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IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Kinetic Particle Model of Matter

Paper 2 — Theory / Structured Questions (topical compilation)

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M.Eng NUS Singapore · B.Eng NUST · 15+ years of teaching experience in Singapore, UAE & Pakistan · 60,000+ subscribers and 20 million+ video lecture views.

1 Fig. 4.1 shows the arrangement of molecules in a solid and in a liquid.

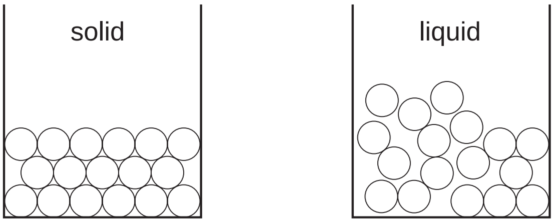


Fig. 4.1

(a) State one difference between the two arrangements.

....

....

.... [1]

(b) By writing about the forces between molecules and the motion of molecules, explain why

(i) the molecules of a solid and of a liquid have different arrangements,

....

.... [1]

[5054/02/M/J/09/Q4]

2 **(b)** **(iii)** Describe the arrangement and the movement of the molecules

1. in liquid water,

....

....

....

.... [2]

2. in ice.

....

....

....

.... [2]

(iv) Ice at 0 °C becomes water at 0 °C.

State what, if anything, happens to the kinetic energy and the potential energy of the molecules as this happens.

kinetic energy: ....

potential energy: ....
[1]

[5054/21/M/J/13/Q10]

3 Fig. 9.1 shows a flask, partly full of a liquid and partly full of air.

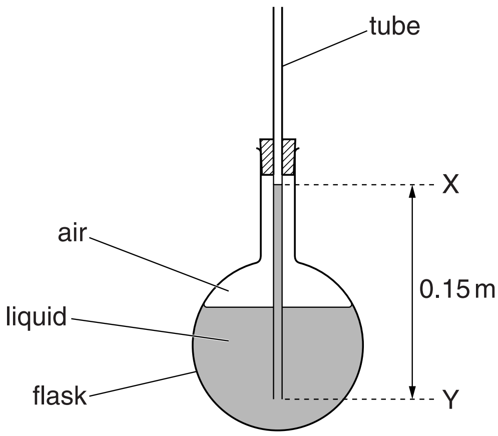


Fig. 9.1

When the flask is heated, the pressure of the air inside the flask increases and the liquid rises up the tube.

(a) Explain, using ideas about molecules, why heating the air inside the flask causes the pressure to increase.

....

....

.... [3]

[5054/22/M/J/13/Q9]

4 **(a)** A student makes a diagram of the molecules in a liquid, as shown in Fig. 10.1.

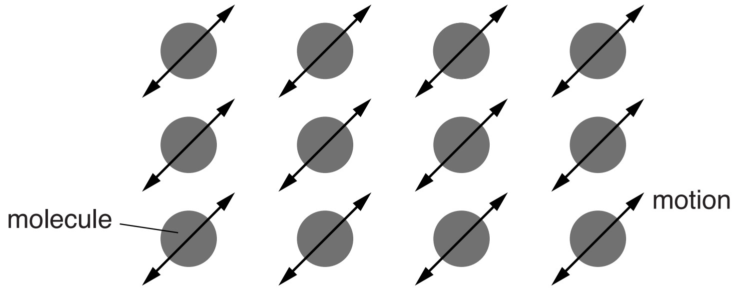


Fig. 10.1

Suggest two ways in which the student's diagram does not show the positions and motion of the molecules accurately.

1. ....

....

2. ....

....[2]

[5054/21/M/J/15/Q10]

5 When a sample of a solid is heated, it becomes a liquid and eventually becomes a gas.

(a) Fig. 5.1 shows the arrangement of the molecules in the solid.

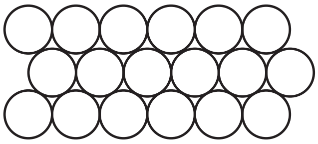


Fig. 5.1

In the space below, draw the arrangement of the molecules in the liquid.

[1]

(b) Complete the table by describing the motion of the molecules in the solid, liquid and gas.

	motion of the molecules
solid	
liquid	
gas	

[3]

(c) Suggest why a gas is able to fill a container but a solid has a fixed shape.

....

....

....

....

....[2]

[5054/22/M/J/17/Q5]

6 Fig. 4.1 shows a cylinder with a piston that contains a gas.

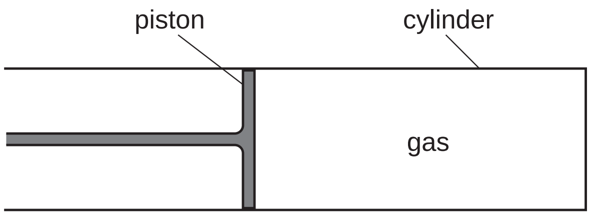


Fig. 4.1

(a) A liquid occupies a much smaller volume than a gas which has the same number of molecules.

