Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Kinetic particle model

Time allowed: 1 hour 10 minutes

Subject code **0625**

Physics

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 72

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 72 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Fig. 6.1 shows a smoke cell. The smoke cell contains air molecules and smoke particles. A student views the motion of the smoke particles in the smoke cell by using a microscope.

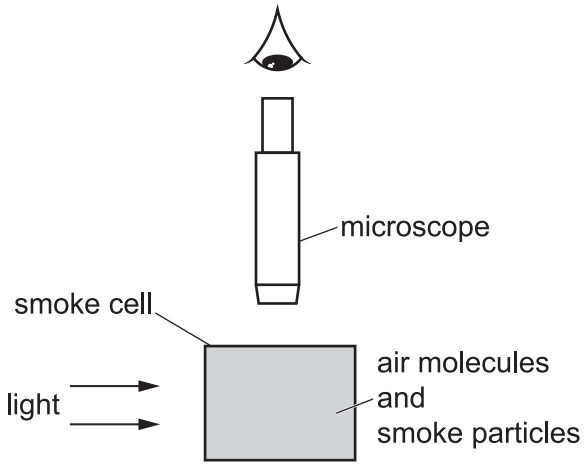


Fig. 6.1

Fig. 6.2 shows the path of one of the smoke particles.

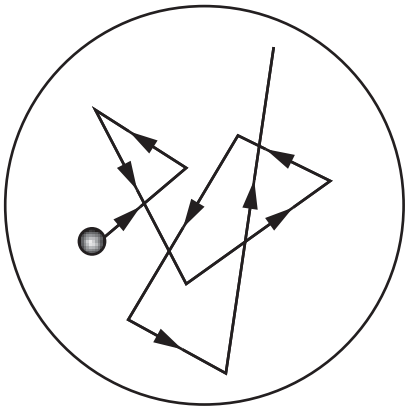


Fig. 6.2

(a) State the term used for the motion of the smoke particle.

..... [1]

(b) Explain the motion of the smoke particle in Fig. 6.2.

.....

.....

.....

..... [3]

[Total: 4]

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1(a)	Brownian (motion)	**B1**
1(b)	any **three** from: air molecules (air molecules) collide with (smoke particle) (air molecules) moving randomly (air molecules/collisions) cause change in direction (of smoke particle) (air molecules moving with) high speed idea of more collisions on one side (of particle at a given time)	**B3**

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2 **(a)** The arrows on Fig. 5.1 represent changes of state.

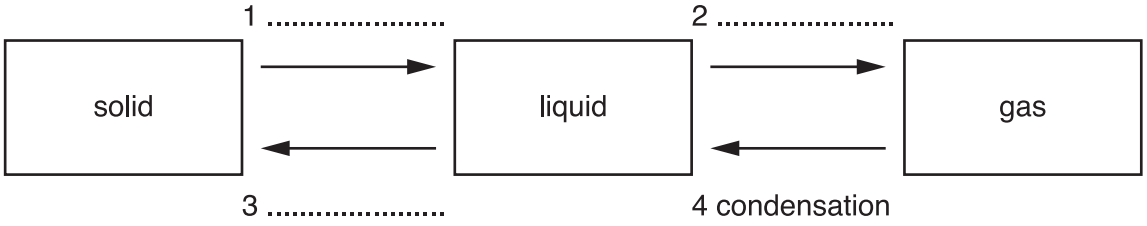


Fig. 5.1

One of the arrows is labelled. Label each of the other arrows with the correct change of state. Write the change of state on the dotted lines next to each arrow. [3]

(b) A beaker contains some liquid with a low boiling point. The beaker is placed onto a small amount of water, as shown in Fig. 5.2.

