3 **(a)** Two metal cuboids P and Q are in thermal contact with each other.

(i) P and Q are in thermal equilibrium.

State what is meant by the term thermal equilibrium.

.....

.....

..... [2]

(ii) Data for P and Q are given in Table 3.1.

Table 3.1

	P	Q
specific heat capacity / J kg^{-1} K^{-1}	390	910
mass / kg	0.54	0.37

P and Q are initially both at the same temperature.

P is supplied with 24 kJ of thermal energy. After some time, P and Q are once again both at the same temperature as each other.

P and Q are perfectly insulated from the surroundings.

Determine the change in temperature ΔT of Q.

ΔT = ... K [3]

(b) Nitrogen may be assumed to be an ideal gas. A fixed amount of nitrogen gas is contained at a constant pressure of 1.6×10^5 Pa.

The variation of the volume V of the gas with the temperature θ of the gas is shown in Fig. 3.1.

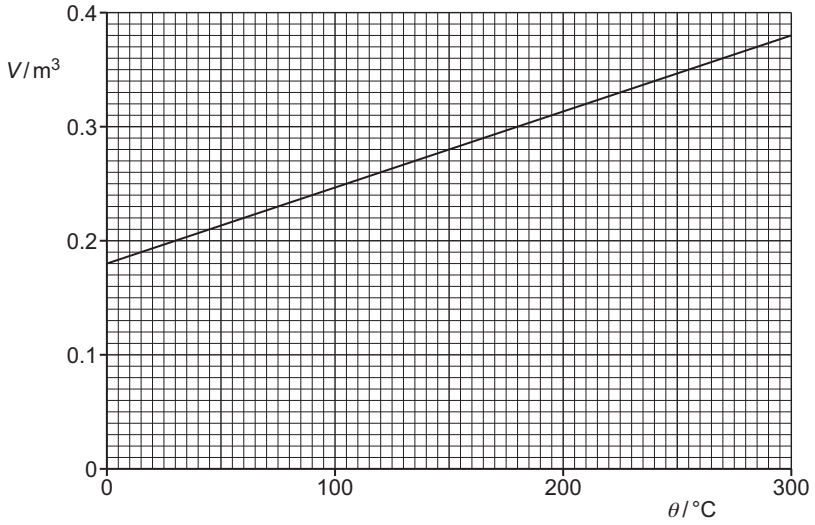

Fig. 3.1

(i) The temperature of the nitrogen gas is increased from 0 °C to 210 °C.
Determine the work done on the gas.

work done = ... J [3]

(ii) Determine the number N of molecules of nitrogen gas.

N = ... [2]

(iii) The mass of a nitrogen molecule is 4.7×10^{-26} kg.

Calculate the root-mean-square (r.m.s.) speed of a nitrogen molecule at 210 °C.

r.m.s. speed = ... $m\,s^{-1}$ [2]

[Total: 12]