SECTION A (25 MARKS)

INSTRUCTION: Answer all the questions in this section

1. **Figure 1** below shows part of the thimble scale of a screw gauge of 50 divisions.

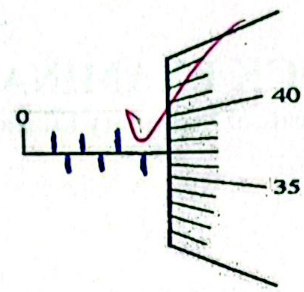


Figure 1

On the diagram, draw the sleeve scale to show a reading of 3.87mm. (1mark)

2. Explain why the mass of a body does not change from place to place. (1mark)

Particles in the body remain constant/do not change yet mass of the body is the sum of masses of particles in it.

3. **Figure 2** below shows a bimetallic strip made of metals A and **B** at room temperature. Given that A has a higher linear expansivity rate;

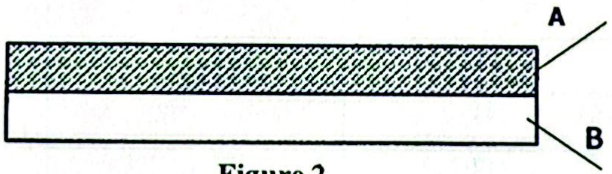
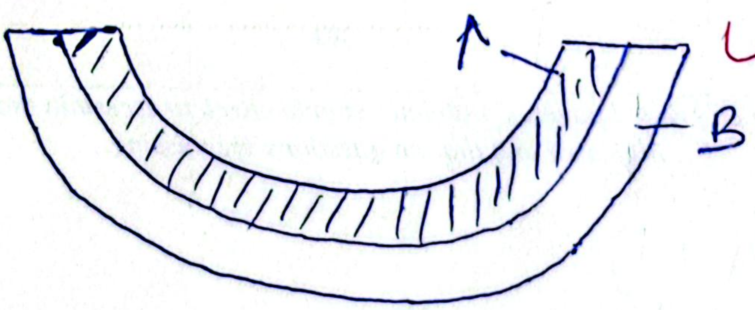


Figure 2

Sketch the appearance of the strip when the temperature is lowered to -10^{0}c (1mark)



4. **Figure 3** below shows a uniform rod of length 3m and mass 5kg balanced by two forces and a string tied to one of its ends.

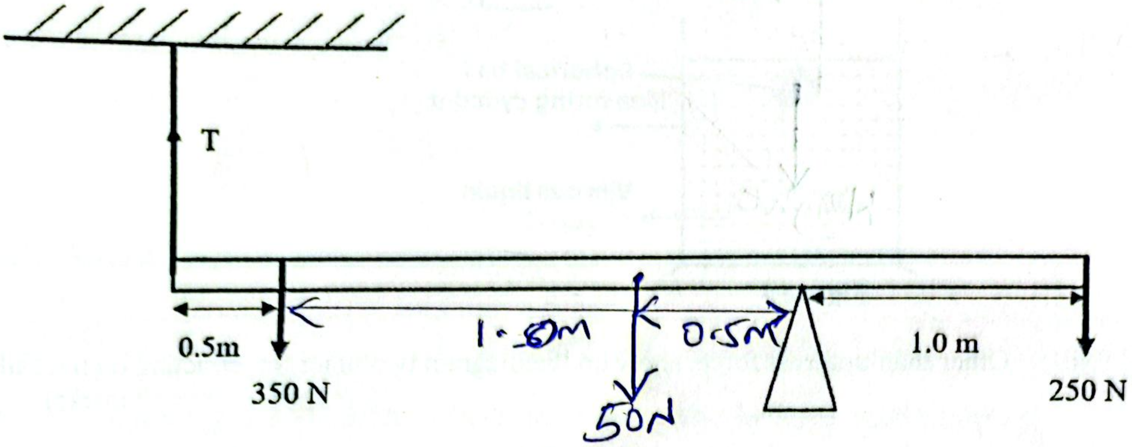


Figure 3

Determine the tensional force in the string. (3 marks)

$F_1 d_1 = F_2 d_2$ ✓1

$(T \times 2) + 250 \times 1 = (350 \times 1.5) + (50 \times 0.5)$ ✓1

$2T + 250 = 525 + 25$

$2T = 550 - 250$

$2T = 300$

$T = \frac{300}{2}$

$= 150N$ ✓1

3

5. **Figure 4** below shows a beaker placed on a bench. A block of ice is placed in the beaker as shown.

