PHYSICS

SCIENCE Paper – 1

(One hour and a half)

Answers to this Paper must be written on the paper provided separately.

*You will **not** be allowed to write during the first **15** minutes.*

This time is to be spent in reading the Question Paper.

The time given at the head of this Paper is the time allowed for writing the answers.

***Section I** is compulsory. Attempt **any four** questions from **Section II**.*

The intended marks for questions or parts of questions are given in brackets [ ].

SECTION I (40 Marks)

*Attempt **all** questions from this Section.*

Question 1

(a) (i) Define one newton.

(ii) Write the relation between S.I. unit and C.G.S unit of force. [2]

(b) Where does the position of centre of gravity lie for

(i) a circular lamina

(ii) a triangular lamina? [2]

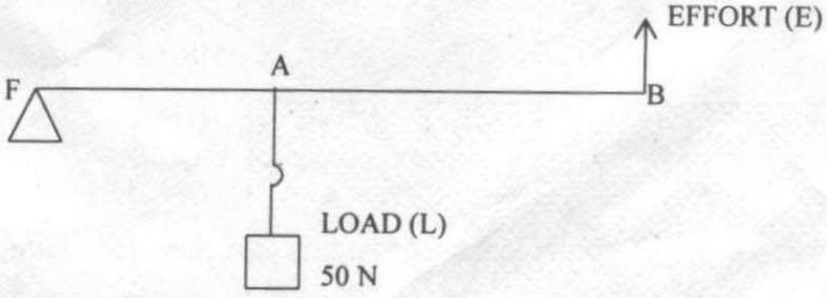
(c) A man can open a nut by applying a force of 150 N by using a lever handle of length 0.4 m. What should be the length of the handle if he is able to open it by applying a force of 60 N? [2]

(d) Name a machine which can be used to

(i) multiply force

(ii) change the direction of force applied. [2]

(e) The diagram below shows a lever in use.



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

(ii) If FA = 40 cm, AB = 60 cm, then find the mechanical advantage of the lever. [2]

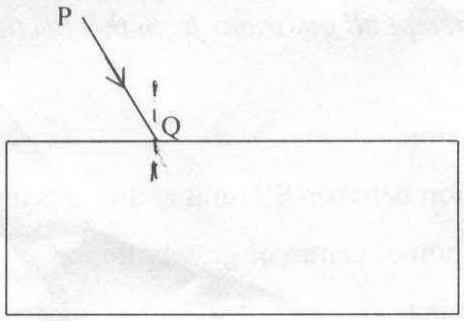
Question 2

(a) A ball of mass 200 g falls from a height of 5 m. What will be its kinetic energy when it just reaches the ground? ($g = 9.8\ m\ s^{-2}$) [2]

(b) In the diagram below, PQ is a ray of light incident on a rectangular glass block.

(i) Copy the diagram and complete the path of the ray of light through the glass block. In your diagram, mark the angle of incidence by letter 'i' and the angle of emergence by the letter 'e'.

(ii) How are the angles 'i' and 'e' related to each other?

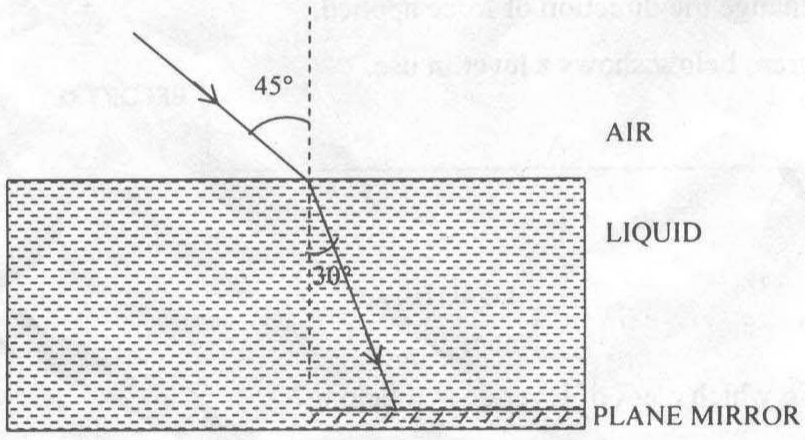


[2]

(c) A ray of monochromatic light enters a liquid from air as shown in the diagram given below.

