4 **(a)** State the value of absolute zero on:

(i) the Celsius temperature scale

temperature = ... °C [1]

(ii) the thermodynamic temperature scale. Give a unit with your answer.

temperature = ... unit ..... [1]

(b) A sample contains a fixed amount of gas. The gas has pressure p, volume V and thermodynamic temperature T.

Fig. 4.1 shows the variation of pV with kT for the sample, where k is the Boltzmann constant.

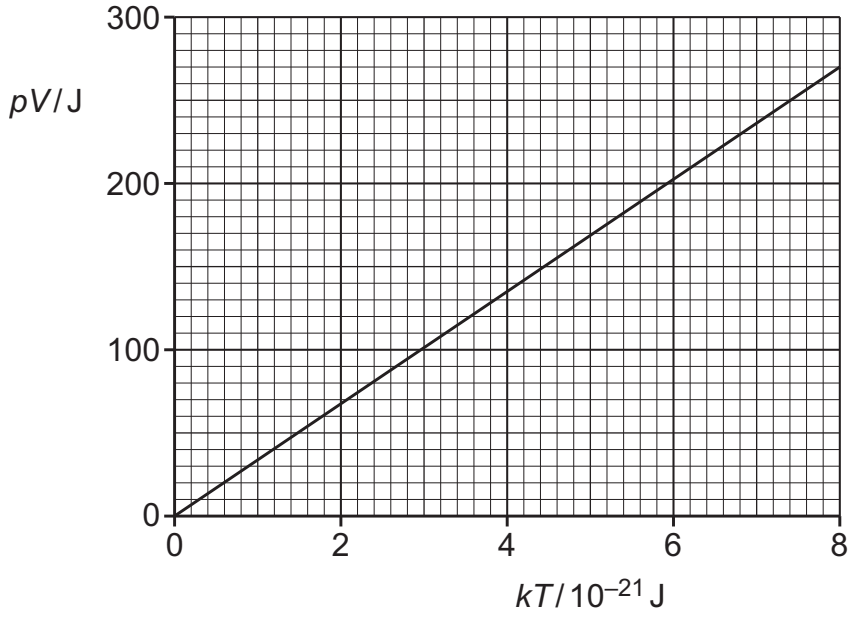

Fig. 4.1

(i) State what is indicated about the nature of the gas from the variation shown in Fig. 4.1.

..... [1]

(ii) Determine the number N of molecules of the gas in the sample.

N = ... [2]

(iii) Use your answer in **(b)(ii)** to determine the amount n of gas in the sample.

n = ... mol [1]

(c) The root-mean-square (r.m.s.) speed of the molecules of the gas is $1900\,\text{m}\,\text{s}^{-1}$ when pV is equal to 270 J.

Determine the mass, in u, of one molecule of the gas, where u is the unified atomic mass unit.

mass = ... u [4]

[Total: 10]

2 **(a)** **(i)** State the magnitude and unit of absolute zero on the thermodynamic temperature scale.

..... [1]

(ii) Explain why temperature measured using a laboratory liquid-in-glass thermometer does **not** give a measurement of thermodynamic temperature.

.....

..... [1]

(b) Fig. 2.1 shows a simplified diagram of a type of thermometer called a platinum resistance thermometer.