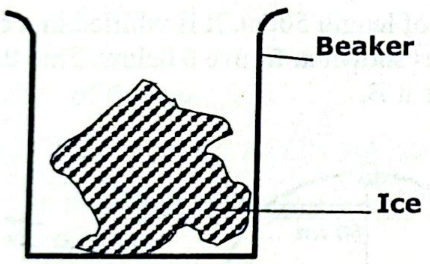


Figure 4

State and explain the change in the stability of the beaker when the ice melts. (2 marks)

Stability increases ✓1; position of centre of gravity is lowered ✓1 upon ice melting since more weight goes to the bottom.

2

05

6. **Figure 5** below shows a spherical ball moving in a viscous liquid in a tall measuring cylinder

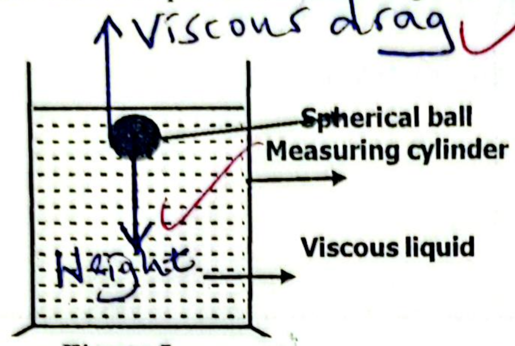
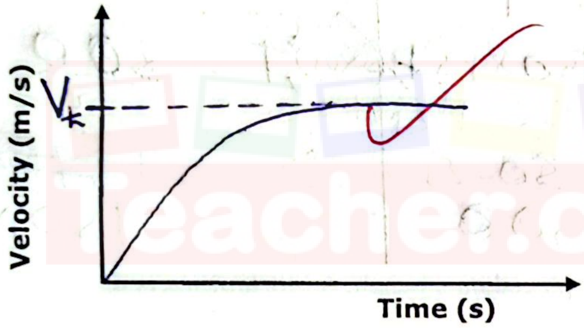


Figure 5

i. Other than upthrust force, show on the diagram two other forces acting on the ball. (2 marks)

ii. Sketch a graph showing the variation of velocity with time and show on the sketch the terminal velocity V_t. (1mark)



7. A mass of 1kg is attached to a cord of length 50cm. It is whirled in a circle in a vertical plane at 10 revolutions per second as shown in **figure 6** below. Find the tension in the cord when the mass is at the lowest point at **B**. (3 marks)

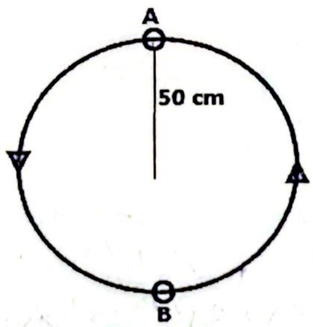


Figure 6

$T_{Max} = \frac{mv^2}{r} + mg$

$T_B = mr\omega^2 + mg$

$= 1 \times 0.5 \times (2 \times 3.142 \times 10)^2 + 1 \times 10$

$= 0.5 \times 3948.9 + 10$

$= 1974.4 + 10$

$= 1984.4\,N$

8. **Figure 7** below shows a setup of pulley system.

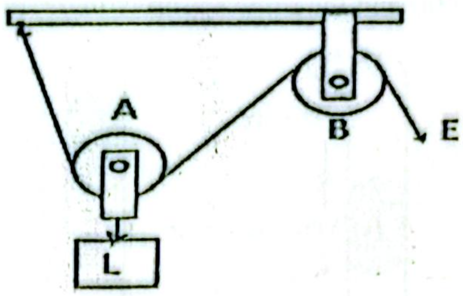


Figure 7

a. State the purpose of the pulley labelled B. (1 mark)

To change direction of effort enhancing efficiency

b. State two ways in which the efficiency of the system be improved? (2 marks)

- Oiling or lubricating moving parts
- Use of lighter pulley A.