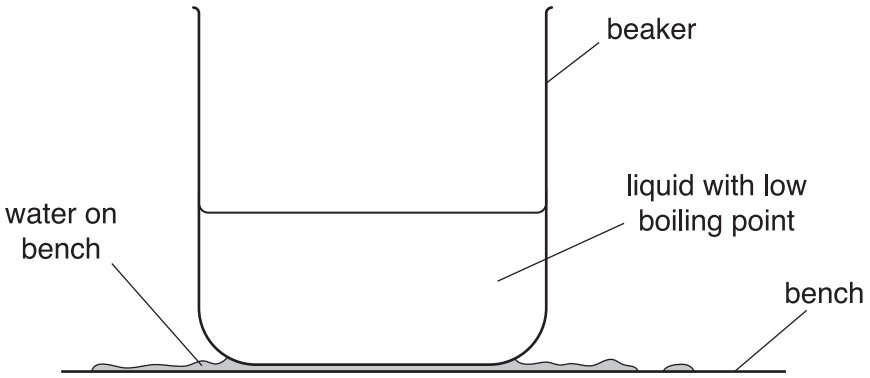


Fig. 5.2

The liquid in the beaker evaporates quickly. The water on the bench cools and turns to ice.

Explain why the water cools.

.....

.....

.....

.....

..... [3]

[Total: 6]

States of matter and the particle model Click for more variations

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Reduced to 78% to fit the page (wider than A4).

2(a)	1. melting 2. boiling / evaporation 3. freezing / solidification	**B1** **B1** **B1**
2(b)	Any **three** from: (evaporation –) most energetic molecules escape from surface of liquid average KE of molecules remaining in liquid decreases temperature of liquid decreases energy transfers from water (on bench) to liquid (so water cools / freezes)	**B3**

3 Fig. 4.1 shows some gas, at room temperature, in a cylinder with a piston that can move. The gas cannot escape from the cylinder.

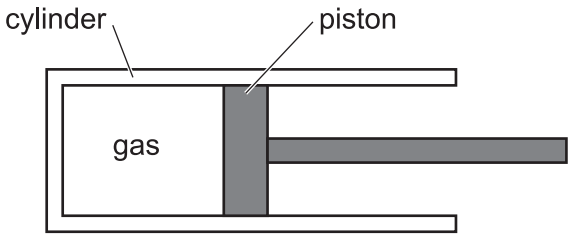


Fig. 4.1

(a) (i) Describe the movement of the gas particles.

.....

..... [2]

(ii) Describe how the gas particles exert a pressure on the walls of the cylinder and piston.

.....

..... [1]

(b) The piston in Fig. 4.1 moves to the left.
The volume of the gas decreases. The temperature of the gas does not change.
State and explain any change in the pressure of the gas when the piston moves to the left.

.....

.....

.....

..... [3]

[Total: 6]

Gas pressure, volume and temperature Click for more variations

Reduced to 77% to fit the page (wider than A4).

3(a)(i)	any **two** from: high speed moving freely random (motion) OR (moving in) any / all directions	**B2**
3(a)(ii)	collisions (of particles with walls of cylinder OR surface)	**B1**
3(b)	any **three** from: pressure increases (because) molecules are closer together / more densely packed OR area of cylinder decreases (so there are) more collisions per unit area (with walls of cylinder) pressure = force ÷ area	**B3**

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4 A teacher fills a copper can with solid wax and heats the can. She measures the temperature of the wax every minute. She continues heating once the wax has melted and stops heating when the wax is boiling.

(a) (i) State the term used for the process that transfers thermal energy through the copper.

..... [1]

(ii) Fig. 6.1 shows how the temperature of the wax changes as it is heated.

