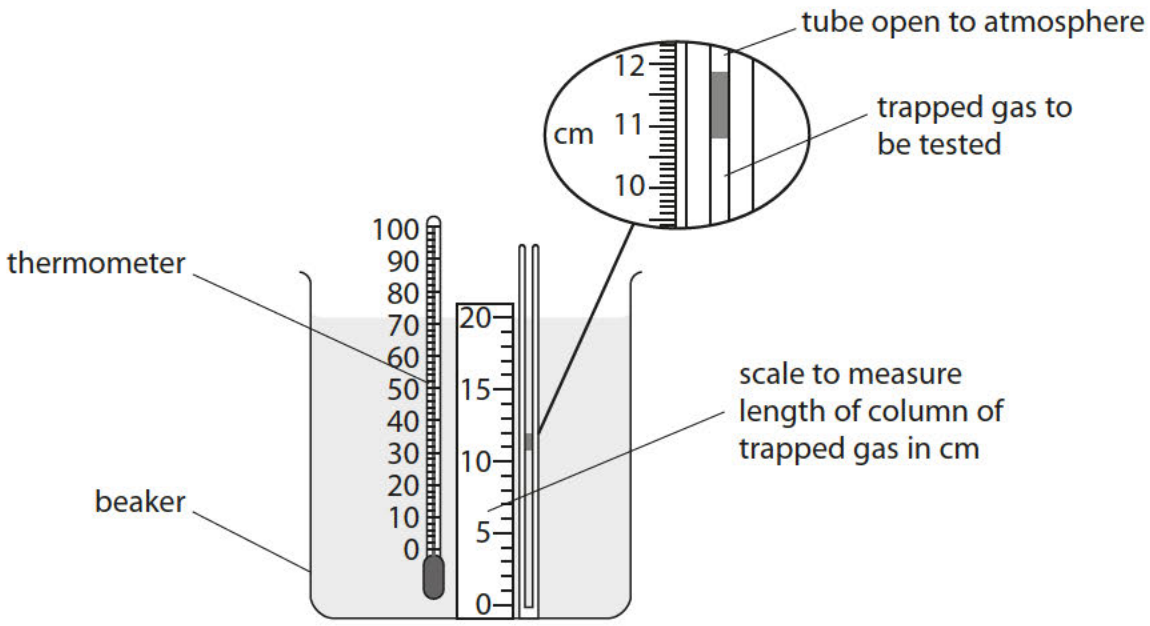
Gas laws

1 A student investigates how the volume of a gas changes when its temperature increases.

The diagram shows the equipment used and the length of the trapped gas at 25 °C.



(a) (i) Use the scale to estimate the length of the column of trapped gas.

(1)

length of column of trapped gas = ... cm

(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

The cross-sectional area of the capillary tube is 1.94×10^{-3} cm^2.

The volume of the column of trapped gas at 25 °C is about

(1)

☐ **A** $5.6 \times 10^{+3}$ cm^3

☐ **B** 2.1×10^{-2} cm^3

☐ **C** 2.1×10^{-3} cm^3

☐ **D** 5.6×10^{-4} cm^3

(iii) The gas is heated to 50 °C.

The volume of the trapped gas at 50 °C is 2.31×10^{-2} cm^3.

Calculate the volume of the trapped gas at 100 °C.

(3)

volume of the trapped gas = ... cm^3

(b) Describe how the average kinetic energy of the particles of the gas changes as the temperature of the gas changes.

(3)

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(Total for Question 2 = 8 marks)

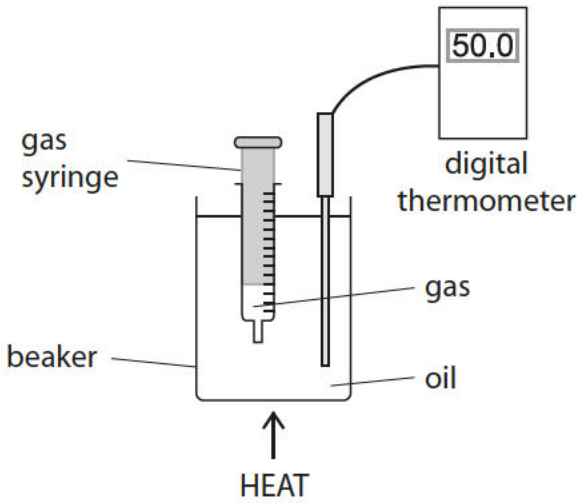
2 (a) Complete the sentence by putting a cross (☒) in the box next to your answer.