9. **Figure 8** below shows the motion of a pollen grain placed on the surface of still water and observed using a hand lens.

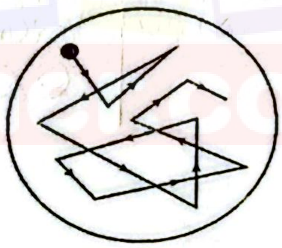


Figure 8

a) State the function of the hand lens. (1 mark)

Magnifys or enlarges pollen grains.

b) State and explain the effect on the motion of the pollen grain when the temperature of water is decreased. (2 marks)

Motion decreases; decrease in temperature decreases kinetic energy of the particles decreasing collisions reducing brownian motion.

06

10. The diagram in **figure 9** below shows a gas trapped by a mercury thread with the mouth of the tube facing down in (a) and the same set-up with the mouth facing upwards in (b)

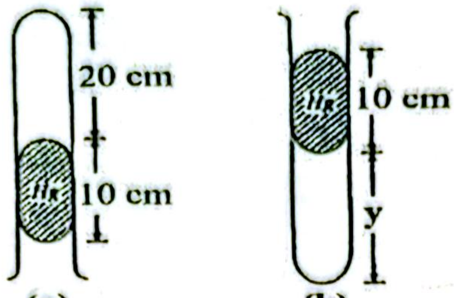


Figure 9

Given that the atmospheric pressure is 76 cmHg, determine the height labelled **y**. (2 marks)

$P_1V_1 = P_2V_2$

$(76-10)20 = (76+10)y$

$66 \times 20 = 86y$

$1320 = 86y$

$y = \frac{1320}{86}$

$= 15.35\text{ cm}$

OR 0.1535 M.

2

11. State one way in which surface tension of water can be reduced. (1mark)

Increasing temperature of water

Addition of impurities

01

12. **Figure 10** shows a spiral spring fixed on a bench vertically. A mass of **0.5kg** is placed on top as shown in the figure below.

Figure 10

In **(a)** the height of the spring is **6cm** while in **(b)** the height is **4cm**. find the energy stored in the spring in figure **(b)** (2 marks)

$e = 6-4 = 2\text{ cm}$ or 0.02 m

$E = \frac{1}{2}Fe$

$= \frac{1}{2} \times 0.5 \times 10 \times 0.02$

$E = \frac{0.1}{2}$

$= 0.05\text{ J}$

2

05

SECTION B (55 MARKS)

INSTRUCTION: Answer all the questions in this section

13. (a) State Pressure Law for an ideal gas. (1 mark)

The pressure of a fixed mass of a gas is directly proportional to its absolute temperature at constant volume. 1

(b) State **one** basic assumption of the Kinetic Theory of gases. (1mark)

- The size of gas particles is negligible 1
- Intermolecular forces are negligible
- Collisions are perfectly elastic

(c) **Figure 11 below** shows a set up that may be used to verify Pressure Law.

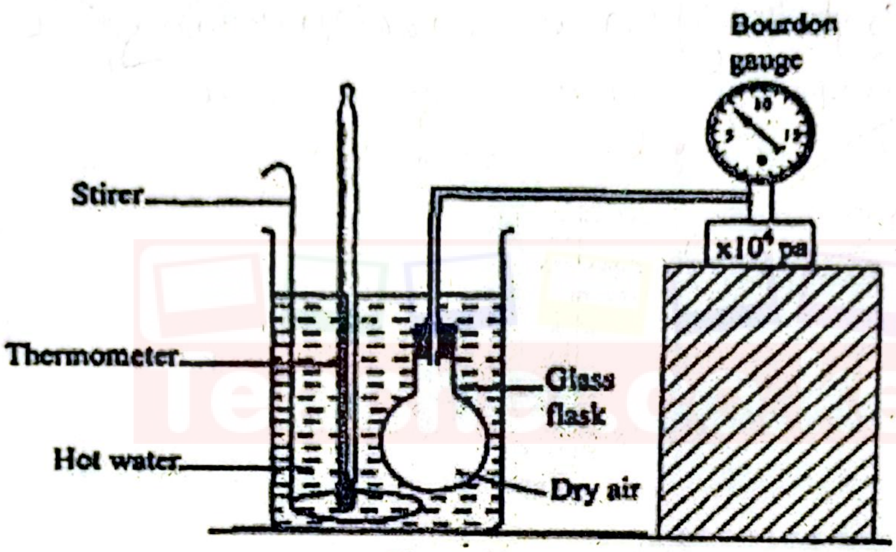


Figure 11

(i) *State the measurements that may be taken in the experiment.* (2 marks)

