

# Rates of Reactions & Equilibrium (Qualitative)

## AS & A Level

### Question Paper 2

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 2

**Time allowed:** 46 minutes

**Score:** /34

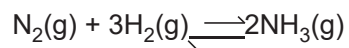
**Percentage:** /100

**Grade Boundaries:**

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

## Question 1

The reversible reaction below is at equilibrium.



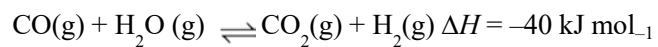
What is the expression for  $K_c$ ?

[1]

- A**  $\frac{[\text{N}_2(\text{g})] [\text{H}_2(\text{g})]^3}{[\text{NH}_3(\text{g})]^2}$
- B**  $\frac{[\text{NH}_3(\text{g})]^2}{[\text{N}_2(\text{g})] [\text{H}_2(\text{g})]^3}$
- C**  $\frac{[\text{N}_2(\text{g})] + 3[\text{H}_2(\text{g})]}{2[\text{NH}_3(\text{g})]}$
- D**  $\frac{2[\text{NH}_3(\text{g})]}{[\text{N}_2(\text{g})] + 3[\text{H}_2(\text{g})]}$

## Question 2

Carbon monoxide reacts with steam in the following reaction equation:



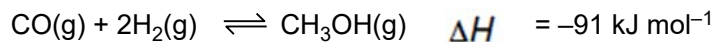
Which change will shift the position of equilibrium to the right hand side of the equation?

[1]

- A** decrease in pressure
- B** increase in pressure
- C** decrease in temperature
- D** increase in temperature

### Question 3

In the chemical industry methanol, CH<sub>3</sub>OH, is synthesised by reacting together carbon monoxide and hydrogen in the presence of copper, zinc oxide and alumina which act as a catalyst. This is a reversible reaction.



- (a) High pressures and low temperatures would give the maximum equilibrium yield of methanol. Explain why.

[2]

- (a) Explain why the actual conditions used in the chemical industry might be different from those in **(a)** above.

[2]

- (a) Catalysts are increasingly being used in chemical processes.

*A catalyst speeds up a reaction without being consumed by the overall reaction.  
A catalyst provides an alternative reaction route with a lower activation energy.*

- (i) Chlorine radicals, Cl<sup>•</sup>, catalyse some reactions.

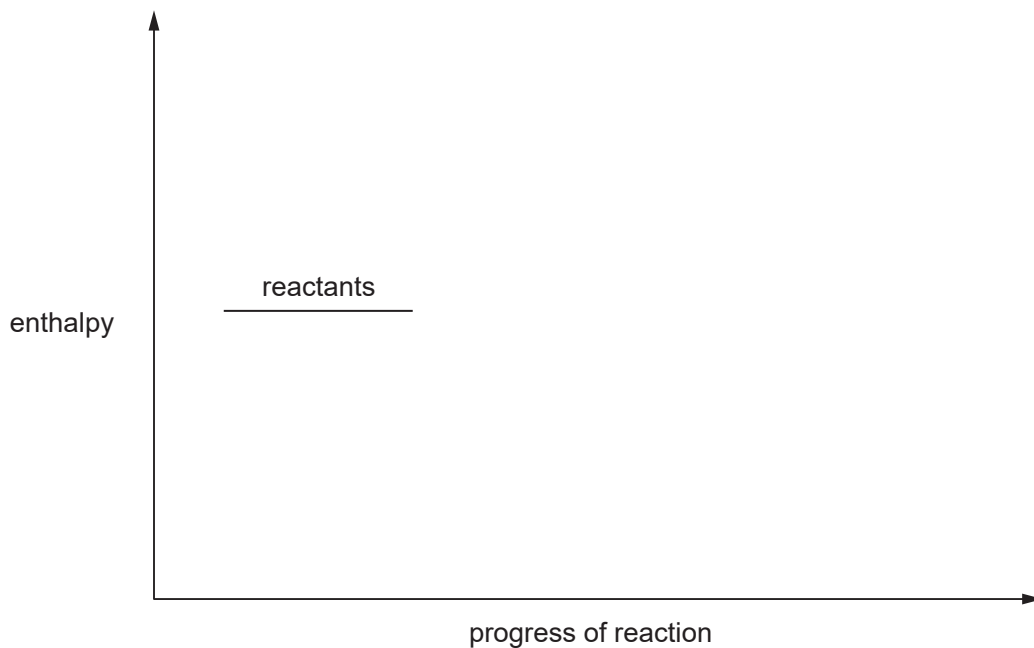
Choose a reaction that you have studied that is catalysed by chlorine radicals.

Write down an equation for the overall reaction and show how chlorine radicals are **not** consumed by the overall reaction.

[3]

(ii) Using the axes below, sketch an enthalpy profile diagram for an exothermic reaction to show how a catalyst provides an alternative reaction route with a lower activation energy. Include on your diagram labels for:

- enthalpy change,  $\Delta H$  ; [3]
- activation energy for the catalysed route,  $E_c$ ;
- activation energy for the uncatalysed route,  $E_a$ .



(d) Chemical companies are using catalysts to develop processes that are more sustainable. These processes reduce costs and are less harmful to the environment.

Suggest **two** ways in which the use of catalysts helps chemical companies to make their processes more sustainable.

[4]

[Total 14 Marks]

## Question 4

Catalysts speed up the rate of a reaction without being consumed by the overall reaction.

(a) Chlorine radicals in the stratosphere act as a catalyst for ozone depletion.

(i) Research chemists have proposed possible reaction mechanisms for ozone depletion. The equations below represent part of such a mechanism.

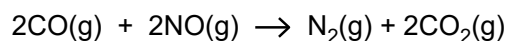
[2]

Complete the equations.

(ii) Write an equation for the overall reaction in (i).

[1]

(b) One of the catalysed reactions that takes place in a catalytic converter is shown below.



The catalyst used is platinum/rhodium attached to a ceramic surface.

Outline the stages that take place in a catalytic converter to allow CO to react with NO.

[4]

(c) Explain, using an enthalpy profile diagram and a Boltzmann distribution, how the presence of a catalyst increases the rate of reaction.

*In your answer you should organise your answer and use the correct technical terms.*



[7]

(d) Explain why many industrial manufacturing processes use catalysts.

Include in your answer ideas about sustainability, economics and pollution control.

[4]

**[Total: 18 Marks]**