Redox

Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Redox
Booklet	Question Paper

Time Allowed: **71 minutes**

Score: **/59**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Which is a disproportionation reaction?

☒ **A** $CaCO_3 \rightarrow CaO + CO_2$

☒ **B** $2H_2O_2 \rightarrow 2H_2O + O_2$

☒ **C** $2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$

☒ **D** $Mg(OH)_2 \rightarrow MgO + H_2O$

(Total for Question 1 = 1 mark)

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2 What is the volume of dilute sulfuric acid, concentration 0.0250 mol dm^{-3}, required to neutralize 20.0 cm^3 aqueous sodium hydroxide, concentration 0.0100 mol dm^{-3}?

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

☒ **A** 4.00 cm^3

☒ **B** 8.00 cm^3

☒ **C** 16.0 cm^3

☒ **D** 40.0 cm^3

(Total for Question 2 = 1 mark)

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3 The oxidation number of sulfur in potassium aluminium sulfate (potash alum), $KAl(SO_4)_2.12H_2O$, is

☒ **A** –2

☒ **B** +2

☒ **C** +6

☒ **D** +8

(Total for Question 3 = 1 mark)

4 The oxidation number of chlorine in $HClO_3$ is

- ☒ **A** –1
- ☒ **B** +3
- ☒ **C** +5
- ☒ **D** +7

(Total for Question 4 = 1 mark)

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5 Consider the following reaction.

$$Ca(OH)_2(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$$

This reaction can be classified as

- ☒ **A** acid-base.
- ☒ **B** precipitation.
- ☒ **C** redox.
- ☒ **D** thermal decomposition.

(Total for Question 5 = 1 mark)

6 Solid calcium hydroxide, $Ca(OH)_2$, is also known as 'slaked lime'. Over one million tonnes of slaked lime are produced annually in the UK.

(a) Limewater is an aqueous solution of calcium hydroxide, $Ca(OH)_2$. Limewater is used in the laboratory as a test for carbon dioxide.

(i) Suggest a value for the pH of limewater.

(1)

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(ii) Write an equation, including state symbols, for the reaction that takes place when limewater is used to confirm the presence of carbon dioxide.

(2)

(b) An aqueous solution of calcium hydroxide contains calcium ions and hydroxide ions.

(i) How many moles of **ions** are there in one mole of calcium hydroxide?

(1)

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(ii) How many moles of **electrons** are there in one mole of hydroxide ions?

(1)

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(c) 'Slaked lime' (solid calcium hydroxide) can be prepared from calcium carbonate, $CaCO_3$, in two stages.

Outline how this preparation would be carried out in the laboratory. Include an equation for each stage. State symbols are not required. You do **not** need to include any details of apparatus in your answer, but you should mention any essential conditions.

(4)

(d) Coal-fired power stations produce sulfur dioxide, SO_2. This pollutant gas is toxic and causes acid rain.

(i) The sulfur dioxide combines with water and oxygen in the atmosphere to produce sulfuric acid, H_2SO_4.

Write a balanced equation, including state symbols, for this overall reaction.

(2)

(ii) One way to lower the amount of sulfur dioxide emissions is to pass the waste gas through a fine powder of calcium oxide, CaO(s).

Explain why calcium oxide would be expected to react with sulfur dioxide.

(1)

(iii) State **one** other environmental problem associated with coal-fired power stations. Identify the substance which causes this problem.

(2)

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(Total for Question 6 = 14 marks)

7 This is a question about catalysis.

A spectacular demonstration of catalytic oxidation is the addition of chromium(III) oxide to ammonia gas in the presence of oxygen. This produces flashes, sometimes described as 'fireflies'.

Some concentrated ammonia solution is allowed to vaporise in a very large flask. Heated chromium(III) oxide catalyst is added.

The equation below shows one possible reaction.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

(a) The nitrogen atoms in ammonia are oxidized. Give the oxidation numbers of the nitrogen atoms in ammonia and nitrogen monoxide.

(2)

NH_3 ..... NO .....

(b) Nitrogen monoxide is an example of a free radical.

(i) Explain why nitrogen monoxide is classed as a free radical.

(1)

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(ii) Draw the dot and cross diagram of nitrogen monoxide, using dots (●) for the nitrogen electrons and crosses (×) for the oxygen electrons. Show outer shell electrons only.

(2)

(c) Suggest **one** suitable safety precaution for this demonstration. Justify your choice. You can assume that the demonstrator is wearing a lab coat and safety goggles.

