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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
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For Supervisor's use only

Level 3 Chemistry, 2007

90696 Describe oxidation-reduction processes

Credits: Three
9.30 am Monday 19 November 2007

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

A periodic table is provided on the Resource Sheet L3–CHEMR.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only	**Achievement Criteria**				
Achievement		**Achievement with Merit**		**Achievement with Excellence**	
Describe oxidation-reduction processes.		Explain and apply oxidation-reduction processes.		Discuss oxidation-reduction processes.	
Overall Level of Performance					

You are advised to spend 35 minutes answering the questions in this booklet.

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QUESTION ONE

Iron can be protected from corrosion by coating its surface with paint or another metal such as tin or zinc, preventing water and oxygen from reaching the surface of the iron. This is shown in Diagram 1.

Diagram 1

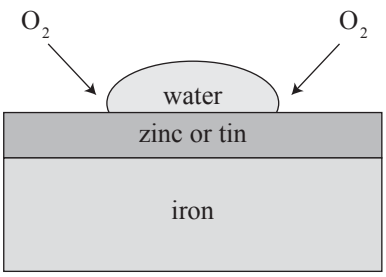
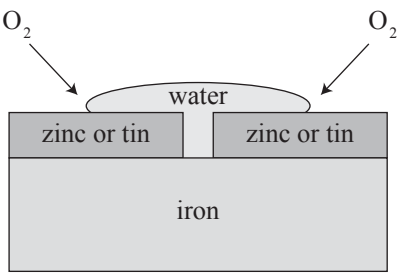
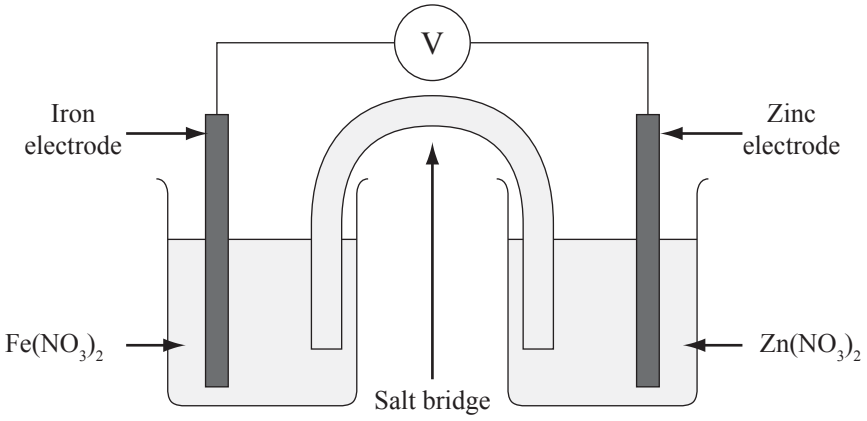


Diagram 2



However, if the protective surface coating is damaged, as in Diagram 2, corrosion of the iron may still be prevented, if a suitable metal is in contact with the iron, by a process called cathodic protection.

(a) The electrochemical cell below is set up to investigate the use of zinc to prevent the corrosion of iron.



(i) Calculate the E^o for the spontaneous reaction in the cell, using the standard electrode potentials below.

$$E^o\ (Fe^{2+} / Fe) = -0.44\ V$$
$$E^o\ (Zn^{2+} / Zn) = -0.76\ V$$

(ii) Write a balanced equation for the spontaneous reaction that would occur in the cell.

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(b) In the past, cans were often constructed from iron with a thin coating of zinc or tin. **Neither type of can rusted when intact.** But once the protective surface coating was damaged by the cans being opened and exposed to water and oxygen from the atmosphere, the **iron coated with tin rusted very quickly**, while the **iron coated with zinc did not rust**.

By referring to the **standard electrode** potentials below, discuss the reasons for these observations.

$$E^{o}\ (Fe^{2+} / Fe) = -0.44\ V$$
$$E^{o}\ (Zn^{2+} / Zn) = -0.76\ V$$
$$E^{o}\ (Sn^{2+} / Sn) = -0.14\ V$$

QUESTION TWO

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When K_2MnO_4 is sprinkled into water, it **initially dissolves** and then undergoes *disproportionation* forming MnO_2 and MnO_4^-. The **unbalanced** equation is shown below.

$$MnO_4^{2-}(aq) \rightarrow MnO_2(s) + MnO_4^-(aq)$$

(a) (i) **Identify** the oxidation number of the Mn in K_2MnO_4, MnO_2 and MnO_4^- in the table below.

Species	Oxidation number of Mn
K_2MnO_4	
MnO_2	
MnO_4^-	

(ii) Use the information in the table above showing the oxidation numbers of Mn in the three species to describe what happens in a disproportionation reaction.

