

## Chapter test with answers

# Chapter 3 Introduction to redox chemistry

Time permitted: 50 minutes

	Section	Number of questions	Marks available
<b>A</b>	Multiple choice	15	15
<b>B</b>	Short answer	5	15
	<b>Total</b>	<b>20</b>	<b>30</b>

Scale:

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

- Which of the following is correct?
  - Reduction is the loss of electrons with an increase in oxidation number.
  - Oxidation is the loss of electrons with an increase in oxidation number.*
  - Reduction is the gain of electrons with an increase in oxidation number.
  - Oxidation is the gain of electrons with an increase in oxidation number.
- Which of the following are redox reactions?
  - $\text{PI}_3 + 3\text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_3 + 3\text{HI}$
  - $\text{Sn} + \text{Cu}^{2+} \rightarrow \text{Sn}^{2+} + \text{Cu}$
  - $\text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{O} + \text{CO}_2$
  - $\text{KOH} + \text{HCl} \rightarrow \text{H}_2\text{O} + \text{KCl}$
  - $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$
  - i ii and v
  - ii and v*
  - ii, iii and v
  - 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:  $576 \text{ kJ mol}^{-1}$

2nd:  $1817 \text{ kJ mol}^{-1}$

3rd:  $2745 \text{ kJ mol}^{-1}$

4th:  $11\,577 \text{ kJ mol}^{-1}$

- 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.*

#### Metal list data to answer Questions 5–8

$\text{Li}^+/\text{Li}$ :  $-3.04$

$\text{K}^+/\text{K}$ :  $-2.92$

$\text{Zn}^{2+}/\text{Zn}$ :  $-0.76$

$\text{H}^+/\text{H}$ :  $0.00$

$\text{S}_4\text{O}_6^{2-}/\text{S}_2\text{O}_3^{2-}$ :  $+0.08$

$\text{Br}_2/\text{Br}^-$ :  $+1.08$

$\text{Cl}_2/\text{Cl}^-$ :  $+1.36$

$\text{F}_2/\text{F}^-$ :  $+2.87$

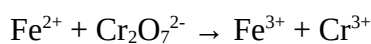
- 5 Which metal from the list above is the strongest reducing agent?  
 A *Lithium*  
 B Fluorine  
 C Potassium  
 D Chlorine
- 6 Which from the list above is the strongest oxidising agent?  
 A Lithium  
 B *Fluorine*  
 C Potassium  
 D Chlorine
- 7 Which ion from the list above is the strongest reducing agent?  
 A  $\text{Li}^+$   
 B  *$\text{S}_2\text{O}_3^{2-}$*

- C**  $\text{F}^-$
- D**  $\text{Zn}^{2+}$

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



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

10 What species is being reduced?

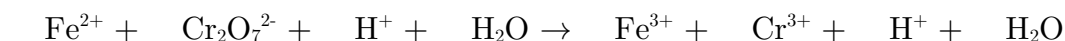
- A  $Fe^{2+}$
- B  $Cr_2O_7^{2-}$
- C  $Fe^{3+}$
- D  $Cr^{3+}$

11 What species is being oxidised?

- A  $Fe^{2+}$
- B  $Cr_2O_7^{2-}$
- C  $Fe^{3+}$
- D  $Cr^{3+}$

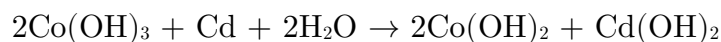
12 Choose the necessary coefficients of each species to balance this equation.

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



- 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?



- 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  $1.0 \text{ mol L}^{-1}$  solutions of the respective ions. The  $E^\circ$  of the cell at  $25^\circ\text{C}$  is  $3.08 \text{ V}$ .

- 14** If the temperature rose to  $90^\circ\text{C}$ :
- A** the  $E^\circ$  of the cell would not change.
  - B** *the  $E^\circ$  of the cell would increase.*
  - C** the  $E^\circ$  of the cell would decrease.
  - D** the  $E^\circ$  of the cell cannot be determined.
- 15** If  $[\text{Mg}^{2+}]$  was changed to  $0.1 \text{ mol L}^{-1}$ :
- A** the  $E^\circ$  of the cell would not change.
  - B** the  $E^\circ$  of the cell would increase.
  - C** *the  $E^\circ$  of the cell would decrease.*
  - D** the  $E^\circ$  of the cell cannot be determined.

