Year 12 Chemistry
Test: Redox 2009

Name: _____ Time allowed : 45min

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

	Mark	**Out of**
Part 1		10
Part 2		19
Part 3		9
Total		38

PART ONE: MULTIPLE CHOICE (10 QUESTIONS 10 MARKS)

Please answer these questions on the separate multiple choice answer sheet provided.

1. When Fe^{2+} is oxidised to Fe^{3+}, the Fe^{2+} ion

a) loses 1 electron
b) gains 1 electron
c) loses 1 proton
d) gains 1 proton

2. Each of the elements below is placed in water. Which one will react violently with the water?

a) Ne
b) Fe
c) Cu
d) Na

3. The following redox reaction occurs in an acidic solution:

$$Ce^{4+} + Bi \rightarrow Ce^{3+} + BiO^{+}$$

What is the coefficient before the Ce^{4+} when the equation is fully balanced?

a) 1
b) 2
c) 3
d) 6

4. Which of the following elements will NOT react with hydrochloric acid to produce hydrogen gas?

a) Zn
b) Fe
c) Hg
d) Ca

5. In which one of the following reactions is disproportionation taking place?

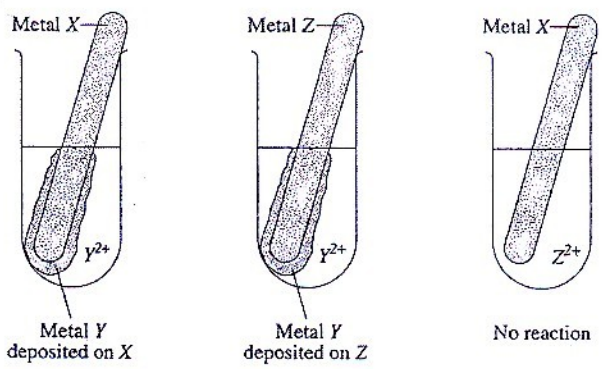
a) $4H^{+} + 3\ MnO_4^{2-} \rightarrow 2MnO_4^{-} + MnO_2 + 2H_2O$

b) $2\ FeCl_2 + Cl_2 \rightarrow 2\ FeCl_3$

c) $H_2O_2 + 2\ NO_3^{-} + 2H^{+} \rightarrow O_2 + 2\ NO_2 + 2\ H_2O$

d) $2\ Cu^{+} + Sn^{2+} \rightarrow 2Cu + Sn^{4+}$

6. A student performed three tests to investigate the relative activity of metals. In each test a metal strip was placed in a solution containing ions of a different metal. The results are shown in the diagram below.



What is the order of activity of the metals, based on these results?

a) X > Z > Y
b) Y > X > Z
c) Z > Y > X
d) Z > X > Y

7. Use the Standard Reduction Table to predict the reaction products when copper (II) chloride solution is shaken with an iron nail.

a) Fe^{2+} and Cu^{+}

b) Fe^{3+} and Cu^{+}

c) Fe^{3+} and Cu^{2+}

d) Fe^{2+} and Cu

8. Which one of the following species is the strongest oxidising agent at 25 ^{o}C?

a) $F_2(g)$

b) $F^{-}(aq)$

c) Na(s)

d) $Na^{+}(aq)$

9. Consider the following equation, which represents a reaction in the extraction of chromium from its ore

$$2Fe_2O_3.Cr_2O_3 + 4Na_2CO_3 + 3O_2 \longrightarrow 2Fe_2O_3 + 4Na_2CrO_4 + 4CO_2$$

Which of the following statements about the oxidation states of the substances is correct?

a) The iron has been reduced from a +3 to a +2 oxidation state

b) The chromium has been oxidised from a +3 to a +6 state

c) The carbon has been oxidised from a +2 to a +4 state

d) The reaction is not a REDOX reaction and no species have changed oxidation state

10. According to the Standard Reduction Table, which of the following 1.0 mol L^{-1} solutions is not stable due to a predicted spontaneous redox reaction between its ions?

a) $Hg_2(NO_3)_2$

b) CuBr

c) $MgSO_4$

d) FeI_3

PART TWO WRITTEN 5 QUESTIONS 19 MARKS

1. In a lightning flash the following reaction occurs

$$N_2 + O_2 \leftrightarrow 2NO \quad \Delta H = +180 kJmol^{-1}$$

a) Give the oxidation number for nitrogen in N_2 and NO

N_2 _____

NO _____ (2 marks)

b) Name the oxidising agent in the forward reaction (1 mark)

