Year 12 Chemistry **Topic Test #5 (Electrochemistry) - 2012**

Name: **ANSWERS** Mark = _____ / 43

Part 1: Multiple Choice Section **10 marks**

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

Part 2: Short Answer Section **33 marks**

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11. Assign oxidation numbers to the element in bold type in each of following:

(a) $Na_3\mathbf{P}O_4$ **+5** (b) $H_2\mathbf{C}_2O_4$ **+3** (c) $\mathbf{Fe}(CN)_6^{3-}$ **+3**

✓ **each** (3 marks)

12. Consider the following equation:

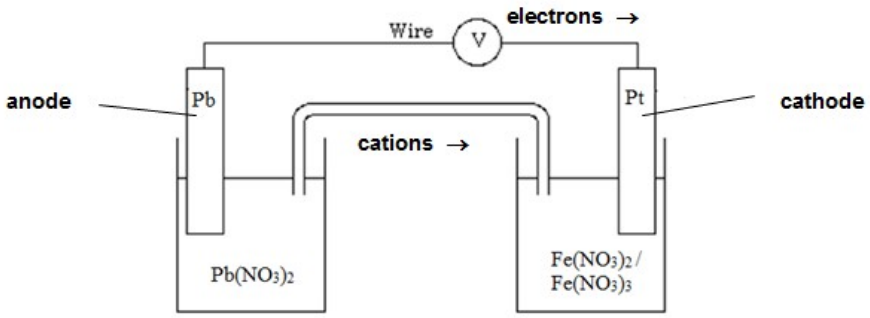
$$2\ NaC\ell O_3 + SO_2 + H_2SO_4 \rightarrow 2\ C\ell O_2 + 2\ NaHSO_4$$

(a) Identify the oxidant. **$NaC\ell O_3$** ✓ (1 mark)

(b) Give a reason for your answer.

The oxidant is reduced in a redox reaction. ✓
$NaC\ell O_3$ contains chlorine, which is reduced from +5 to +4 (1 mark)

13. Consider the following electrochemical cell:



(a) Identify the anode and cathode. ✓ (1 mark)

(b) Indicate the direction of flow of electrons in the wire and of cations within the salt-bridge.

✓✓ (2 marks)

(c) Write equations for the reactions occuring at the anode and cathode.

anode: **$Pb(s) \rightarrow Pb^{2+}(aq) + 2\ e^-$** ✓

cathode: **$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$** ✓ (2 marks)

(d) Assuming standard conidtions, what will be the reading on the voltmeter? **+ 0.90 V** ✓

(1 mark)

(e) Suggest a suitable solution for use in the salt bridge. **saturated $KNO_3(aq)$**
saturated $NH_4NO_3(aq)$
✓ (1 mark)

14. (a) Construct half-equations and write a balanced redox equation for the reaction with the following observation:

An acidified purple solution reacts with a colourless solution to give a colourless gas.

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

$H_2C_2O_4(aq) \rightarrow 2\ CO_2(g) + 2\ H^+(aq) + 2\ e^-$ ✓

$5\ H_2C_2O_4(aq) + 2\ MnO_4^-(aq) + 6\ H^+(aq) \rightarrow 10\ CO_2(g) + 2\ Mn^{2+}(aq) + 8\ H_2O(l)$ ✓

**** $H_2O_2(aq) \rightarrow O_2(g) + 2\ H^+(aq) + 2\ e^-$ is an alternative oxidation reaction***

(3 marks)

(b) Is it wise to store copper(II) sulfate solution in an aluminium container? Explain, with the aid of equations.

No, there would be a spontaneous metal displacement reaction. ✓

Assuming standard conditions:

$Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$	**$E°_{red} = +0.34$ V**
$A\ell(s) \rightarrow A\ell^{3+}(aq) + 3\ e^-$	**$\underline{E°_{ox} = +1.68\ V}$**
	$E°_{cell} = +2.02$ V ✓✓

(3 marks)

(c) Consider the following description:

A greenish-yellow gas is bubbled through waste water to remove hydrogen sulfide.

(i) Write a balanced equation for the reaction.

$C\ell_2(g) + 2\ e^- \rightarrow 2\ C\ell^-(aq)$ ✓

$H_2S(aq) \rightarrow S(s) + 2\ H^+(aq) + 2\ e^-$ ✓

$C\ell_2(g) + H_2S(aq) \rightarrow 2\ C\ell^-(aq) + S(s) + 2\ H^+(aq)$ ✓

(3 marks)

(ii) Give an observation for the reaction.

A green-yellow gas bubbles through a colourless solution forming a pale yellow precipitate ✓

(1 mark)

15. Tellurite, TeO_2, is used in the manufacture of optical fibres. The amount of tellurite in a sample of ore can be determined by reaction with a strong oxidising agent such as acidified dichromate solution, forming the tellurate ion, TeO_4^{2-}.

(a) Write a half equation for the oxidation of TeO_2 to TeO_4^{2-}.

$TeO_2(s) + 2\ H_2O(l) \rightarrow TeO_4^{2-}(aq) + 4\ H^+(aq) + 2\ e^-$ ✓✓

(2 marks)

(b) Write the full redox equation for the oxidation of TeO_2 by reaction with acidified potassium dichromate solution.

$Cr_2O_7^{2-}(aq) + 14\ H+(aq) + 6\ e^- \rightarrow 2\ Cr^{3+}(aq) + 7\ H_2O(l)$

$TeO_2(s) + 2\ H_2O(l) \rightarrow TeO_4^{2-}(aq) + 4\ H^+(aq) + 2\ e^-$ **(x3)**

$Cr_2O_7^{2-}(aq) + 3\ TeO_2(s) + 2\ H^+(aq) \rightarrow 2\ Cr^{3+}(aq) + 3\ TeO_4^{2-}(aq) + H_2O(l)$ ✓✓

(2 marks)

A sample of ore contaiing tellurite was analysed in the following manner:

I A 1.054 g sample of ore was crushed and added to 50.00 mL of 0.03052 mol L^{-1} potassium dichromate solution.

II Excess dichromate was determined through titration with 0.0525 mol L^{-1} $Fe(NO_3)_2$ solution, according to the following equation:

$$Cr_2O_7^{2-}(aq) + 6\ Fe^{2+}(aq) + 14\ H^+(aq) \rightarrow 2\ Cr^{3+}(aq) + 6\ Fe^{3+}(aq) + 7\ H_2O(l)$$

A titre of 19.71 mL was required to reach equivalence.

(c) Calculate the percentage, by mass, of tellurite in the sample.

(7 marks)

$n(Cr_2O_7^{2-})_{total} = n(K_2Cr_2O_7) = c.V = 0.03052 \times 0.05000 = 0.001526$ mol ✓

$n(Fe^{2+}) = n(Fe(NO_3)_2) = c.V = 0.0525 \times 0.01971 = 0.001035$ mol ✓

$n(Cr_2O_7^{2-})_{excess} = 1/6\ n(Fe^{2+}) = 0.0001725$ mol ✓

$n(Cr_2O_7^{2-})_{reacted} = 0.001526 - 0.0001725 = 0.001354$ mol ✓

$n(TeO_2) = 3.n(Cr_2O_7^{2-})_{reacted} = 0.004061$ mol ✓

$m(TeO_2) = n.M = 0.004061 \times 159.6 = 0.6481$ g ✓

$\%(TeO_2) = 0.6481 / 1.054 \times 100 =$ <u>61.5%</u> ✓

End of Test