4 **(a)** Define *specific heat capacity*.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………..

…………………………………………………………………………………………………...[1]

(b) A container of volume V contains N molecules, each of mass m, of an ideal gas at pressure p. Each molecule travels with a mean-square speed $<c^2>$.

The pressure p of an ideal gas is given by

$$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle .$$

(i) Show that the mean kinetic energy $\langle E_K \rangle$ of a molecule is given by:

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

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

[2]

(ii) Explain why the internal energy of the gas is equal to the total kinetic energy of the molecules.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..[2]

(c) The mass of a hydrogen molecule is 3.34×10^{-27} kg.

Use the expression in **(b)(i)** to determine the root-mean-square (r.m.s) speed of a molecule of hydrogen gas at 25°C.

r.m.s. speed = ……………………… m s^{-1} [2]

(d) Use the first law of thermodynamics to explain the following observations:

(i) The specific heat capacity of an ideal gas measured at constant volume is lower than the specific heat capacity when measured at constant pressure.

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………….... [2]

(ii) The internal energy of the water in an ice cube increases when the ice melts, at atmospheric pressure, to form a liquid without any change of temperature.

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………..................

……………………………………………………………………………………….... [2]

[Total: 11]