3AB Chemistry 2010

In-class Assignment : Redox

(on-line Term 3 Week 1)

Multiple Choice Answer Sheet

Please put a cross through the correct alternative

Name:_____

1	A	B	C	D
2	A	B	C	D
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9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D

	Mark	**Out of**
Part One		12
Part Two		29
Total		41

Part Two: Written **(4 questions, 29 marks)**

Please answer these questions in the spaces provided below.

1. Explain the following terms using the extraction of iron from iron(III) oxide as an example; equations may benefit your answers.

   $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

   a) Oxidation _____

   _____

   _____

   b) Reduction _____

   _____

   _____

   c) Oxidising agent _____

   _____

   d) Reducing agent _____

   _____

   (4 marks)

2. Complete the following half equations and write the full redox equation.

   a) half equation Br_2 + _____ → HOBr + _____

   b) half equation FeO_4^{2-} + _____ → Fe^{3+} + _____

   c) Redox equation:

   _____

   (3 marks)

3. Use half equations to write balanced equations for the following reactions stating any observations.

   a) Bromine water is slowly added to potassium iodide solution.

   Oxidation: _____

   Reduction: _____

   Redox Equation: _____

   Observation: _____

   (4 marks)

b) Aluminium metal is placed in a solution of copper(II) sulfate(assume oxide layer removed from aluminium)

Oxidation: _____

Reduction: _____

Redox Equation: _____

Observation: _____

_____

(4 marks)

c) Calcium is added to dilute hydrochloric acid

Oxidation: _____

Reduction: _____

Redox Equation: _____

Observation: _____

_____

(4 marks)

4. An experiment was carried out to determine the percentage of manganese in a particular sample of steel by the above method. A 13.936 g sample of steel was dissolved in acid and the manganese was converted to MnO_4^-(aq) ions. The solution containing the MnO_4^-(aq) ions was filtered and made up to a volume of 1.00 L.

19.55 g of iron (II) ammonium sulfate $\{(NH_4)_2Fe(SO_4)_2.6H_2O\}$ were dissolved in distilled water to make 500.0 mL of solution. Three 20.0 mL samples of this solution, were acidified with sulfuric acid, titrated and required 24.02, 23.96 and 24.01 mL the permanganate solution for complete reaction.

a) Use the unbalanced half equations below to write the equation used in the titration.

$Fe^{2+} \rightarrow Fe^{3+}$

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

(2 marks)

b) From the mass and volume, determine the concentration of the iron (II) ammonium sulfate solution.

(2 marks)

c) Use the titration to determine the concentration of the permanganate solution.

(3 marks)

d) Calculate the mass of **manganese** in the steel sample. The moles of permanganate will be equal to the moles of manganese in the steel.

(2 marks)

e) Calculate the percentage, by mass, of **manganese** in the steel sample.

(1 mark)

Part One: Multiple Choice **(12 questions, 12 marks)**

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

1. Which of the following reactions are redox reactions?

   I $CaCO_3 \rightarrow CaO + CO_2$

   II $2Al_2O_3 \rightarrow 4Al + 3O_2$

   III $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

   IV $HCl + NaOH \rightarrow NaCl + H_2O$

   a) I and IV
   b) II and III
   c) II only
   d) IV and III

2. Iodide ions react with iodate ions in acid solution according to the following equation:

   $5I^- + IO_3^- + 6H^+ \rightarrow 3I_2 + 3H_2O$

   Which statement about this reaction is correct?

   a) The iodide ion loses electrons and is reduced
   b) The oxidation number of the iodine in the iodate ion changes from -5 to 0
   c) The iodate ion acts as an oxidising agent
   d) This is an example of a disproportionation reaction

3. Use the table of reduction potentials to predict the reaction products when iron (III) chloride solution is shaken with copper metal.

   a) Fe^{2+} and Cu^+
   b) Fe^{2+} and Cu^{2+}
   c) Fe and Cu^{2+}
   d) There is no chemical reaction

4. What would happen if you tried to store 1M $Fe_2(SO_4)_3$ in a container made of Ni metal?

   a) The 1M $Fe_2(SO_4)_3$ could be stored quite safely.
   b) The nickel of the container would dissolve and Fe metal would be formed.
   c) The nickel of the container would dissolve and Fe^{2+} ions would be formed.
   d) The nickel of the container would dissolve and H_2 gas would be evolved.

