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VCE Chemistry ¾
Introduction to Redox [1.6]
Homework

Homework Outline:

Compulsory Questions	Pg 2 – Pg 11
Supplementary Questions	Pg 12 – Pg 21

Section A: Compulsory Questions (47 Marks)

Sub-Section [1.6.1]: Apply Oxidation Numbers to Find Oxidant & Reductant

Question 1 (4 marks)

Find the oxidation number for all elements in each of the following molecules:

a. C_2H_5COOH. (1 mark)

b. H_2O. (1 mark)

c. O_2. (1 mark)

d. CH_4. (1 mark)

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Question 2 (4 marks)

Preesha is investigating the following chemical reaction:

$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$$

a. Find the oxidation numbers for all atoms in the following molecules:

i. CuO. (1 mark)

_____

_____

ii. Cu. (1 mark)

_____

b. Hence, determine and justify whether CuO is an oxidant or a reductant. (2 marks)

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Question 3 (4 marks)

Micah is observing the following reaction occurring at school.

$$2MnO_4^-(aq) + 16H^+(aq) + 10I^-(aq) \rightarrow 2Mn^{2+}(aq) + 5I_2(s) + 8H_2O(l)$$

His friend explains that the oxidising agent in this reaction is MnO_4^-. Evaluate Micah's friend's statement, using calculations as justification.

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Sub-Section [1.6.2]: Apply KOHES to Write Balanced Half-Equations in Acidic & Basic Conditions

Question 4 (2 marks)

Nitrate ions (NO_3^-) turn into nitrogen gas (N_2) in a laboratory.

a. Write the half-equation in acidic conditions. (1 mark)

b. Write the half-equation in alkaline conditions. (1 mark)

Question 5 (4 marks)

Complete the balanced half-equation for each of the following, and state whether it is a reduction or oxidation reaction.

a. Iron (II) ions turning into iron solid. (1 mark)

b. $AgNO_3$ turning into silver solid. (1 mark)

c. Ethanol (CH_3CH_2OH) turning into ethanoic acid (CH_3COOH). (1 mark)

_____

_____

d. Nitrogen dioxide (NO_2) turning into nitrogen gas (N_2). (1 mark)

_____

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Question 6 (4 marks)

In acidic conditions, dichromate ($Cr_2O_7^{2-}$) can react and turn into chromium ions (Cr^{3+}).

a. Write a balanced half-equation for this process. (1 mark)

_____

b. State whether this is an oxidation or reduction reaction and justify why. (2 marks)

_____

_____

c. Hence or otherwise, is Cr^{3+} an oxidant or reductant? (1 mark)

_____

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Sub-Section [1.6.3]: Apply KOHES to Write Balanced Half-Equations and Overall Equations in Acidic & Basic Conditions

Question 7 (6 marks)

Express the overall equation using the half equations provided.

a. Oxidation half-equation: (2 marks)

$$2I^-(aq) \rightarrow I_2(s) + 2e^-$$

Reduction half-equation:

$$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$$

b. Oxidation half-equation: (2 marks)

$$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$$

Reduction half-equation:

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

c. Oxidation half-equation: (2 marks)

$$H_2O_2(aq) \rightarrow O_2(g) + 2e^-$$

Reduction half-equation:

$$H_2O_2(aq) + 2e^- + 2H^+(aq) \rightarrow H_2O(l)$$

Question 8 (3 marks)

Lead (II) Pb^{2+} can be formed from Lead solid, Pb, when reacted with permanganate ions (MnO_4^-). Mn^{2+} ions are formed in the process.

Write the balanced equation for:

a. The oxidation reaction. (1 mark)

b. The reduction reaction. (1 mark)

c. The overall reaction. (1 mark)

Question 9 (4 marks)

Magnesium (Mg) can react with water (H_2O) in an alkaline environment to form magnesium hydroxide ($Mg(OH)_2$) and hydrogen gas (H_2).

Write the balanced equation for:

a. The oxidation reaction. (1 mark)

_____

_____

b. The reduction reaction. (1 mark)

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c. The overall reaction. (2 marks)

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Sub-Section: The 'Final Boss'

Question 10 (12 marks)

Liam is experimenting with Potassium dichromate ($K_2Cr_2O_7$) reacting with ethanol (C_2H_5OH), forming chromium (III) ions and acetic acid (CH_3COOH) in a reaction vessel with a pH of 8.2.

a. His friend explains that the reducing agent in this reaction is $K_2Cr_2O_7$. Evaluate Liam's friend's statement, using calculations as justification. (4 marks)

b. Express the half-equations involving the following and state the type of reaction occurring.

i. Oxidant. (2 marks)

ii. Reductant. (2 marks)

c. Write the complete reaction that Liam is observing. (2 marks)

d. Liam is also curious about the following reaction:

$$HNO_3(aq) + KOH(aq) \rightarrow KNO_3(aq) + H_2O(l)$$

State and explain whether the above reaction is a redox reaction. (2 marks)

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Section B: Supplementary Questions (43 Marks)

Sub-Section [1.6.1]: Apply Oxidation Numbers to Find Oxidant & Reductant

Question 11 (4 marks)

State the oxidation number for the element specified in the molecule/ion provided.

a. Oxidation number of Chromium in CrO_4^{2-}. (1 mark)

b. Oxidation number of Sulphur in SO_3^{2-}. (1 mark)

c. Oxidation number of Phosphorus in $H_2PO_4^-$. (1 mark)

d. Oxidation number of Nitrogen in NO_3^-. (1 mark)