(b) Describe what would be **observed** when the K_2MnO_4 is sprinkled into water, and link the observations to the **species** initially present and to those produced by the disproportionation reaction.

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(c) (i) Write balanced half-equations for the oxidation and reduction reactions and write a balanced equation for the overall reaction occurring. Assume **acidic** conditions.

Oxidation half-equation

Reduction half-equation

Balanced equation for the overall reaction

(ii) Calculate the mass of $MnO_2(s)$ that will form if 1.05 g of $K_2MnO_4(s)$ is added to water.

$M(K) = 39.1$ g mol^{-1}, $M(Mn) = 54.9$ g mol^{-1}, $M(O) = 16.0$ g mol^{-1}

QUESTION THREE

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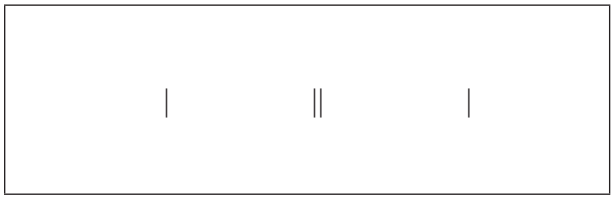
A layer of copper can be deposited on an iron nail by placing the iron nail in an aqueous solution of copper sulfate. An electrochemical cell is set up based on the reaction between the iron nail and copper sulfate solution.

$$E^{o}\ (Fe^{2+} / Fe\ ) = -0.44\ V$$
$$E^{o}\ (Cu^{2+} / Cu) = 0.34\ V$$

(a) Complete the standard cell diagram for this cell.



(b) What is the standard cell voltage for this cell?

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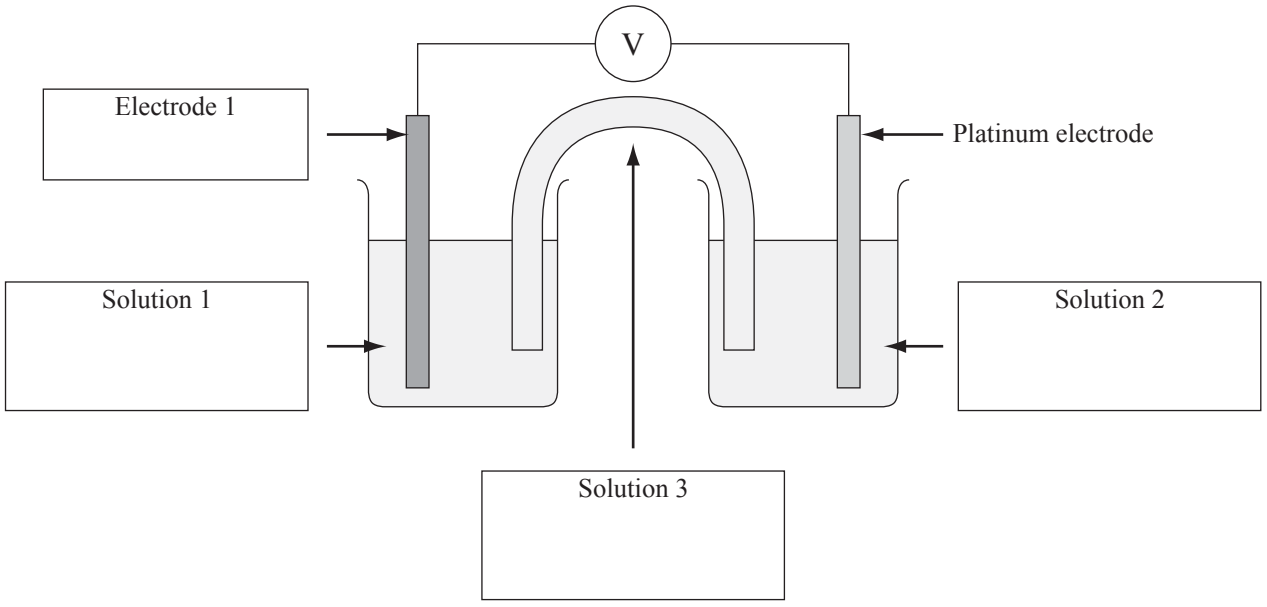
(c) A student assembled the apparatus below to measure the cell voltage of the electrochemical cell above.

(i) Identify Solution 1, Solution 2 and Solution 3.

(ii) Identify Electrode 1.



(iii) Discuss why the electrode you have chosen and the platinum (Pt) electrode are suitable electrodes for this electrochemical cell.

(d) Discuss the movement of **electrons and ions** for this electrochemical cell. Include in your discussion the direction of electron and ion movement and the species involved. You may draw on the diagram opposite to illustrate your answer.

Extra paper for continuation of answers if required.
Clearly number the question.

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