3 The feasibility of a physical or a chemical change depends on the balance between the thermodynamic quantities of enthalpy change (ΔH), entropy change (ΔS) and temperature (T).

3 (a) Suggest how these quantities can be used to predict whether a change is feasible.

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(2 marks)

3 (b) Explain why the evaporation of water is spontaneous even though this change is endothermic.
In your answer, refer to the change in the arrangement of water molecules and the entropy change.

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(4 marks)

Question 3 continues on the next page

3 (c) This table contains some thermodynamic data for hydrogen, oxygen and water.

	$S^{\ominus}$ / J K^{-1} mol^{-1}	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
$H_2(g)$	131	0
$O_2(g)$	205	0
$H_2O(g)$	189	–242
$H_2O(l)$	70	

3 (c) (i) Calculate the temperature above which the reaction between hydrogen and oxygen to form gaseous water is **not** feasible.

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(4 marks)

3 (c) (ii) State what would happen to a sample of gaseous water that was heated to a temperature higher than that of your answer to part **(c) (i)**.
Give a reason for your answer.

What would happen to gaseous water .....

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Reason .....

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(2 marks)

3 (d) When hydrogen is used as a fuel, more heat energy can be obtained if the gaseous water formed is condensed into liquid water.

Use entropy data from the table in part **(c)** to calculate the enthalpy change when one mole of gaseous water is condensed at 373 K.
Assume that the free-energy change for this condensation is zero.

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(3 marks)

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Turn over for the next question