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CHEMISTRY

Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	Oxidation Reducation & Redox
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	10
TOTAL MARKS	38

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Oxidation, Reduction and Redox Equations - 1

1. This question is about redox reactions.

(a) State, in terms of electrons, the meaning of the term oxidising agent.

(1)

(b) $\text{Cr}_2\text{O}_7^{2-}$ can oxidise SO_3^{2-} in acidic conditions to form Cr^{3+} and SO_4^{2-}

Deduce a half-equation for the oxidation of SO_3^{2-} to SO_4^{2-}

Deduce a half-equation for the reduction of $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+}

Deduce the overall equation for the oxidation of SO_3^{2-} by $\text{Cr}_2\text{O}_7^{2-}$

(3)

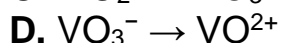
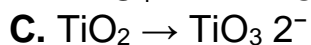
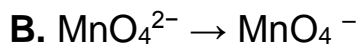
2. NO_2^- ions can be reduced in acidic solution to NO How many electrons are gained when each NO_2^- ion is reduced?

- A. 1
- B. 2
- C. 3
- D. 4

(Total 1 mark)

3. In which conversion is the metal reduced?

A. $\text{Cr}_2\text{O}_7^{2-} \rightarrow \text{CrO}_4^{2-}$



(Total 1 mark)

4. A student carried out an experiment to find the mass of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in an impure sample, X. The student recorded the mass of X.

This sample was dissolved in water and made up to 250 cm^3 of solution.

The student found that, after an excess of acid had been added, 25.0 cm^3 of this solution reacted with 21.3 cm^3 of a $0.0150 \text{ mol dm}^{-3}$ solution of $\text{K}_2\text{Cr}_2\text{O}_7$

- (a)** Use this information to calculate a value for the mass of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in the sample of X.

(5)

- (b)** The student found that the calculated mass of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ was greater than the actual mass of the sample that had been weighed out.

The student realised that this could be due to the nature of the impurity.

Suggest one property of an impurity that would cause the calculated mass of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in X to be greater than the actual mass of X. Explain your answer.

(2)

5. Which compound contains a chlorine atom with an oxidation state of +4?

- A. KClO_4
- B. CCl_4
- C. ClO_2
- D. ClO_2F

(Total 1 mark)

6. For many years, swimming pool water has been treated with chlorine gas. The chlorine is added to kill any harmful bacteria unintentionally introduced by swimmers.

Pool managers are required to check that the chlorine concentration is high enough to kill the bacteria without being a health hazard to the swimmers.

When chlorine reacts with water in the absence of sunlight, the chlorine is both oxidised and reduced and an equilibrium is established.

(a) Write an equation for this equilibrium.

For each chlorine-containing species in the equation, write the oxidation state of chlorine below the species.

(2)

(b) The pool manager maintains the water at a pH slightly greater than 7.0

Explain how this affects the equilibrium established when chlorine is added to water.

(2)

(c) Explain why chlorine is used to kill bacteria in swimming pools, even though chlorine is toxic.

(2)

7. Which equation does not represent a redox reaction?

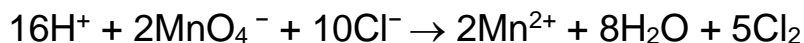
- A. $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$
- B. $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- C. $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$
- D. $\text{CuO} + 2\text{HCl} \rightarrow \text{CuCl}_2 + \text{H}_2\text{O}$

(Total 1 mark)

8. Chlorine is an important industrial chemical.

(a) Chlorine is formed when KMnO_4 reacts with hydrochloric acid.

The ionic equation for this redox reaction is



- i. Deduce the half-equation for the oxidation of chloride ions to chlorine.

ii. Give the oxidation state of manganese in the MnO_4^- ion. . (1)

iii. Deduce the half-equation for the reduction of the MnO_4^- ions in acidified solution to manganese(II) ions and water. (1)

(1)

(b) Chlorine behaves as an oxidising agent in the extraction of bromine from seawater.

In this process, chlorine gas is bubbled through a solution containing bromide ions.

i. Write the simplest ionic equation for the reaction of chlorine with bromide ions.

(1)

ii. Give one observation that would be made during this reaction.

(1)

iii. In terms of electrons, state the meaning of the term oxidising agent.

(1)

(c) In sunlight, chlorine can also oxidise water slowly to form oxygen.

Write an equation for this reaction.

Give the oxidation state of chlorine in the chlorine-containing species that is formed.

(2)

(d) Explain why chlorine has a lower boiling point than bromine.

(2)

9. Metals can be extracted by different methods.

(a) Give one reason why titanium cannot be extracted directly from titanium(IV) oxide using carbon.

(1)

(b) Titanium steel is an alloy of titanium and iron.

Titanium steel is extracted from the mineral ilmenite (FeTiO_3) in a two-stage process. Purified FeTiO_3 is first converted into a mixture of two metal chlorides.

These two metal chlorides are then reduced simultaneously using sodium.

- i.** Write an equation for the reaction of FeTiO_3 with chlorine and carbon to produce iron(III) chloride (FeCl_3), titanium(IV) chloride and carbon monoxide.

(1)

- ii. Write an equation for the simultaneous reduction of the mixture of iron(III) chloride and titanium(IV) chloride to iron and titanium using sodium.

(1)

- (c) Scrap iron is used to extract copper from dilute aqueous solutions containing copper(II) ions.

Explain, in terms of redox, what happens to the copper(II) ions in this extractio.

(2)

- (d) Aluminium is an expensive metal because it is extracted from molten aluminium oxide using electrolysis.

Write the half-equation for the reaction that occurs at the positive electrode during this extraction.

(1)

10. Which compound contains chlorine in an oxidation state of +1?

- A. Cl_2O
- B. KClO_3
- C. ClF_3
- D. CCl_4

(Total 1 mark)



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