Explain why there is this difference.

....

....

.... [2]

(b) The volume of the gas changes from V_1 to V_2 as the piston moves into the cylinder. This increases the pressure from p_1 to p_2. The temperature remains the same.

(i) State the formula that relates V_1, V_2, p_1 and p_2.

.... [1]

(ii) The initial pressure of the gas in the cylinder is 1.2×10^5 Pa and its initial volume is $100\,\text{cm}^3$. The cross-sectional area of the piston is $5.0\,\text{cm}^2$.

The piston is pushed in a distance of 8.0 cm.

Calculate the final pressure of the gas in the cylinder.

pressure = ... [3]

(iii) Explain, using ideas about molecules, why the pressure of the gas changes.

....

....

.... [1]

[5054/21/M/J/19/Q4]

7 **(a)** Use the relationship between pressure, force and area to explain why it is harder to cut something with a blunt knife than with a sharp knife.

....

....

.... [2]

(b) Experimental measurements on gas pressures were made by Robert Boyle.

He showed that $p_1V_1 = p_2V_2$ where p_1 and p_2 are the initial and final pressures of a gas, and V_1 and V_2 are the initial and final volumes of the gas.

(i) State **two** quantities that must remain constant when this equation is used.

1. ....

2. ....
[2]

(ii) Fig. 5.1 shows the molecules of a gas as the volume of the gas is halved.

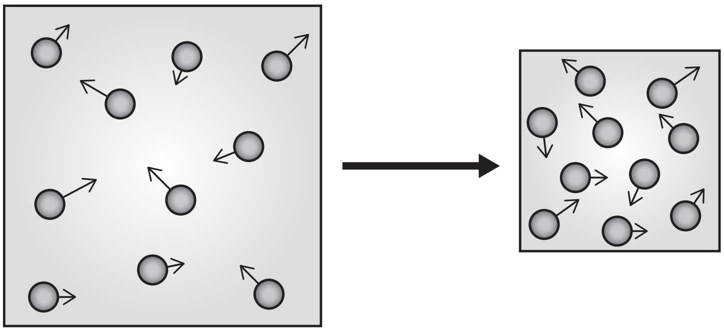


Fig. 5.1 (not to scale)

The equation suggests that when the volume of a gas halves the pressure doubles.

Using ideas about molecules, explain why this happens.

....

....

....

.... [2]

[5054/21/M/J/20/Q5]

8 Fig. 3.1 shows a syringe mounted vertically in a block of wood and sealed at one end. A plunger is free to move inside the syringe.

There is trapped air in the syringe.

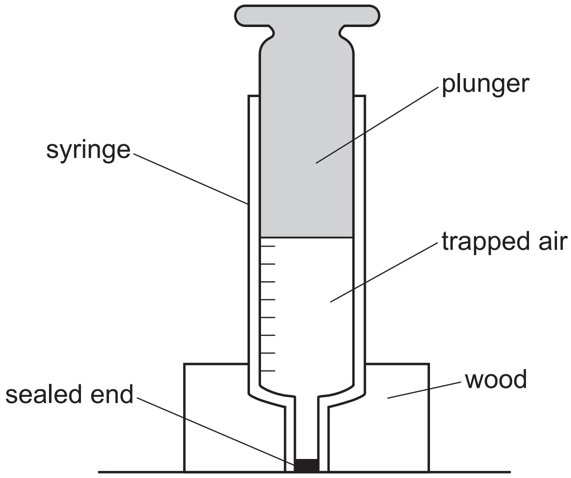


Fig. 3.1

The air inside the syringe exerts a pressure on the walls of the syringe.

(a) Define the term pressure.

....

....

.... [1]

(b) Explain how the air molecules in the cylinder of the syringe create a pressure.

....

....

....

....

.... [3]

(c) A 10 N weight is placed on top of the plunger. The plunger moves down slowly so that the temperature of the air inside the syringe does not change.

Before the weight is placed on top of the plunger:

- the pressure of the air inside the syringe is 1.0×10^5 Pa
- the volume of the air is 50 cm^3.

The cross-sectional area of the plunger is 1.2×10^{-4} m^2.

(i) Calculate the pressure of the air in the syringe after the plunger stops moving.

pressure = ... [2]

(ii) Calculate the volume of air inside the syringe after the plunger stops moving.

volume = ... [2]

[5054/22/M/J/22/Q3]

9 Some details about nitrogen are given in Fig. 6.1.

	melting point °C	boiling point °C	specific heat capacity of liquid J/(g °C)	specific latent heat of vaporisation J/g
nitrogen	–210	–195	1.4	200

Fig. 6.1

(a) At –209 °C, will nitrogen be a solid, a liquid or a gas?

