2 A fixed mass of an ideal gas has a volume V and a pressure p.

The gas undergoes a cycle of changes, X to Y to Z to X, as shown in Fig. 2.1.

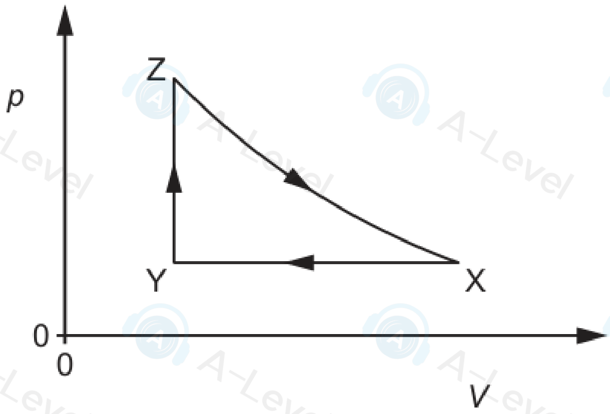

Fig. 2.1

Table 2.1 shows data for p, V and temperature T for the gas at points X, Y and Z.

Table 2.1

	$p / 10^5$ Pa	$V / 10^{-3}$ m^3	T / K
X	1.5	4.2	540
Y			230
Z	5.1		782

(a) State the change in internal energy ΔU for one complete cycle, XYZX.

ΔU = ... J [1]

(b) Calculate the amount n of gas.

n = ... mol [2]

(c) Complete Table 2.1.
Use the space below for any working.

3 **(a)** The equation of state for an ideal gas can be written as

$$pV = NkT.$$

State the meaning of each of the symbols in this equation.

p: ....

V: ....

N: ....

k: ....

T: ....
[3]

(b) Use the equation in **(a)** to show that the average translational kinetic energy E_K of a molecule of an ideal gas is given by

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

[2]

(c) The mass of an oxygen molecule is 5.31×10^{-26} kg. Assume that oxygen behaves as an ideal gas.

(i) Use the equation in **(b)** to determine the root-mean-square (r.m.s.) speed u of an oxygen molecule at 23 °C.

u = ... $m\,s^{-1}$ [3]

(ii) A fixed mass of oxygen gas at initial pressure *P* is sealed in a cylindrical container by a movable piston at one end, as shown in Fig. 3.1.

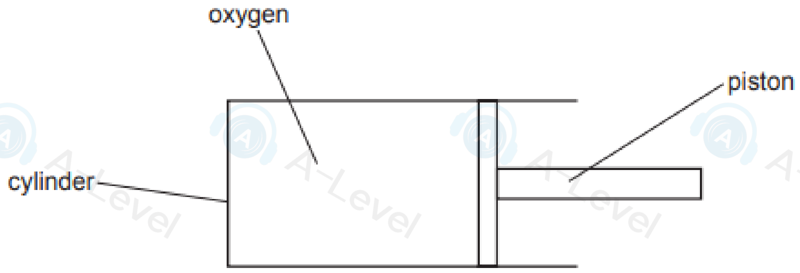

Fig. 3.1

The temperature of the gas is 23 °C.

The piston is slowly moved into the cylinder so that the oxygen gas is compressed. At all times, the gas and the container remain in thermal equilibrium with the surroundings.

On Fig. 3.2, sketch the variation with pressure of the r.m.s. speed of the oxygen molecules as the pressure increases.

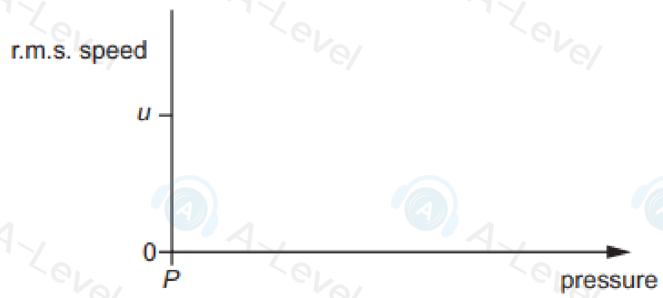

Fig. 3.2

[2]

[Total: 10]