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**90696**

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

# Level 3 Chemistry, 2005

## 90696 Describe oxidation-reduction processes

Credits: Three
9.30 am Wednesday 23 November 2005

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.

Show all working for all calculations.

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

A periodic table is provided on the Resource Sheet in your Level 3 Chemistry package.

Check that this booklet has pages 2–6 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** |
| Identify and describe oxidation-reduction processes. ☐ | Use information about oxidation-reduction processes. ☐ | Analyse and interpret information about oxidation-reduction processes. ☐ |
| **Overall Level of Performance** ☐ | | |

You are advised to spend 30 minutes answering the questions in this booklet.

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## QUESTION ONE: COBALT AND CHROMIUM IN REDOX REACTIONS

An electrochemical cell is set up using appropriate electrodes and solutions of potassium dichromate and cobalt(II) nitrate. It is based on the following half-cell reactions:

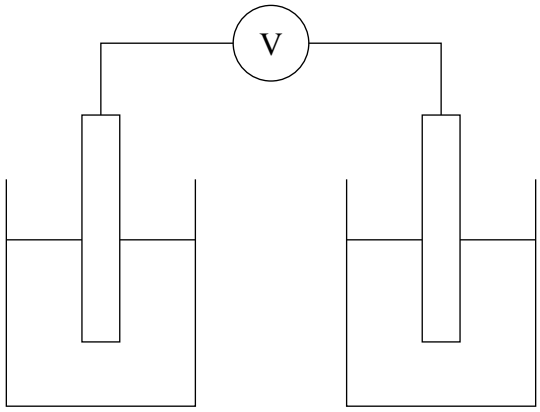
$Co^{2+} + 2e^- \rightarrow Co$ $\quad E° = -0.28$ V

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ $\quad E° = +1.36$ V

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

(b) Calculate the $E°$ for the spontaneous reaction in the above cell.

(c) **Complete** the diagram below to show how the electrochemical cell would be set up. On your diagram **label** the electrodes, the solutions (electrolytes) and indicate the **direction** of the flow of charge (cations, anions and electrons) between the two half-cells.




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

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(e) Cobalt is a transition metal that exists in both the +2 and +3 oxidation states.

A piece of cobalt metal is reacted with acidified potassium dichromate solution.

Using the relevant reduction potentials, determine if the cobalt ion produced in this reaction is $Co^{2+}$ or $Co^{3+}$.

$$E°(Co^{3+}/Co^{2+}) = +1.82 \text{ V}$$

(f) Use the information below to arrange the standard reduction potentials $E°(Co^{3+}/Co^{2+})$, $E°(U^{4+}/U^{3+})$, $E°(Fe^{3+}/Fe^{2+})$ from highest to lowest **and** identify the ion that is the strongest oxidant. Justify your answer.

$U^{3+}(aq) + Co^{3+}(aq) \rightarrow Co^{2+}(aq) + U^{4+}(aq)$ (1)

$Fe^{2+}(aq) + U^{4+}(aq) \rightarrow$ no reaction (2)

$Co^{3+}(aq) + Fe^{2+}(aq) \rightarrow Co^{2+}(aq) + Fe^{3+}(aq)$ (3)

## QUESTION TWO: CAR BATTERIES

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Lead storage batteries have been used in cars for the past 85 years. The spontaneous reaction for each cell in the battery is:

$$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

(a) (i) Give the oxidation numbers for lead in:

Pb _____ $PbO_2$ _____ $PbSO_4$ _____

(ii) Show how these oxidation numbers can be used to identify the oxidant and reductant in the cell reaction.

_____

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(b) Write balanced half-equations for the reactions occurring at the anode and the cathode of each cell in the battery.

Anode:

Cathode:

## QUESTION THREE: ANALYSIS OF COPPER IN BRASS

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In an analysis of the amount of **copper** in a brass screw, the following series of reactions were carried out.

Step 1 The brass screw was placed in concentrated nitric acid and left until the reaction was complete.

Step 2 Aqueous potassium iodide was added. Reaction occurred to give a white precipitate in a yellow-brown solution.

Step 3 The mixture was filtered to remove the white precipitate. The remaining yellow-brown solution was titrated with sodium thiosulfate (using starch as an indicator). At the end point of the titration, the solution was colourless.

(a) Describe the observations that would be made as step 1 is carried out.

(b) Write balanced half-equations for the reaction of copper with concentrated nitric acid.

(c) Account for the observations at steps 2 and 3 by identifying the reactions occurring. Include balanced equations for each reaction.

Step 2:

Step 3:

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

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| Question number | |
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