1 The kinetic theory of matter states that all matters are made up of ________________ or ________________, which are in ________________ and ________________ motion. ________________ forces hold the atoms or molecules together. The nature of these forces differs in the ________________ different states of matter.

In ________________, the intermolecular forces are strong enough to hold the particles together in a ________________ pattern and so give the solid its rigid ________________ and ________________. Particles in a solid are packed ________________ together. They can only ________________ about a fixed ________________ position. As the solid is heated, the vibration of the particles becomes more ________________ and the average intermolecular ________________ increases slightly. The average ________________ energy of the particles increases hence the ________________ of the solid also increases.

If the solid is heated to its ________________ point, the particles will have gained enough energy to ________________ the intermolecular forces. The average kinetic energy of the particles does not change; hence there is no change in the temperature. The average ________________ energy of the particles increases. Solid will then melt into a liquid.

The intermolecular forces in liquids are not as ________________ as that of a solid and thus the particles are not held in a regular pattern and hence ________________ take the shape of the container. However, the intermolecular forces are still strong enough to hold the molecules together in a liquid hence liquids have ________________ volume. The particles are slightly apart than in a solid. They can vibrate and move ________________ within the liquid.

If a liquid is heated, the particles gain kinetic energy and the temperature of the liquid rises. The temperature of the liquid keeps rising until the ________________ point is reached. At this stage, there is no further increase in temperature. The energy gained by the particles is used to ________________ free from the intermolecular forces that hold the particles together.

In gases, the intermolecular forces are ________________; the particles are free to move randomly and ________________. The particles are very ________________ apart from each other and they are free to take up any space which is available to them. Particles in a gas are about ________________ times further apart than particles in the other two states under ordinary conditions.

2 The diagram shows the apparatus used for observing Brownian motion in air.

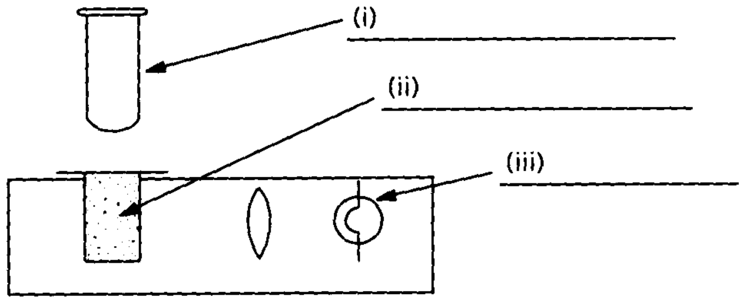
(a) Add to the diagram the missing labels.

(b) When using the apparatus, points of light can be observed moving about in a random manner.

(i) What are these points of light?

(ii) Why are they moving randomly?

(c) Name two ways by which this random motion could be made less vigorous.



3 In terms of kinetic theory, state and explain how a gas exerts pressure in a container.

4 Explain using kinetic theory, why pressure of a gas increases with temperature if volume is constant.

5 Using kinetic theory, state and explain the effect of decreasing the temperature of the gas in the sealed container.

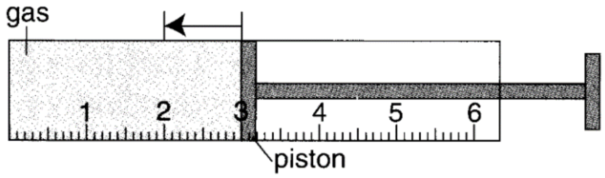
6 (a) Why is energy required to evaporate a liquid?

(b) State the condition required for molecules in a liquid to be able to leave the liquid surface.

(c) Why is cooling a result of evaporation?

7 A cylinder containing gas is fitted with an air-tight piston. The piston is initially at rest at the 3 cm mark.

(a) The piston is slowly pushed until it is at the 2 cm mark. The temperature of this gas is kept constant. Explain, using the Kinetic Theory of Matter, what happens to the pressure of the gas in the cylinder.



(b) The force that holds me piston at the 2 cm mark is released. State what happens subsequently.