(2)

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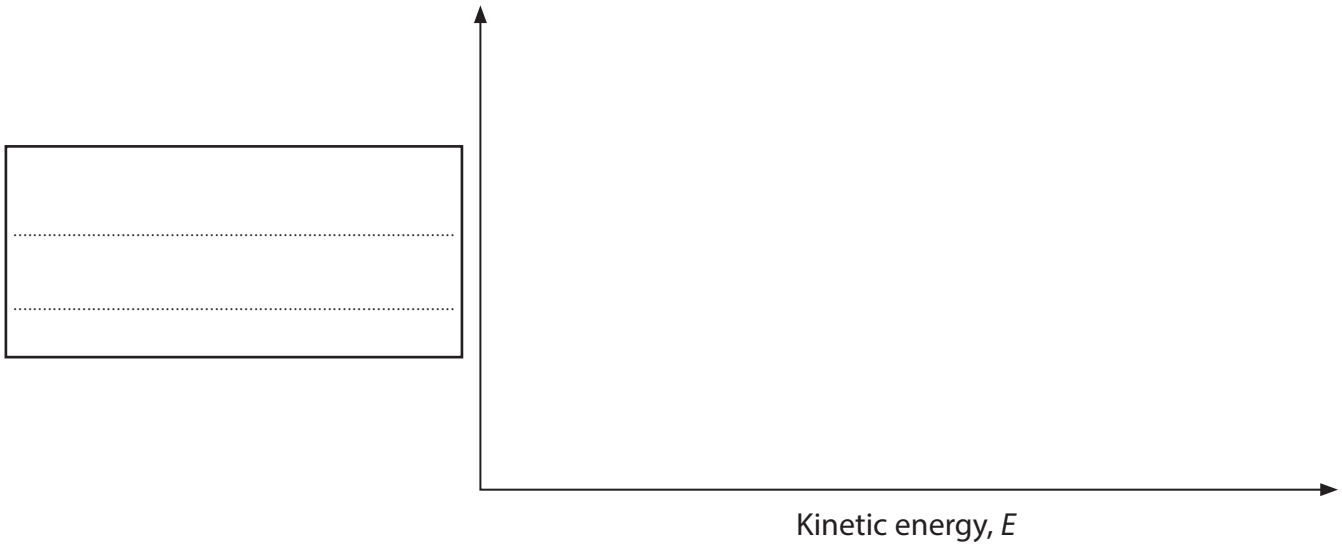
(d) (i) Draw a Maxwell-Boltzmann diagram on the axes below, labelling the activation energy of the reaction and the vertical axis.

(2)



*(ii) Use your diagram to explain how the presence of a catalyst such as chromium(III) oxide affects the rate of a chemical reaction.

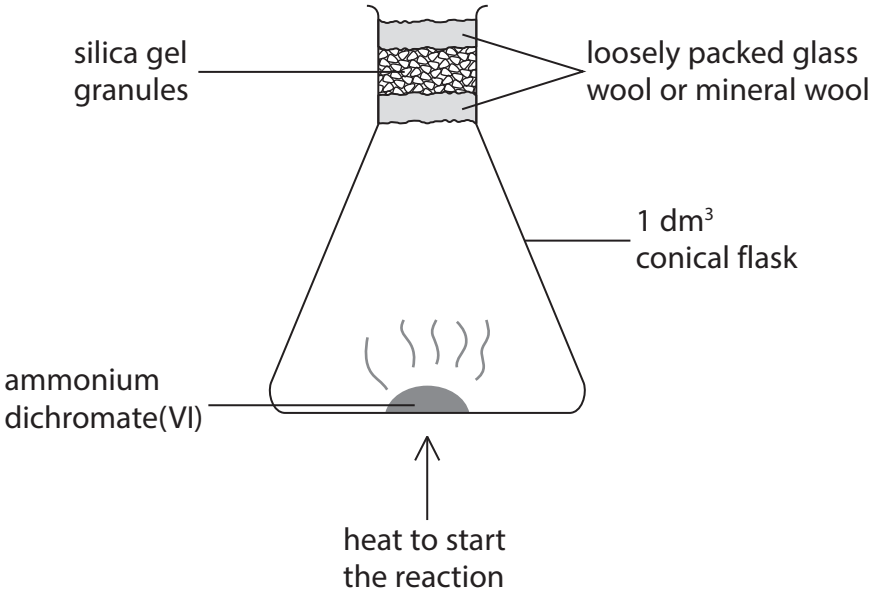
(2)

(e) Suggest how solid catalysts work in gaseous reactions.

(2)

(f) The chromium(III) oxide catalyst can be produced from a remarkable demonstration commonly called the 'dichromate volcano'.

One experimental apparatus that could be used is shown below.



(i) The substance used is ammonium dichromate(VI). Give the formula of ammonium dichromate(VI).

(1)

(ii) This thermal decomposition reaction is also a redox reaction involving the oxidation of nitrogen atoms. However, it does not require oxygen gas.

Suggest how the procedure could be modified to confirm that oxygen gas is not necessary for this oxidation.

(1)

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(iii) From your knowledge of other dichromate(VI) compounds, suggest the colour change that is observed in this demonstration.