5. A standard solution of potassium permanganate ($KMnO_4$) has a concentration of 0.0240M. It is titrated against a solution of iron(II) sulfate ($FeSO_4$).

   The equation for the reaction is

   $5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$

   15.60mL of the $KMnO_4$ solution reacts exactly with 20.00mL of the $FeSO_4$ solution.

   The concentration of the $FeSO_4$ solution, in M, is

   a) 0.0187

   b) 0.0307

   c) 0.0936

   d) 0.1540

6. Which of the following could not be a product of the reduction of sulfuric acid when it acts as an oxidant?

   a) S

   b) H_2S

   c) SO_2

   d) $H_2S_2O_7$

7. The oxidation number of chlorine in $KClO_4$ is:

   a) –3

   b) +7

   c) -7

   d) +3

8. For the reaction below, the oxidation number of the nitrogen changes from:

$$\mathbf{NO_2 + H_2O \rightarrow e^- + NO_3^- + 2H^+}$$

   a) 0 to +1

   b) 0 to –1

   c) +2 to –3

   d) +4 to +5

<u>Use the following information for question 9 to 11.</u>

Four metallic elements A, B, C and D form soluble nitrates having formulae: ANO_3, $B(NO_3)_2$, CNO_3 and $D(NO_3)_3$.

When pieces of each of the four metals were placed in 0.10 mol L^{-1} aqueous solutions of the other metal nitrates the following reactions occur:

I Metal B reacted with all solutions.

II Metal A only reacted with CNO_3.

9. Metal D could react with:

   a) ANO_3 and CNO_3 only.

   b) $B(NO_3)_2$ and CNO_3 only.

   c) ANO_3 and $B(NO_3)_2$ only.

   d) ANO_3, $B(NO_3)_2$ and CNO_3.

10. The order of increasing strength of the metals as reducing agents could be:

a) C, A, D, B.

b) B, C, D, A.

c) A, D, C, B.

d) B, D, A, C.

11. Which of the following ions is the weakest oxidizing agent?

a) A^+

b) B^{2+}

c) C^+

d) D^{3+}

12. Which of the following reactions represent disproportionation (self oxidation – reduction)?

I $2CrO_4^{2-}(aq) + H^+(aq) \rightarrow Cr_2O_7^{2-}(aq) + OH^-(aq)$

II $3I_2(s) + 6OH^-(aq) \rightarrow 5I^-(aq) + IO_3^-(aq) + 3H_2O(l)$

III $Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$

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

a) I only

b) II and IV only

c) III only

d) IV only

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1. Explain the following terms using the extraction of iron from iron(III) oxide as an example; equations may benefit your answers.

   $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

   a) Oxidation involves loss of electrons e.g. $CO \rightarrow CO_2$, the oxidation number of C from +2 → +4 indicating it has lost electrons.

   b) Reduction involves gain of electrons e.g. $Fe_2O_3 \rightarrow Fe$ the Fe^{3+} gain electrons to become Fe atoms.

   c) Oxidising agent A substance that is reduced. It allows oxidation to occur by accepting electrons from another substance.

   d) Reducing agent A substance that is oxidised.

   (4 marks)

2. Complete the following half equations and write the full redox equation.

   a) half equation $Br_2 + 2H_2O \rightarrow 2HOBr + 2H^+ + 2e^-) \times 3$

   b) half equation $FeO_4^{2-} + 8H^+ + 3e^- \rightarrow Fe^{3+} + 4H_2O) \times 2$

   c) Redox equation:

   $3Br_2 + 10H^+ + 2FeO_4^{2-} \rightarrow 6HOBr + 2Fe^{3+} + 2H_2O$

   (3 marks)

3. Use half equations to write balanced equations for the following reactions stating any observations.

   a) Bromine water is slowly added to potassium iodide solution.

