2 An ideal gas is contained in a cylinder by means of a movable frictionless piston, as illustrated in Fig. 2.1.

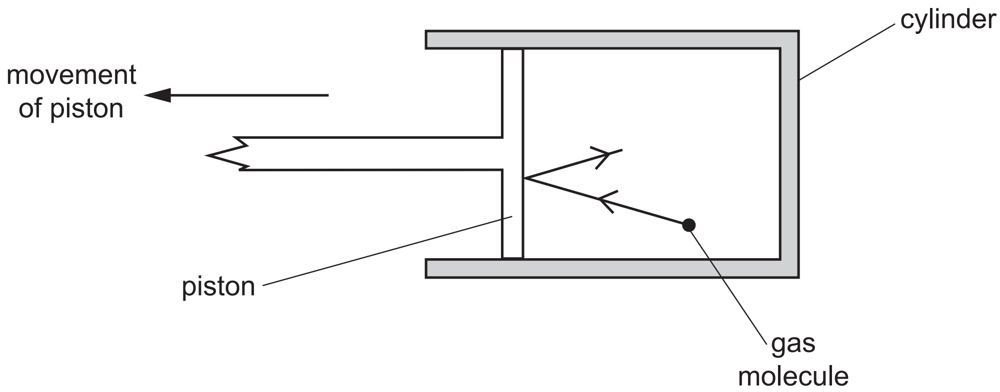

Fig. 2.1

Initially, the gas has a volume of $1.8 \times 10^{-3}\,m^3$ at a pressure of $3.3 \times 10^5\,Pa$ and a temperature of 310 K.

(a) Show that the number of gas molecules in the cylinder is 1.4×10^{23}.

[2]

(b) Use kinetic theory to explain why, when the piston is moved so that the gas expands, this causes a decrease in the temperature of the gas.

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....

....

.... [3]

(c) The gas expands so that its volume increases to $2.4 \times 10^{-3}\,\text{m}^3$ at a pressure of $2.3 \times 10^5\,\text{Pa}$ and a temperature of 288 K, as shown in Fig. 2.2.

$1.8 \times 10^{-3}\,\text{m}^3$		$2.4 \times 10^{-3}\,\text{m}^3$
$3.3 \times 10^5\,\text{Pa}$	$\longrightarrow$	$2.3 \times 10^5\,\text{Pa}$
310 K		288 K

Fig. 2.2

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

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

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

Calculate the increase in internal energy ΔU of the gas during the expansion.

ΔU = ... J [3]

(ii) The work done by the gas during the expansion is 76 J.

Use your answer in **(i)** to explain whether thermal energy is transferred to or from the gas during the expansion.

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.... [2]

[Total: 10]