....[1]

[5054/2/O/N/02/Q6]

7 Fig. 7.1 shows a syringe that contains gas at the same pressure as the air outside. The piston moves freely along the cylinder without any friction. No gas escapes.

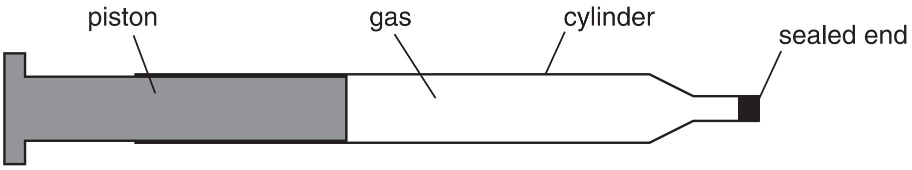


Fig. 7.1

As the syringe is heated from 20 °C to 100 °C, the piston moves outwards. It stops moving when the temperature is steady. State how the value of each of the following quantities compares at 100 °C, after the piston stops, with its value at 20 °C.

For each quantity you should write *greater*, *the same* or *less*.

the average distance between the gas molecules	
the pressure of the gas after the piston stops	
the average speed of the gas molecules	
the frequency of the collisions between the gas molecules and the piston	

[4]

[5054/2/O/N/02/Q7]

10 Fig. 5.1 shows the arrangement of atoms in a solid block.

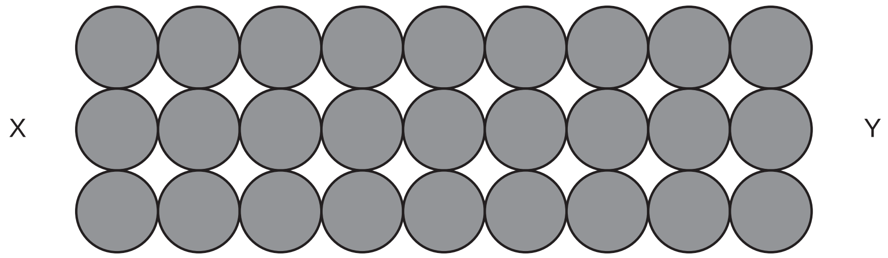


Fig. 5.1

(b) The block is heated and becomes a liquid.

Describe the changes that occur to the arrangement and the motion of the atoms.

....

....

....

.... [2]

5054/02/O/N/07/Q6

11 Many cars are fitted with an air-bag, as shown in Fig. 9.1. In a collision, the air-bag inflates and reduces the effect of the impact between the passenger and the dashboard.

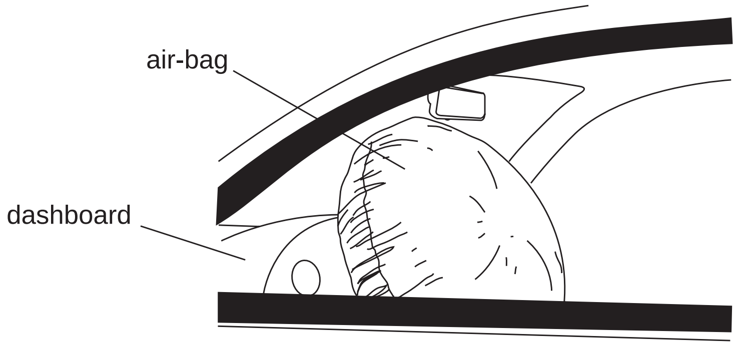


Fig. 9.1

(c) Compressed gas from a small cylinder inflates the air-bag. The cylinder contains a volume of 600 cm^3 of gas at a pressure of 1.4×10^7 Pa. The cylinder and the inflated air-bag have a volume of 30 000 cm^3.

(i) Calculate the pressure of the gas in the inflated air-bag, assuming that the temperature is constant. [3]

(ii) The pressure inside the cylinder decreases as the air-bag is inflated. Explain, using ideas about molecules, why the pressure decreases. [2]

5054/02/O/N/07/Q9

12 **(a)** State **two** differences between the properties of liquids and gases at normal pressures. Explain these differences in molecular terms.

Difference 1 ....

Explanation 1 ....

....

Difference 2 ....

Explanation 2 ....