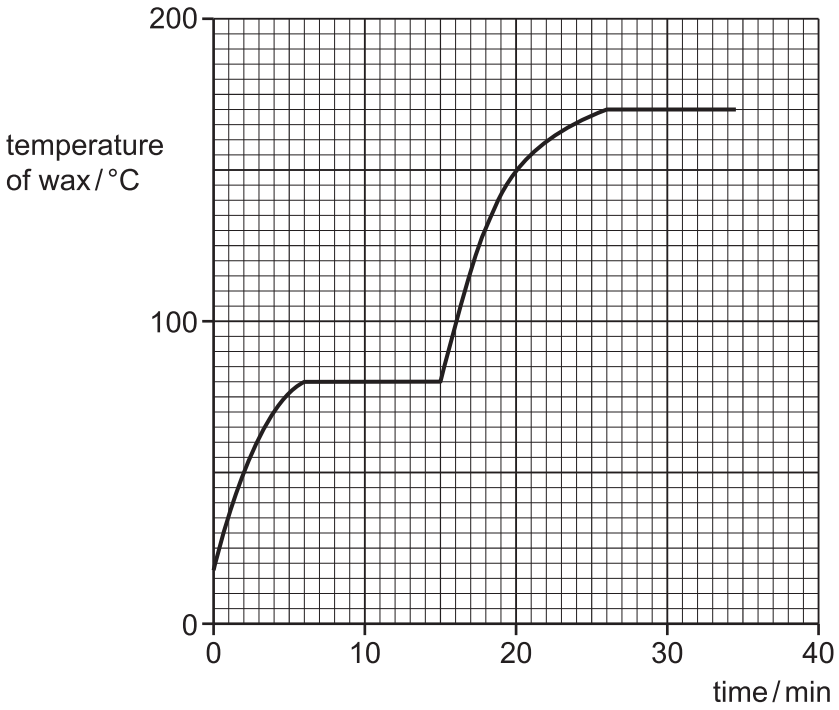


Fig. 6.1

Using the graph in Fig. 6.1, determine:

1. the melting point of the wax ..... °C [1]

2. the boiling point of the wax ..... °C [1]

3. the time at which the wax starts to boil. ..... min [1]

(b) Describe the molecular structure of the wax in terms of the arrangement, separation and motion of its molecules when it is a solid and when it is a gas.

solid wax .....

.....

wax as a gas .....

.....

[6]

[Total: 10]

States of matter and the particle model Click for more variations

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4(a)(i)	conduction	**B1**
4(a)(ii)	1 80 (°C)	**B1**
	2 170 (°C)	**B1**
	3 26 (minutes)	**B1**

4(b)	(solid:) particles/molecules any **three** from: (are) fixed in place/position/arrangement regular spacing / pattern / arrangement vibrating close together	**B3**
	(gas:) particles/molecules any **three** from: (are) moving randomly at high speed colliding (with each other/walls) randomly arranged/no pattern (relatively) far apart	**B3**

5 Solids have a fixed shape. Liquids adapt to the shape of their container. Gases fill their container.

Explain in terms of forces between molecules and arrangement of molecules, why solids, liquids and gases have these properties.

Solids .....

.....

.....

Liquids .....

.....

.....

Gases .....

.....

.....

[6]

[Total: 6]

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States of matter and the particle model Click for more variations

5	Solids – molecules in lattice arrangement	B1
	solids – strong forces between molecules	B1
	liquids – molecules not fixed in place OR molecules have an irregular arrangement OR molecules (slightly) further apart (on average) than in solids OR spaces between the molecules	B1
	liquids – (average) forces too weak to keep molecules in a definite pattern OR forces just enough to hold molecules in the bulk of the liquid	B1
	gases – molecules far apart	B1
	gases – weak / no forces between molecules (except during collisions)	B1

6 A rubber balloon is inflated with helium and sealed so that no helium escapes.

The balloon is positioned immediately below the ceiling in a room.

Heaters are switched on and the temperature of the air in the room increases.

(a) When the heaters are first switched on, the temperature of the air immediately below the ceiling increases more quickly than the temperature of the air in the rest of the room.

Explain why this happens.

.....

.....

..... [2]

(b) The temperature of the helium in the balloon increases and as the rubber stretches, the volume occupied by the helium increases.

(i) State what happens to the motion of the helium particles as the temperature increases.

.....

..... [1]

(ii) As the rubber stretches and the volume of the helium increases, the pressure of the helium remains constant.

Explain, in terms of the particles of helium, how the pressure of the helium remains constant.

.....

.....

.....