Kinetic theory describes gases as particles that

(1)

- ☐ **A** only vibrate
- ☐ **B** do not move at absolute zero
- ☐ **C** only move at high temperatures
- ☐ **D** only move at low temperatures

(b) The apparatus shown in the diagram is used to investigate how the volume of a gas changes with temperature when its pressure is constant.



(i) Explain how the particles in the gas exert a pressure on the syringe.

(2)

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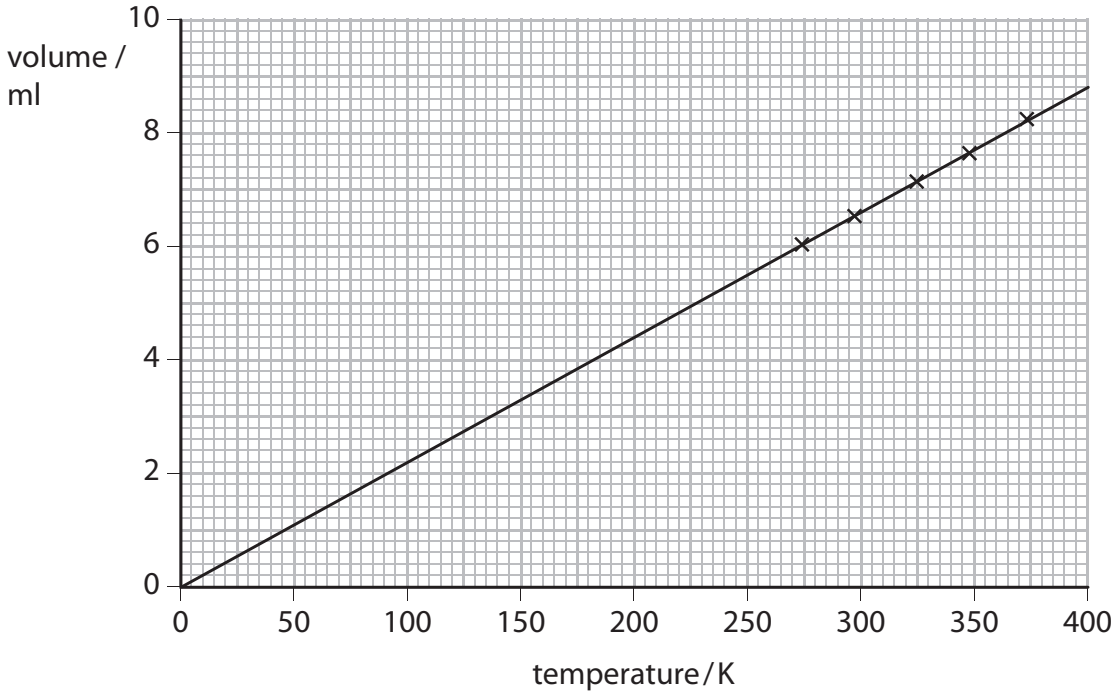
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(ii) The results from the investigation are given in the table.
Fill in the gap in the table.

(1)

volume / ml	temperature / °C	temperature / K
6.0	0.0	273
6.5	25	298
7.1	50	
7.6	75	348
8.2	100	373

(iii) The volume of the gas is plotted against the temperature in Kelvin and a line of best fit is drawn.



Describe what this line of best fit shows about how the volume of the gas varies with temperature.

(2)

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(c) When the temperature of the gas is 298 K, the volume of the gas in the syringe is 6.5 ml.

Calculate the volume of gas when its temperature is increased to 450 K.

Use the equation $V_2 = \frac{V_1 T_2}{T_1}$

(2)

volume of gas = ... ml

(Total for Question 2 = 8 marks)

Kinetic theory of gases

3 Kinetic theory describes the behaviour of gas particles.

(a) (i) Complete the sentence by putting a cross (☒) in the box next to your answer.

At –273 °C the particles in a gas are

(1)

- ☐ **A** moving rapidly
- ☐ **B** moving slowly
- ☐ **C** stationary
- ☐ **D** vibrating

(ii) The temperature of a gas changes from 300 K to 150 K.

