3 (a) (i) The kinetic theory for an ideal gas of volume V at pressure p leads to the equation

$$pV = \frac{1}{3}Nm\langle c^2 \rangle,$$

where the other symbols refer to their usual meanings.

Use the equation of state for an ideal gas to show that the average translational kinetic energy E_K of a molecule of ideal gas is given by

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

[1]

(ii) One helium atom has a mass of 6.68×10^{-27} kg.
Helium may be considered as an ideal gas.

Show that the total kinetic energy of the helium atoms in 1.00 mol of helium gas at 25 °C is 3720 J.

[1]

(iii) State the value of the internal energy of 1.00 mol of helium gas at 25 °C. Explain your answer.

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.....[2]

(iv) The helium gas is gradually cooled from 25 °C to –150 °C at which the internal energy is 1540 J.

On Fig. 3.1, plot points and draw a line to show the variation with temperature θ of the internal energy U of the helium gas.

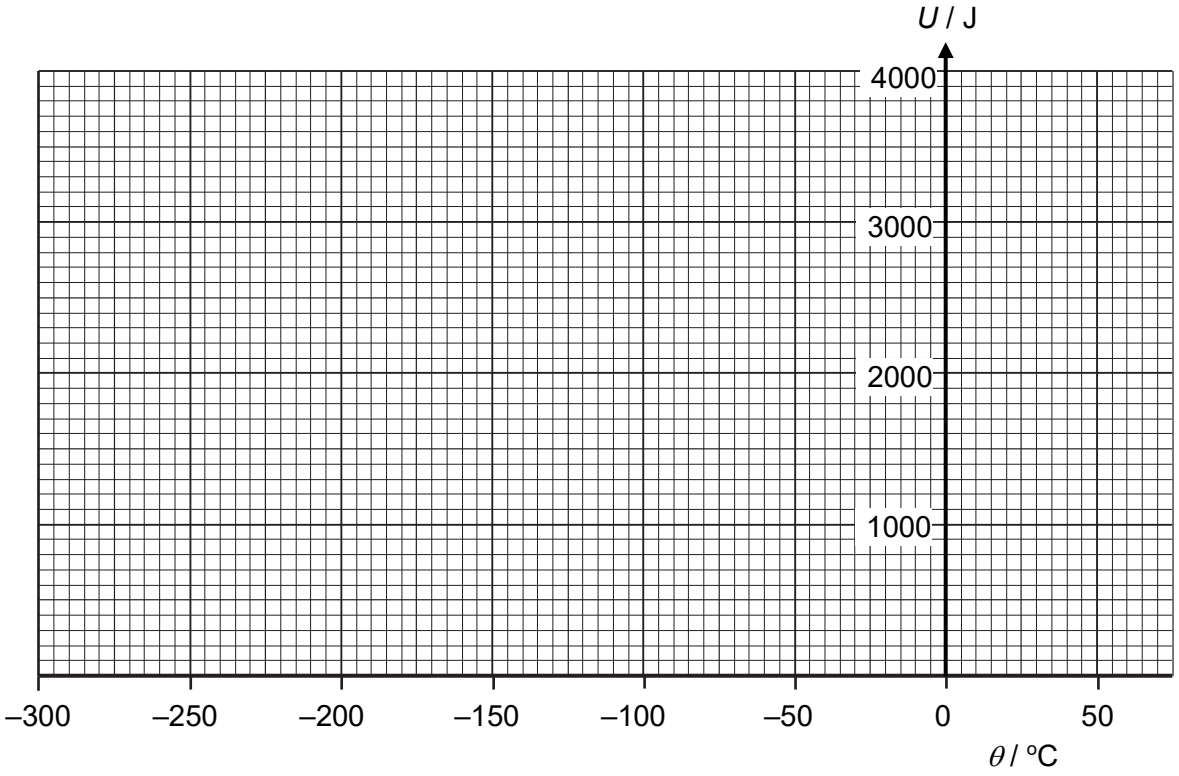

Fig. 3.1

[1]

(v) Explain how your graph leads to the idea of an absolute zero of temperature.

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.....[1]

(b) Gases like hydrogen and helium are found mainly in stars. These gases are at a very high pressure.

Use the assumptions of the kinetic theory of gases to suggest why, in practice, the gas found in stars is unlikely to behave as an ideal gas.

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.....[2]

[Total: 8]