(i) Copy the diagram and show in the diagram the path of the ray of light after it strikes the mirror and re-enters the medium of air.

(ii) Mark in your diagram the two angles on the surface of separation when the ray of light moves out from the liquid to air. [2]



(d) (i) When does a ray of light falling on a lens pass through it undeviated?

(ii) Which lens can produce a real and inverted image of an object? [2]

(e) (i) How is the refractive index of a medium related to its real depth and apparent depth?

(ii) Which characteristic property of light is responsible for the blue colour of the sky? [2]

Question 3

(a) When acoustic resonance takes place, a loud sound is heard. Why does this happen? Explain. [2]

(b) (i) Three musical instruments give out notes at the frequencies listed below. Flute: 400 Hz; Guitar: 200 Hz; Trumpet: 500 Hz. Which one of these has the highest pitch?

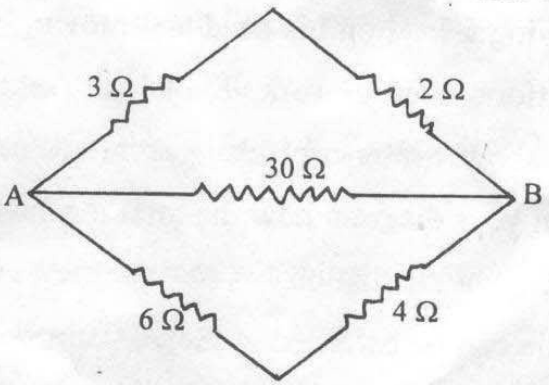
(ii) With which of the following frequencies does a tuning fork of 256 Hz resonate? 288 Hz, 314 Hz, 333 Hz, 512 Hz. [2]

(c) Two bulbs are marked 100 W, 220 V and 60 W, 110 V. Calculate the ratio of their resistances. [2]

(d) (i) What is the colour code for the insulation on the earth wire?

(ii) Write an expression for calculating electrical power in terms of current and resistance. [2]

(e) Calculate the equivalent resistance between A and B from the following diagram: [2]



Question 4

(a) Differentiate between heat and temperature. [2]

(b) (i) Define Calorimetry.

(ii) What is meant by Energy degradation? [2]

(c) 200 g of hot water at 80 °C is added to 300 g of cold water at 10 °C. Calculate the final temperature of the mixture of water. Consider the heat taken by the container to be negligible. [specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$] [2]

(d) Fill in the blanks in the following sentences with appropriate words:

(i) During the emission of a beta particle, the _____ number remains the same.

(ii) The minimum amount of energy required to emit an electron from a metal surface is called _____ [2]

(e) A mixture of radioactive substances gives off three types of radiations.

(i) Name the radiation which travels with the speed of light.

(ii) Name the radiation which has the highest ionizing power. [2]

SECTION II (40 Marks)

*Attempt any **four** questions from this Section*

Question 5

(a) (i) What is meant by an ideal machine?

(ii) Write a relationship between the mechanical advantage (M.A.) and velocity ratio (V.R.) of an ideal machine.

(iii) A coolie carrying a load on his head and moving on a frictionless horizontal platform does no work. Explain the reason why. [3]

(b) Draw a diagram to show the energy changes in an oscillating simple pendulum. Indicate in your diagram how the total mechanical energy in it remains constant during the oscillation. [3]

(c) A uniform metre scale can be balanced at the 70.0 cm mark when a mass of 0.05 kg is hung from the 94.0 cm mark.

(i) Draw a diagram of the arrangement.

(ii) Find the mass of the metre scale. [4]

Question 6

(a) (i) State the laws of refraction of light.

(ii) Write a relation between the angle of incidence (i), angle of emergence (e), angle of prism (A) and angle of deviation (d) for a ray of light passing through an equilateral prism. [3]

(b) (i) Suggest one way, in each case, by which we can detect the presence of:

(1) Infrared radiations

(2) Ultraviolet radiations.

