1 **(a)** One assumption required for the development of the kinetic model of a gas is that molecules undergo perfectly elastic collisions with the walls of their containing vessel and with each other.

(i) Explain what is meant by a *perfectly elastic collision*.

.....

..... **[1]**

(ii) State **three** other assumptions of the kinetic theory of gases.

1. .....

.....

2. .....

.....

3. .....

..... **[3]**

(b) Fig. 5.1 shows a cubical box of side length 0.20 m. The box contains one molecule of mass 4.8×10^{-26} kg moving with a constant speed of 500 m s^{-1}. The molecule collides elastically at right angles with the opposite faces **X** and **Y** of the box.

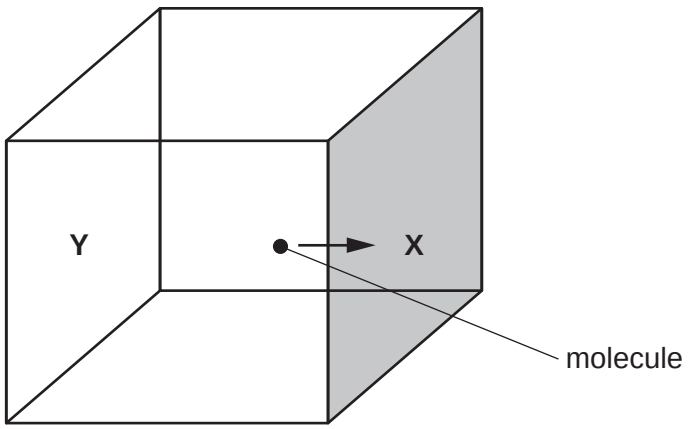

Fig. 5.1

(i) Calculate the change of momentum each time the molecule collides with face **X**.

change of momentum = ...kg m s^{-1} **[2]**

(ii) Calculate the number of collisions made by the molecule with face **X** in 1.0 s.

number = ... **[1]**

(iii) Calculate the mean force exerted on the molecule by face **X**.

force = ...N **[2]**

(iv) Hence state the force exerted on face **X** by the molecule. Justify your answer.

.....

..... **[1]**

(c) The single molecule in the box in **(b)** is replaced by 3 moles of air at atmospheric pressure.

(i) Calculate the number of air molecules in the box.

number = ... **[1]**

(ii) Suggest why the pressure exerted by the air on each of the six faces of the box is the same.

.....

..... **[1]**

(iii) The temperature of the air inside the box is increased. Explain in terms of the **motion** of the air molecules how the pressure exerted by the air will change.

.....

.....

..... **[2]**

[Total: 14]

2 (a) (i) A container has **1 mole** of an ideal gas. The volume of the container is V cubic metres (m^3) and the gas exerts pressure p pascal (Pa). On Fig. 6.1, show the relationship between the product pV and the absolute temperature T of the gas. **[1]**

Fig. 6.1

(ii) State the value of the gradient of this graph.

..... **[1]**

(b) The volume of 1.5 moles of an ideal gas at –40 °C is $2.4 \times 10^{-2}\ m^3$. The gas is now heated at constant pressure p. Calculate

(i) the new volume of the gas at a temperature of 250 °C

volume = ...m^3 **[3]**

(ii) the value of the pressure p.

p = ... Pa **[2]**

[Total: 7]

3 **(a)** A particular collision between two objects is *inelastic*. Place a tick (✓) at the end of each statement that applies to such a collision. **[2]**

Statement	
The magnitude of the impulse on each object is the same.	
Kinetic energy and momentum for the objects are conserved.	
Total energy is conserved.	
After the collision, the objects have the same momentum.	

(b) Fig. 1.1 shows a tennis ball before and after striking a wall at right angles.