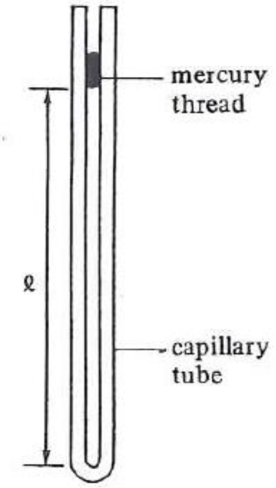
(c) The gas in the cylinder is then cooled and the piston is observed to move inwards again. Explain, using Kinetic Theory of Matter, why this happens.

8 The pressure at the bottom of a lake is 7 times the pressure at the surface. A bubble of air at the bottom has a radius of r_1. As it rises to the surface, its radius increases to r_2. Assume that the temperature remains constant, find the ratio r_2 to r_1.

9 A student uses a uniform bore capillary tube with a small mercury thread as a thermometer to measure the room temperature. The student first put the tube into the melting ice and finds that the length ***l*** to be 0.10 m. Then the tube is left standing in the air and the length ***l*** is found to be 0.11 m.

(a) Determine the room temperature.

(b) What is the length ***l*** if the tube is in boiling water?



10 At 0°C, the pressure of air inside a flask is 1.20×10^5 Pa. Assume that the change in volume of the flask is negligible, find the pressure of air inside at 50°C?

11 The density of air at 0°C and a pressure of 1.03×10^5 Pa is 1.29 kg/m^3. Find the mass of air in a classroom of 5.0 m × 6.0 m × 4.0 m when the temperature is 20°C and the pressure remains constant.

12 ***Diagram I*** shows an iron ring with a brass ball and ***Diagram II*** shows an iron ring with an iron ball. Before heating, each ball is able to pass through the respective ring.

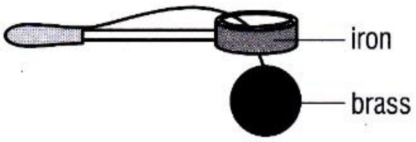


Diagram **I**

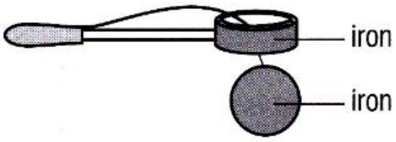


Diagram **II**

When the iron ring and the brass ball are heated together to the same temperature, the ball cannot pass through the ring. However, when the iron ring and the iron ball are heated together to the same temperature, the ball is able to pass through the ring. Explain why the results of both experiments are different.

13 The following diagram shows how a bimetallic strip is used in an electrical iron.

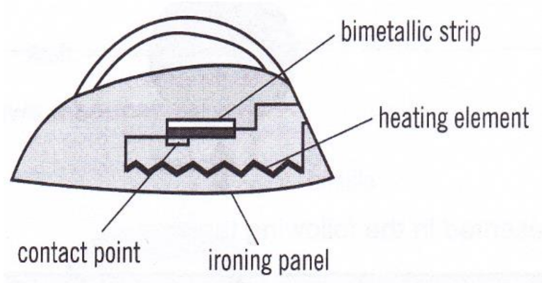
(a) (i) What is a bimetallic strip?

(ii) What is the function of the bimetallic strip in the electrical iron?

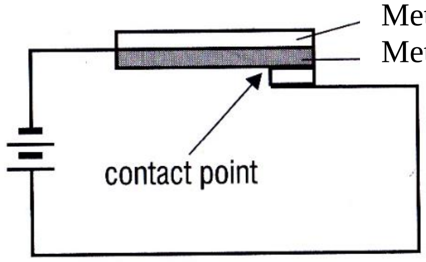
(iii) How is the bimetallic strip suitable to perform the function as stated in (a)(ii)?

(b) The ironing panel is made of iron metal. Explain why it is so.

(c) Give another example which makes use of a bimetallic strip in its application.

