by water = $m \times s \times t$ = 104 × 4·2 × (30 – 10) = 8736 J

The heat given by calorimeter = $m \times s \times t$ = 42 × 0·4 × (30 – 10) = 336 J

Let mass of ice added be mgm

Heat taken by ice to melt = mL = 336 mJ

Heat takent by ice-water to reach the mixture temperature = mst = m × 4·2 × (10 – 0)

∴ From principle of calorimetry, heat taken = Heat given,

i.e. 336 m + 42 m = 8736 + 336

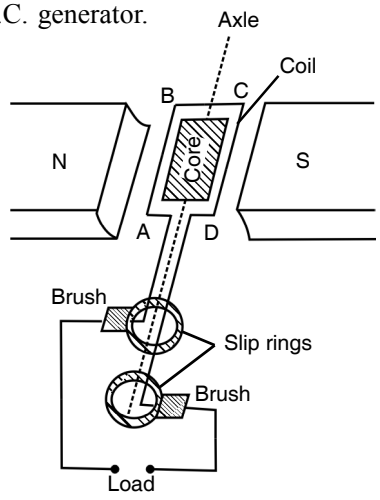
$\therefore \quad m = \dfrac{9072}{378} = 24$ g

Mass of ice added = 24 g

***Question* 10**

(a) Draw a neat labeled diagram of an A.C. generator. **[3]**

Ans.



(b) (i) Define nuclear fission. **[3]**

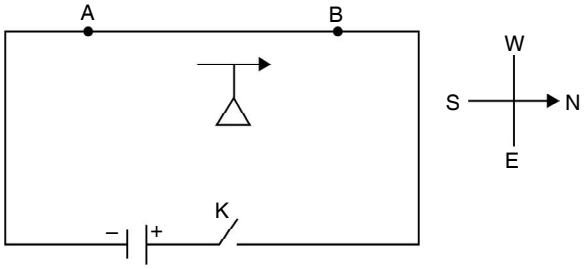
(ii) Rewrite and complete the following nuclear reaction by filling in the atomic number of Ba and mass number of Kr :

$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{.....}Ba + {}^{.....}_{36}Kr + 3{}^{1}_{0}n + \text{Energy}$

Ans. (i) The process of splitting of a heavy nucleus into two lighter nuclei of nearly same mass, when bombarded with slow neutrons, is called nuclear fission.

(ii) $^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{56}Ba + {}^{89}_{36}Kr + 3{}^{1}_{0}n + \text{Energy}$

(c) The diagram below shows a magnetic needle kept just below the conductor AB which is kept in North South direction. **[4]**



(i) In which direction will the needle deflect when the key is closed ?

(ii) Why is the deflection produced ?

(iii) What will be the change in the deflection if the magnetic needle is taken just above the conductor AB ?

(iv) Name one device which works on this principle.

Ans. (i) North pole of needle deflects towards east.

(ii) On passing current through the wire AB, a magnetic field is produced around the wire which aligns the magnetic needle in its direction.

(iii) The direction of deflection of needle gets reversed *i.e.* now it deflects towards West.

(iv) Transformer.