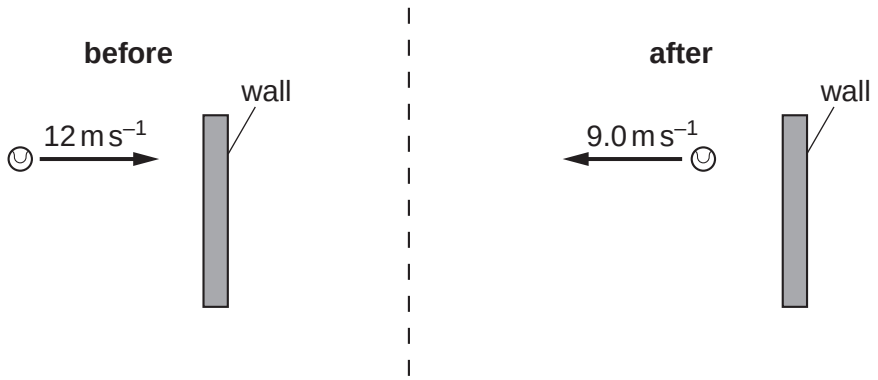

Fig. 1.1

The ball of mass 0.060 kg hits the wall at a speed of 12 m s^{-1}. The ball is in contact with the wall for 0.15 s. It rebounds with a speed of 9.0 m s^{-1}. Calculate

(i) the loss of kinetic energy during the collision

loss of kinetic energy = ... J **[2]**

(ii) the magnitude of the average force exerted on the ball by the wall

average force on ball = ... N **[2]**

(iii) the magnitude of the average force exerted on the wall by the ball during this collision.

average force on wall = ... N **[1]**

(c) (i) State **three** assumptions of the kinetic model of ideal gases.

.....

.....

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..... **[3]**

(ii) Use the kinetic theory of gases to explain how a gas exerts a pressure.

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.....

.....

..... **[3]**

[Total: 13]

4 Fig. 4.1 shows smoke particles suspended in air. The arrows indicate the directions in which the smoke particles are moving at a particular instant. The lengths of the arrows indicate the different speeds of the particles.

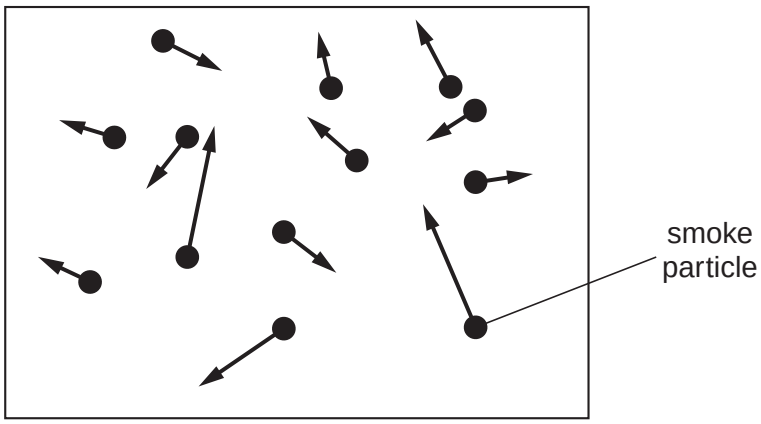

Fig. 4.1

(a) (i) State the name given to this type of random motion of smoke particles in air.

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

.....

..... **[1]**

(ii) State **two** conclusions about the air molecules that may be deduced from the observed motion of the smoke particles.

.....

.....

.....

..... **[2]**

(b) (i) The radius of an inflated football is 0.11 m. The temperature of the air inside the ball is 17 °C. Calculate the mass of air in the ball when the pressure inside it is 2.6×10^5 Pa.

The mass of one mole of air is 0.028 kg.

mass of air = ... kg **[4]**

(ii) The football is left in a room at a temperature of 0 °C until it reaches thermal equilibrium.

1 Explain the term *thermal equilibrium*.

.....

.....

..... **[1]**

2 Calculate the pressure exerted by the air inside the football when the temperature drops to 0 °C.

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

[Total: 10]