4 The reaction of ammonia, NH_3, with oxygen to form nitrogen monoxide, NO, is an important industrial process.

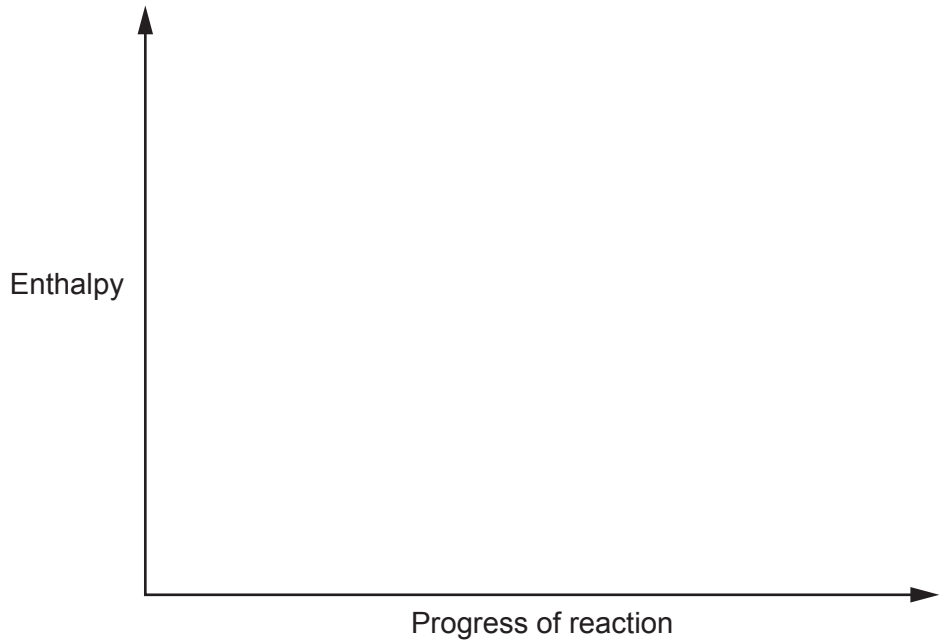
The equation for this reaction is shown in **equilibrium 4.1** below.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -905 \text{ kJ mol}^{-1} \qquad \textbf{Equilibrium 4.1}$$

(a) The forward reaction in **equilibrium 4.1** converts NH_3 into NO.

(i) Complete the enthalpy profile diagram for this reaction.

On your diagram:
- Label the activation energy, E_a
- Label the enthalpy change of reaction, ΔH
- Include the formulae of the reactants and products.



[2]

(ii) 5.10 tonnes of NH_3 are converted into NO.

Calculate the energy released, in kJ, for this conversion.

Give your answer in **standard form** and to an **appropriate** number of significant figures.

energy released = ... kJ **[4]**

(b) Write an expression for the equilibrium constant, K_c, in **equilibrium 4.1**.

[1]

(c) Predict the conditions of temperature and pressure for a maximum equilibrium yield of nitrogen monoxide in **equilibrium 4.1**.

- Explain your prediction in terms of le Chatelier's principle.
- State and explain how these conditions could be changed to achieve a compromise between equilibrium yield, rate and other operational factors.

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