(ii) Give one use of Infrared radiations. [3]

(c) An object is placed in front of a lens between its optical centre and the focus and forms a virtual, erect and diminished image.

(i) Name the lens which formed this image.

(ii) Draw a ray diagram to show the formation of the image with the above stated characteristics. [4]

Question 7

(a) (i) Name the type of waves which are used for sound ranging.

(ii) Why are these waves mentioned in (i) above, not audible to us?

(iii) Give one use of sound ranging. [3]

(b) A man standing 25 m away from a wall produces a sound and receives the reflected sound.

(i) Calculate the time after which he receives the reflected sound if the speed of sound in air is 350 m s^{-1}.

(ii) Will the man be able to hear a distinct echo? Give a reason for your answer. [3]

(c) (i) Name two safety devices which are connected to the live wire of a household electrical circuit.

(ii) Give one important function of each of these two devices. [4]

Question 8

(a) (i) Draw a graph of Potential difference (V) *versus* Current (I) for an ohmic resistor.

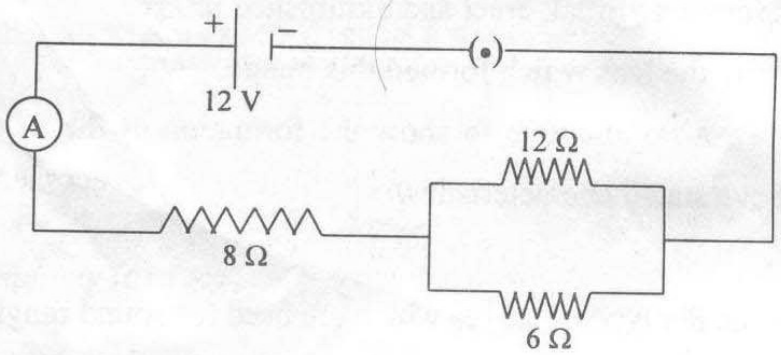
(ii) How can you find the resistance of the resistor from this graph?

(iii) What is a non-ohmic resistor? [3]

(b) (i) An electric bulb is marked 100 W, 250 V. What information does this convey?

(ii) How much current will the bulb draw if connected to a 250 V supply? [3]

(c) Three resistors are connected to a 12 V battery as shown in the figure given below:



(i) What is the current through the 8 ohm resistor?

(ii) What is the potential difference across the parallel combination of 6 ohm and 12 ohm resistor?

(iii) What is the current through the 6 ohm resistor? [4]

Question 9

(a) (i) Explain why the weather becomes very cold after a hail storm.

(ii) What happens to the heat supplied to a substance when the heat supplied causes no change in the temperature of the substance? [3]

(b) (i) When 1 g of ice at 0 °C melts to form 1 g of water at 0 °C then, is the latent heat absorbed by the ice or given out by it?

(ii) Give one example where high specific heat capacity of water is used as a heat reservoir.

(iii) Give one example where high specific heat capacity of water is used for cooling purposes. [3]

(c) 250 g of water at 30 °C is present in a copper vessel of mass 50 g. Calculate the mass of ice required to bring down the temperature of the vessel and its contents to 5 °C.

Specific latent heat of fusion of ice = 336×10^3 J kg^{-1}

Specific heat capacity of copper vessel = 400 J kg^{-1} $°C^{-1}$

Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$. [4]

Question 10

(a) (i) State two properties which a substance should possess when used as a thermionic emitter.

(ii) When an alpha particle gains two electrons it becomes neutral and becomes an atom of an element which is a rare gas. What is the name of this rare gas? [3]

(b) (i) Define radioactivity.

(ii) What happens inside the nucleus that causes the emission of beta particle?

(iii) Express the above change in the form of an equation. [3]

(c) (i) Name a device which is commonly used to convert an electrical signal into a visual signal.

(ii) The nucleus $^{202}_{84}X$ emits an alpha particle and forms the nucleus Y. Represent this change in the form of an equation.