(1)

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(Total for Question 7 = 16 marks)

8 When concentrated sulfuric acid is added to solid sodium chloride, the gas hydrogen chloride is produced.

(a) Write an equation for this reaction. State symbols are not required.

(1)

(b) Fumes of hydrogen chloride gas can be identified by bringing the fumes into contact with another gas, **X**. Identify gas **X** and state the observation you would make.

(2)

Gas **X** .....

Observation .....

(c) Chloride ions in solution can be distinguished from other halide ions by the addition of silver nitrate solution followed by dilute, aqueous ammonia.

State what you would see when silver nitrate solution is added to chloride ions, followed by dilute aqueous ammonia.

Suggest why concentrated ammonia should not be used to confirm that silver chloride has been formed.

(3)

Observation on addition of $AgNO_3$ .....

Observation on addition of dilute NH_3 .....

Reason why concentrated NH_3 should **not** be used .....

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(Total for Question 8 = 6 marks)

9 The thermit reaction is a 'classic' chemical demonstration. It is also a chemical reaction which has a number of important industrial uses.

(a) The thermit reaction is between iron(III) oxide and aluminium powder and produces aluminium oxide and iron. Complete the balanced equation. State symbols are not required.

(1)

$$Fe_2O_3 + 2Al \rightarrow \text{.....} + \text{.....}$$

(b) For the thermit reaction to work successfully, the iron(III) oxide and aluminium must be mixed in the correct stoichiometric ratio.

Calculate the mass of aluminium that would be required to react with 34.0 g of iron(III) oxide.

(3)

(c) The iron(III) oxide needs to be dried before it can be used in the thermit reaction. Suggest how this could be carried out.

(1)

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(d) The iron(III) oxide and aluminium must be thoroughly mixed. Suggest why this is essential for the reaction to work.

(1)

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(e) The thermit reaction requires a source of ignition in order to start. This source needs to generate a lot of heat. Simply heating to 'red-heat' is insufficient, as heating to 'white-heat' is necessary. Often a strip of magnesium ribbon is used as a fuse to ignite the thermit mixture.

(i) What would be seen when the magnesium ribbon is first lit?

(1)

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(ii) What is the chemical product of this reaction?

(1)

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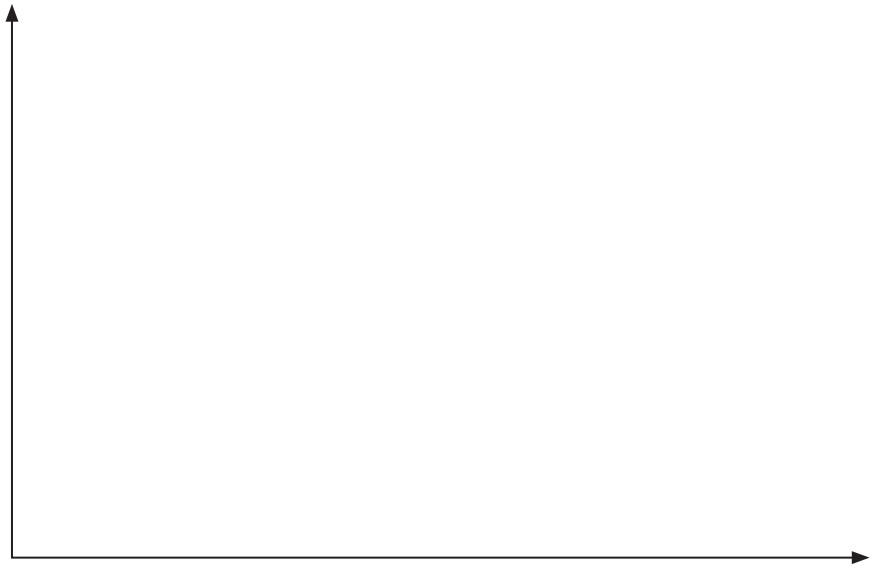
(iii) The lighting of the magnesium fuse creates enough heat energy to initiate the thermit reaction.

Draw a fully labelled reaction profile diagram for the thermit reaction.

The enthalpy change for this reaction is –825 kJ mol^{-1}.

(4)



(iv) Use your reaction profile to explain the role of the magnesium fuse in initiating the thermit reaction.

(1)

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(v) Explain why the magnesium fuse is **not** acting as a catalyst for the reaction.

(1)

(vi) Only a small quantity of magnesium is required to start the reaction. Suggest why this is the case.

(1)

(f) Occasionally, the thermit mixture can fail to ignite. Suggest why extreme caution should be exercised under such a situation.

(1)

(g) One industrial application of the thermit reaction is the welding, or the joining, of railway lines. How does the thermit reaction achieve this function?

(1)

(h) Many alternative chemicals can be used in a 'thermit-type' of reaction. In principle, other reactive metals could be used in place of aluminium, but this is rarely the case in real-life situations. Suggest why.

(1)

(Total for Question 9 = 18 marks)