_____

2. The green manganate ion $MnO_4^{2-}{}_{(aq)}$ in an acidic solution spontaneously undergoes a disproportionation reaction forming the pink-purple permanganate ion $MnO_4^{-}{}_{(aq)}$ and colourless manganese (II) ions $Mn^{2+}{}_{(aq)}$

a) Write a balanced half equation to represent the oxidation process

_____

(2 marks)

b) Write a balanced half equation to represent the reduction process

_____

(2 marks)

c) Write a balanced equation that represents the redox process

_____

(1 mark)

3. The addition of lead (II) nitrate , $Pb(NO_3)_{2(aq)}$ to a solution containing $I^-{}_{(aq)}$ ions, such $NaI_{(aq)}$, produces a bright yellow precipitate of $PbI_{2(s)}$. Is this a redox reaction? Explain your answer. (2 marks)

_____

_____

4. Write balanced ionic equations for the following reactions. In each case describe observations such as colour changes, precipitate formation (give colour) or gas evolution (give colour or describe as colourless)

a) Concentrated nitric acid is added to magnesium metal.

Equation _____

_____

Observation _____

b) Hydrogen gas is mixed with chlorine gas.

Equation _____

_____

Observation _____

c) Bromine water is added to zinc metal

Equation _____

_____

Observation _____

(6 marks)

5. Acidified potassium permanganate solution oxidises ammonium iron (II) sulfate, $(NH_4)_2SO_4$. $FeSO_4.6H_2O$.

Write a balanced overall ionic equation for the reaction and describe what is observed.

Equation _____

(2 marks)

Observation _____

_____

(1 mark)

PART THREE CALCULATIONS 1 QUESTION 9 MARKS

1. Pyrolusite, an ore of manganese, contains manganese in the form of MnO_2. A sample of pyrolusite from a newly discovered deposit is analysed to determine the degree of purity of the deposit.

   To determine the amount of Mn in the pyrolusite sample, 1.25g of dried pyrolusite was heated with 100mL of 0.150M oxalic acid ($H_2C_2O_4$). The oxalic acid was in excess, so that all of the MnO_2 reacted according to the following equation

   $$MnO_{2(s)} + H_2C_2O_{4(aq)} + 2H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 2CO_{2(g)} + 2H_2O_{(l)}$$

   20.00mL of the resulting solution is then titrated with an 0.0510M solution of the triiodide ion

   $$I_3^-{}_{(aq)} + H_2C_2O_{4(aq)} \rightarrow 2CO_{2(g)} + 2H^+_{(aq)} + 3I^-_{(aq)}$$

   22.00mL of the 0.05M triiodide solution was needed to react with the remaining oxalic acid.

   a) Calculate the moles of oxalic acid remaining in the original 100mL solution after the pyrolusite had been reacted with the oxalic acid.

   (4 marks)

   b) Calculate the moles of oxalic acid used to reduce the MnO_2 in the 1.25g of pyrolusite.

   (2 marks)

c) Calculate the percentage by mass of MnO_2 in the pyrolusite.

(3 marks)

Year 12 Chemistry
Test: Redox 2009 ANSWERS

Multiple choice

1. a 2. d 3. c 4. c 5. a 6. d 7. d 8. a 9. b 10. d

Part Two

1. In a lightning flash the following reaction occurs

$$N_2 + O_2 \leftrightarrow 2NO \quad \Delta H = +180 kJmol^{-1}$$

b) Give the oxidation number for nitrogen in N_2 and NO

N_2 0

NO +2 (2 marks)

b) Name the oxidising agent in the forward reaction (1 mark)

oxygen gas

2. The green manganate ion $MnO_4^{2-}{}_{(aq)}$ in an acidic solution spontaneously undergoes a disproportionation reaction forming the pink-purple permanganate ion $MnO_4^{-}{}_{(aq)}$ and colourless manganese (II) ions $Mn^{2+}{}_{(aq)}$

b) Write a balanced half equation to represent the oxidation process

$MnO_4^{2-} \rightarrow MnO_4^{-} + e^{-}$

(2 marks)

b) Write a balanced half equation to represent the reduction process

$MnO_4^{2-} + 8H^{+} + 4e^{-} \rightarrow Mn^{2+} + 4H_2O$

(2 marks)

c) Write a balanced equation that represents the redox process

$5MnO_4^{2-} + 8H^{+} \rightarrow 4\,MnO_4^{-} + Mn^{2+} + 4H_2O$

(1 mark)

3. The addition of lead (II) nitrate , $Pb(NO_3)_{2(aq)}$ to a solution containing $I^{-}{}_{(aq)}$ ions, such $NaI_{(aq)}$, produces a bright yellow precipitate of $PbI_{2(s)}$. Is this a redox reaction? Explain your answer. (2 marks)

- **Not redox (1mk)**
- **No change in oxidation number for any species (1mk)**

4. Write balanced ionic equations for the following reactions. In each case describe observations such as colour changes, precipitate formation (give colour) or gas evolution (give colour or describe as colourless)

a) Concentrated nitric acid is added to magnesium metal.