(iii) What changes will take place in the mass number and atomic number of the nucleus Y if it emits gamma radiations? [4]

ICSE Board Exam 2011

Physics

Science paper – 1

Solutions

SECTION I

Answer 1

(a)

(i) One newton is that force which when acting on a body of mass 1 kg, produces an acceleration of 1 ms^{-2} in it. [1mark]

(ii) 1N = 10^5 dyne [1 mark]

Here N is the SI unit of force and dyne is the CGS unit of force.

(b)

(i) The centre of gravity of a circular lamina lies at its geometrical centre.

[1 mark]

(ii) The centre of gravity of a triangular lamina lies at its centroid that is at the point of intersection of its medians. [1 mark]

(c)

$F_1 = 150N$
$d_1 = 0.4m$
$F_2 = 60N$
$d_2 = ?$

As the same turning effect is required in both the cases,

$\tau_1 = \tau_2$
$\Rightarrow F_1 \times d_1 = F_2 \times d_2$
$\Rightarrow 150 \times 0.4 = 60 \times d_2$
$\Rightarrow d_2 = 1m$

Therefore, the required length of handle is 1m. [2 marks]

(d)

(i) A second class lever (e.g. a nut cracker) works as a force multiplier.

[1 mark]

(ii)A single fixed pulley can be used to change the direction of the force applied.

[1 mark]

(e)

(i) The lever shown in the diagram is a class II lever as the load is in between the effort and the fulcrum. [0.5 mark]

(ii) Load arm = FA = 40 cm

Effort arm = FB = (40 + 60)cm = 100 cm

Load = L = 50 N

Mechanical Advantage = Effort arm / Load arm

$$= \frac{100}{40} = 2.5$$

[1.5 marks]

Answer 2.

(a) m = 200g = 0.2 kg

h = 5 m

g = 9.8 ms^{-2}

According to the law of conservation of mechanical energy,

Kinetic energy at the bottom = Potential energy at the top

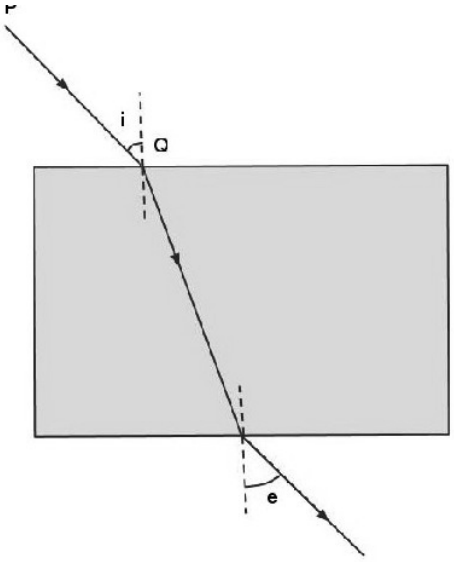
$\Rightarrow$ KE at bottom = mgh

$$= 0.2 \times 9.8 \times 5$$
$$= 9.8J$$

[2 marks]

(b)

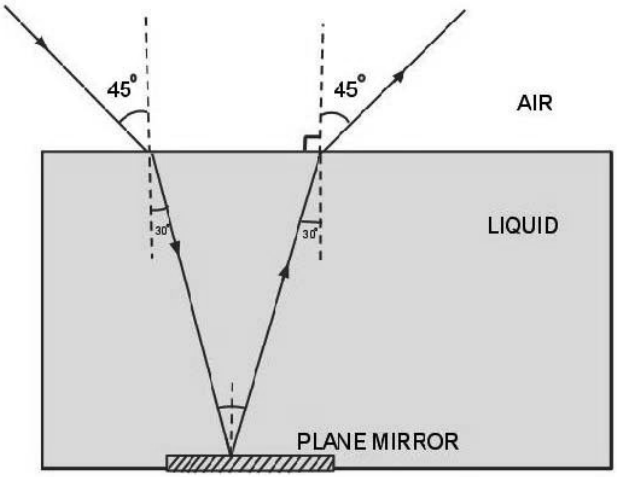
(i)



[1 mark]

(ii) i = e [1 mark]

(c)



[2 marks]

(d)

(i) A ray of light falling on a lens passes undeviated through it when it passes through the optical centre of the lens. [1 mark]

(ii) A convex lens can produce a real and inverted image of an object.

