2 **(a)** With reference to thermal energy, state what is meant by two objects being in thermal equilibrium.

.....

.....

..... [1]

(b) Two cylinders X and Y each contain a sample of an ideal gas. The samples are in thermal equilibrium with each other.

X has a volume of $0.0260\,m^3$ and contains 0.740 mol of gas at a pressure of 1.20×10^5 Pa. Y has a volume of $0.0430\,m^3$ and contains gas at a pressure of 2.90×10^5 Pa. Data for the two cylinders are shown in Fig. 2.1.

Fig. 2.1

(i) Show that the temperature of the gas in X is 234 °C.

[3]

(ii) Determine the number N of molecules of the gas in Y. Explain your reasoning.

N = ... [3]

(iii) The gas in X consists of molecules that each have a mass that is four times the mass of a molecule of the gas in Y.

Explain how the root-mean-square (r.m.s.) speed of the molecules in X compares with the r.m.s. speed of the molecules in Y.

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..... [3]

[Total: 10]