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Chapter test

Chapter 5 Electrochemical cells

Name: _____

Class: _____

Time permitted: 50 minutes

	Section	Number of questions	Marks available	Marks achieved
A	Multiple choice	15	15	
B	Short answer	5	15	
	Total	**20**	**30**	

Grade: _____

Scale:

A+	29–30	A	26–28	B	23–25	C	19–22	D	15–18	E	9–14	UG	0–8

Comments:

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Section A Multiple choice (15 marks)

Section A consists of 15 questions, each worth one mark. Each question has only one correct answer. Circle the correct answer. Attempt all questions. Marks will not be deducted for incorrect answers. You are advised to spend no more than 15 minutes on this section.

1   An electrolytic cell and galvanic cell both:
    A   convert chemical energy into electrical energy.
    B   are spontaneous chemical reactions.
    C   are in one container.
    D   have a battery to supply electrons.

2   In an electrochemical cell the anode is the:
    A   positive electrode where reduction occurs.
    B   positive electrode where oxidation occurs.
    C   negative electrode where reduction occurs.
    D   negative electrode where oxidation occurs.

3   Write the correct notation for the following galvanic cell: a zinc electrode in a solution of tin ions, connected by a salt bridge to a beaker of zinc ions with a tin electrode.
    A $Zn|Zn^{2+}||Sn^{2+}|Sn$
    B $Sn|Zn^{2+}||Sn^{2+}|Zn$
    C $Sn|Sn^{2+}||Zn^{2+}|Zn$
    D $Zn|Sn^{2+}||Zn^{2+}|Sn$

4   Using your data sheet, which of the following reactions are likely?
    i $Sn(s) + Zn^{2+}(aq) \rightarrow Sn^{2+}(aq) + Zn(s)$
    ii $Zn(s) + 2Fe^{3+}(aq) \rightarrow Zn^{2+}(aq) + 2Fe^{2+}(aq)$
    iii $2Fe^{2+}(aq) + Sn^{2+}(aq) \rightarrow 2Fe^{3+}(aq) + Sn(s)$
    iv $Zn^{2+}(aq) + H_2(g) \rightarrow Zn(s) + 2H^+(aq)$
    v $3Sn^{2+}(aq) + 2Al(s) \rightarrow 2Al^{3+}(aq) + 3Sn(s)$

    A   i, ii and v
    B   ii and v
    C   i and ii
    D   iii and iv

Reaction to answer Questions 5–6

$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$

5   Which statement below is true?
    A   The oxidation number of iron drops.
    B   The oxidation number of oxygen increases.

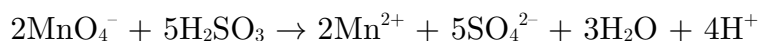**C** Iron is oxidised.

D Aluminium is reduced.

6　Which two half equations is this reaction a summation of?

    i　$Fe_2O_3 + 6H^+ \rightarrow 2Fe + 3H_2O + 6e^-$

    ii　$Al + 6H^+ + 6e^- \rightarrow Al_2O_3 + 3H_2O$

    iii　$Fe_2O_3 + 6H^+ + 6e^- \rightarrow 2Fe + 3H_2O$

    iv　$Al_2O_3 + 6H^+ + 6e^- \rightarrow 2Al + 3H_2O$

    v　$2Al + 3H_2O \rightarrow Al_2O_3 + 6H^+ + 6e^-$

A i and ii

B ii and iii

C ii and v

D iii and iv

7　Copper purification removes impurities from the raw copper. Which equations below best describe this process?

A Anode: $Cu^{2+} + 2e^- \rightarrow Cu$, Cathode: $Cu \rightarrow Cu^{2+} + 2e^-$

B Anode: $Cu \rightarrow Cu^{2+} + 2e^-$, Cathode: $Cu \rightarrow Cu^{2+} + 2e^-$

C Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$, Anode: $Cu^{2+} + 2e^- \rightarrow Cu$

D Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$, Anode: $Cu \rightarrow Cu^{2+} + 2e^-$

8　Electrolysis of water is touted as a clean source of fuel for cars. The overall reaction is $2H_2O \rightarrow O_2 + H_2$. Which reactions combine to give this result?

    i　$H_2O + 2e^- \rightarrow 2OH^- + H_2$

    ii　$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

    iii　$4H^+ + 4e^- \rightarrow 2H_2$

    iv　$2H_2O \rightarrow 2H_2 + O_2$

    v　$4OH^- \rightarrow 2H_2O + O + 4e^-$

A Only iv

B iii and v

C i and iv

D iii and iv

9　In the electrolysis of water above, which species are oxidised and which are reduced?

A OH^- is oxidised and H^+ is reduced.