[1 mark]

(e)

Refractive index (μ)= Real depth / Apparent depth [1 mark]

(ii) The characteristic property of light responsible for the blue colour of sky is 'Scattering of light'

Since blue color and its family have much

lesser wavelength as compared to other colours present in white sunlight, the blue color is scattered much more as compared to the other colours and this makes the sky appear blue.

[1 mark]

Answer 3

(a)

At acoustic resonance, the amplitude of vibrations increases as the forced frequency of the vibrating body matches with its natural frequency and hence a loud sound is heard.

[2 marks]

(b)

(i) Out of the three given instruments, trumpet has the highest pitch as its frequency of 500 Hz is maximum out of the given frequencies. [1 mark]

(ii) A tuning fork of 256 Hz will resonate with 512 Hz as 512 is a multiple of 256. .
[1 mark]

(c)

$P_1 = 100W$

$V_1 = 220V$

$P_2 = 60W$

$V_2 = 110V$

$We-know: R = \frac{V^2}{P}$

$\Rightarrow \frac{R_1}{R_2} = \frac{V_1^2}{V_2^2} \times \frac{P_2}{P_1}$

$\Rightarrow \frac{R_1}{R_2} = \frac{220 \times 220 \times 60}{100 \times 110 \times 110} = \frac{12}{5}$

[2 marks]

(d)

(i) The colour code for the earth wire is green or yellow.

[1 mark]

(ii) $P = I^2R$ [1 mark]

here P = Power

I = Current

R = Resistance

(e)

$$R_{AB} = (3+2)\Omega \,||\, 30\Omega \,||\, (6+4)\Omega$$
$$\Rightarrow \frac{1}{R_{AB}} = \frac{1}{(3+2)} + \frac{1}{30} + \frac{1}{10}$$
$$\Rightarrow \frac{1}{R_{AB}} = \frac{6+1+3}{30} = \frac{10}{30} = \frac{1}{3}$$
$$\Rightarrow R_{AB} = 3\Omega$$

[2 marks]

Answer 4

(a)

(i) The sum total of the kinetic energy due to the random motion of the molecules of a body is known as its heat energy whereas the average kinetic energy of the molecules of a body is the measure of the temperature of the body.

[1 mark]

(ii) The heat energy possessed by a body depends on the mass of the body whereas the temperature of a body is independent of its mass.

[1 mark]

(b)

(i) The measurement of heat energy is called calorimetry. [1 mark]

(ii) Energy degradation is the conversion of energy into an undesirable form during the transformation of energy. For example in an incandescent lamp, while the energy is transformed from electrical to light energy, it is also degraded to heat energy.
[1 mark]

(c)

Given,

For, hot – water :

$m_1 = 200g = 0.2kg$

$t_i = 80^oC$

Let, t^oC = final – temperature.

Then, $\Delta t_1 = t_i - t = (80 - t)^oC$

For, cold – water :

$m_2 = 300g = 0.3kg$

$t_i = 10^oC$

$\Delta t_2 = t - t_i = (t - 10)^oC$

Now, $C = 4200 Jkg^{-1o}C^{-1}$

Heat lost by hot water = Heat gained by cold water

$\therefore m_1 C\Delta t_1 = m_2 C\Delta t_2$

or, $0.2 \times 4200 \times (80 - t) = 0.3 \times 4200 \times (t - 10)$

or, $2(80 - t) = 3(t - 10)$

or, $160 - 2t = 3t - 30$

or, $190 = 5t$

or, $t = 38^0C$

[2 marks]

(d)

(i) mass [1 mark]

(ii) work function [1 mark]

(e)

(i) Gamma radiation [1 mark]

(ii) Alpha radiation [1 mark]

SECTION II

Answer 5

(a)

(i) An ideal machine is the one in which there is no dissipation of energy in any manner. As a result the efficiency of an ideal machine is 100%. [1 mark]