.... [4]

5054/02/O/N/08/Q5

13 A car has a gas-filled shock absorber for each of its four wheels. Fig. 8.1 shows one of these shock absorbers.

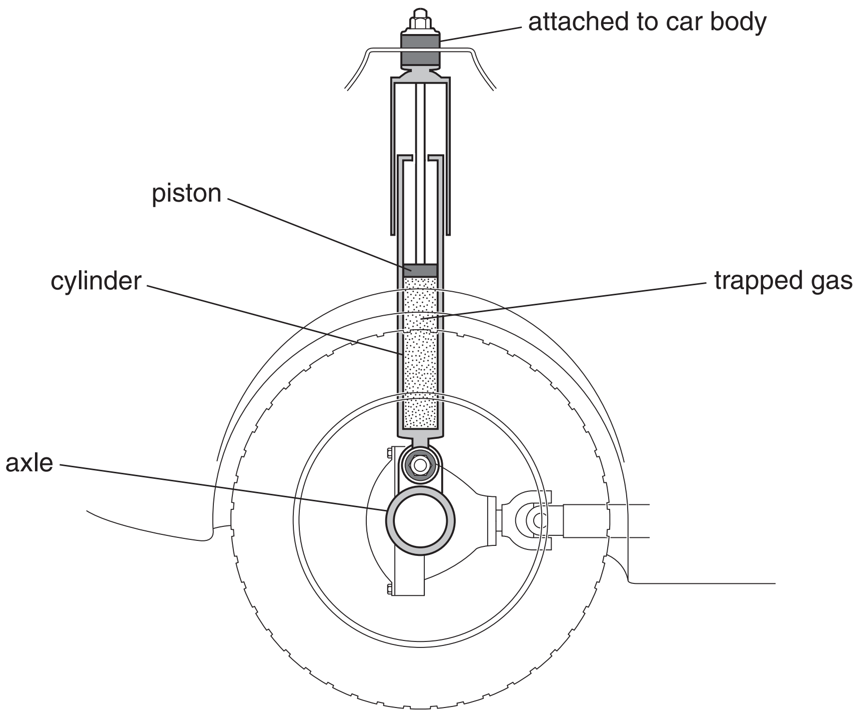


Fig. 8.1

The axles are attached to the cylinders. The body of the car is supported by the four pistons, which can move up and down inside the cylinders. Each piston has a cross-sectional area of 35 cm^2.

(a) A driver of mass 70 kg gets into the car. Calculate

(i) the driver's weight,

weight = ... [2]

(ii) the average increase in the pressure of the gas in the cylinders.

pressure increase = ... [3]

(b) **(i)** Explain in detail how the molecules of the gas trapped inside the cylinder by the piston exert a pressure on the cylinder.

....

....

....

....

....

....

.... [4]

(ii) The temperature of the trapped gas remains constant. Explain why the pressure of the gas increases as the piston is moved further into the cylinder.

....

....

.... [2]

(c) At the end of a long journey, the temperature of the trapped gas in the shock absorbers has increased substantially.

(i) State what happens to the molecules of the trapped gas due to the temperature increase.

....

.... [1]

(ii) State and explain the effect of the increased temperature of the gas on the height of the car body above the road surface.

....

....

....

....

.... [3]

5054/21/O/N/10/Q8

14 **(b)** The force *F* on the crankshaft at P is exerted by a metal rod connected to a piston. The piston traps high-pressure gas in a cylinder, as shown in Fig. 11.2.

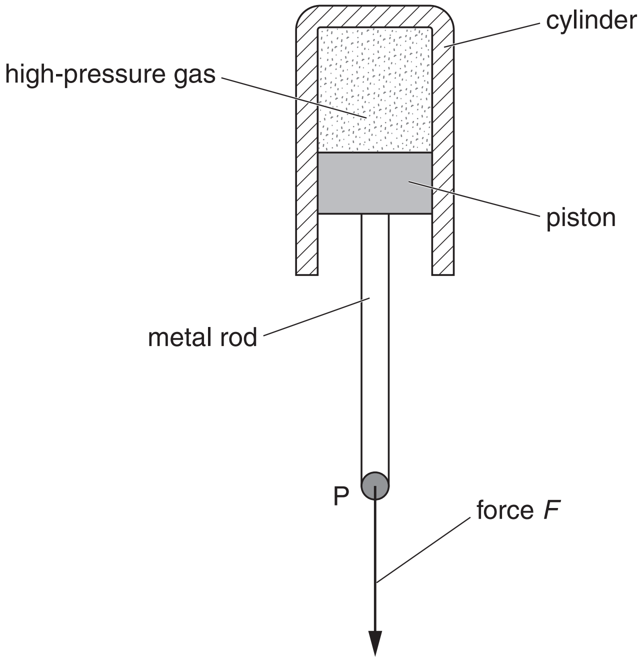


Fig. 11.2

The force *F*, of 8200 N, acts because the high-pressure gas pushes down on the piston. The air pressure outside the cylinder is 1.0×10^5 Pa and the cross-sectional area of the piston is $0.0067\,m^2$.

(i) Calculate the minimum value of the pressure of the gas in the cylinder.

pressure = ...[3]

(ii) Suggest why, in practice, the pressure of the gas in the cylinder is greater than the value calculated in **(i)**.

....

....

....[2]

(c) The piston moves in the cylinder and the gas expands. State and explain what happens to the force *F*.

....[1]

(d) Explain, in molecular terms, why heating a gas at constant volume causes its pressure to increase.

....

....

....

....

