Billanook College – Unit 2 Chemistry

Term 4 Test 2017 – Reactions in water

Name:_____ 44 marks

SECTION A

1. Which of the following equations represents a reaction in which the Fe^{2+} ion is behaving as a reductant?

A. $Fe^{2+}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2(s)$
B. $Fe^{2+}(aq) + Ag^{+}(aq) \rightarrow Fe^{3+}(aq) + Ag(s)$
C. $2Fe^{2+}(aq) + Mg(s) \rightarrow 2Fe(s) + Mg^{2+}(aq)$
D. $Fe^{2+}(aq) + S^{2-}(aq) \rightarrow FeS(s)$

2. For the reaction

$Ni^{2+}(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + Ni(s)$

which of the following statements is correct?

A. Zn(s) is oxidised and $Ni^{2+}(aq)$ is the reductant.
B. Zn(s) is reduced and $Ni^{2+}(aq)$ is the oxidant.
C. Zn(s) is oxidised and $Ni^{2+}(aq)$ is the oxidant.
D. Zn(s) is reduced and $Ni^{2+}(aq)$ is the reductant.

3. Consider the following equation.

$Sn^{2+}(aq) + Mg(s) \rightarrow Sn(s) + Mg^{2+}(aq)$

Which of the following represents one of the two half-equations of this full equation?

A. $Sn^{2+}(aq) \rightarrow Sn(s) + 2e^{-}$
B. $Mg(s) + 2e^{-} \rightarrow Mg^{2+}(aq)$
C. $Mg^{2+}(aq) + 2e^{-} \rightarrow Mg(s)$
D. $Sn^{2+}(aq) + 2e^{-} \rightarrow Sn(s)$

4. When a piece of cobalt metal, Co, is added to a solution of tin(II) ions, Sn^{2+}, in a beaker

A. $Sn^{2+}(aq)$ ions will be oxidised.
B. cobalt atoms will be oxidised.
C. no reaction will occur.
D. $Sn^{2+}(aq)$ ions will act as the reductant.

5. When a piece of iron metal, Fe, is added to a solution of zinc ions, Zn^{2+}, in a beaker

A. iron atoms will be oxidised.
B. $Zn^{2+}(aq)$ ions will be oxidised.
C. $Zn^{2+}(aq)$ ions will act as the oxidant.
D. no reaction will occur.

6. Several small pieces of nickel, Ni, are added to a solution of copper(II) sulfate, which is blue in colour. The equation for this reaction is given below.

$Ni(s) + CuSO_4(aq) \rightarrow NiSO_4(aq) + Cu(s)$

Which of the following observations would be made?

A. A deposit of copper would form and the nickel pieces would dissolve.
B. The nickel pieces would dissolve and the copper(II) sulfate solution would become a more intense blue colour.
C. No reaction would occur.
D. A precipitate of nickel sulfate would form and the copper(II) sulfate solution would become a less intense blue colour.

7. Which of the following correctly lists the coefficients for the following half-equation?

$\_\_MnO_4^-(aq) + \_\_H^+(aq) + \_\_e^- \rightarrow \_\_Mn^{2+}(aq) + \_\_H_2O(l)$

A. 1, 1, 1, 1, 1
B. 1, 2, 1, 1, 1
C. 1, 8, 7, 1, 4
D. 1, 8, 5, 1, 4

For Questions 8-10, assume the temperature is 25°C

8. What is the pH of a 1.0M solution of HCl?

A. 0
B. 1
C. 3
D. 13

9. What is the pH of a 1.0M solution of CH_3COOH?

A. 0
B. 1
C. 3
D.13

10. What is the pH of a 1.0M solution of $Ba(OH)_2$?

A. -0.3
B. 13.7
C. 14.0
D. 14.3

SECTION B

1. When heated, magnesium reacts with oxygen gas to form magnesium oxide. An equation for this reaction is

$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

(a) Write a half-equation, including states, for the reaction involving magnesium.