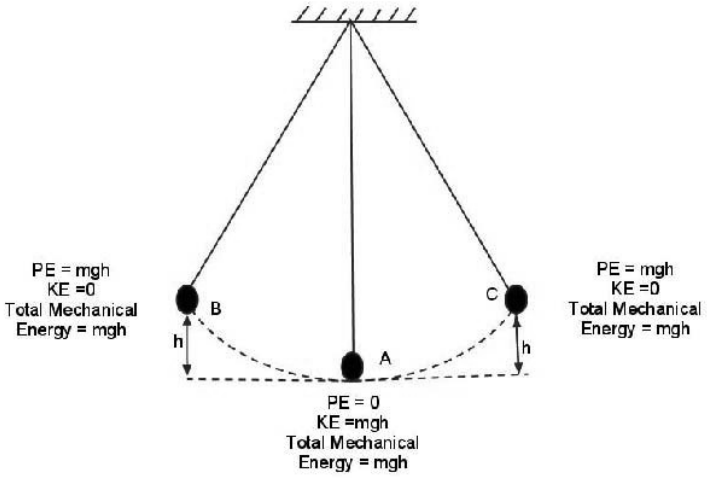
(ii) In an ideal machine MA = VR [1 mark]

(iii) A coolie carrying a load on his head and moving on a frictionless horizontal platform does no work because the displacement being horizontal is normal to the force of gravity.

Hence according to the formula $W = FS\cos\theta$,

$\theta = 90^{o}$ which means that $\cos 90^{o} = 0$ or $W = 0$. [1 mark]

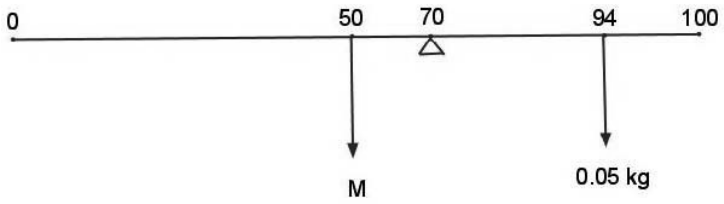
(b)



[3 marks]

(c)

(i)



[2 marks]

(ii) Let the mass of the metre scale be M.

Mass hung from the 94 cm mark = 0.05 kg = (0.05 x 1000)g = 50g

According to the principle of moments,

Anticlockwise moment = Clockwise moment

$\Rightarrow M \times (70 - 50) = 50 \times (94 - 70)$

$\Rightarrow M \times 20 = 50 \times 24$

$\Rightarrow M = 60g$

[2 marks]

Answer 6

(a) (i)

- According to the first law of refraction, the incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane.

- According to the second law of refraction, the ratio of the sine of angle of incidence to the sine of angle of refraction is constant for a given pair of media. This constant is called the refractive index of the second medium with respect to the first. It is denoted by μ Symbolically: $\mu = \frac{\sin I}{\sin r}$ [2 marks]

(ii) i + e = A + d [1 mark]

(b)

(i)

1. Infrared radiations can be detected by exposing a blackened bulb thermometer to the

[1 mark]

2. Ultraviolet radiations can be detected with the help of silver chloride solution. From red to the violet end of a spectrum the solution remains unaffected but beyond the violet end that is in the UV region the solution turns dark brown or black in colour.

[1 mark]

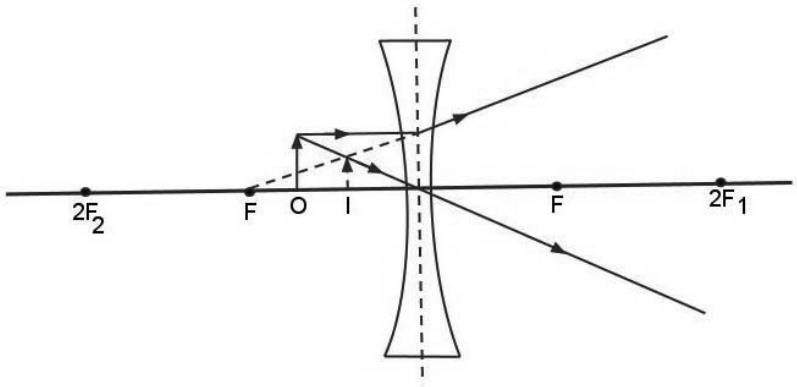
(ii) Infrared radiations can be used for therapeutic purposes by doctors.