State how the average kinetic energy of the gas particles changes.

(1)

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.....

(b) The photograph shows a weather balloon filled with helium.
When released the balloon rises rapidly to a height of 30 000 m above the Earth.



Explain how the helium gas exerts a pressure on the balloon.

(3)

(c) On the surface of the Earth the weather balloon has a volume of 9.1 m^3, when the temperature is 0 °C and the pressure inside the balloon is 101 kPa.

At 30 000 m above the Earth, the temperature is –46 °C and the pressure inside the balloon is 1.12 kPa.

(i) Show that –46 °C is 227 K.

(1)

(ii) Calculate the volume of the weather balloon when it is at a height of 30 000 m.

(3)

volume = ... m^3

(iii) Suggest what will happen to the balloon as it carries on rising above 30 000 m.

(1)

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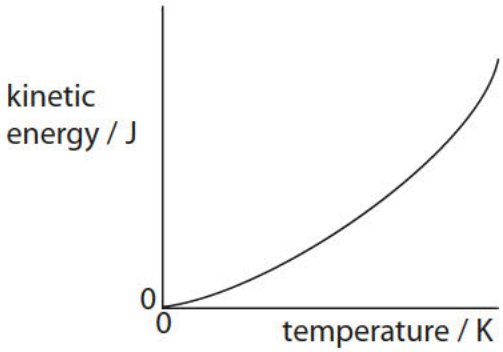
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(Total for Question 4 = 10 marks)

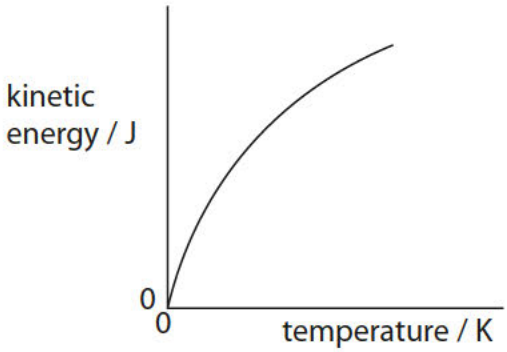
4 (a) Which graph shows the way in which the average kinetic energy of the molecules of a gas changes with temperature?

Put a cross (☒) in the box next to your answer.

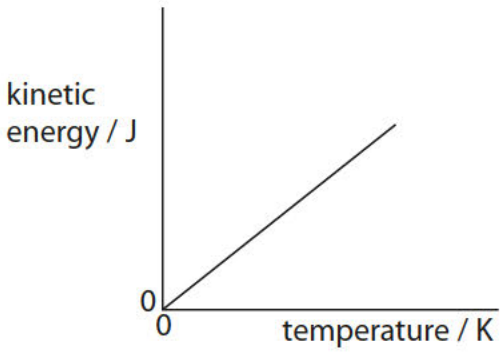
(1)



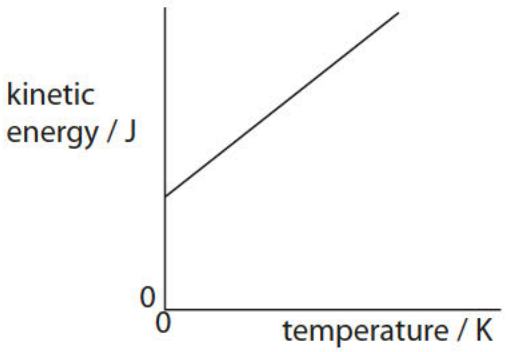
☒ **A**



☒ **B**



☒ **C**



☒ **D**

(b) The photograph shows a scuba diver.
She can breathe under water because she carries a cylinder of air on her back.



(i) The air molecules in the cylinder move randomly.
Describe how these air molecules exert a pressure on the cylinder.

(2)

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(ii) The cylinder contains air at a pressure of 21 000 kPa.

The volume of air in the cylinder is 15.0 litres.
When the valve on the cylinder is opened, the air expands until its pressure is 100 kPa.
The temperature of the air does not change.

Show that the new volume of air is about 3 200 litres.

(2)

(iii) The cylinder is filled with air in a hot country and then taken to a cold country.

The temperature in the hot country is 305 K.
The temperature in the cold country is 278 K.
The pressure in the cylinder in the hot country is 21 000 kPa.