_____

(b) Is the half-reaction involving oxygen an oxidation or reduction reaction? _____

(c) Give the formula of the oxidant in the above reaction. _____

[3 × 1 = 3 marks]

2. The corrosion of iron (as steel) is a huge cost to an industrialised society. There is a range of methods by which such corrosion can be reduced. These include

Method I: sacrificial protection with a more reactive metal
Method II: surface protection
Method III: the formation of a hard, protective oxide coating

For each of the following examples choose one of the four methods to state (*an explanation is not required*) how the iron (as steel) is protected. Methods may be selected more than once.

(a) covering the body of a car with many layers of paint _____
(b) attaching zinc blocks to the steel 'legs' of a Bass Strait gas-drilling platform _____
(c) coating the steel, Fe, of a food can with tin _____
(d) coating steel, Fe, roofs with zinc in a process called galvanising _____

[4 × 1 = 4 marks]

3. Write balanced chemical equations for the following reactions, including states:

a. Barium chloride solution is mixed with potassium sulfate solution.

i. Full equation:

_____

ii. Ionic equation:

_____

iii. Type of reaction:_____

b. The two-stage ionisation of the diprotic sulfuric acid, $H_2SO_{4(aq)}$ in water:

_____

_____

c. The reaction between solid calcium and dilute nitric acid, $HNO_{3(aq)}$.

i. Full equation:

_____

ii. Ionic equation:

_____

iii. Type of reaction: _____

d. The oxidation of ethanol, $C_2H_5OH_{(aq)}$ to ethanoic acid, $CH_3COOH_{(aq)}$ by dichromate, $Cr_2O_7^{2-}{}_{(aq)}$.
The reaction happens in an acidic environment (ie. balance with H^+ ions and water as needed) and another product of the reaction is $Cr^{3+}{}_{(aq)}$.

i. Oxidation half equation:

_____

ii. Reduction half equation:

_____

iii. Unsimplified full equation:

_____

_____

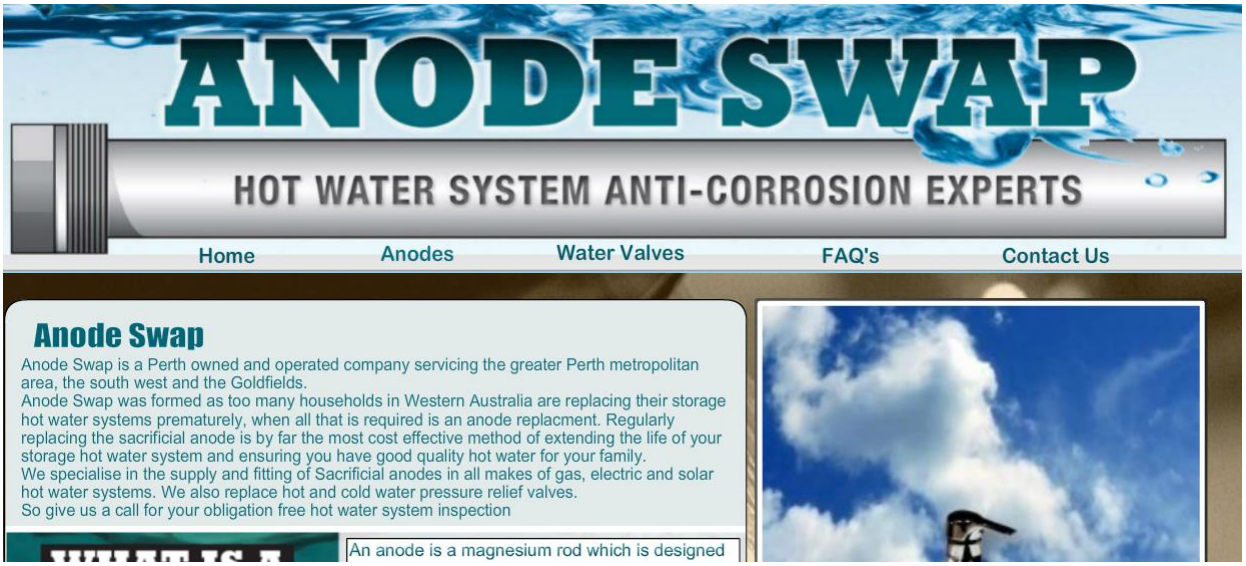
iv. Simplified full equation:

