

26. Reaction kinetics

26.2 Homogeneous and heterogeneous catalysts

Paper 4

Question Paper

- 1 (b) The reaction of persulfate ions, $S_2O_8^{2-}$, with iodide ions is catalysed by Fe^{2+} ions.

Write **two** equations to show how Fe^{2+} catalyses reaction 1.

equation 1

equation 2

[2]

- 2 (b) Catalysts may be homogeneous or heterogeneous.

- (i) Platinum is a transition element. Explain why transition elements behave as catalysts.

.....

 [1]

- (ii) Name the metal catalyst in the Haber process and explain why it is a **heterogeneous** catalyst.

metal

..... [1]

- (iii) Platinum acts as a heterogeneous catalyst in the removal of nitrogen dioxide, NO_2 , from the exhaust gases of car engines.

Describe the mode of action of a platinum catalyst in this process.

.....

 [2]

- (iv) NO_2 acts as a homogeneous catalyst in the oxidation of atmospheric sulfur dioxide, SO_2 .

Write equations for the **two** reactions that occur.

equation 1

equation 2

[1]

- 3 (a)** The exhaust systems of most modern gasoline-fuelled cars contain a catalytic converter with three metal catalysts.

These metals act as heterogeneous catalysts.

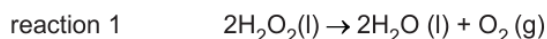
- (i)** Name **three** metal catalysts used in catalytic converters.

1 2 3 [1]

- (ii)** Explain what is meant by a heterogeneous catalyst.

.....
 [1]

- 4** Hydrogen peroxide is a liquid at 298 K. It is moderately stable under room conditions but will decompose quickly if a catalyst is added.



- (d)** The decomposition of $\text{H}_2\text{O}_2(\text{aq})$ is catalysed by aqueous iron(III) chloride and by silver metal.

Identify which of these two catalysts is acting as a homogeneous catalyst.

Explain your answer.

homogeneous catalyst

explanation

[1]

- 5 (c)** Manganese(IV) oxide, MnO_2 , acts as a heterogeneous catalyst in the decomposition of hydrogen peroxide, H_2O_2 .

- (i)** Explain what is meant by a heterogeneous catalyst.

.....
 [1]

- (ii)** Describe the mode of action of a heterogeneous catalyst in a reaction.

.....

 [3]

6 (a) (i) Explain what is meant by the following terms:

homogeneous catalyst

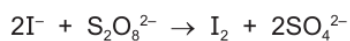
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heterogeneous catalyst

.....

[1]

(ii) Iodide ions react with peroxydisulfate ions.



This reaction is slow, but it is catalysed by Fe^{2+} ions.

Write two equations to explain how this reaction is catalysed by Fe^{2+} ions.

1

2

[2]

(iii) Suggest why the alternative route in the presence of Fe^{2+} ions has a lower activation energy than the route in the absence of a catalyst.

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..... [1]

7 (c) Many enzymes contain transition element complexes.

Describe, with the aid of a suitably labelled diagram, how an enzyme catalyses the breakdown of a substrate molecule.

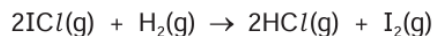
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..... [3]

- 8 Iodine monochloride, ICl , is a yellow-brown gas. It reacts with hydrogen gas under certain conditions as shown.



Experiments are performed using different starting concentrations of ICl and H_2 . The initial rate of each reaction is measured. The following results are obtained.

experiment	$[\text{ICl}]/\text{mol dm}^{-3}$	$[\text{H}_2]/\text{mol dm}^{-3}$	relative rate of reaction
1	4.00×10^{-3}	4.00×10^{-3}	1.00
2	4.00×10^{-3}	7.00×10^{-3}	1.75
3	4.00×10^{-3}	1.00×10^{-2}	2.50
4	5.00×10^{-3}	8.00×10^{-3}	2.50
5	7.00×10^{-3}	8.00×10^{-3}	3.50

- (h) A chemical reaction may be speeded up by the presence of a catalyst.

Explain why a catalyst increases the rate of a chemical reaction.

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..... [1]