Pressure of gas using Bourdon gauge 1
Temperature of air/water bath using thermometer. 1

(ii) Explain how the measurement in (i) above may be used to verify Pressure Law. (4 marks)

- The initial values of temperature and corresponding pressure are measured and recorded
- The water bath is ~~heated~~ stirred and more values of temperature and corresponding pressure measured and recorded
- The results are tabulated in the table.
- A graph of pressure of gas against absolute temperature is plotted.

It is a straight line, passing through the origin hence verifying pressure law.

08

(d) A car tyre is at an air pressure of 4.0×10^5 Pa at a temperature of $27\,^0C$. While the car is moving, the temperature of the tyre rises to 75^0C. Calculate the new pressure in the tyre assuming the tyre does not expand. (3 marks)

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$ 1

$$\frac{4.0\times10^5}{27+273} = \frac{P}{75+273}$$

$$\frac{4\times10^5}{300} = \frac{P}{350}$$ 3

$$P = \frac{4\times10^5\times350}{300}$$

$$= 4.667\times10^5\ Pa$$

14. (a) Define the term 'atmospheric pressure' (1 mark)

Pressure exerted on earth's surface due to the weight of air surrounding it. 1

(b) **Figure 12** below shows an accurate simple mercury barometer.

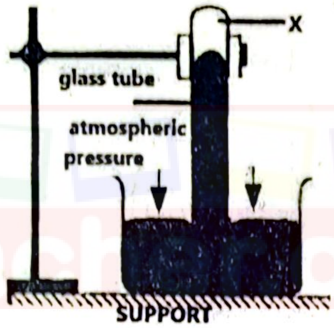


Figure 12

i. Identify the part labelled X. (1 mark)

Vacuum or Torricellian vacuum. 1

ii. Explain how you would test for the X. (2 marks)

The glass tube is slightly tilted; if mercury fills it completely then X exists. 2

(c) The **figure 13** below shows a U-tube filled with water, mercury and another liquid

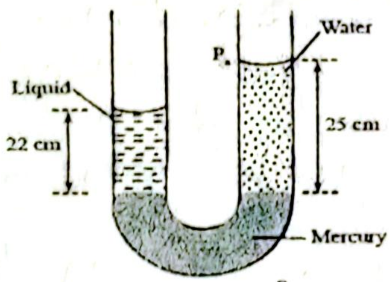


Figure 13

9/7

Determine the density of the liquid. (2 marks)

$h_L \times \rho_L \times g = h_w \times \rho_w \times g$

$0.22 \times \rho \times 10 = 0.25 \times 1000 \times 10$

$\rho = \frac{2500}{2.2}$

$= 1136.4\ kg/m^3$

2

(d) Give one reason why mercury is used for this experiment. (1 mark)

- Immiscible with the liquid and water
- Its more dense than the liquid and water.

Any

(e) The diagram in **figureb14** below shows water in a long pipe with parts **A** and **B** as shown

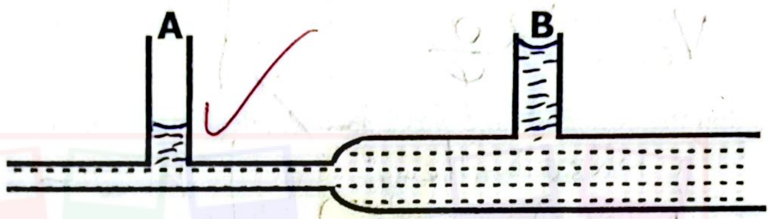


Figure 1

(i) Show on the diagram, the likely levels of water in section **A** and **B**. (1 mark)

(ii) Explain your answer above. (1 mark)

Water flows at a higher velocity in narrower section of the pipe than in wider this lower pressure in narrower than in wider.