..... [3]

[Total: 6]

Gas pressure, volume and temperature Click for more variations

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6(a)	heated / hot(ter) / warm(er) air is less dense **OR** cool(er) air is more dense	**B1**
	heated / hot(ter) / warm(er) air rises (to ceiling displacing cooler air) **OR** cool(er) air falls (displaced by warm(er) air)	**B1**
6(b)(i)	speed / velocity (of particles) increases **OR** (they) move faster	**B1**
6(b)(ii)	(higher temperature means) particles collide (with rubber) harder / with more force / with greater momentum (change)	**B1**
	(larger volume means) particles collide (with rubber) less frequently **OR** (larger volume means) larger (surface) area (for particle collisions)	**B1**
	effect of larger volume cancels effect of increased temperature / owtte **OR** the effect of larger area cancels the effect of larger force / owtte **OR** $P = F / A$ so the two changes cancel each other / owtte	**B1**

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7 **(a)** **(i)** State two ways in which the molecular structure of a gas differs from the molecular structure of a liquid.

1. .....

2. .....
[2]

(ii) Compressibility is the ease with which a substance can be compressed.

State and explain, in terms of the forces between the molecules, how the compressibility of a gas differs from that of a liquid.

.....

.....

..... [2]

(b) Fig. 6.1 shows a weather balloon being inflated by helium from a cylinder.

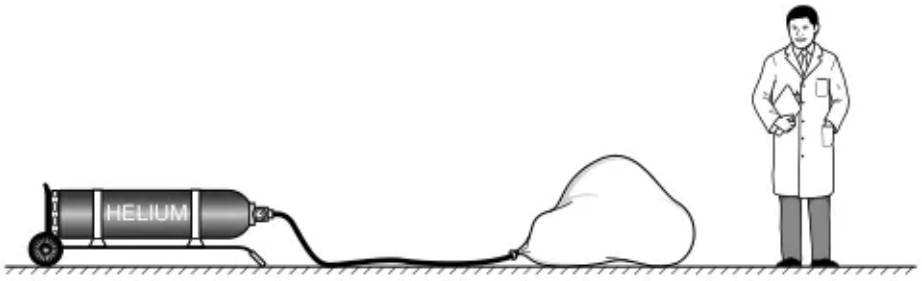


Fig. 6.1

(i) The helium that inflates the balloon had a volume of $0.035\,m^3$ at a pressure of $2.6 \times 10^6\,Pa$, inside the cylinder.

The pressure of the helium in the balloon is $1.0 \times 10^5\,Pa$ and its temperature is the same as it was when in the cylinder.

Calculate the volume occupied by the helium in the balloon.

volume = ... [3]

(ii) As the balloon rises up through the atmosphere, the temperature of the helium decreases.

State the effect of this temperature change on the helium molecules.

.....

..... [1]
[Total: 8]

Gas pressure, volume and temperature Click for more variations

7 **(a) (i)** any two of:
(gas) molecules further apart
greater PE
move singly / in straight lines
OR vice versa for. liquid molecules
(allow faster) B2

(ii) gases compressible OR liquids incompressible B1
forces between gas molecules weaker OR vice versa for liquid molecules B1

(b) (i) pV = constant OR $p_1V_1 = p_2V_2$ OR $2.6 \times 10^6 \times 0.035$ OR 91 000 C1
$2.6 \times 10^6 \times 0.035/1.0 \times 10^5$ OR $91\,000/1.0 \times 10^5$ C1
$0.91\,m^3$ A1

(ii) slower / less KE B1 [8]

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8 Fig. 3.1 shows gas trapped in the sealed end of a tube by a dense liquid.

