Rates of Reactions & Equilibrium (Qualitative) AS & A Level

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Periodic Table & Energy
Topic	Rates of Reactions & Equilibrium(Qualitative)
Paper	AS & A Level
Booklet	Question Paper 1

Time allowed: **30 minutes**

Score: **/22**

Percentage: **/100**

Grade Boundaries:

| A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

Which statement(s) explain(s) why reaction rates increase as temperature increases?   **[1]**

1   The activation energy is less.

2   Collisions between molecules are more frequent.

3   A greater proportion of molecules have energy greater than the activation energy.

A.   1, 2 and 3

B.   Only 1 and 2

C.   Only 2 and 3

D.   Only 1

The reversible reaction below is at equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197\,kJ\,mol^{-1}$$
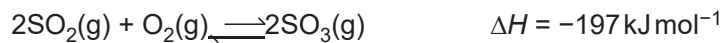
Which changes in pressure and temperature would shift the equilibrium position towards the products?

[1]

	Pressure	Temperature
A	Decrease	Decrease
B	Decrease	Increase
C	Increase	Decrease
D	Increase	Increase

Methanol, CH_3OH, is an important feedstock for the chemical industry.

In the manufacture of methanol, carbon dioxide and hydrogen are reacted together in the reversible reaction shown below.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g) \qquad \Delta H = -49 \, kJ \, mol^{-1}$$
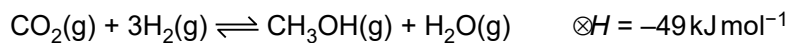
(a) Describe and explain the effect of increasing the pressure on the reaction **rate**.   [2]

(b) State le Chatelier's principle.   [1]

(c) High pressures and low temperatures would give a maximum equilibrium yield of methanol.

(i) Explain this statement in terms of le Chatelier's principle.   [3]

(ii) Explain why the actual conditions used by the chemical industry might be different.   [2]

(d) The manufacture of methanol uses a catalyst.

- Sketch a labelled diagram of the Boltzmann distribution on the grid provided.
- Label your axes.
- Using your Boltzmann distribution, explain how the catalyst increases the rate of reaction.
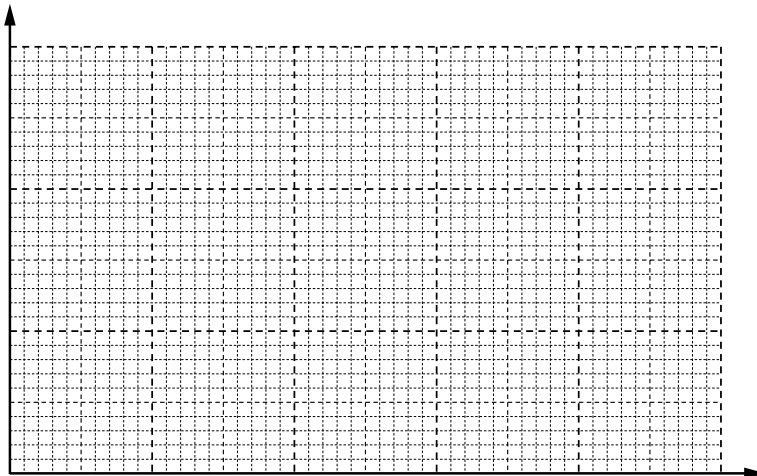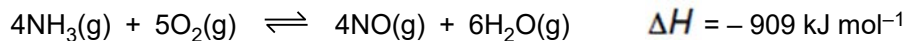
[4]

(e) Explain why the use of a catalyst can reduce the demand for energy. [1]

[Total 13 Marks]

An important reaction in the manufacture of nitric acid is the catalytic oxidation of ammonia.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -909 \text{ kJ mol}^{-1}$$

(a) Low pressures and low temperatures would give the maximum equilibrium yield of NO.

Explain why. [2]

(b) The actual conditions used in the catalytic oxidation of ammonia include 900 °C and an increase in pressure.

Suggest why these conditions are a compromise. [3]

(c) A factory makes 2.50×10^5 mol of NO a day.

(i) How much energy is released every day? [1]

(ii) Suggest how this energy can be used to reduce the cost of making NO. [1]

[Total 7 Marks]