(iii) State two assumptions made when deriving equation of continuity. (2marks)

- Fluid is incompressible
- Fluid is non-viscous
- Flow is streamline or steady.

2

07

15. a) **Figure 15** below shows two trolleys of mass **6kg** and **8kg** traveling towards each other at **10m/s** and **5m/s** respectively. The trolleys combine on collision.

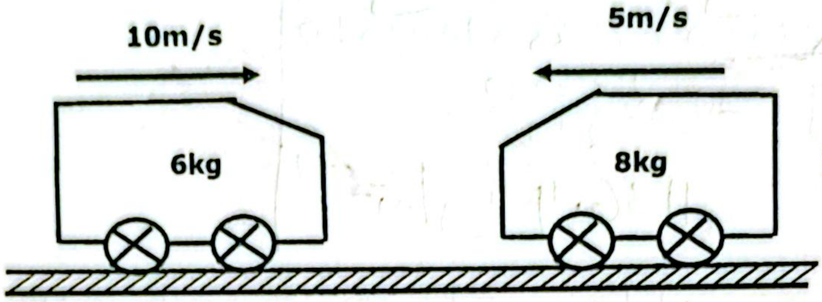


Figure 15

i. Calculate the velocity of the combined trolleys after collision. (3 marks)

$M_1U_1 + M_2U_2 = (M_1+M_2)V_c$

$(6\times10)+(8\times-5) = (6+8)V_c$

$60 - 40 = 14V_c$

$V_c = \frac{20}{14}$

$V_c = 1.429$ m/s

3

ii. Given that the collision time was 2 seconds, determine the impulsive force (3 marks)

$F = \frac{mv - mu}{t}$

For 6kg mass trolley:

$F = \frac{(6\times1.429)-(6\times10)}{2}$

$= \frac{8.571 - 60}{2}$

$F = \frac{-51.43}{2}$

$= -25.71$ N

ACCEPT for the other trolley (+25.72 N).

3

b) An object is projected horizontally at a velocity of **50m/s** from a cliff **45m** high. Calculate:

i. The time taken to hit the ground (2 marks)

$h = \frac{1}{2}gt^2$

$45 = \frac{1}{2}\times10\times t^2$

$t^2 = \frac{45}{5} = 9$

$t = \sqrt{9}$

$= 3$ seconds

2

ii) The distance from the foot of the cliff when the object hits the ground. (2 marks)

$R = ut$

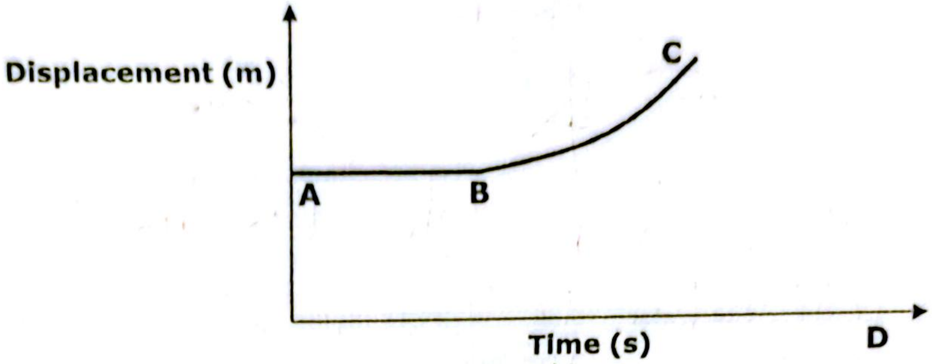
$= 50\times3$

$= 150$ m

2

10

c) The graph below shows the displacement time graph of the motion of a particle



State the nature of the motion of the particle between

i. **A and B** (1 mark)

Particle is at rest or stationary or not moving

ii. **B and C** (1mark)

Particle moving with non-uniformly increasing velocity

16. (a) State Archimedes' Principle. (1 mark)

When a body is partially or totally immersed in a fluid it experiences an upthrust force which is equal to the weight of the fluid displaced

