

- 9 (a) One assumption of the kinetic theory of gases is that the particles of the gas make perfectly elastic collisions among themselves and with the wall of the container. State two other assumptions of the kinetic theory of gases.

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[2]

- (b) Consider a single molecule of mass m in a cuboidal container of internal side length L . The molecule is travelling with velocity v directly towards one of the walls W as shown in Fig 9.1.

Collisions between the molecule and the walls are elastic. This molecule makes multiple collisions in unit time. The pressure the molecule exerts on the wall is dependent on the frequency of the collisions with the wall.

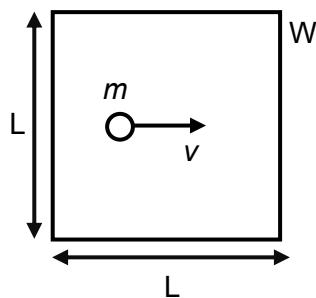


Fig. 9.1

Write expressions for

- (i) the change in momentum of the molecule when it collides with wall W .

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[1]

- (ii) time between collisions of the molecule and the wall W .

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(iii) the frequency of the collisions of the molecule with the wall W.

[1]

(iv) the average momentum change per unit time for this molecule.

[1]

(v) the average force on wall W as a result of impacts by the molecule.

[2]

(vi) the average pressure of wall W.

[1]

(c) A cuboidal container contains N molecules of an ideal gas has volume V and pressure p given by the relation

$$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

where m is the mass of each molecule.

Explain briefly how the expression in (b)(vi) leads to this relation.

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[4]

- (d) (i) Use the equation of state for an ideal gas, together with the equation given in (c) to show that K , the average translational kinetic energy of a molecule is proportional to its absolute temperature [3]

- (ii) Calculate , for oxygen and hydrogen at the same temperature, the ratio
$$\frac{\text{root mean square speed of a hydrogen molecule}}{\text{root mean square speed of an oxygen molecule}}$$

The masses of the molecules are given the following table:

$$\text{Mass of a hydrogen molecule} = 3.34 \times 10^{-27} \text{ kg}$$

$$\text{Mass of an oxygen molecule} = 5.34 \times 10^{-26} \text{ kg}$$

$$\text{Ratio} = \dots \text{ N s} [2]$$

- (iii) Suggest why the atmosphere of the Earth contains very little hydrogen.

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[Total: 20]

End of Paper