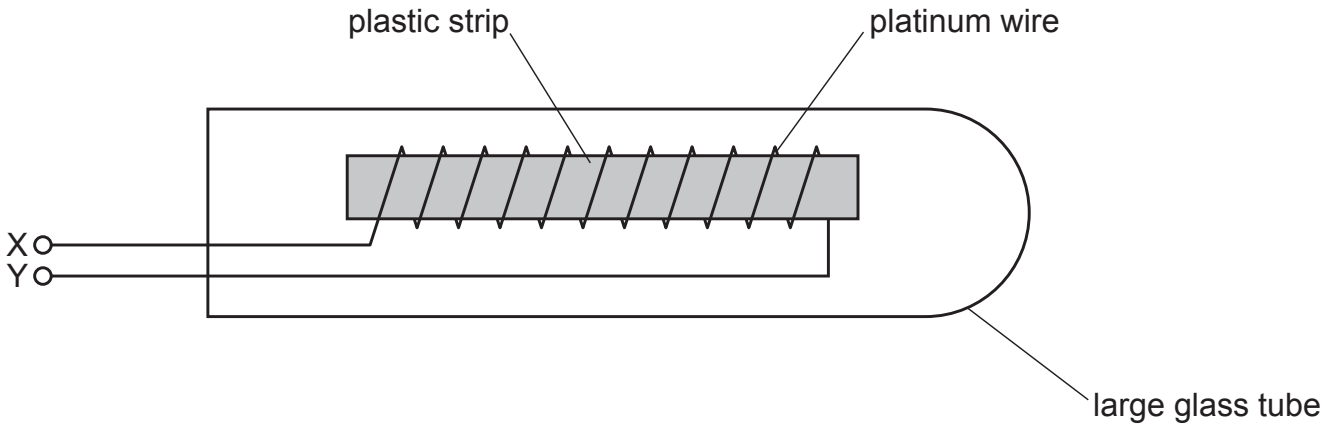

Fig. 2.1

The glass tube is immersed in the environment for which the temperature is to be determined. The resistance between the terminals X and Y is measured.

Fig. 2.2 shows the variation of the resistivity ρ of platinum with thermodynamic temperature T.

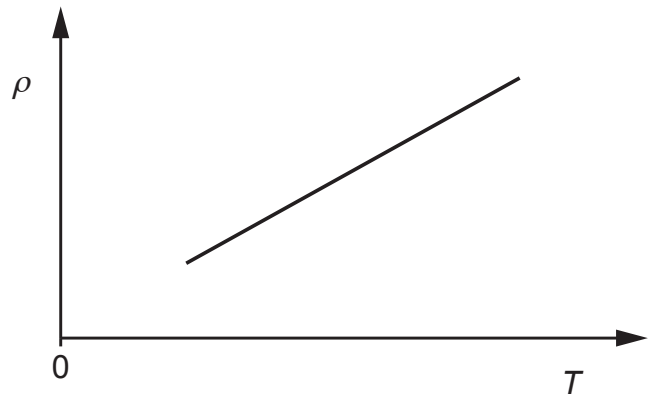

Fig. 2.2

(i) Explain how Fig. 2.2 shows that platinum is a suitable metal for use in a resistance thermometer.

.....

.....

..... [2]

(ii) Suggest a reason why a platinum resistance thermometer is **not** suitable for measuring a rapidly changing temperature.

.....

.....

..... [1]

(iii) Suggest a type of thermometer that is suitable for measuring a rapidly changing temperature.

..... [1]

(c) A negative temperature coefficient thermistor may be used as a type of resistance thermometer.

State **one** way in which the variation with temperature of the resistance of a thermistor differs from that of a platinum wire.

.....

..... [1]

[Total: 7]

2 **(a)** **(i)** State what is meant by an ideal gas.

.....

.....

..... [2]

(ii) State the temperature, in degrees Celsius, of absolute zero.

temperature = ... °C [1]

(b) A sealed vessel contains a mass of 0.0424 kg of an ideal gas at 227 °C.
The pressure of the gas is 1.37×10^5 Pa and the volume of the gas is 0.640 m^3.

Calculate:

(i) the number of molecules of the gas in the vessel

number of molecules = ... [3]

(ii) the mass of one molecule of the gas

mass = ... kg [1]

(iii) the root-mean-square (r.m.s.) speed v of the molecules of the gas.

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

(c) The gas in **(b)** is now cooled gradually to absolute zero.

On Fig. 2.1, sketch the variation with thermodynamic temperature T of the r.m.s. speed of the molecules of the gas.

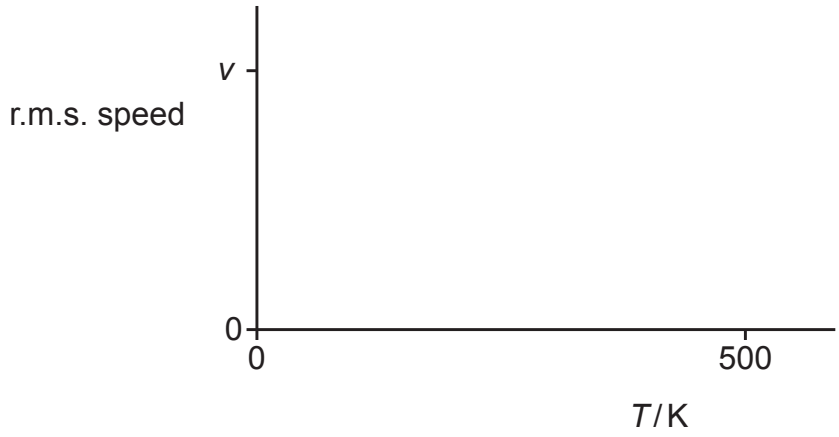

Fig. 2.1

[2]

[Total: 12]