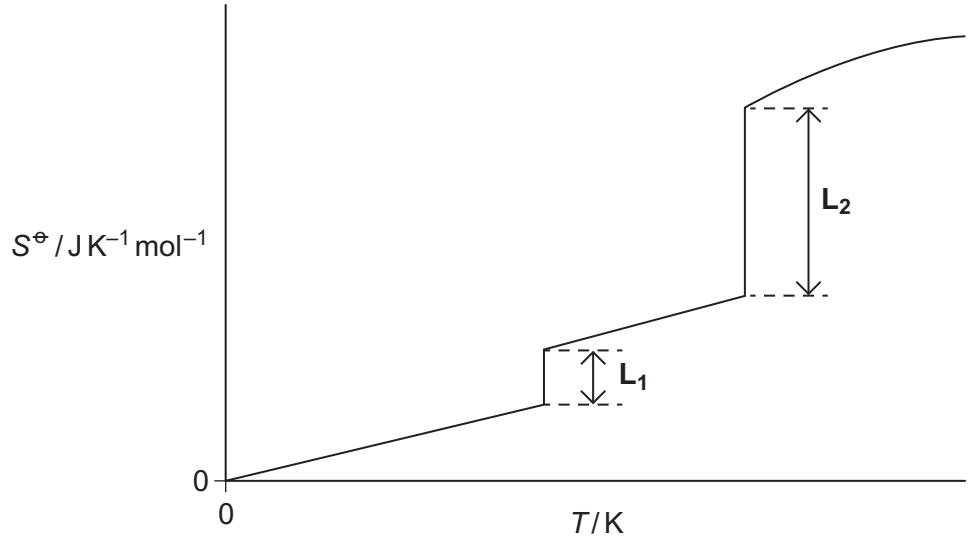
3 (a) **Figure 1** shows how the entropy of a molecular substance **X** varies with temperature.

Figure 1



3 (a) (i) Explain, in terms of molecules, why the entropy is zero when the temperature is zero Kelvin.

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(2 marks)

(Extra space) .....

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3 (a) (ii) Explain, in terms of molecules, why the first part of the graph in **Figure 1** is a line that slopes up from the origin.

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(2 marks)

(Extra space) .....

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3 (a) (iii) On **Figure 1**, mark on the appropriate axis the boiling point (T_b) of substance **X**.

(1 mark)

3 (a) (iv) In terms of the behaviour of molecules, explain why $\mathbf{L_2}$ is longer than $\mathbf{L_1}$ in **Figure 1**.

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(2 marks)

(Extra space) .....

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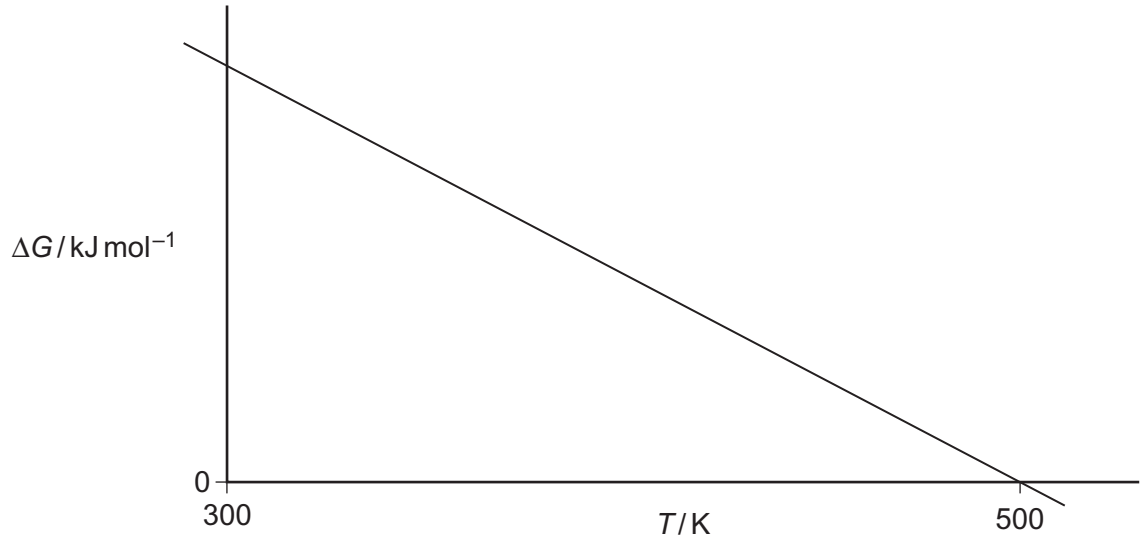
Question 3 continues on the next page

3 (b) **Figure 2** shows how the free-energy change for a particular gas-phase reaction varies with temperature.

Figure 2



3 (b) (i) Explain, with the aid of a thermodynamic equation, why this line obeys the mathematical equation for a straight line, $y = mx + c$.

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(2 marks)

3 (b) (ii) Explain why the magnitude of ΔG decreases as T increases in this reaction.

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(1 mark)

3 (b) (iii) State what you can deduce about the feasibility of this reaction at temperatures lower than 500 K.

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(1 mark)

3 (c) The following reaction becomes feasible at temperatures above 5440 K.

$$H_2O(g) \longrightarrow H_2(g) + \tfrac{1}{2}O_2(g)$$

The entropies of the species involved are shown in the following table.

	$H_2O(g)$	$H_2(g)$	$O_2(g)$
S / J K^{-1} mol^{-1}	189	131	205

3 (c) (i) Calculate the entropy change ΔS for this reaction.

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(1 mark)

3 (c) (ii) Calculate a value, with units, for the enthalpy change for this reaction at 5440 K.

(If you have been unable to answer part **(c) (i)**, you may assume that the value of the entropy change is +98 J K^{-1} mol^{-1}. This is **not** the correct value.)

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(3 marks)

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