1 **(a)** A gas molecule of mass m travelling perpendicular to the wall of a container hits the wall with speed v. Explain why the molecule rebounds with speed v and undergoes a change of momentum of $2mv$.

In your answer you should use appropriate technical terms spelled correctly.

....

....

....

....

.... **[2]**

(b) A constant mass of gas occupies a container of constant volume. Use the kinetic theory of gases to explain the increase in the force exerted on the walls of the container by the gas when its temperature is raised.

....

....

....

....

....

.... **[3]**

(c) **(i)** The pressure of the air in the tyres of a car before a journey is 2.2×10^5 Pa at 18 °C. After travelling some distance, the temperature of the air in the tyres rises to 54 °C. Calculate the new pressure of the air. Assume the volume of air in the tyre stays constant.

pressure = ... Pa **[2]**

(ii) Assuming that the total mass of the car in **(i)** stays constant at 1200 kg, calculate the change in the total area of contact of the tyres with the road as a result of the rise in temperature.

change in area = ... m^2 **[3]**

[Total: 10]

2 **(a)** **(i)** State, in words, Boyle's law.

....

....

.... **[2]**

(ii) Fig. 6.1 is a graph showing the relationship between the quantities involved in Boyle's law. Label the axes appropriately. **[1]**

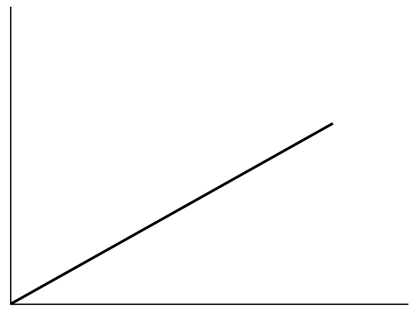


Fig. 6.1

(b) A gas cylinder of internal volume 0.050 m^3 contains compressed air at 21 °C and pressure 1.2×10^7 Pa. The molar mass of air is 0.029 kg mol^{-1}.

(i) Calculate

1 the number of moles of air in the cylinder

number of moles = ...

2 the mass of air in the cylinder.

mass = ... kg
[3]

(ii) An additional 1.5 m^3 of air at 21 °C and at atmospheric pressure, 1.0×10^5 Pa, is pumped into the cylinder. Calculate the new pressure of air in the cylinder, assuming no change in temperature during the process.

pressure = ... Pa **[4]**

[Total: 10]

3 (a) (i) Define *specific heat capacity*.

....

....

.... [1]

(ii) Describe the difference between the *latent heat of fusion* and the *latent heat of vaporisation*.

....

....

.... [1]

(b) The graph in Fig. 4.1 shows the variation of temperature with time for a fixed mass of substance when heated by a constant power source. At **A** the substance is a solid; at **E** the substance is a vapour.

