3 **(a)** According to the kinetic theory of gases, the average random translational kinetic energy E_K of an ideal gas particle is given by:

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

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

(i) Using the above expression, show that the root-mean-square speed $c_{r.m.s.}$ of the gas particles is given by:

$$c_{r.m.s.} = \sqrt{\frac{3RT}{M}}$$

where R is the molar gas constant and M is the molar mass.

[2]

(ii) A sealed canister contains 0.200 mol of oxygen (molar mass = 32 g). An identical canister contains 0.300 mol of nitrogen (molar mass = 28 g) at the same temperature.

Assuming ideal gas behaviour, determine the ratio

$$\frac{c_{r.m.s.} \text{ of oxygen molecules}}{c_{r.m.s.} \text{ of nitrogen molecules}}$$

ratio = ………………. [1]

(b) The root-mean-square speed of particles at the centre of the Sun is 4.85×10^5 m s^{-1} and the density of the particles in that region is 1.50×10^5 kg m^{-3}.

(i) Assuming that the particles behaved like ideal gas, calculate the pressure in that region.

pressure = ……………. Pa [2]

(ii) The actual pressure at the centre of the Sun is much higher than the value calculated above. This shows that some of the assumptions used in the kinetic theory of gases cannot be applied to the particles in that region of the Sun.

State one assumption that is no longer applicable and explain how it leads to the actual pressure being higher than the one calculated above.

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(c) A fixed mass of ideal gas is made to undergo the processes shown in Fig 3.1 starting from state A.

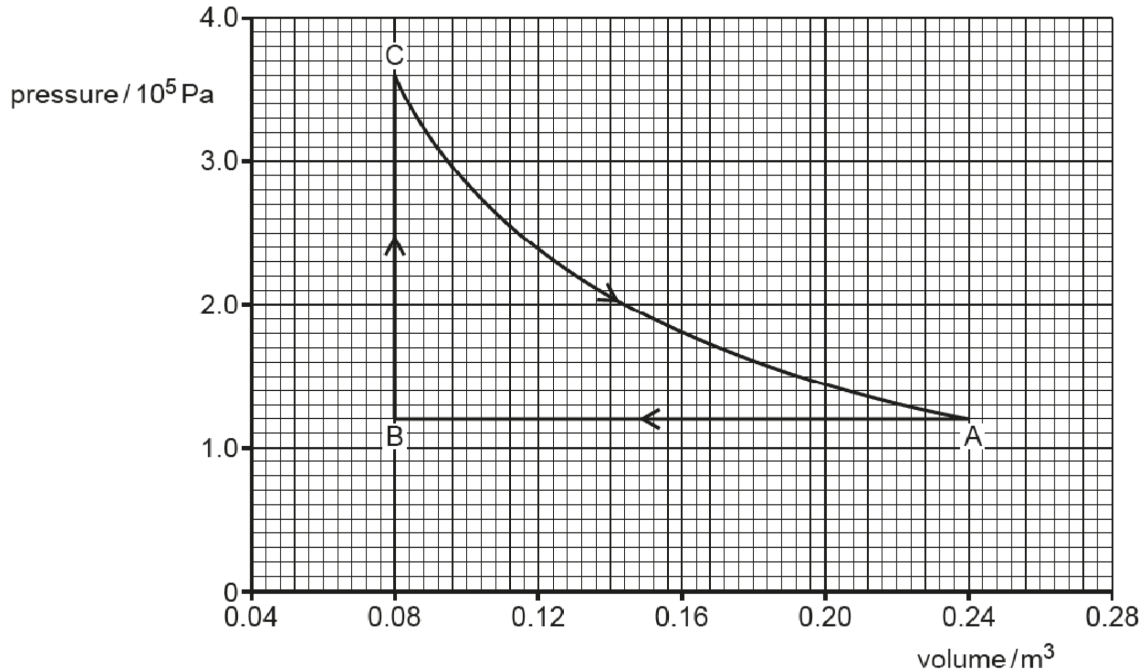

Fig. 3.1

Complete the table below for each of the processes shown in Fig. 3.1.

Process	w / kJ	q / kJ	⊗U / kJ
A to B		67.2	
B to C	0		
C to A	31.6	31.6	0

[3]

[Total: 10]

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