2 A cylinder that contains a fixed amount of an ideal gas is shown in Fig. 2.1.

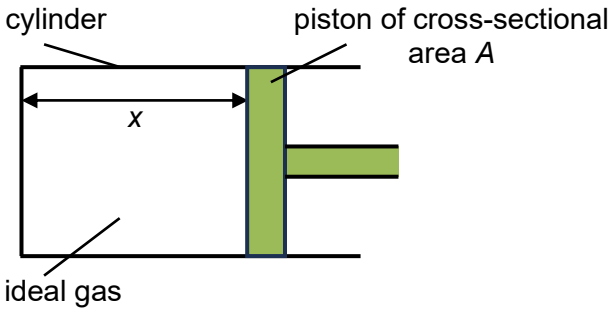

Fig. 2.1

The cylinder is tightly fitted with a piston, of cross-sectional area *A*. The piston moves freely in the horizontal direction, trapping the gas within a length *x*.

(a) A gas molecule of mass *m* travels at a speed of *u* in the horizontal direction and collides elastically with the piston and the walls of the container.

(i) State an expression, in terms of some or all of the symbols defined above, for the magnitude of the change in momentum during each collision.

change in momentum = ... [1]

(ii) Hence, show that the average force exerted on the piston by the molecule is $\frac{mu^2}{x}$.

[1]

(b) The gas in the cylinder undergoes a cycle of changes A → B → C → A, as shown in Fig. 2.2.

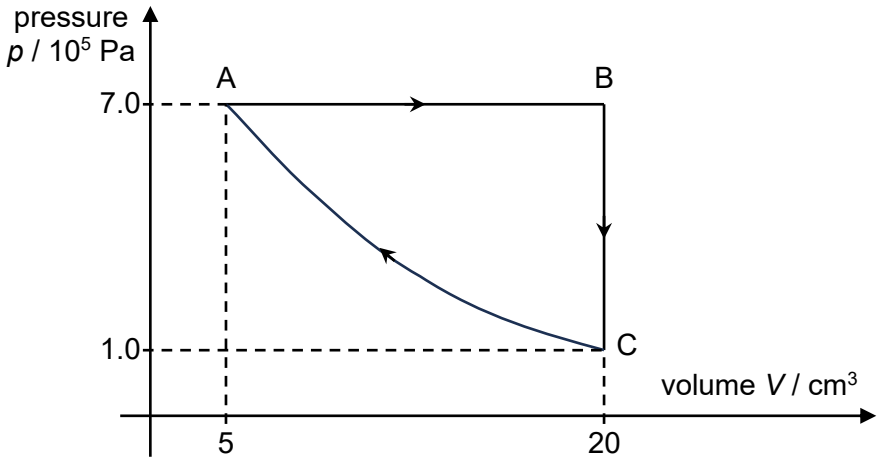

Fig. 2.2

(i) Calculate the work done by the gas during the change A → B.

work done by the gas = ... J [2]

(ii) Fig. 2.3 is a table of energy changes during one cycle. Complete Fig. 2.3.

section of cycle	heating supplied to gas / J	work done on gas / J	increase in internal energy of gas / J
A → B			
B → C	−30		
C → A	zero	3.7	

Fig. 4.2

[4]

(iii) The net work done by the gas is considered the useful work done of the cycle.

The efficiency of this cycle is given by

$$efficiency = \frac{useful\ work\ done}{total\ energy\ input} \times 100\%$$

Determine the efficiency of the cycle.

efficiency = …… % [2]

[Total: 10]