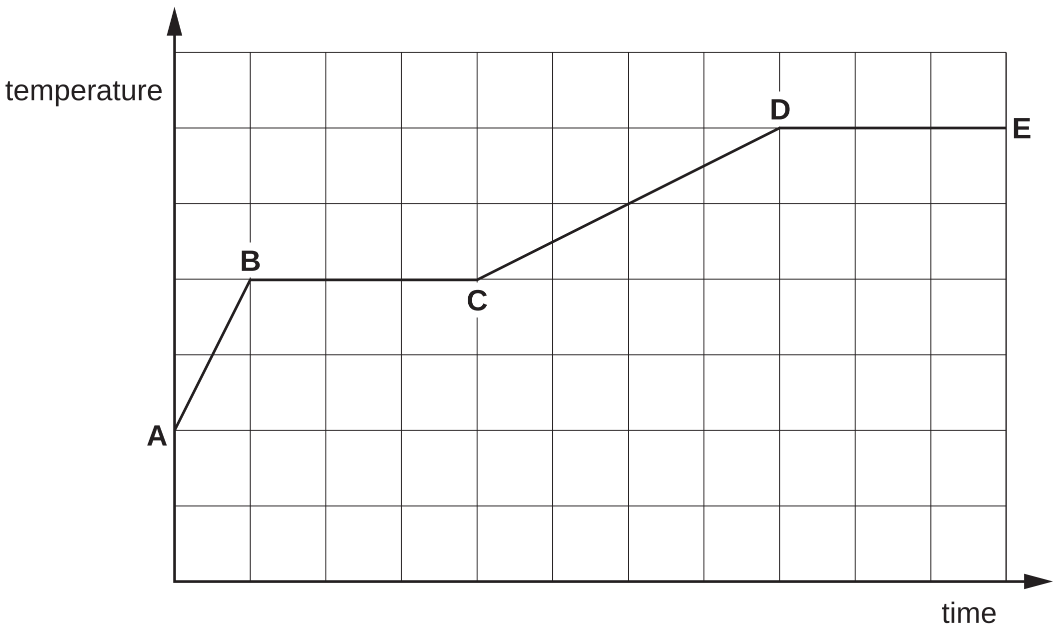


Fig. 4.1

(i) Describe the changes taking place in the kinetic energy and potential energy of the molecules for the following sections:

A to **B**

....

....

....

B to **C**

....

....

.... **[2]**

(ii) State and explain what you can conclude from Fig. 4.1 about the specific heat capacity of the substance in the solid state compared with the specific heat capacity of the substance in the liquid state.

....

....

....

....

.... **[2]**

(c) The electric heating element of a bathroom shower has a power rating of 5.0 kW. An attempt is made to test the accuracy of this value by measuring the rate of flow of the water and the temperature of the water before and after passing the element.

The results of the test and other required data are as follows:

temperature of water supply to the shower = 17.4 °C
temperature of water after being heated by the element = 36.7 °C
rate of flow of water = 3.60×10^{-3} m^3 min^{-1}
density of water = 1000 kg m^{-3}
specific heat capacity of water = 4200 J kg^{-1} K^{-1}

(i) Show that the power of the heating element is approximately 5 kW.

[4]

(ii) State and explain a possible source of uncertainty that might affect the reliability of the test.

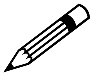
....

....

.... **[2]**

[Total: 12]

4 **(a)** State a conclusion about the movement of gas molecules provided by observations of Brownian motion.



In your answer, you should use appropriate technical terms, spelled correctly.

....

....

.... **[1]**

(b) Fig. 5.1 shows a gas contained in a cylinder enclosed by a piston. The volume of the gas inside the cylinder is 120 cm^3. The pressure inside the cylinder is 350 kPa.

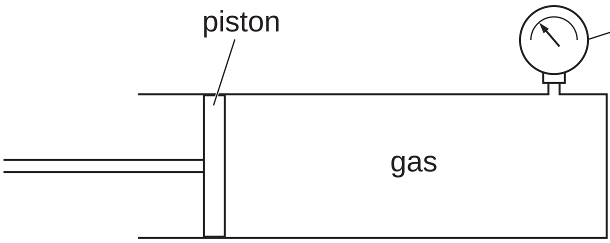


Fig. 5.1

(i) State a necessary condition for Boyle's law to apply to a fixed quantity of gas.

....

....

.... **[1]**

(ii) The piston in Fig. 5.1 is moved quickly so that the gas occupies a volume of 55 cm^3. Use Boyle's law to calculate the new pressure of the gas.

pressure = ………….kPa **[2]**

(iii) In practice, the quick movement of the piston during compression of the gas causes an increase in the temperature of the gas. Explain this increase in temperature in terms of the **movement of the piston** and **the motion of the gas molecules**.

....

....

....

.... **[2]**

[Total: 6]

5 **(a)** *In your answer you should use appropriate technical terms spelled correctly.*

State the terms used to describe the thermal energy required to change

(i) a solid into a liquid at a constant temperature

.... **[1]**

(ii) a liquid into a gas at a constant temperature.

.... **[1]**

(b) Most households waste energy by overfilling electric kettles. Assume that, on average, 0.80 kg of water per household per day is unnecessarily boiled.

(i) Estimate the energy required when 0.80 kg of water, initially at 18 °C, is heated in an electric kettle. The kettle switches off automatically when the water is boiling steadily at 100 °C. The specific heat capacity of water is 4200 J kg^{-1} K^{-1}.

heat energy = ... J **[2]**

(ii) State and explain **two** different reasons why the actual quantity of energy required to warm the water to 100 °C is greater than the estimate in **(i)**.

1. ....

....

2. ....

.... **[2]**

(iii) Calculate, in kW h, the average annual energy wasted per household by boiling too much water.

energy = ...kW h **[2]**

[Total: 8]