B H_2O is both oxidised and reduced.

C OH^- is reduced and H^+ is oxidised.

D H_2O is oxidised and H^+ is reduced.

10　Which of the following is essential for rust to form on iron?

A Oxygen

B Oxygen and water

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C Oxygen, water and salt

D Water and salt

11 What happens to an oxidant in a redox reaction?

   A It is oxidised and gains electrons.

   B It is oxidised and loses electrons.

   C It is reduced and gains electrons.

   D It is reduced and loses electrons.

12 Consider the following reaction:

$$2MnO_4^- + 5H_2SO_3 \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O + 4H^+$$

   What is the reduced species?

   A MnO_4^-

   B Mn^{2+}

   C H_2SO_3

   D SO_4^{2-}

13 For the following electrochemical cell, which statement is correct?

$$Zn(s)\,|\,Zn^{2+}(aq)\,||\,Ag^+(aq)\,|\,Ag(s)$$

   A Zn is oxidised and is the anode.

   B Zn is reduced and is the anode.

   C Zn is oxidised and is the cathode.

   D Zn is reduced and is the cathode.

14 For a reaction to be spontaneous in an electrochemical cell:

   A the E° value must be positive and the battery supplies energy.

   B the E° value must be negative and the battery supplies energy.

   C the E° value must be positive and the reaction supplies energy.

   D the E° value must be negative and the reaction supplies energy.

15 Which is the correct oxidation half equation for the following redox reaction?

$$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$
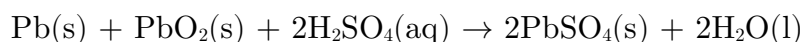
   A $4H^+ + 2O^- \rightarrow 2H_2O(l)$

   B $Pb(s) \rightarrow Pb^{2+} + 2e^-$

   C $2H^+ + O^- \rightarrow H_2O(l)$

   D $Pb(s) \rightarrow Pb^+ + e^-$

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Section B Short answer (15 marks)

Section B consists of five questions. Write your answers in the spaces provided. You are advised to spend 20 minutes on this section.

1   Steel sheets are coated with zinc to protect them from rusting; these galvanised sheets are protected from rusting as the zinc corrodes sacrificially to stop the iron from rusting.

    a Using your data sheet explain why zinc and magnesium can be used but not lead to protect steel.

    b Use $E°$ values to show why rusting (the reaction between iron and oxygen) occurs, where iron is oxidised to ferrous ions and oxygen is reduced to hydroxide ions.

(2 + 2 = 4 marks)

2 **a** Describe oxidation and reduction in terms of electron transfer.

    b What are the advantages of fuel cells in vehicles?

(1 + 1 = 2 marks)

An electrochemical cell to answer Questions 3–4

Silver rod immersed in a solution of silver nitrate connected via wires and voltmeter to a nickel rod immersed in nickel nitrate solution.

3   Sketch the electrochemical cell and label the solutions, electrodes, direction of electron flow and which electrode is the anode and cathode.

(3 marks)

4 **a** Describe what happens in the salt bridge and suggest a suitable solution to use in the salt bridge.

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b Calculate the $E°$ value of the cell.

(2 + 1 = 3 marks)

5 A methane fuel cell has been proposed for development. Below are the unbalanced reduction and oxidation half reactions. Complete them and give the overall redox reaction.

Oxidation ½ equation	$CH_4 + OH^- \rightarrow CO_2 + H_2O + e^-$
Reduction ½ equation	$O_2 + H_2O + e^- \rightarrow OH^-$
Overall reaction	$CH_4 + 2O_2 \rightarrow CO_2 + 2\ H_2O$

(3 marks)