....[4]

5054/21/O/N/11/Q11

15 Fig. 9.1 shows a diver working below the surface of a lake. The density of the water in the lake is 1000 kg/m^3, the atmospheric pressure at the surface is 1.0×10^5 Pa and the gravitational field strength is 10 N/kg.

Fig. 9.1

The diver inflates a balloon with air at a depth of 15 m and attaches the balloon to a tray of objects.

(a) Calculate

(i) the pressure due to 15 m of water,

pressure = ... [2]

(ii) the total pressure at 15 m below the surface of the lake.

total pressure = ... [1]

(b) The air in the balloon occupies a volume of 0.048 m^3 at the pressure calculated in **(a)(ii)**. The diver releases the tray and the balloon, and they begin to rise. The temperature of the air in the balloon does not change.

(i) Calculate the volume occupied by the air in the balloon at atmospheric pressure.

volume = ... [2]

(ii) The pressure of the air inside the balloon is less at the surface than at a depth of 15 m. Explain, in terms of the air molecules inside the balloon, why the pressure is less.

....

....

....

.... [3]

(c) State one difference between the arrangement of the molecules of water in the lake and the molecules of air in the balloon.

....

.... [1]

5054/22/O/N/12/Q9

16 Fig. 2.1 shows a freezer for keeping food frozen.

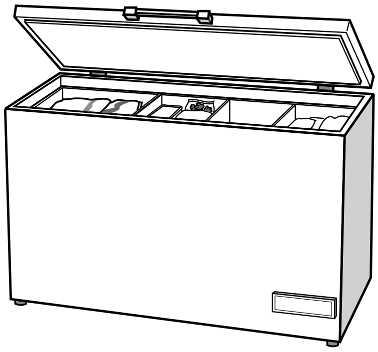


Fig. 2.1

(a) The outside surface of a freezer is painted white.

Explain one advantage of having the outside surface of the freezer painted white.

....

....

.... [2]

(b) **(i)** The lid of the freezer is closed and air at room temperature is trapped inside the freezer. The freezer is switched on.

State and explain, using ideas about molecules, what happens to the pressure of the air in the freezer, as it cools.

....

....

....

....

.... [3]

(ii) When the freezer reaches its operating temperature, it is more difficult to open the lid.

Explain why.

....

....

.... [1]

5054/21/O/N/15/Q2

17 A gas is trapped at atmospheric pressure in a cylinder by a piston. The piston is held in a fixed position by a movable rod. Fig. 6.1 shows the cylinder.

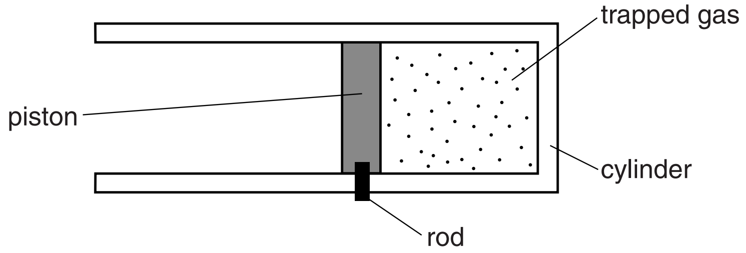


Fig. 6.1

The cylinder is heated. As the temperature of the gas increases, its pressure increases.

(a) Explain, in terms of molecules, why the pressure of the trapped gas increases.

....

....

....

.... [2]

(b) The rod is pulled down and the piston is then free to move as shown in Fig. 6.2.

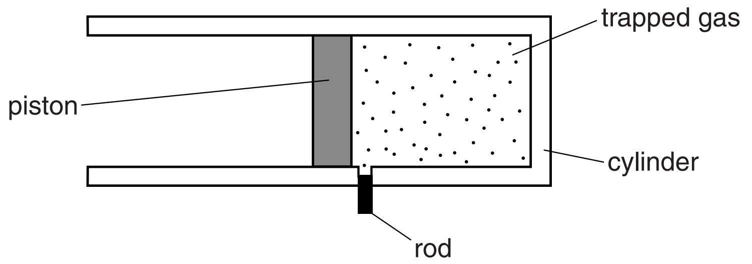


Fig. 6.2

As the piston moves, the temperature of the gas remains constant.

State and explain, in terms of molecules, what happens to the pressure of the gas.

....

....

....

....

....

.... [3]

5054/22/O/N/15/Q6

18 **(d)** As the solid ice melts, it changes into liquid water.

Describe, in terms of molecules, how ice differs from liquid water.

....

....

....

....

....

.... [3]

5054/22/O/N/15/Q9

19 A particular type of cooking oil is a liquid at room temperature.

(a) At room temperature, air is easily compressed but the oil cannot be compressed.

Explain, in terms of molecules,

(i) why the density of the oil is much greater than that of a gas,

....

....

....[1]

(ii) why the oil cannot be compressed.

....

....