(b) An object weights 1.04N in air, 0.64N when fully immersed in water and 0.72N when fully immersed in a liquid. If the density of water is $1000kgm^{-3}$, determine the density of the liquid. (3 marks)

$R.D_L = \frac{\text{Upthrust in Liquid}}{\text{Upthrust in Water}}$

$= \frac{1.04 - 0.72}{1.04 - 0.64}$

$= \frac{0.32}{0.4}$

$= 0.8$

$\rho_L = 0.8 \times 1000$

$= 800\ kg/m^3$

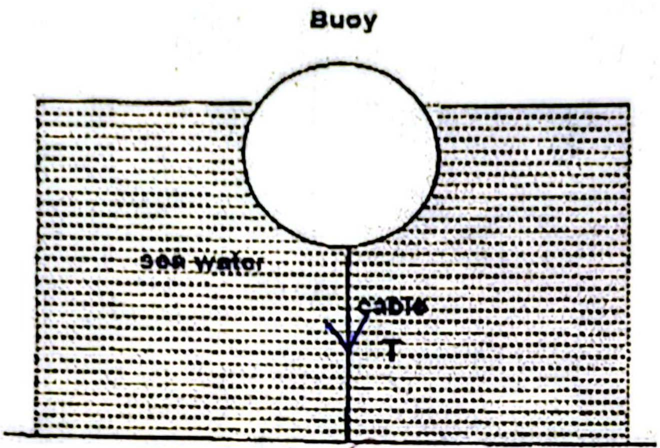
or

$0.8 g/cm^3$

3

(c) **Figure 16** below shows a buoy, B, of volume 40 litres and mass 10 kg. It is held in position in sea water of density $1.04 gcm^{-3}$ by a light cable fixed to the bottom so that ¾ of the volume of the buoy is below the surface of the sea water.

Figure 16



Determine the tension T in the cable. (3 marks)

$T = U - W$

$= \cancel{\tfrac{3}{4} \times \tfrac{4}{3} \times \tfrac{22}{7} \times}$

$= (\tfrac{3}{4} \times 40 \times 10^{-3} \times 1040 \times 10) - 10 \times 10$

$= 312 - 100$

$T = 212\,N$

3

(d) **Figure 17** shows a diagram of a hydrometer which is suitable for measuring the densities of liquids varying between $1.0 gcm^{-3}$ and $1.2 gcm^{-3}$.

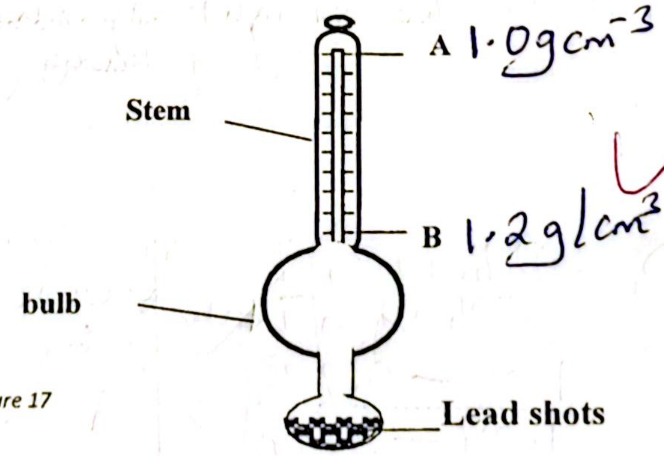


Figure 17

04

i. On the diagram, indicate the label corresponding to 1.0 and 1.2g/cm^3. (1 mark)

ii. State how the sensitivity of the above instrument be **increased.** (1 mark)

– Use of narrower stem.
– Increasing size of the bulb.

(e) A ship made of steel floats in water yet steel is denser than water. Give a reason. (1 mark)

The ship is made hollow displacing larger volume of water providing greater upthrust force enabling it to float.

17. **(a) Figure 18** below shows a block of ice with two heavy weights hanging such that the copper wire connecting them passes over the block of ice.