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Question 12 (4 marks)

Natalie is investigating the following chemical reaction:

$$ZnO(s) + C(s) \rightarrow Zn(s) + CO_2(g)$$

a. Find the oxidation numbers for all atoms in the following molecules:

i. C. (1 mark)

_____

ii. CO_2. (1 mark)

_____

_____

b. Hence, determine and justify whether C (carbon) is a reductant or an oxidant. (2 marks)

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Question 13 (4 marks)

Kanta is observing the following reaction occurring at school:

$$2Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6I^-(aq) \rightarrow 2Cr^{3+}(aq) + 3I_2(g) + 7H_2O(l)$$

His friend explains that the reducing agent in this reaction is $Cr_2O_7^{2-}$. Evaluate Kanta's friend's statement, using calculations as justification.

Question 14

In an acidic solution, ascorbic acid ($C_6H_8O_6$) reacts with dichromate ions ($Cr_2O_7^{2-}$), resulting in the formation of chromium(III) ions (Cr^{3+}) and dehydroascorbic acid ($C_6H_6O_6$).

$$C_6H_8O_6(aq) + Cr_2O_7^{2-}(aq) + 8H^+(aq) \rightarrow C_6H_6O_6(aq) + 2Cr^{3+}(aq) + 4H_2O(l)$$

A friend claims that $\mathbf{C_6H_8O_6}$ is the reducing agent in this reaction. Evaluate this claim, justify your response with the relevant calculations.

Sub-Section [1.6.2]: Apply KOHES to Write Balanced Half-Equations in Acidic & Basic Conditions

Question 15 (2 marks)

Perchlorate ions (ClO_4^-) turn into chlorine gas (Cl_2) in a laboratory.

a. Write the half-equation in acidic conditions. (1 mark)

b. Write the half-equation in alkaline conditions. (1 mark)

Question 16 (4 marks)

Complete the balanced half-equation for each of the following, and state whether it is a reduction or oxidation reaction.

a. Copper (II) ions turning into copper solid. (1 mark)

b. Silver oxide (Ag_2O) turning into silver solid. (1 mark)

c. Butanol (C_4H_9OH) turning into butanoic acid ($C_4H_8O_2$). (1 mark)

d. Nitrous oxide (N_2O) turning into nitrogen gas (N_2). (1 mark)

Question 17 (4 marks)

In acidic conditions, potassium permanganate ($KMnO_4$) can react and turn into manganese ions (Mn^{2+}).

a. Write a balanced half-equation for this process. (1 mark)

b. State whether this is an oxidation or reduction reaction and justify why. (2 marks)

c. Hence or otherwise, is Mn^{2+} an oxidant or reductant? (1 mark)

Question 18 (4 marks)

In acidic conditions, potassium dichromate ($K_2Cr_2O_7$) reacts and turns into chromium(III) ions (Cr^{3+}).

a. Write a balanced half-equation for the reduction of potassium dichromate to chromium(III) ions in acidic conditions. (1 mark)

_____

_____

b. State whether this is an oxidation or reduction reaction and justify why. (2 marks)

_____

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c. Hence or otherwise, is Cr^{3+} an oxidant or reductant? (1 mark)

_____

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Sub-Section [1.6.3]: Apply KOHES to Write Balanced Half-Equations and Overall Equations in Acidic & Basic Conditions

Question 19 (4 marks)

Express the overall equation using the half-equations provided.

a. Oxidation half-equation: (2 marks)

$$Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^{-}$$

Reduction half-equation:

$$Cr_2O_7{}^{2-}(aq) + 14H^{+}(aq) + 6e^{-} \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

b. Oxidation half-equation: (2 marks)

$$2Cl^{-}(aq) \rightarrow Cl_2(g) + 2e^{-}$$

Reduction half-equation:

$$2H^{+}(aq) + 2e^{-} \rightarrow H_2(g)$$

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Question 20 (4 marks)

Zinc(II) Zn^{2+} can be formed from Zinc solid, Zn, when reacted with dichromate ions ($Cr_2O_7^{2-}$). Cr^{3+} ions are formed in the process.

Write the balanced equation for:

a. The oxidation reaction. (1 mark)

b. The reduction reaction. (1 mark)

c. The overall reaction. (2 marks)

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Question 21 (4 marks)

Sodium (Na) reacts with water in an alkaline environment to form sodium hydroxide and hydrogen gas.

Write the balanced equation for:

a. The oxidation reaction. (1 mark)

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b. The reduction reaction. (1 mark)

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c. The overall reaction. (2 marks)

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Question 22 (5 marks)

In the paper industry, bleaching is a crucial process to eliminate colour from pulp, ensuring the production of high-quality paper. Chlorine or chlorine compounds are commonly used in redox reactions to oxidise and remove impurities, enhancing the paper's brightness and quality.

a. Chlorine gas is used in a reaction with water. This purifies pulp and produces oxygen gas (O_2) and hypochlorous acid (HOCl).

Write a balanced equation for the:

i. Oxidation reaction. (1 mark)

_____

ii. Reduction reaction. (1 mark)

_____

iii. Overall reaction. (1 mark)

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_____

b. Hydrochloric acid (HCl) is also often used as an alternative to using chlorine gas. HCl can undergo the following reaction:

$$HCl(aq) + NaOH(aq) \rightarrow H_2O(l) + NaCl(aq)$$

State and explain whether the above reaction is a redox reaction. (2 marks)

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