....[1]

5054/21/O/N/16/Q10

20 Gas is trapped in a syringe by a piston. Fig. 5.1 shows that the narrow end of the syringe is sealed.

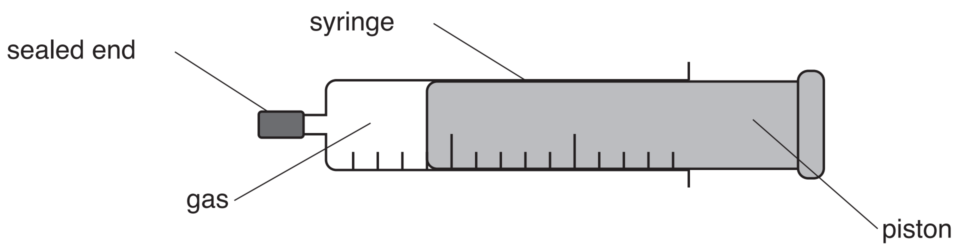


Fig. 5.1

When the gas is at a pressure of 1.1×10^5 Pa, it occupies a volume of $40\,cm^3$.

(a) Explain, in terms of the molecules, how the gas exerts a pressure on the inside of the syringe.

....

....

....

....

....

....[3]

(b) The piston is slowly pulled to the right until the volume occupied by the gas is $110\,cm^3$. The temperature of the gas does not change.

Calculate the new pressure of the gas.

pressure = ...[2]

5054/22/O/N/16/Q5

21 Unwanted gold jewellery is heated in a furnace until it melts. Fig. 3.1 shows the liquid gold being poured into a mould to make a gold bar.

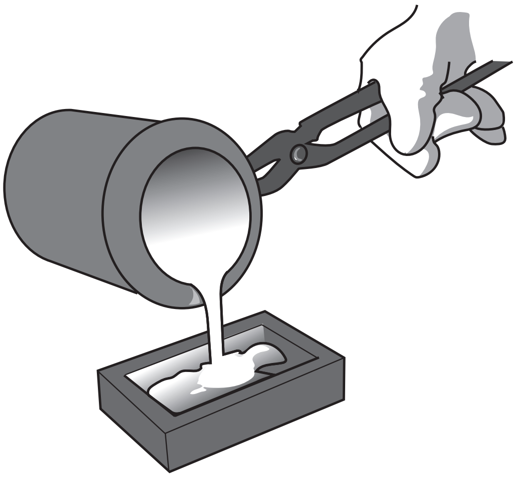


Fig. 3.1

The melting point of gold is 1100 °C.

(a) State two ways in which the molecular structure of gold at 1200 °C differs from its structure at 1000 °C.

1. ....

....

2. ....

....
[2]

5054/21/O/N/17/Q3

22 Fig. 9.1 shows the structure of a water cooler that is used to supply cold water to the workers in a hot office.

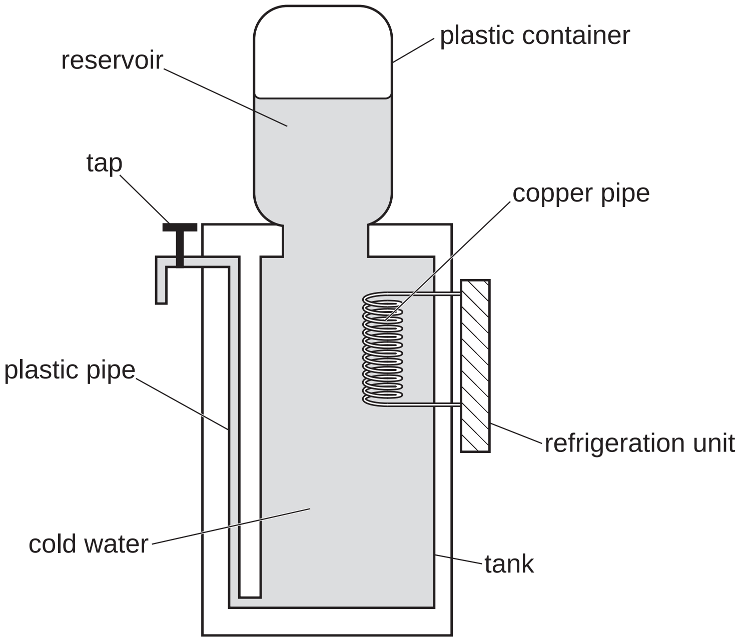


Fig 9.1

(d) **(i)** Describe the motion of the molecules in a liquid which is at a uniform temperature throughout.

....

....

.... [2]

(ii) State what happens to the motion of the molecules in a liquid as the temperature of the liquid decreases.

....

.... [1]

5054/21/O/N/19/Q9

23 A student uses a pump to inflate a bicycle tyre.

Fig. 2.1 shows the pump and the tyre.