### 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.

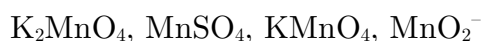


*Answer:*

$\text{CO}_2$	$\text{PCl}_3$	$\text{CH}_4$	$\text{H}_3\text{PO}_4$	$[\text{Cu}(\text{NH}_3)_4]^{2+}$
+4, -2	+3, -1	-4, +1	+1, +5, -2	+2, -3, +1

(1 mark)

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

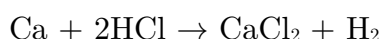


*Answer:* Oxidation number for each Mn in order is +5, +2, +7, +3 and -4

So order becomes  $\text{MnSO}_4, \text{MnO}_2^-, \text{K}_2\text{MnO}_4, \text{KMnO}_4$  (2 marks)

(= 3 marks total)

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



*Answer:* Oxidation is an increase and reduction is a decrease in oxidation number.

Ca	2HCl	CaCl <sub>2</sub>	H <sub>2</sub>
0	+1, -1	+2, -1	0

Ca is oxidised and HCl is reduced.

(= 1 mark total)

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

O = 1314

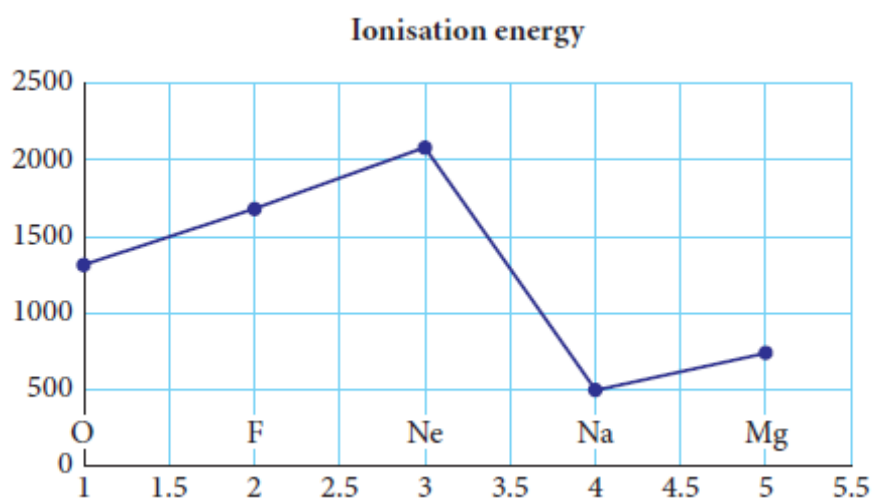
F = 1681

Ne = 2081

Mg = 496

Mg = 738

Answer:



(2 marks)

- b Write the electron configurations for each element listed above.

Answer:

O	F	Ne	Na	Mg
2, 6	2, 7	2, 8	2, 8, 1	2, 8, 2

- c Explain the trends in the first ionisation energies shown.

Answer: As you look from O to Ne the outer shell of electrons is being filled *and* the proton number is increasing which progressively holds those electrons tighter across the period.

The next shell appears at Na, so it is further from the nucleus and easier to remove hence the drop in ionisation energy, again as you move across a period the nuclear charge increases making it more difficult to remove the outer electrons.

(1 mark)

- d Is ionisation endothermic or exothermic? Explain.

Answer: Ionisation is endothermic, energy is needed to remove an electron from an atom.

(1 mark)

(= 5 marks total)





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?

Answer: B

(1 mark)

b Which is likely to belong to Group 14?

Answer: F

(1 mark)

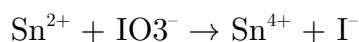
c Which group would Element A belong to?

Answer: Group 18

(1 mark)

(= 3 marks total)

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



a Reduction half equation

Answer:



(1 mark)

b Oxidation half equation

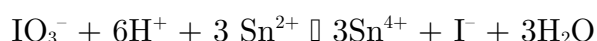
Answer:



(1 mark)

c Overall balanced redox reaction

Answer:



(1 mark)

(= 3 marks total)