1 Fig. 4.1 is a design for remotely operating an electrical switch using air pressure.

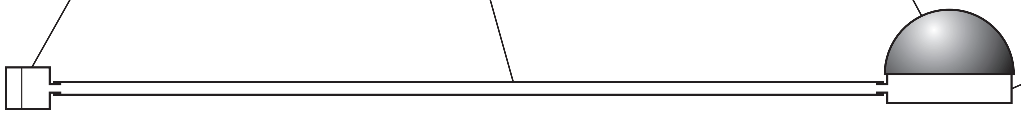

Fig. 4.1

The metal box and the pipe contain air at normal atmospheric pressure and the switch is off. When the pressure in the metal box and pipe is raised to 1.5 times atmospheric pressure by pressing down on the flexible rubber box cover, the switch comes on.

(a) Explain in terms of pressure and volume how the switch is made to come on.

....

....

....

.... [2]

(b) Normal atmospheric pressure is 1.0×10^5 Pa. At this pressure, the volume of the box and pipe is $60\,cm^3$.

Calculate the **reduction** in volume that must occur for the switch to be on.

reduction in volume = ... [3]

(c) Explain, in terms of air particles, why the switch may operate, without the rubber cover being squashed, when there is a large rise in temperature.

....

....

....

.... [2]

[Total: 7]

2 **(a)** One of the laws about the behaviour of gases states that

"For a fixed amount of gas at constant temperature, the pressure is inversely proportional to the volume".

In the space below, write an **equation** that represents this law.

[1]

(b) Table 4.1 gives a series of pressures and their corresponding volumes, obtained in an experiment with a fixed amount of gas. The gas obeys the law referred to in **(a)**.

pressure / kPa	100	200	400	500	1000
volume / cm^3	50.0	25.0	12.5	10.0	5.0

Table 4.1

How do these figures indicate that the temperature was constant throughout the experiment?

....

....

....

.... [2]

(c) Air is trapped by a piston in a cylinder. The pressure of the air is 1.2×10^5 Pa. The distance from the closed end of the cylinder to the piston is 75 mm.

The piston is pushed in until the pressure of the air has risen to 3.0×10^5 Pa.

Calculate how far the piston has moved.

distance moved = ... [4]

[Total: 7]

3 The whole of a sealed, empty, dusty room is kept at a constant temperature of 15 °C. Light shines into the room through a small outside window.

An observer points a TV camera with a magnifying lens into the room through a second small window, set in an inside wall at right angles to the outside wall.

Dust particles in the room show up on the TV monitor screen as tiny specks of light.

(a) In the space below draw a diagram to show the motion of one of the specks of light over a short period of time.

[1]

(b) After a period of one hour the specks are still observed, showing that the dust particles have not fallen to the floor.

Explain why the dust particles have not fallen to the floor. You may draw a labelled diagram to help your explanation.

....

....

....

.... [2]

(c) On another day, the temperature of the room is only 5 °C. All other conditions are the same and the specks of light are again observed.

Suggest any differences that you would expect in the movement of the specks when the temperature is 5 °C, compared to before.

....

....

.... [1]

[Total: 4]

4 Fig. 4.1 shows a sealed steel cylinder filled with high pressure steam.

Fig. 4.1

Fig. 4.2 shows the same cylinder much later when all the steam has condensed.

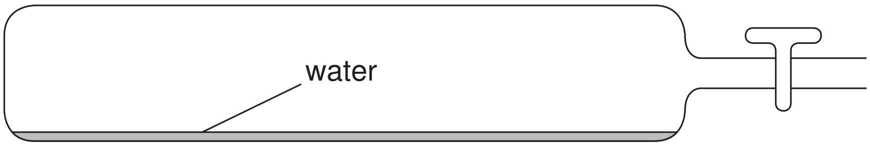

Fig. 4.2

(a) (i) Describe the movement of the molecules in the high pressure steam.

....

....

.... [2]

(ii) Explain how the molecules in the steam exert a high pressure on the inside walls of the cylinder.

....

....

.... [2]

(b) Describe, in terms of particles, the process by which heat is transferred through the cylinder wall.

....

....

.... [2]

(c) When all the steam has condensed, 75 g of water is in the cylinder.

Under these high pressure conditions, the specific latent heat of vaporisation of steam is 3200 J / g.