_____

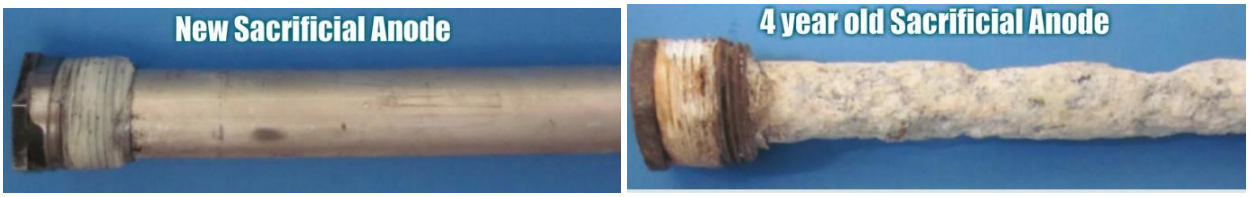
_____

[12 marks]

4. Examine the online advertisement below:



Also on the page:



Source: www.anodeswap.com

The hot water systems where these anodes are used have an enamel (paint)-coated steel cylinder.

(Don't forget there is an electrochemical series in the data booklet.)

a. Write the oxidation half equation showing what would happen to the steel in the absence of the magnesium:

_____

b. Write the oxidation half equation showing how the magnesium acts as a sacrificial anode:

_____

c. Write the relevant reduction half equation. This involves reduction of oxygen in the presence of water:

_____

d. Hence write the overall redox equation for occurring in a hot water tank with an **intact** anode:

_____

e. Write the overall redox equation for occurring in a hot water tank with an **exhausted** anode. Describe the result of this reaction being allowed to occur:

_____

_____

[6 marks]

5. The iron content of a fertiliser can be determined by titrating a solution of the fertiliser with potassium permanganate solution. In this redox titration, the intense purple of the permanganate ion will be reduced to colourless Mn^{2+} ions. Therefore, as is common with redox titrations, it is self-indicating, ie. there is no need for addition of an indicator.

Juddy's Supa Boost Iron Fertiliser* will "banish yellow leaves forever." The analysis on the packet says it contains 13.0% Fe as $FeSO_4$.

A 2.687g sample of the fertiliser was weighed into a beaker and about 100mL of deionised water was used to dissolve all the soluble components by stirring for several minutes. The beaker's contents were then filtered, making sure that the beaker was thoroughly washed out with deionised water into the filter paper. 20mL of 1M $H_2SO_{4(aq)}$ was then added to the filtrate and it was transferred to a 250.0 mL volumetric flask and the volume made up to the calibration line. Therefore all of the iron in the fertiliser sample is now assumed to be in the 250.0 mL volumetric flask.

20.00 mL aliquots of the fertiliser solution were titrated with 0.0100M $KMnO_4$ solution. As the permanganate reacts with the iron, the deep purple colour disappears. Therefore the end point is when a small excess cannot be swirled out and the aliquot remains pale pink. The average titre was found to be 10.13 mL.

The overall titration reaction is:

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

a. Write the oxidation half equation:_____

b. What is the purpose of adding the sulfuric acid to the filtrate?_____

_____

c. Calculate the amount, in mole, of permanganate, MnO_4^-, in the average titre.

d. State the mole ratio of iron(II) to permanganate:

e. Calculate the amount, in mole, of Fe^{2+} in each aliquot.

f. Calculate the mass, in grams, of Fe^{2+} in each aliquot.

g. Calculate the mass, in grams, of Fe^{2+} in the 250.0 mL volumetric flask.

h. Calculate the % by mass of iron in the fertiliser.

i. Is Juddy's Supa Boost Iron making a reasonable claim about its iron content?

[9 marks]

*Not available in stores. Special two for the price of one.

But wait, there's more. You also get to work on this problem!

END OF TEST