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

   Reduction: $Br_2 + 2e^- \rightarrow 2Br^-$

   Redox Equation: $Br_2 + 2I^-(aq) \rightarrow I_2(s) + 2Br^-(aq)$

   Observation: Orange solution is added to a colourless solution and a brown solution is formed.

   (4 marks)

b) Aluminium metal is placed in a solution of copper(II) sulfate(assume oxide layer removed from aluminium)

Oxidation: $Al(s) \rightarrow Al^{3+}(aq) + 3e^-$

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

Redox Equation: $2Al(s) + 3Cu^{2+}(aq) \rightarrow 3Cu(s) + 2Al^{3+}(aq)$

Observation: silver/grey solid placed in a blue solution and salmon/pink crystals form, the blue colour of solution fades.

(4 marks)

c) Calcium is added to dilute hydrochloric acid

Oxidation: $Ca(s) \rightarrow Ca^{2+}(aq) + 2e^-$

Reduction: $2H^+(aq) + 2e^- \rightarrow H_2(g)$

Redox Equation: $Ca(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2(g)$

Observation: silver/grey solid placed in a colourless solution and a colourless, odourless gas is formed in a colourless solution.

(4 marks)

4. An experiment was carried out to determine the percentage of manganese in a particular sample of steel by the above method. A 13.936 g sample of steel was dissolved in acid and the manganese was converted to MnO_4^-(aq) ions. The solution containing the MnO_4^-(aq) ions was filtered and made up to a volume of 1.00 L.

19.55 g of iron (II) ammonium sulfate $\{(NH_4)_2Fe(SO_4)_2.6H_2O\}$ were dissolved in distilled water to make 500.0 mL of solution. Three 20.0 mL samples of this solution, were acidified with sulfuric acid, titrated and required 24.02, 23.96 and 24.01 mL the permanganate solution for complete reaction.

a) Use the unbalanced half equations below to write the equation used in the titration.

$Fe^{2+} \rightarrow Fe^{3+} + e^-) \times 5$

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

(2 marks)

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

v = 20 mL v = 0.023997

c = 0.01

n = cv

= (0.01)(0.02)

= 0.0002 mol

b) From the mass and volume, determine the concentration of the iron (II) ammonium sulfate solution.

$^n(NH_4)_3Fe(SO_4)_2.6H_2O = \dfrac{19.55}{(2 \times 14.01) + (8 \times 1.008) + 55.85 + (2 \times 32.06) + (8 \times 16) + 6 \times 18.016}$

$c = \dfrac{n}{v} = \dfrac{0.04985}{0.5} = 0.0100$ M

(2 marks)

c) Use the titration to determine the concentration of the permanganate solution.

Average titre = 23.997 mL

$^nMnO_4^- = \frac{1}{5} \times {}^nFe^{2+} = \frac{1}{5} \times 0.0002 = 4 \times 10^{-5}$

$c = \dfrac{n}{v} = \dfrac{4 \times 10^{-5}}{0.023997} = 1.67 \times 10^{-3}$ M

(3 marks)

d) Calculate the mass of **manganese** in the steel sample. The moles of permanganate will be equal to the moles of manganese in the steel.

$^{n}MnO_4^- = cv = (1.67 \times 10^{-3})(1) = 1.67 \times 10^{-3}$

$^{n}Mn = nMnO_4^- = 1.67 \times 10^{-3}$

$^{mass}Mn = 1.67 \times 10^{-3} \times 54.94 = 0.0916$ g

(2 marks)

e) Calculate the percentage, by mass, of **manganese** in the steel sample.

$$\%Mn = \frac{0.0916}{13.936} \times 100$$

$$= 0.657\%$$

(1 mark)