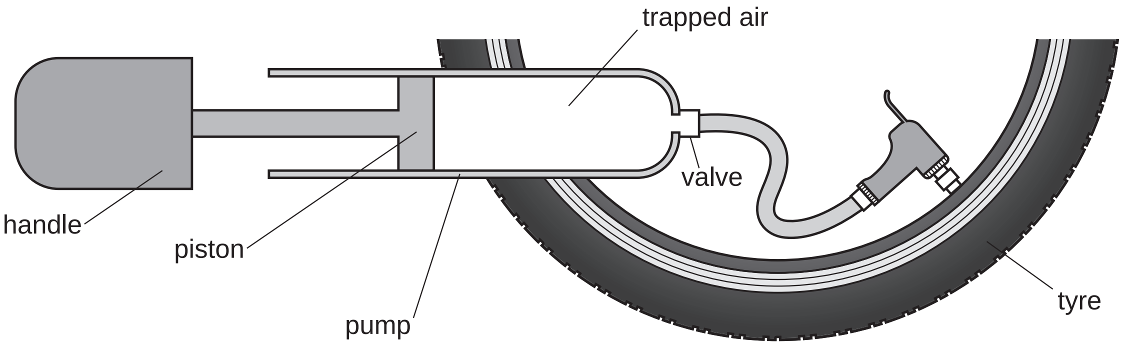


Fig. 2.1 (not to scale)

(a) The pressure of the trapped air in the pump is 3.8×10^5 Pa and the cross-sectional area of the piston is $6.1 \times 10^{-4}\,m^2$.

(i) Calculate the force exerted on the piston by the trapped air in the pump.

force = ... [2]

(ii) The student pushes the handle to the right and the piston forces the trapped air into the tyre. The force exerted by the student is less than the value in **(a)(i)**.

Suggest one reason why.

....

.... [1]

(b) The temperature of the air in the pump remains constant as the handle moves to the right.

Explain, in terms of its molecules, why the pressure of a gas increases when its volume is decreased at constant temperature.

....

....

....

....

.... [3]

5054/22/O/N/19/Q2

24 Fig. 9.1 shows a boiling liquid at its boiling point, trapped in a cylinder by a piston.

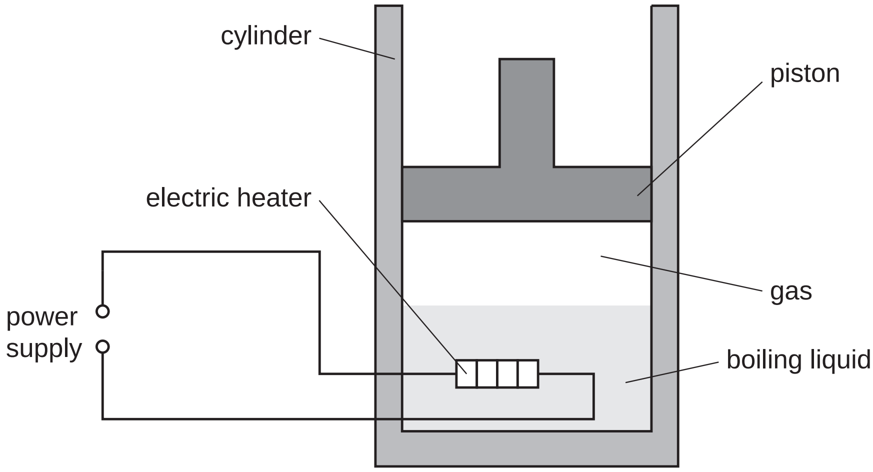


Fig. 9.1

There is an electric heater in the liquid which is connected to a power supply. The thermal energy produced by the heater gradually turns the boiling liquid into a gas.

(a) State what is meant by *boiling point*.

....

.... [2]

(b) Explain, in terms of molecules, why it is necessary to supply energy in order to turn a liquid at its boiling point into a gas.

....

....

....

.... [3]

(e) The piston is free to move in the cylinder. As the liquid boils, the piston is pushed upwards in the cylinder at a constant speed. The volume occupied by the gas just above the liquid increases.

Discuss whether the upward force on the piston changes as the piston moves upwards at constant speed.

....

....

....

.... [2]

5054/22/O/N/19/Q9

25 The density of water in a lake is 1000 kg / m^3.

At a depth of 25 m beneath the surface of the lake, the total pressure is 3.5×10^5 Pa.

(a) State what is meant by *pressure*.

....

.... [1]

(b) The gravitational field strength is 10 N / kg.

Determine:

(i) the pressure due to 25 m of water

pressure = ... [2]

(ii) the atmospheric pressure.

atmospheric pressure = ... [1]

(c) An underwater depth gauge contains a small cylinder as shown in Fig. 8.1. Gas is trapped inside the cylinder by a piston. The piston is free to move.