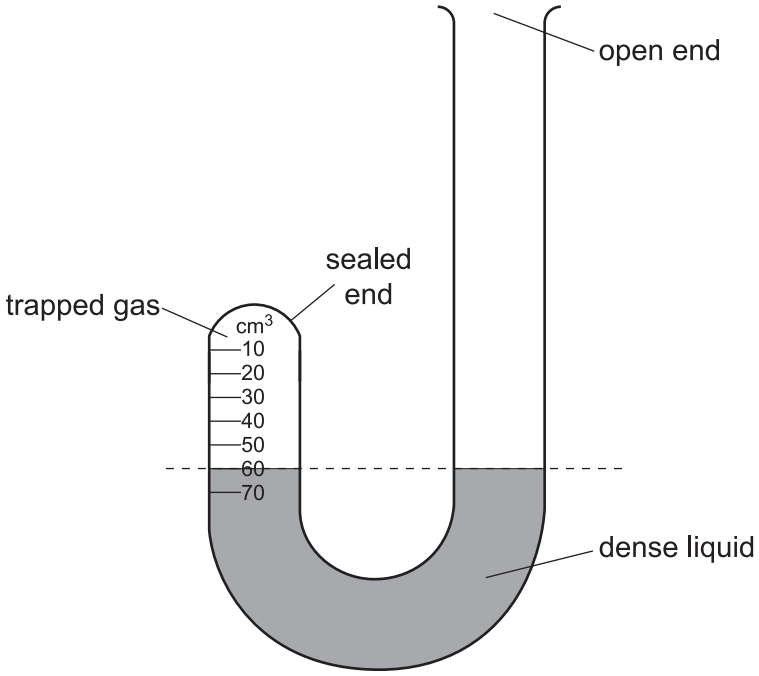


Fig. 3.1

The scale marked on the sealed end of the tube is calibrated to read the volume of gas trapped above the liquid surface. Fig. 3.1 shows that initially the volume V_1 of the gas is 60 cm^3.

The pressure of the atmosphere is 1.0×10^5 Pa.

(a) State how Fig. 3.1 shows that the pressure of the trapped gas is equal to the pressure of the atmosphere.

.....

..... [1]

(b) Explain, in terms of the momentum of its molecules, why the trapped gas exerts a pressure on the walls of the tube.

.....

.....

.....

..... [3]

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(c) More of the dense liquid is poured into the open end of the tube. The level of the liquid surface in both the sealed and the open ends of the tube rises as shown in Fig. 3.2. The temperature of the trapped gas and atmospheric pressure both remain constant.

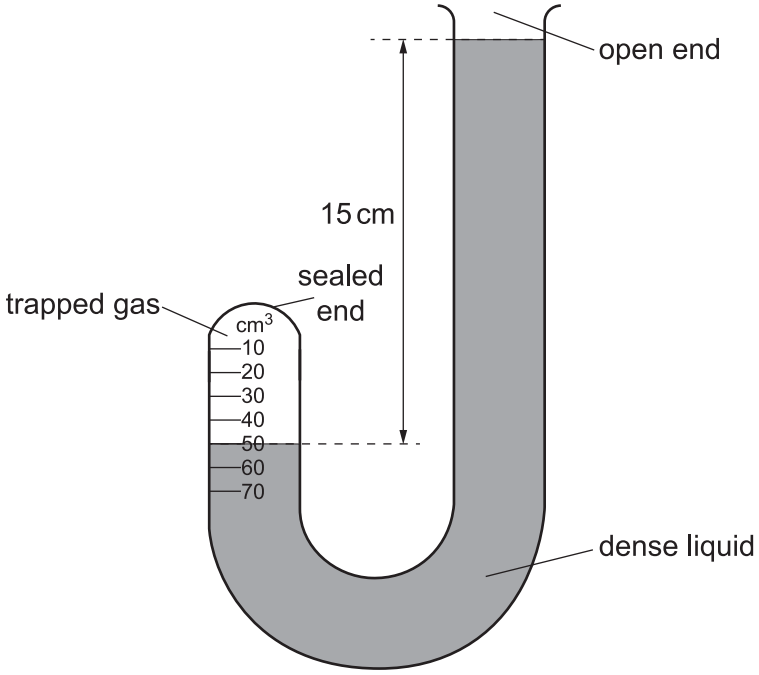


Fig. 3.2

(i) In the sealed end of the tube, the volume V_2 of the trapped gas is 50 cm^3. In the open end of the tube, the liquid surface is 15 cm above the new level in the sealed tube.

