

- 4 (a) A cube of length L contains N molecules of an ideal gas. Each molecule has a component c_x of velocity normal to one side S of the cube, as shown in Fig. 4.1.

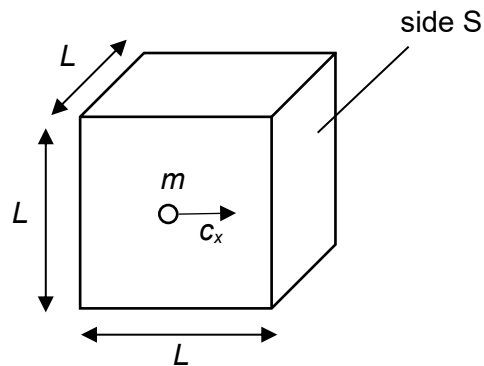


Fig. 4.1

The pressure p of the gas due to the component c_x of velocity is given by the expression

$$p = \frac{Nm\langle c_x^2 \rangle}{V}$$

where V is the volume of the gas and m is the mass of a molecule.

Explain how the expression leads to the relation

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

where $\langle c^2 \rangle$ is the mean square speed of the molecules.

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[3]

- (b) In a diesel engine a fixed amount of gas can be considered to undergo a cycle of four stages. The cycle is shown in Fig. 4.2.

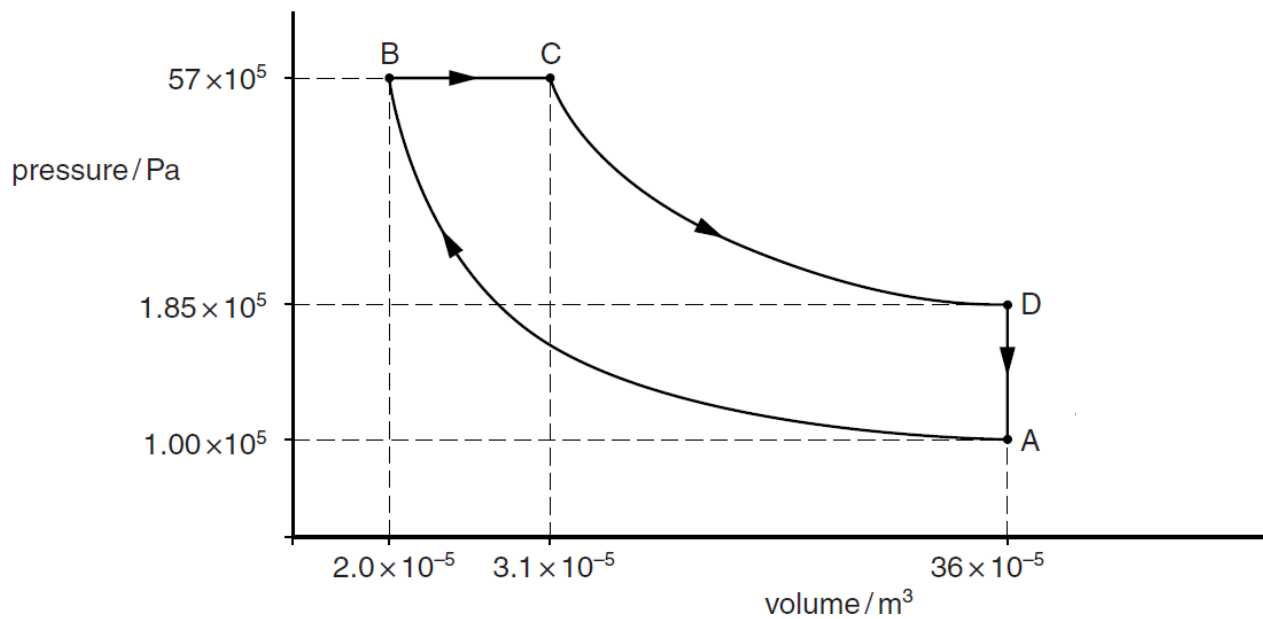


Fig. 4.2

The four stages are

$A \rightarrow B$ a compression with a rise in pressure and temperature from an initial temperature of 300 K,

$B \rightarrow C$ an expansion at constant pressure while fuel is being burnt,

$C \rightarrow D$ a further expansion with a drop in both temperature and pressure,

$D \rightarrow A$ a return to the starting point.

Some numerical values of pressure and volume are given on Fig. 4.2. The values are for an idealised engine.

Using Fig. 4.2, determine the work done by the gas during the stage $B \rightarrow C$.

work done = J [2]

(c) Complete the following table for the four stages of the cycle given in (b).

stage of cycle	heat supplied to the gas/J	work done on the gas/J	increase in the internal energy of the system/J
A → B	0	235	
B → C	246		
C → D	0	−333	
D → A			

[3]