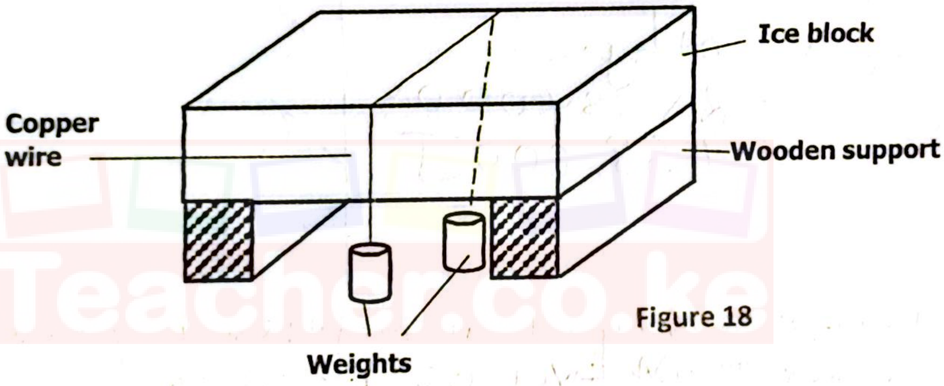


Figure 18

i. It is observed that the wire gradually cuts its way through the ice block, but leaves it as one piece. Explain this observation. (2marks)

Hanging weights make copper wire exert pressure on the ice block causing it to melt at a temperature below its melting point. Since melted ice (water) is no longer under pressure, it releases latent heat of fusion which is then conducted by copper wire causing ice below to melt. The process is repeated until the wire cuts through.

ii. State the change that would be observed if the copper wire used in the experiment was replaced by a cotton thread. (1mark)

The cotton thread would not cut through.

TS

(b) Define the term specific latent heat of vaporization. (1 mark)

Is the amount of heat energy required to change a unit mass of a substance from liquid to vapour at constant temperature.

(c) An electric heat rated 6000W is used to heat 2kg of ice initially at -5°C until all the mass turns to steam. Given that, the specific Latent heat of fusion of ice = 334000JKg^{-1} Specific heat capacity of ice = 2100JKg^{-1}K^{-1} Specific heat capacity of water = 4200JKgK^{-1} Specific latent heat of vaporization of steam = 226000JKg^{-1}.
Determine:

(i) The amount of heat required to convert ice into water at O°C. (2 marks)

$Q = mL_f$
$= 2 \times 334000$
$= 668,000J$

2

(ii) The amount of heat required to convert water to steam at 100°C. (2 marks)

$Q = mL_v$
$= 2 \times 226000$
$= 452,000J$

2

(iii) The minimum time required in minutes for activity in (i) and (ii) to take place. (2 marks)

$Pt = 668000 + 452000$
$\frac{6000 \times t}{6000} = \frac{1120000}{6000}$
$t = 186.67$ seconds

$t = \frac{186.67}{60}$
$= 3.111$ minutes

2

07

(d) **Figure 19** below shows a set-up that was used to determine the specific heat capacity of aluminium block. Study the diagram and answer the questions that follow

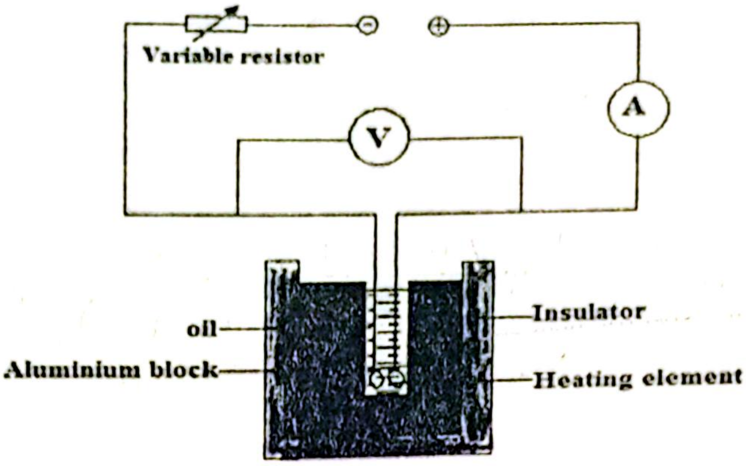


Figure 19

Apart from **voltage**, **current** and **temperature**, state any other quantity that is required for the determination of the specific capacity of the aluminium block. (1 mark)

Time using stop watch.
Mass of the block using beam balance.