Calculate the pressure p_2 of the trapped gas.

pressure p_2 = ... [2]

(ii) Calculate the density of the liquid in the tube.

density = ... [2]

[Total: 8]

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8(a)	liquid levels in the two limbs of the tube are equal	**B1**
8(b)	molecules collide with the walls (of the container)	**B1**
	momentum of molecules changes (reverses)	**B1**
	this causes a force AND force spread out (over area of walls)	**B1**
8(c)(i)	$(p_2 =)\ p_1V_1 / V_2 = 1.0 \times 10^5 \times 60 / 50$	**C1**
	1.2×10^5 Pa	**A1**
8(c)(ii)	$p_2 = p_{atm} + h\rho g$ OR $1.2 \times 10^5 - 1.0 \times 10^5$ OR 2.0×10^4 OR $(\rho =)\ 2.0 \times 10^4 / (0.15 \times 10)$	**C1**
	1.3×10^4 kg m^{-3}	**A1**

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9 **(a)** In terms of the momentum of molecules, explain how a gas exerts pressure on the walls of its container.

.....

.....

.....

.....

.....

.....

..... [4]

(b) A fixed mass of gas of volume V_1 is at a pressure p_1. It is compressed to a volume V_2.

(i) Complete the equation for the final pressure p_2 of the gas when the gas is compressed at constant temperature.

$p_2 =$

[2]

(ii) State and explain how the final pressure compares with p_2 when the temperature of the gas increases during compression.

statement .....

explanation .....

.....

.....

.....

[3]

[Total: 9]

States of matter and the particle model Click for more variations

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9(a)	molecules strike walls	**B1**
	momentum (of molecules) changes / momentum = mass × velocity	**B1**
	force = rate of change of momentum	**B1**
	pressure = (sum of) force(s) / area / pressure = rate of change of momentum / area	**B1**

9(b)(i)	(p_2=) p_1V_1 / V_2	**A2**
	$p_1V_1 = p_2V_2$	C1
9(b)(ii)	greater	**B1**
	molecules move faster / have greater KE / molecules have greater momentum	**B1**
	(leads to) more frequent / harder collisions (with walls) / great rate of change of momentum	**B1**

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10 **(a)** The lowest possible temperature is zero kelvin (0 K).

(i) State the name of this lowest possible temperature.

..... [1]

(ii) Nitrogen boils at 77 K.

Calculate the boiling point of nitrogen on the Celsius scale.

boiling point = ... °C [2]

(b) The temperature of a fixed mass of gas at constant volume changes from 300 K to 400 K.

State and explain, in terms of particles, the effect on the pressure of the gas.

statement .....

explanation .....

.....

.....

.....

[4]

(c) A sample of gas is at a pressure of 120 kPa. The volume of the gas is doubled at constant temperature.

Calculate the new pressure of the gas.

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pressure = ... [2]

[Total: 9]

Gas pressure, volume and temperature Click for more variations

10(a)(i)	absolute zero	**B1**
10(a)(ii)	–196 (°C)	**A2**
	(absolute zero / 0 K) = –273 (°C)	C1
10(b)	increased (pressure)	**B1**
	particles of gas move faster **OR** have more KE / momentum / velocity	**B1**
	any **two** from from: • more frequent collisions of particles (with walls) • particles collide (with walls) with a larger force **OR** larger impulse • (greater change in momentum of particles) causes greater force (on walls) • pressure = force / area	**B2**
10(c)	(pressure =) 60 kPa **OR** 6.0×10^4 Pa	**A2**
	$p_1 V_1 = p_2 V_2$ **OR** (p_2 =) $p_1 V_1 / V_2$ **OR** pV = constant **OR** $p \propto 1 / V$ **OR** $1.2 \times 10^5 \times 0.5$ **OR** 6.0×10^n	C1

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