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Chapter test

Chapter 3 Introduction to redox chemistry

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 Which of the following is correct?

   A Reduction is the loss of electrons with an increase in oxidation number.

   B Oxidation is the loss of electrons with an increase in oxidation number.

   C Reduction is the gain of electrons with an increase in oxidation number.

   D Oxidation is the gain of electrons with an increase in oxidation number.

2 Which of the following are redox reactions?

   i $PI_3 + 3H_2O \rightarrow H_3PO_3 + 3HI$

   ii $Sn + Cu^{2+} \rightarrow Sn^{2+} + Cu$

   iii $Na_2CO_3 \rightarrow Na_2O + CO_2$

   iv $KOH + HCl \rightarrow H_2O + KCl$

   v $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

   A i, ii and v

   B ii and v

   C ii, iii and v

   D ii, iii and iv

3 Successive ionisation energies can determine the group to which an element belongs.

   Which group does this element belong to?

   1st: 576 kJ mol^{-1}

   2nd: 1817 kJ mol^{-1}

   3rd: 2745 kJ mol^{-1}

   4th: 11 577 kJ mol^{-1}

   A 2

   B 13

   C 14

   D 15

4 A redox reaction is one where:

   A a reactant *is* oxidised.

   B a reactant *is* reduced.

   C reactants are *either* oxidised or reduced.

   D reactants are *both* oxidised and reduced.

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Metal list data to answer Questions 5–8

Li^+/Li: –3.04
K^+/K: –2.92
Zn^{2+}/Zn: –0.76
H^+/H: 0.00
$S_4O_6^{2-}/S_2O_3^{2-}$: +0.08
Br_2/Br^-: +1.08
Cl_2/Cl^-: +1.36
F_2/F^-: +2.87

5   Which metal from the list above is the strongest reducing agent?

    A Lithium

    B Fluorine

    C Potassium

    D Chlorine

6   Which from the list above is the strongest oxidising agent?

    A Lithium

    B Fluorine

    C Potassium

    D Chlorine

7   Which ion from the list above is the strongest reducing agent?

    A Li^+

    B $S_2O_3^{2-}$

    C F^-

    D Zn^{2+}

8   Which combination of electrode potentials would produce the largest voltage?

    A $Li^+|Li||F_2|F^-$

    B $Li^+|Li||H^+|H$

    C $F_2|F^-||H^+|H$

    D $S_4O_6^{2-}|S_2O_3^{2-}||Cl_2|Cl^-$

Unbalanced reaction to answer Questions 9–11

$$Fe^{2+} + Cr_2O_7^{2-} \rightarrow Fe^{3+} + Cr^{3+}$$
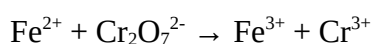
9   In order, what are the oxidation numbers of Fe and Cr in the reactants?

    A 0, –2

    B +2, +6

    C +2, +12

    D 0, +14

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10 What species is being reduced?

   A Fe^{2+}

   B $Cr_2O_7^{2-}$

   C Fe^{3+}

   D Cr^{3+}

11 What species is being oxidised?

   A Fe^{2+}

   B $Cr_2O_7^{2-}$

   C Fe^{3+}

   D Cr^{3+}

12 Choose the necessary coefficients of each species to balance this equation.

(*Note*: Some will be zero; i.e. are not there at all.)

$$\underline{\quad}Fe^{2+} + \underline{\quad}Cr_2O_7^{2-} + \underline{\quad}H^+ + \underline{\quad}H_2O \rightarrow \underline{\quad}Fe^{3+} + \underline{\quad}Cr^{3+} + \underline{\quad}H^+ + \underline{\quad}H_2O$$

   A 1, 1, 2, 0 → 1, 2, 0, 1

   B 1, 1, 14, 0 → 1, 2, 0, 7

   C 6, 1, 14, 0 → 6, 2, 0, 7

   D 2, 1, 14, 0 → 2, 2, 0, 7

13 The cobalt cadmium battery converts chemical energy to electrical energy, which species is oxidised when the battery discharges?

$$2Co(OH)_3 + Cd + 2H_2O \rightarrow 2Co(OH)_2 + Cd(OH)_2$$

   A Co^{3+}

   B Co^{2+}

   C Cd

   D Cd^{2+}

Information to answer Questions 14–15

An electrochemical cell was set up using magnesium and silver electrodes and 1.0 mol L^{-1} solutions of the respective ions. The $E°$ of the cell at 25°C is 3.08 V.

14 If the temperature rose to 90°C:

   A the $E°$ of the cell would not change.

   B the $E°$ of the cell would increase.

   C the $E°$ of the cell would decrease.

   D the $E°$ of the cell cannot be determined.

15 If [Mg^{2+}] was changed to 0.1 mol L^{-1}:

   A the $E°$ of the cell would not change.

   B the $E°$ of the cell would increase.

   C the $E°$ of the cell would decrease.

**D** the $E°$ of the cell cannot be determined.

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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 **a** Determine the oxidation number of each element in each compound listed.
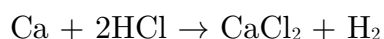
$$CO_2, \ PCl_3, \ CH_4, \ H_3PO_4, \ [Cu(NH_3)_4]^{2+}$$

b Place the following in order of oxidation number for Mn.

$$K_2MnO_4, \ MnSO_4, \ KMnO_4, \ MnO_2^{-}$$
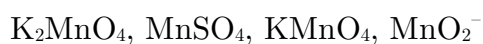
(1 + 2 = 3 marks)

2 Using oxidation numbers, show whether the following are redox reactions. Identify which species is oxidised and which is reduced.

$$Ca + 2HCl \rightarrow CaCl_2 + H_2$$
$$3HCl + HNO_3 \rightarrow Cl_2 + NOCl + 2H_2O$$

(2 marks)

3 **a** Graph the following first ionisation energies in kJ mol^{-1}:

O = 1314   Mg = 496

F = 1681   Mg = 738

Ne = 2081

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b Write the electron configurations for each element listed above.

c Explain the trends in the first ionisation energies shown.

d Is ionisation endothermic or exothermic? Explain.

(1 + 1 + 1 + 1 = 4 marks)

4 The table below shows successive ionisation energies for several elements.

| Element	1st	2nd	3rd	4th	5th	6th
A	2000	4000	6000	9500	12 000	15 500
B	500	4500	7000	9500	13 500	16 500
C	750	1500	7700	10 500	13 500	18 000
D	1400	2900	4600	5900	8000	9500
E	400	3000	4500	5900	8000	9600
F	1000	2400	4600	6200	38 000	47 000

a Which is likely to belong to Group 1?

b Which is likely to belong to Group 14?

c Which group would Element A belong to?

(1 + 1 + 1 = 3 marks)

5 Balance the following redox reaction, showing the balanced half equations first.

$$Sn^{2+} + IO_3^- \rightarrow Sn^{4+} + I^-$$
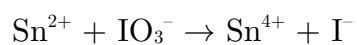
a Reduction half equation

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b Oxidation half equation

c Overall balanced redox reaction

(1 + 1 + 1 = 3 marks)