Calculate the heat lost by the steam as it condenses.

heat = ... [2]

[Total: 8]

5 **(a)** Fig. 5.1 shows the paths of a few air molecules and a single dust particle. The actual air molecules are too small to show on the diagram.

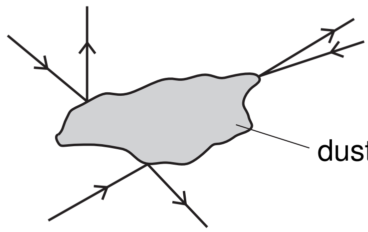

Fig. 5.1

Explain why the dust particle undergoes small random movements.

....

....

....

.... [4]

(b) Fig. 5.2 shows the paths of a few molecules leaving the surface of a liquid. The liquid is below its boiling point.

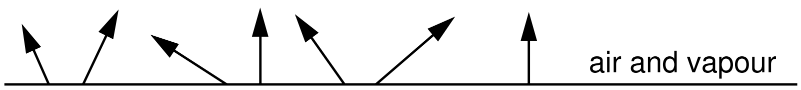

Fig. 5.2

(i) State which liquid molecules are most likely to leave the surface.

....

.... [1]

(ii) Explain your answer to **(i)**.

....

....

.... [2]

[Total : 7]

6 Fig. 5.1 shows a way of indicating the positions and direction of movement of some molecules in a gas at one instant.

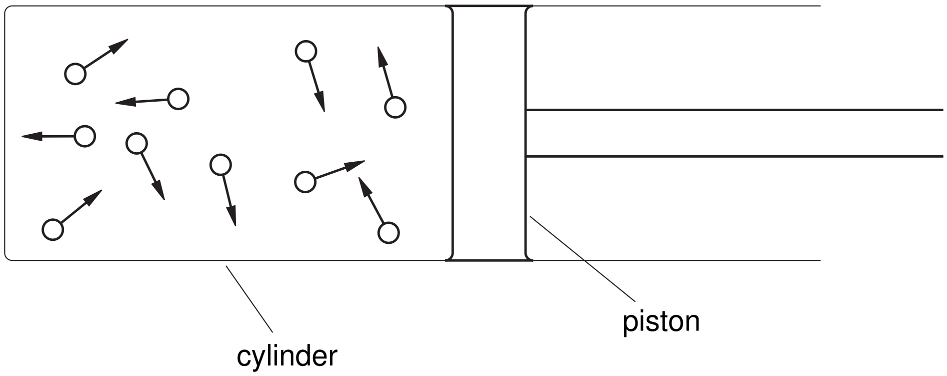

Fig. 5.1

(a) (i) Describe the movement of the molecules.

.... [1]

(ii) Explain how the molecules exert a pressure on the container walls.

....

.... [1]

(b) When the gas in the cylinder is heated, it pushes the piston further out of the cylinder.

State what happens to

(i) the average spacing of the molecules,

.... [1]

(ii) the average speed of the molecules.

.... [1]

(c) The gas shown in Fig. 5.1 is changed into a liquid and then into a solid by cooling.

Compare the gaseous and solid states in terms of

(i) the movement of the molecules,

....

.... [1]

(ii) the average separation of the molecules.

....

.... [1]

[Total : 6]

1 **(a)** Two identical open boxes originally contain the same volume of water.
One is kept at 15 °C and the other at 85 °C for the same length of time.

Fig. 4.1 shows the final water levels.

Fig. 4.1

With reference to the energies of the water molecules, explain why the levels are different.

....

....

....

....[3]

(b) In an experiment to find the specific latent heat of vaporisation of water, it took 34 500 J of energy to evaporate 15 g of water that was originally at 100 °C.

A second experiment showed that 600 J of energy was lost to the atmosphere from the apparatus during the time it took to evaporate 15 g of water.

Calculate the specific latent heat of vaporisation of water that would be obtained from this experiment.

specific latent heat = …………………[3]

[Total : 6]

2 **(a)** Fig. 5.1 shows a sealed box.