. [1 mark]

(c)

(i) A concave lens formed this image [1 mark]

(ii) Ray diagram to show the formation of the image:



(ii) [3 marks]

Answer 7

(a)

(i) Ultrasonic waves [1 mark]

(ii) These waves are not audible to us because their frequency is beyond 20000 Hz which is beyond the human range of audibility. [1 mark]

(iii) Sound ranging is used by fishermen to locate a shoal of fish. [1 mark]

(b)

(i) distance = d = 25m

speed of sound = v = 350 m/s

$2d = v \times t$

$\Rightarrow t = \frac{2d}{v}$ [2 marks]

$\Rightarrow t = \frac{2 \times 25}{350} = \frac{1}{7} = 0.143s$

(ii) The man will be able to hear a distinct echo as 0.143s is greater than 0.1s or the persistence of hearing. [1 mark]

(c)

(i) Switch and fuse are the two safety devices which are connected to the live wire of a household electrical circuit. [2 marks]

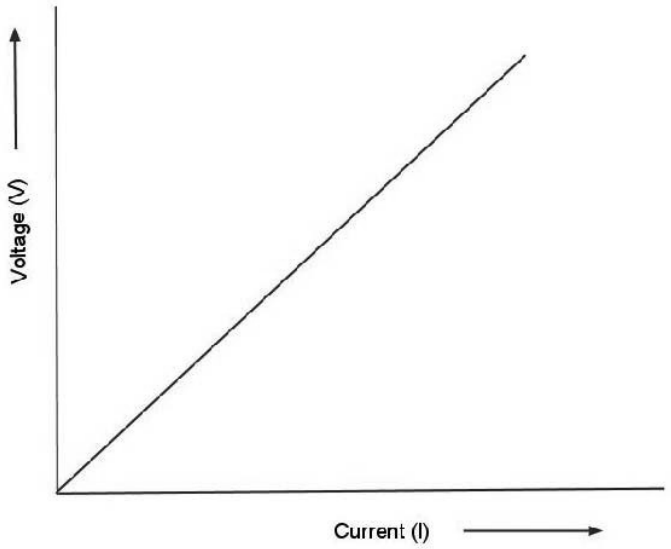
(ii)

- A switch is used connect or disconnect an appliance from a live wire according to the requirement.
- A fuse safeguards a circuit and the appliances connected in the circuit from being damaged in case of an over current in the circuit.

[2 marks]

Answer 8

(a)



Voltage versus Current Graph For An Ohmic Resistor

(i) [1mark]

ii) The resistance of the resistor can be found from this graph as the slope of the graph is equal to the resistance. [1 mark]

(iii) A non ohmic resistor is the one which does not obey the Ohm's law. A graph plotted for voltage versus current for a non ohmic resistor, is not found to be a straight line. [1 mark]

(b)

(i) If a bulb is marked as 100 W and 250 V, it means that if the given bulb is connected to a supply voltage of 250V, then the rate of energy consumption will be 100 J/s.

(ii)

$\text{Given}, P = 100W, V = 250\text{volt}$

$\text{We} - \text{know}:$

$P = VI$ [2 marks]

$\Rightarrow I = \frac{P}{V} = \frac{100}{250} = 0.4A$

(c)

(i)

Let, $R_1 = 12\Omega$

and, $R_2 = 6\Omega$

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{12} + \frac{1}{6}$

or, $\frac{1}{R_P} = \frac{1+2}{12} = \frac{3}{12}$ [1 mark]

or, $R_P = \frac{12}{3} = 4\Omega$

$\therefore$ overall – resistance, $R = (8 + R_P)\Omega = 8 + 4 = 12\Omega$

(i) Now, $V = 12V$

$\therefore I = \frac{V}{R} = \frac{12}{12} = 1A$

Current through 8 Ω resistance is 1A. [1 mark]

(ii) Let V_p = Potential difference across the parallel combination of 6Ω and 12Ω resistance.