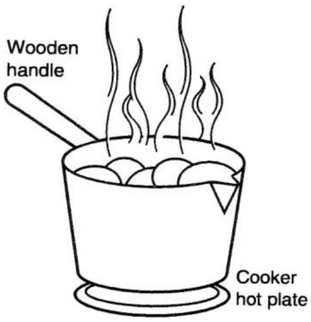


14 The diagram shows a thermostat in an electrical appliance. The thermostat is a bimetallic strip made of brass and iron. The thermostat is used to maintain the constant temperature in the refrigerator. When the electricity is turned on, cooling takes place in the refrigerator. When the temperature becomes too cold, the electricity is turned off by the bimetallic strip to stop further cooling.



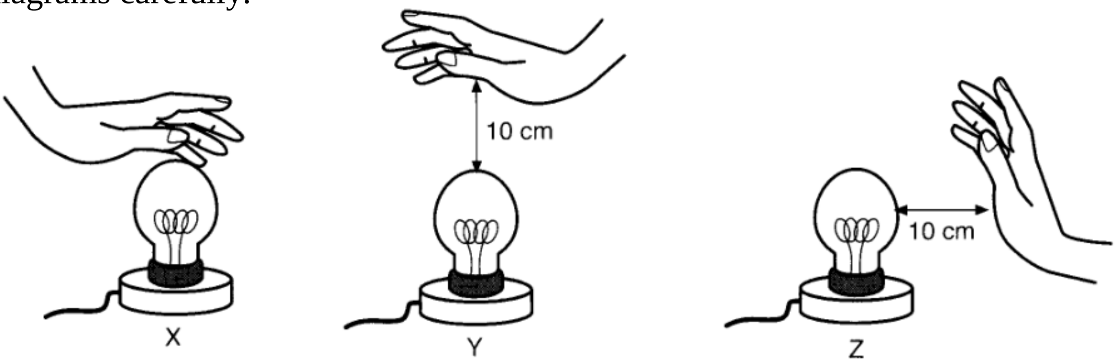
(a) Explain why a bimetallic strip is made of two different metals welded together.
(b) Identify ***X*** and ***Y***.
(c) Describe how electricity can be successfully turned off during extremely low temperature.
(d) Give another appliance which contains a bimetallic strip as a thermostat to keep the temperature constant.

15 A potato is cooked in a microwave oven and then wrapped in aluminium foil to keep it hot.



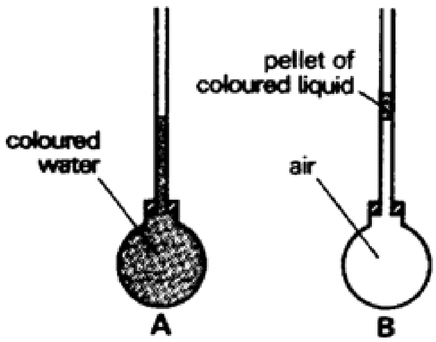
(a) Why is aluminium foil used for this purpose?
(b) Potatoes can also be cooked in boiling water as shown. State the process by which heat energy is transferred from the hot plate to the potatoes in the pan.

16 Study the diagrams carefully.



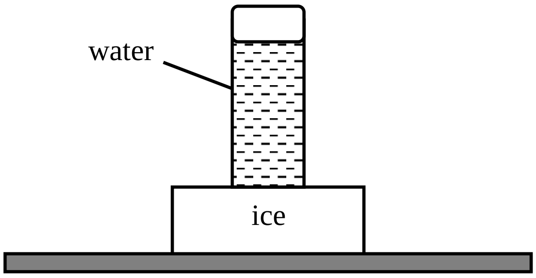
(a) You turn on the bulb and touch it as shown in ***X***. What do you feel? Explain why.
(b) You place your hand about 10 cm above the light bulb as shown in ***Y***. What do you feel? Explain why.
(c) You place your hand about 10 cm to the side of the light bulb as shown in ***Z***. What do you feel? Explain why,

17 In an experiment to compare the properties of water and air, two identical flasks, ***A*** and ***B*** are filled with water and air as shown. ***A*** and ***B*** are then placed above a heater.



(a) What does the diagram suggest about the volume of water compared with the volume of air at the start of the experiment?
(b) How is heat transmitted to ***A*** and ***B***?
(c) Will the water in ***A*** or the coloured pellet in ***B*** rises up the tube faster? Explain.