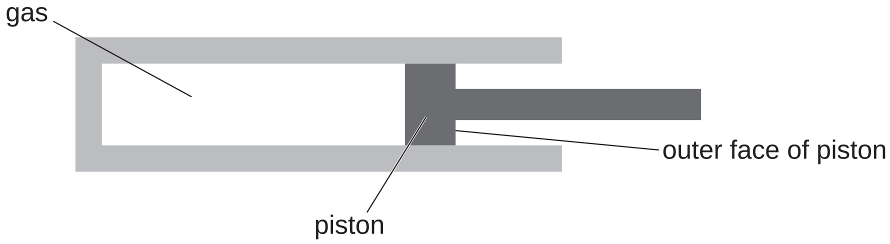


Fig. 8.1

The outer face of the piston is in contact with the water.

As the depth gauge is lowered into the water, the piston moves into the cylinder. This moves a needle on a dial to indicate the depth of the gauge in the water.

(i) Explain why the piston moves into the cylinder.

....

....

....

....

.... [3]

(ii) The temperature of the gas does not change as the piston moves into the cylinder.

Explain, in terms of molecules, what happens to the pressure of the trapped gas as the piston moves into the cylinder.

....

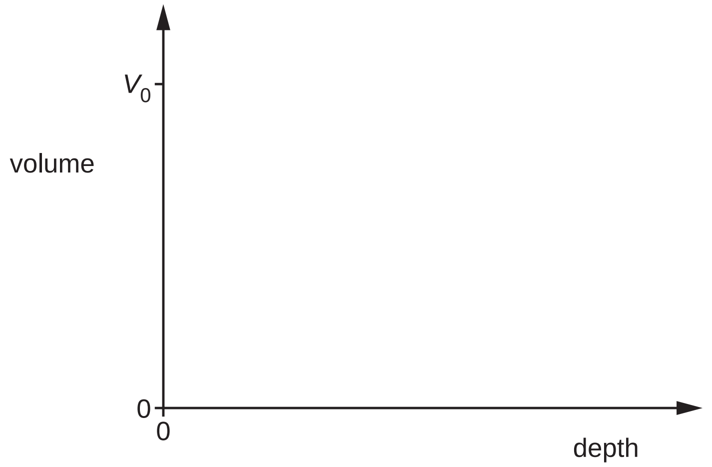
....

....

.... [3]

(iii) At the surface of the water, the volume of the trapped gas in the depth gauge is V_0.

On Fig. 8.2, sketch a graph to show how the volume of trapped gas decreases as the gauge is lowered into the water.



[2]

Fig. 8.2

(iv) The instructions for the depth gauge state that, each time it is used, the needle of the dial must be re-set to zero at the surface of the water.

Suggest **one** reason for this.

....

.... [1]

(v) The density of the air trapped in the depth gauge increases. The density of the water remains constant.

Explain, in terms of the molecules of the water, why the density of the water remains constant.

....

....

.... [2]

5054/21/O/N/20/Q8

26 A saucepan of water is placed on an electric hotplate and the water is brought to the boil.

As the water boils, it changes from a liquid into a gas.

(a) Describe, in terms of the molecules, **three** ways in which a gas differs from a liquid.

1. ....

....

2. ....

....

3. ....

....
[3]

(b) In order to keep the liquid boiling, it is necessary to keep the hotplate switched on.

Explain why energy must be supplied in order to turn a liquid at its boiling point into a gas.

....

....

....

.... [2]

5054/21/O/N/19/Q3

27 Liquid-in-glass thermometers use the expansion of a liquid to indicate the temperature.

(a) Fig. 9.1 shows the molecular structure of a solid and a gas.

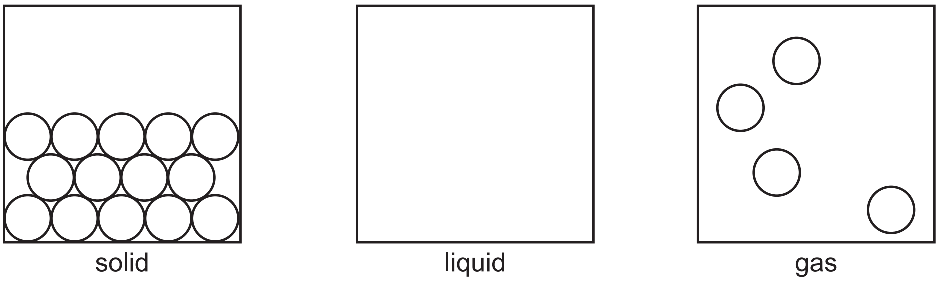


Fig. 9.1

(i) In the middle box of Fig. 9.1, sketch a diagram to show the molecular structure of a liquid. [2]

(ii) Explain why it is easier to compress a gas than to compress a solid.

....

....

.... [2]

(iii) The temperature of a liquid-in-glass thermometer increases.

State **two** ways in which the molecules of the liquid in the thermometer are affected.

1. ....

2. ....
[2]

5054/21/O/N/21/Q9