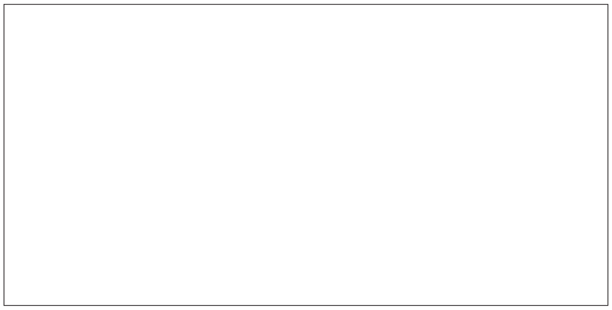

Fig. 5.1

(i) The box contains a large number of air molecules. On Fig. 5.1, draw a possible path of **one** of the air molecules, as it moves inside the box.

(ii) Explain

1 how air molecules in the box create a pressure on the inside walls,

....

....

....

2 why this pressure rises as the temperature of the air in the box increases.

....

....

....
[5]

(b) Air in a cylinder is compressed slowly, so that the temperature does not rise. The pressure changes from 2.0×10^5 Pa to 5.0×10^5 Pa. The original volume was $0.35\,m^3$. Calculate the new volume.

volume = …………………...[3]

[Total :8]

3 Fig. 4.1 shows a sealed glass syringe that contains air and many very tiny suspended dust particles.

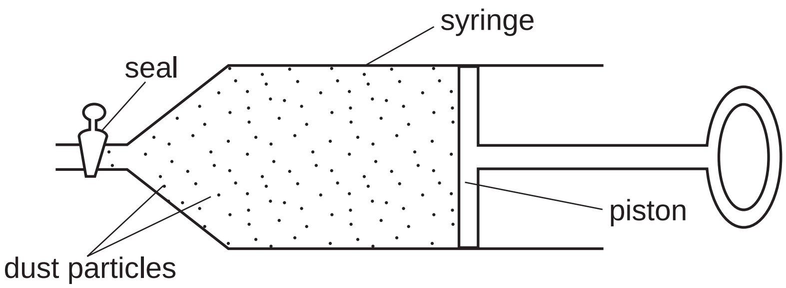

Fig. 4.1

(a) Explain why the dust particles are suspended in the air and do not settle to the bottom.

....

....

....

....[3]

(b) The air in the syringe is at a pressure of 2.0 10^{5} Pa. The piston is slowly moved into the syringe, keeping the temperature constant, until the volume of the air is reduced from 80 cm^{3} to 25 cm^{3}. Calculate the final pressure of the air.

pressure = ...[3]

[Total :6]

4 Fig. 4.1 shows water being heated by an electrical heater. The water in the can is not boiling, but some is evaporating.

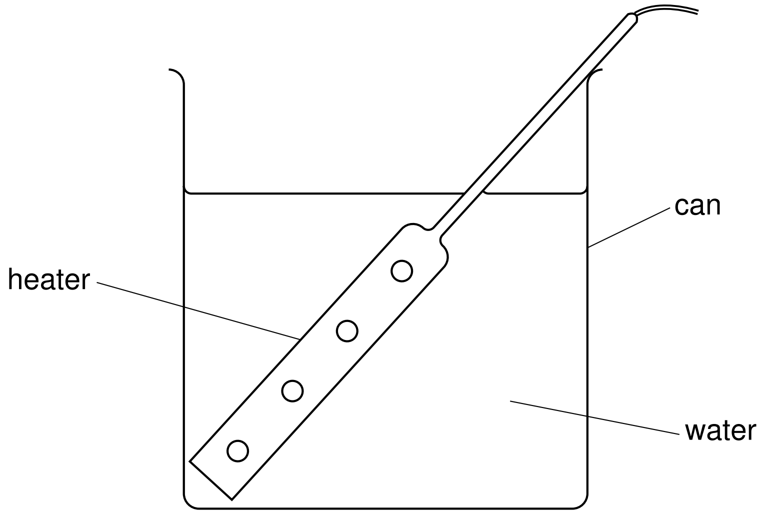

Fig. 4.1

(a) Describe, in terms of the movement and energies of the water molecules, how evaporation takes place.

....

....

....

.... [2]

(b) State two differences between evaporation and boiling.

1 ....

....

2 ....

.... [2]

(c) After the water has reached its boiling point, the mass of water in the can is reduced by 3.2 g in 120 s. The heater supplies energy to the water at a rate of 60 W. Use this information to calculate the specific latent heat of vaporisation of water.

specific latent heat = ... [3]

[Total : 7]