18 The diagram shows a tall cylinder filled with water. The bottom of the cylinder rests on a large block of ice. Explain, with reasons, whether the temperature of the water in the cylinder is higher at the top, constant all the way up or higher at the bottom. Assume that the cylinder has been in place for a long time, the room temperature is steady at about 30°C and that there are no droughts.

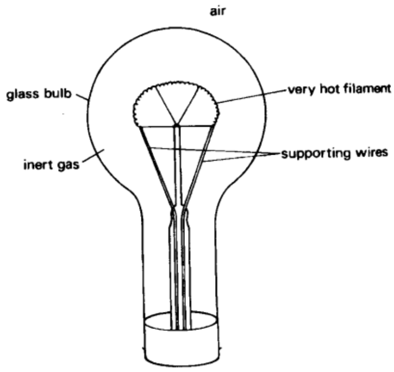


19 The diagram shows a filament lamp standing upright in air. The connections to the lamp are not shown.

(a) On the diagram, draw arrows to represent radiation from the filament.

(b) State two places where thermal conduction takes place.

(c) Describe how two convection currents can be set up.

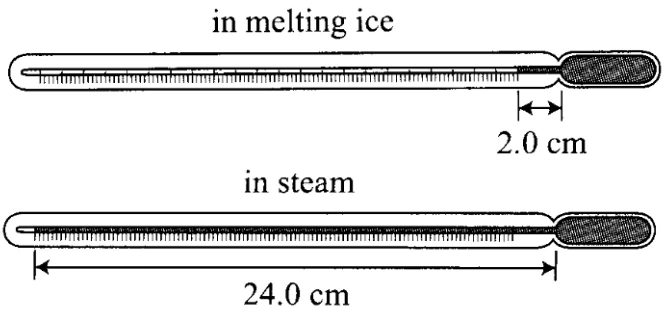


20 The diagram shows the positions of the mercury thread in a thermometer.

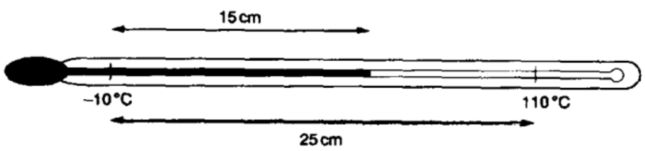
(a) What is the distance between each 1°C mark on the thermometer?

(b) What is the sensitivity of the thermometer?

(c) When the thermometer is placed inside hot liquid naphthalene, the length of the mercury thread is measured to be 22.5 cm. Calculate the temperature of the liquid naphthalene.



21 The diagram shows a mercury-in-glass thermometer. The distance between –10°C and the 110°C markings is 25 cm. At which temperature is the end of the mercury thread 15 cm from the –10°C mark?

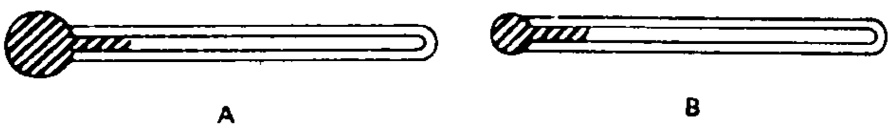


22 The diagram (not to scale) shows two mercury thermometers, ***A*** and ***B***, identical in every aspect except that the bulb of ***A*** is much larger than that of ***B***.

State, giving a reason for your answer in each case, which thermometer

(a) will cover a larger range of temperature;

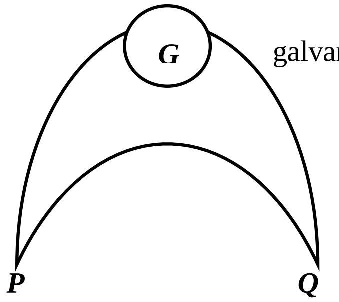
(b) will indicate more quickly a small rise in temperature.



23 A thermocouple is constructed by putting the two soldered ends (junctions) of two different metals into different temperatures. A galvanometer shows a deflection in mV that depends on the temperature difference between the junctions ***P*** and ***Q***.

(a) State the thermometric property for the thermocouple.

