

Structured Questions: Paper 2

8.3 Acid Deposition

8.3.1 Acid Deposition / 8.3.2 Effects of Acid Deposition / 8.3.3 Reducing Sulfur Oxide Emissions

Easy (4 questions)	/22
Medium (4 questions)	/36
Hard (3 questions)	/21
Total Marks	/79

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Easy Questions

1 (a) State why chemists use a pH of 5.6 in the classification of acid rain.

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(1 mark)

(b) Carbonic acid, H_2CO_3 , is formed when CO_2 dissolves in rainwater.

i) Formulate an equation to show how carbonic acid is formed in rainwater. [1]

ii) Formulate an equation to show the dissociation of carbonic acid. [1]

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.....
(2 marks)

(c) Two samples of rainwater, A and B, are pH 4.8 and pH 3.8, respectively. What is the relative acidity of sample A compared to sample B, in terms of $[\text{H}^+]$ concentration?

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(1 mark)

(d) State two examples of wet acid deposition.

.....
(1 mark)

2 (a) State the names of four acids that contribute to the formation of acid deposition.

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(1 mark)

(b) Show, by means of balanced equations, the formation of sulfuric acid starting from sulfur.

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(1 mark)

(c) Identify the changes in oxidation state for sulfur in part b).

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(3 marks)

(d) Write a balanced equation to show the formation of nitric acid, from nitrogen dioxide, oxygen and water.

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(1 mark)

3 (a) State two man-made sources of the oxides of sulfur and nitrogen.

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(2 marks)

(b) State two natural sources of the oxides of sulfur and nitrogen.

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(2 marks)

State, giving a suitable equation, the effect of acid deposition, from sulfuric or nitric acids, on an iron bridge.

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(c)

(2 marks)

4 (a) State the two ways by which emissions of sulfur oxides are reduced.

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(1 mark)

(b) State a disadvantage of removing **all** the sulfur found in petroleum.

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(1 mark)

Explain the meaning of the term **hydrodesulfurisation**.

(c)
(1 mark)

(d) Compare and contrast two approaches to reducing sulfur oxide emissions.

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(2 marks)

Medium Questions

1 (a) Outline the difference between **acid rain** and **acid deposition**, and state the names of the two types of acid deposition.

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(3 marks)

(b) Nitric acid is one component of acid rain that mainly comes from the emissions of internal combustion engines.

Describe, using suitable equations, the formation of acid rain from internal combustion engine emissions.

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(4 marks)

(c) The removal of sulfur dioxide is an important strategy in the fight to combat acid rain. It can be achieved pre- or post-combustion. Outline one technique used in the two processes.

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(2 marks)

(d) Discuss the impact of acid rain or acid deposition on human health and on plant life.

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(2 marks)

2 (a) Identify two substances that can be affected by the corrosive effects of acid deposition.

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(1 mark)

(b) Sulfuric(VI) acid, H_2SO_4 , and sulfur dioxide, SO_2 , are known components of acid deposition. Write equations for their reactions with calcium carbonate.

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(2 marks)

(c) Calcium nitrate(V) can be detected in the run-off water from limestone buildings that have been impacted by acid rain.

Write an equation to account for its formation and suggest why this is particularly damaging buildings.

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(2 marks)

(d) Aluminium has a protective oxide layer on its surface which can be weakened and damaged by the effects of acid rain.

(i) Write a balanced equation to show the effect of nitric(V) acid on aluminium oxide.

(ii) The statue of Eros in London is made from aluminium and has stood for more than 100 years, but shows little sign of damage from acid rain. Suggest a reason why.

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(2 marks)

- 3 (a) Nitrogen oxides produced by combustion are largely nitrogen monoxide or nitrogen dioxide.

Draw Lewis diagrams for nitrogen monoxide and nitrogen dioxide and use the diagrams to explain the meaning of the term free radical.

(3 marks)

- (b) Platinum and rhodium are found in catalytic converters and facilitate the conversion of Carbon monoxide and nitrogen monoxides to nitrogen and carbon dioxide.

Write an equation for the reaction and state the changes in oxidation state for each carbon and nitrogen.

(2 marks)

- (c) Use your answer to part (c) and the bond enthalpy data given in **Table 1** to determine the enthalpy change for the reaction between carbon monoxide and nitrogen monoxide.

Table 1

$\text{C}\equiv\text{O}$	$\text{N}=\text{O}$	$\text{N}\equiv\text{N}$	$\text{C}=\text{O}$
1070 kJ mol^{-1}	587 kJ mol^{-1}	945 kJ mol^{-1}	804 kJ mol^{-1}

(4 marks)

- (d) Acid deposition can be produced by the reaction of NO_2 in the atmosphere. State the equation for the reaction.

(1 mark)

4 (a) Natural sources as well as human activities can contribute the formation of acid deposition. Name one natural source of acid deposition.

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(1 mark)

(b) Sulfur from volcanic eruptions can produce sulfurous acid, H_2SO_3 , in a two step reaction.

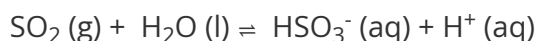
Write equations for the reaction.

.....
.....
(2 marks)

(c) A sample of sulfur is converted to H_2SO_3 using the reactions in part (b). If the % yield in both reactions is 75% determine the mass of sulfur needed to make 2 dm^3 of $0.05 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_3$,

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(3 marks)

(d) Studies show that sulfurous acid, H_2SO_3 , does not actually exist in solution but is the result of an equilibrium between sulfur dioxide and water:



Write an equilibrium expression for this reaction and suggest, with a reason, whether sulphurous is likely to be strong or weak acid.

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(2 marks)

Hard Questions

1 (a) Determine the hydrogen and hydroxide ion concentration of naturally occurring rainwater, of pH 5.6.

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(2 marks)

(b) Write equations to represent the formation of naturally occurring rain water.

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(2 marks)

(c) The solubility of carbon dioxide in water at 25 °C is 0.1449 g per 100 mL water. Determine the concentration of the dissolved carbon dioxide in mol dm⁻³.

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(1 mark)

Determine the solubility of CO₂ in ppm.

.....
(1 mark)

2 (a) Acid rain can release nitrates in the soil that wash into waterways and cause eutrophication.

Discuss the meaning of the term eutrophication and its impact on plant life.

(4 marks)

(b) Identify a metal whose toxic ions can be released into waterways from the effects of acid deposition.

(1 mark)

(c) Aluminium hydroxide can be dissolved out of rocks under acidic conditions and release aluminium ions into the environment. Formulate an ionic equation for the reaction.

(1 mark)

(d) Aluminium hydroxide is amphoteric and can react with alkalis to form aluminate salts. Formulate an equation for the reaction between aluminium hydroxide and sodium hydroxide.

(1 mark)

3 (a) Two of the four oxoacids found in acid deposition are sulfurous acid, H_2SO_3 and nitrous acid, HNO_2 .

Write equations to show the formation of these oxoacids from sulfur and nitrogen.

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(4 marks)

(b) State the name and formula of the conjugate base of sulfurous acid, H_2SO_3 .

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(2 marks)

(c) Suggest ways of decreasing the impact of sulfurous acid on the environment.

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(2 marks)