

- 2 An ideal gas has a volume of $3.1 \times 10^{-3} \text{ m}^3$ at a pressure of $8.5 \times 10^5 \text{ Pa}$ and a temperature of 290K, as shown in Fig. 2.1.

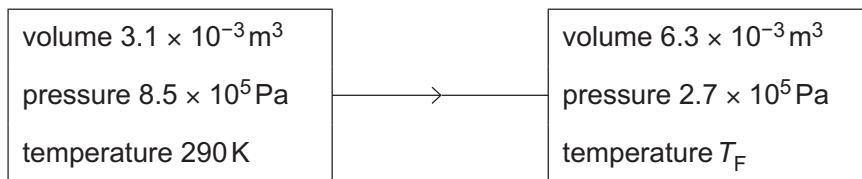


Fig. 2.1

The gas suddenly expands to a volume of $6.3 \times 10^{-3} \text{ m}^3$. During the expansion, no thermal energy is transferred. The final pressure of the gas is $2.7 \times 10^5 \text{ Pa}$ at temperature T_F , as shown in Fig. 2.1.

- (a) Show that the number of gas molecules is 6.6×10^{23} .

[3]

- (b) (i) Show that the final temperature T_F of the gas is 190K.

[1]

- (ii) The average translational kinetic energy E_K of a molecule of an ideal gas is given by

$$E_K = \frac{3}{2} kT$$

where T is the thermodynamic temperature and k is the Boltzmann constant.

Calculate the increase in internal energy ΔU of the gas.

$$\Delta U = \dots \text{ J} [3]$$

- (c) Use the first law of thermodynamics to explain why the external work w done on the gas during the expansion is equal to the increase in internal energy in (b)(ii).

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