$e^- + NO_3^- + 2H^+ \rightarrow NO_2 + H_2O$) x 2

$Mg \rightarrow Mg^{2+} + 2e^-$

Equation $Mg + 2NO_3^- + 4H^+ \rightarrow Mg^{2+} + 2NO_2 + 2H_2O$ (1mk)

Observation a colourless liquid is added to a silver grey solid and a brown pungent gas forms in a colourless solution, the solid begins to disappear (1mk)

b) Hydrogen gas is mixed with chlorine gas.

Equation $Cl_{2(g)} + H_{2(g)} \rightarrow 2HCl_{(g)}$ (1mk)

Observation a colourless, odourless gas is mixed with a pale yellow, pungent gas and a colourless gas is formed (1mk)

c) Bromine water is added to zinc metal

Equation $Br_2 + Zn \rightarrow Zn^{2+} + 2Br^-$ (1mk)

Observation a red/brown solution is added to a silver/grey solid, the red/brown colour fades and the solid begins to disappear (1mk)

(6 marks)

5. Acidified potassium permanganate solution oxidises ammonium iron (II) sulfate, $(NH_4)_2SO_4.FeSO_4.6H_2O$.

Write a balanced overall ionic equation for the reaction and describe what is observed.

$Fe^{2+} \rightarrow Fe^{3+} + e^-$)x5

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

Equation $5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$

(2 marks)

Observation a purple solution is added to pale green crystals and a brown solution forms

_____

(1 mark)

PART THREE CALCULATIONS 1 QUESTION 9 MARKS

1. Pyrolusite, an ore of manganese, contains manganese in the form of MnO_2. A sample of pyrolusite from a newly discovered deposit is analysed to determine the degree of purity of the deposit.
   To determine the amount of Mn in the pyrolusite sample, 1.25g of dried pyrolusite was heated with 100mL of 0.150M oxalic acid ($H_2C_2O_4$). The oxalic acid was in excess, so that all of the MnO_2 reacted according to the following equation

   $$MnO_{2(s)} + H_2C_2O_{4(aq)} + 2H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 2CO_{2(g)} + 2H_2O_{(l)}$$

   20.00mL of the resulting solution is then titrated with an 0.0510M solution of the triiodide ion

   $$I_3^-{}_{(aq)} + H_2C_2O_{4(aq)} \rightarrow 2CO_{2(g)} + 2H^+_{(aq)} + 3I^-_{(aq)}$$

   22.00mL of the 0.05M triiodide solution was needed to react with the remaining oxalic acid.

   a) Calculate the moles of oxalic acid remaining in the original 100mL solution after the pyrolusite had been reacted with the oxalic acid.

$I_3^-{}_{(aq)} + H_2C_2O_{4(aq)} \rightarrow 2CO_{2(g)} + 2H^+_{(aq)} + 3I^-_{(aq)}$

V = 22mL
c = 0.0510
$n\ I_3^-$ = cv
= (0.0510)(0.022)
= 0.001122mol (1mk)

v = 20mL
$n\ H_2C_2O_4 = n\ I_3^-$ = 0.001122 (1mk)
c = n/v = 0.001122/0.02 = 0.0561M (1mk)
$n\ H_2C_2O_4$ (in 100mL) = (0.0561)(0.1) = 0.00561mol (1mk)

b) Calculate the moles of oxalic acid used to reduce the MnO_2 in the 1.25g of pyrolusite.

$MnO_{2(s)} + H_2C_2O_{4(aq)} + 2H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 2CO_{2(g)} + 2H_2O_{(l)}$

V = 100mL
c = 0.150M
n=cv = (0.150)(0.1) = 0.015 (1mk)

Started with – used = 0.015 – 0.00561 = 0.00939mol (1mk)

c) Calculate the percentage by mass of MnO_2 in the pyrolusite.

$n\ MnO_2 = n\ H_2C_2O_4$ = 0.00939mol (1mk)

mass MnO_2 = 0.00939 x (54.94 + 2x16) = 0.00939 x 86.96 = 0.816g (1mk)

$\%MnO_2$ in ore = 0.816/1.25 x 100 = 65.3% (1mk)