$V_P = I \times R_P$

$V_P = 1 \times 4 = 4V$ [1 mark]

(iii) $R_2 = 6\Omega$ (as assumed above)

and I_2 = Current through 6Ω resistor

$V_P = I_2 \times R_2$

$4 = I_2 \times 6$ [1 mark]

$I_2 = \frac{4}{6} = 0.67\Omega$

Question 9

(a)

(i) The weather becomes very cold after a hail storm because after the hail storm the ice absorbs the heat energy required for melting from the surroundings. This makes the temperature of the surroundings fall down.

[1.5 marks]

(ii) If there is no change in temperature even if heat is supplied to a substance, the supplied heat is used up in increasing the potential energy of the molecules of the substance.

[1.5 marks]

(b)

(i) When 1g of ice at 0^oC melts to form 1g of water at the same temperature, then the latent heat is absorbed by it. [1 mark]

(ii) Hot water bottles used for fomentation are used as heat reservoirs due to high specific heat capacity of water. [1 mark]

(iii) The radiator of a vehicle is filled with water for cooling purposes due to high specific heat capacity of water. . [1 mark]

(c)

<u>Hot water:</u>

$m = 250g = 0.25kg$

$T_i = 30^oC$

$T_f = 5^oC$

[1 mark]

$\Delta T = T_i - T_f = (30-5)^oC = 25^oC$

$C = 4200 Jkg^{-1o}C^{-1}$

$Heat - lost = Q_1 = mC\Delta T = 0.25 \times 4200 \times 25^oC = 26250J$

Copper Vessel:

$m = 50g = 0.05kg$

$T_i = 30^oC$

$T_f = 5^oC$

$\Delta T = T_i - T_f = (30-5)^oC = 25^oC$ [1 mark]

$C = 400Jkg^{-1o}C^{-1}$

$Heat-lost = Q_1 = mC\Delta T = 0.05 \times 400 \times 25^oC = 500J$

$Totalheat-lost = Q_1 + Q_2 = 26250 + 500 = 26750J$

Ice:

$m = ?$

$L = 336 \times 10^3 Jkg^{-1}$

Heat gained by ice to melt = Q_3 = mL

= m x 336 x 10^3

= 336000m J

Water Formed From Ice:

$m = 0g$

$C = 4200Jkg^{-1o}C^{-1}$

$T_i = 0^oC$

$T_f = 5^oC$

$\Delta T = T_i - T_f = (5-0)^oC = 5^oC$

Heat gained by water formed from ice = Q_4 = mc ΔT

= m x 4200 x 5

= 21000m J [1 mark]

Total heat gained = Q_3 + Q_4 = 336000m + 21000m

= 357000m J

According to the principle of calorimetry:

Total heat lost = Total heat gained

$Q_1 + Q_2 = Q_3 + Q_4$
$26750 = 357000$
$m = 0.075kg$
$m = 75g = mass - of - ice, required.$

[1 mark]

Answer 10

(a)

(i) Two properties for a substance to be used as a thermionic emitter are:

- The work function should be low so that the electrons may be emitted from it even when it is not heated to a very high temperature.
- The substance should have a high melting point so that it may not melt when heated to emit electrons. [2 marks]

(ii) Helium. [1 mark]

(b)

(i) Radioactivity is a nuclear phenomenon that results in the spontaneous emission of $\alpha\beta$ and γradiations from the nuclei of the atoms of a radioactive substance during their decay.

[1 mark]

(ii)During β emission, a neutron inside the nucleus changes into a proton by emitting an electron. The electron that is emitted from the nucleus is called a β particle.

[1 mark]

(iii) ${}_0n^1 \rightarrow {}_1p^1 + {}_{-1}e^0$

(neutron) (proton) (βparticle) [1 mark]

(c)

(i) A television is commonly used to convert an electrical signal into an audio signal.
[1 mark]

(ii) ${}_{84}X^{202} \rightarrow {}_{82}Y^{198} + {}_2He^4$ [2 marks]

(iii) If the nucleus Y emits γ radiations, no change will take place in its mass number and atomic number. [1 mark]