

Chapter 13

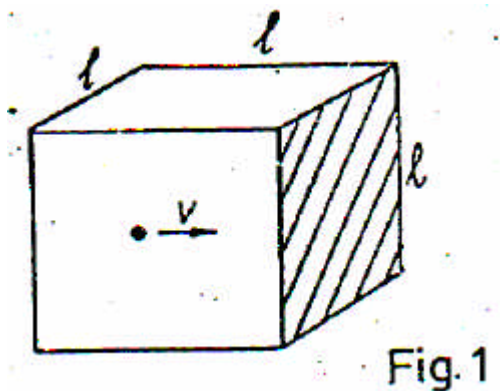
Short answer question

- (a) What is meant by *pressure*?

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

- (b) In what unit is pressure usually measured?

Nm^{-2} or Pa



Consider a molecule of mass m moving inside the cube shown in Fig. 1 with a speed v parallel to one of the edges.

On colliding elastically with the shaded wall, the molecule bounces back with the same speed.

- (c) What is the change in the *kinetic energy* and what is the change in the *momentum*?

Elastic collision $\text{DKE} = 0$

$$\Delta p = mv - (-mv) = 2mv$$

- (d) If the side of the cube is l , write down an expression for the number of times per second that the molecule hits the shaded side of the cube. Assume the molecule keeps moving in the same horizontal direction and that it does not collide with other molecules.

Distance travelled in time $t = vt$

One round trip = $2l$

Number of trips in time $t = \frac{vt}{2l}$

Number of hits is also $\frac{vt}{2l}$ or $\frac{v}{2l}$ per second

- (e) What is the rate of change of momentum of the molecule at the shaded surface?

$$F_1 = \text{rate of change of momentum} = \frac{2mv}{t} \times \frac{vt}{2l} = \frac{2mv^2}{2l} = \frac{mv^2}{l}$$

- (f) If there are x molecules in the box travelling with this speed v , what will be the force which they exert on the shaded area?

$$(\text{total force (F)} = x \times \frac{mv^2}{l})$$

For a perfect gas $pV = 1/3Nmv^2$

- (g) What is V ? What does N stand for?

V = volume of gas (= l^3)

N = total number of molecules of gas in volume

- (h) Explain how this equation is related to the expression you obtained in answer to (e) above. Why is there a $1/3$ in the equation $1/3Nmv^2$?

Three directions of movement (x, y, z); $x = \frac{1}{3}N$.

$$p = \frac{F}{A} = \frac{xmv^2}{e} \times \frac{1}{e^2} \quad A = e^2$$

$$\therefore p \times e^3 = \frac{1}{3}Nmv^2$$

$$\therefore pV = \frac{1}{3}Nmv^2$$

If a gas is contained in a cylinder and a piston is moved inwards to compress it, the gas warms up.

- (i) Explain why the gas warms up.
 (j) Where does the energy come from?

Work done by piston increases the KE of gas particles so temperature of gas increases.