Calculate the pressure in the cylinder in the cold country.

(3)

pressure in the cylinder in the cold country = ... kPa

(Total for Question 1 = 8 marks)

5 An electric heater is used to heat some water.

Figure 8 shows the experimental setup used.

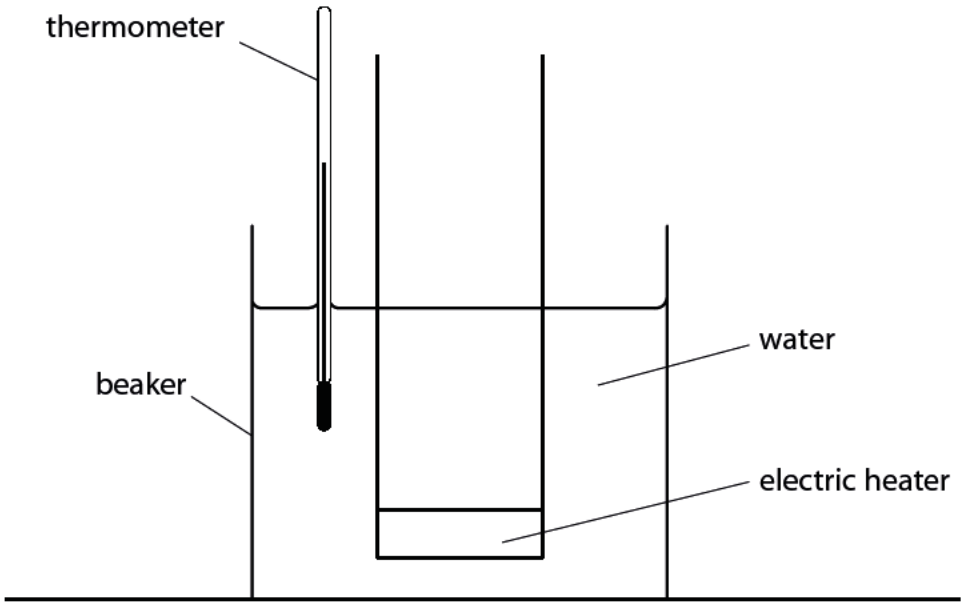


Figure 8

(a) Figure 9 shows the energy transferred by the electric heater in 1 second.

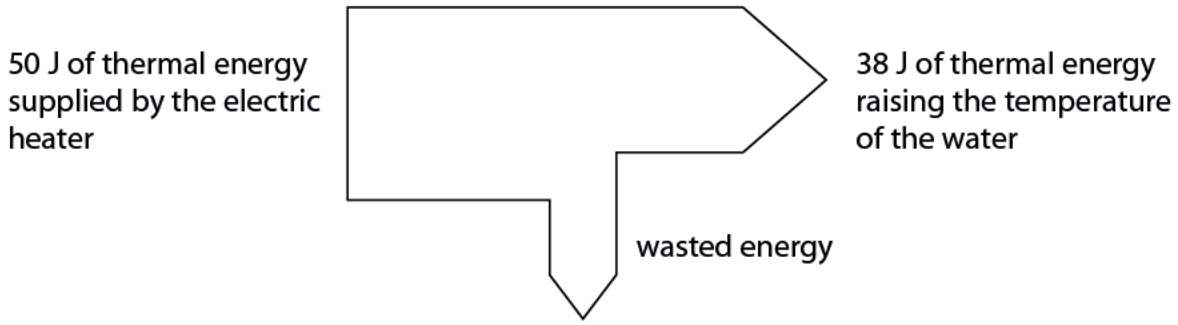


Figure 9

(i) How much energy is wasted each second?

(1)

☒ **A** 12 J

☒ **B** 38 J

☒ **C** 50 J

☒ **D** 88 J

(ii) Describe what happens to the wasted energy.

(2)

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(b) Explain **one** way the experiment can be improved to reduce the amount of wasted energy.

(2)

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(c) The initial mass of the water in the beaker is 0.72 kg.

The electric heater is switched on for some time and the water boils.

The mass of the water after the heater is switched off is 0.60 kg.

The thermal energy transferred to the water while it boils is 270 000 J.

Use an equation from the formula sheet to calculate the specific latent heat of the water.

(3)

specific latent heat = ... J/kg °C

(Total for Question 3 = 8 marks)