0 3 The equation for the reaction between ammonia and oxygen is shown.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -905 \text{ kJ mol}^{-1}$$

Some standard entropies are given in **Table 3**.

Table 3

Gas	$S^{\ominus}$ **/ J K^{-1} mol^{-1}**
$NH_3(g)$	193
$O_2(g)$	205
$NO(g)$	211
$H_2O(g)$	189

0 3 . 1 Calculate the entropy change for the reaction between ammonia and oxygen.

[2 marks]

Entropy change _____ J K^{-1} mol^{-1}

0 3 . 2 Calculate a value for the Gibbs free-energy change (ΔG), in kJ mol^{-1}, for the reaction between ammonia and oxygen at 600 °C

(If you were unable to obtain an answer to Question **03.1**, you should assume that the entropy change is 211 J K^{-1} mol^{-1}. This is **not** the correct answer.)

[2 marks]

ΔG _____ kJ mol^{-1}

0 3 . 3 The reaction between ammonia and oxygen was carried out at a higher temperature.

Explain how this change affects the value of ΔG for the reaction.

[2 marks]

_____

_____

_____

_____

_____

Question 3 continues on the next page

0 3 . 4 Platinum acts as a heterogeneous catalyst in the reaction between ammonia and oxygen. It provides an alternative reaction route with a lower activation energy.

Describe the stages of this alternative route.

[3 marks]

0 3 . 5 Deduce the change in oxidation state of nitrogen, when NH_3 is oxidised to NO

[1 mark]

0 3 . 6 When ammonia reacts with oxygen, nitrous oxide (N_2O) can be produced instead of NO

Give an equation for this reaction.

[1 mark]

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