(b) If ***P*** is placed in a liquid of 20°C and ***Q*** is placed into another liquid of 100°C, the deflection shown on the galvanometer is 3.5 mV. What will be the deflection shown on the galvanometer if ***Q*** is placed in a liquid of 50°C while ***P*** remains in the same liquid?



(c) For each of the following, suggest

(i) a reason why a thermocouple is able to response to rapid changing temperatures,

(ii) how the range of the thermocouple could be changed.

24 The following are two important design features of a clinical thermometer. Explain the purpose of each feature.

(a) The narrow constriction in the tube just above the bulb.

(b) The pear-shaped cross-section of the stem.

25 You are provided with some water at 25°C and some boiling water. If you are to make 5.0 kg of water at 50°C, how much of each would you need?

26 The potential energy of the water at the top of a waterfall is converted to heat energy which raises the temperature of the water at the bottom of the fall. The observed temperature difference is 0.18 K. What is the height of the waterfall?

27 A car of mass 1 200 kg is travelling at 60 km/h. Assuming that all the kinetic energy of the car is transferred equally to the four steel discs when the brakes are applied, calculate the rise in temperature of the disc if the total mass of the four discs is 24 kg and the specific heat capacity of the steel discs is 452 J/kgK.

28 An electric boiler of power rating 200 W contains 1.0 kg of water at 26°C. The boiler is switched on for 25 minutes. Immediately after switching off and a brief stirring, the temperature of the water is 91°C. The temperature continues to rise for a while and the highest temperature reached is 94°C.

(a) Explain why the temperature of the water continues to rise for a while after the boiler is switched off.

(b) Calculate the specific heat capacity of water.

(c) State the assumption you make in your calculation.

(d) Is the calculated specific heat capacity higher or lower than the true value? Briefly explain.

(e) If the heat capacity of the heating coil of 150 J/°C is taken into account in the calculation, what is the specific heat capacity of water?

29 (a) Explain what is meant by the

(i) *specific heat capacity of water is 4 200 J/kg°C.*

(ii) *specific latent heat of fusion of ice is 340 J/g*.

(b) A solid of mass 100 g is heated until it melts completely. Its temperature varies with time according to the graph. The heater supplies energy at a constant rate of 500 W.

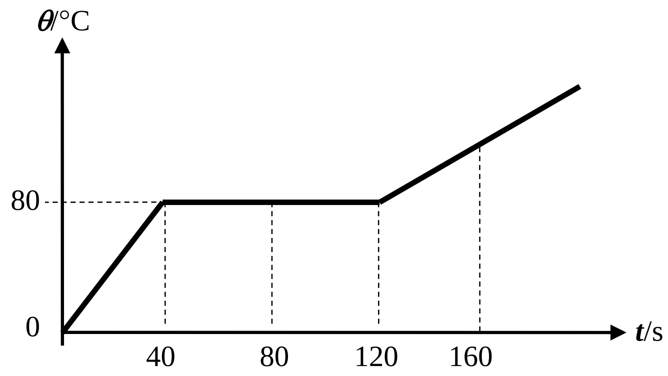
(i) At which point of heating is melting completed?

(ii) What quantity of thermal energy is supplied during melting?

(iii) Calculate the specific heat capacity of the solid.

(iv) How could you tell from the graph whether the liquid has a larger or a smaller specific heat capacity compared with the solid?

(v) Discuss an advantage for a thermometer having a smaller specific heat capacity.



30 In an experiment to determine the specific latent heat of fusion of ice, a copper calorimeter initially contained some warm water at 30°C. The mass of the calorimeter when empty was 1 200 g and its mass became 1 240 g. when partially filled with the warm water. After 8 g of ice were added to the warm water, the final temperature was lowered to a minimum value of 25°C.

Use these data to calculate the following:

[heat capacity of the calorimeter is 480 J/K and the specific heat capacity of water is 4.2 J/gK]

(a) Calculate the total amount of heat lost by the calorimeter and the warm water.

(b) Determine the specific latent heat of fusion of ice from this experiment and state the principle used clearly.

(c) State one possible source of error and explain in what way it affects the result.