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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, 2006

90696 Describe oxidation-reduction processes

Credits: Three
9.30 am Monday 27 November 2006

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

A Periodic Table is provided on the RESOURCE SHEET in your Level 3 Chemistry package.

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.

Check that this booklet has pages 2–11 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 ☐		

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

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QUESTION ONE: REACTIONS IN A CELL

Consider the following standard cell diagram for a cell:

$$Cu(s) \mid Cu^{2+}(aq) \mid\mid Cr_2O_7^{2-}(aq), Cr^{3+}(aq) \mid C(s)$$

(a) Using oxidation numbers, show that the conversion of $Cr_2O_7^{2-}$ to Cr^{3+} is a reduction reaction.

(b) (i) Write equations for the spontaneous oxidation and reduction reactions occurring in this cell.

(ii) Write a balanced equation for the overall spontaneous reaction in the cell.

(c) Describe clearly the changes you would observe in each half-cell as the reaction proceeds. Link these changes to the species involved in any reactions occurring.

QUESTION TWO: REACTIONS OF MANGANESE SPECIES

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(a) Explain why reaction of $Mn^{2+}(aq)$ and $MnO_4^-(aq)$ under standard conditions would **not** be expected to produce $Mn^{3+}(aq)$.

$MnO_4^-(aq) + 8H^+(aq) + 4e^- \rightarrow Mn^{3+}(aq) + 4H_2O(\ell)$ $\quad E° = +0.85$ V

$Mn^{3+}(aq) + e^- \rightarrow Mn^{2+}(aq)$ $\quad E° = +1.49$ V

(b) A few drops of aqueous potassium permanganate solution are added to an aqueous solution of sodium sulfite.

(i) Describe what would be **observed** when the oxidation-reduction reaction is carried out under each of the following conditions. Link the observations to the **species** produced in each reduction reaction.

A solution that is strongly acidic:

A solution that is neutral or weakly basic:

A solution that is strongly basic:

(ii) Write a balanced equation for the reaction occurring when potassium permanganate solution is reacted with aqueous sodium sulfite in acidic solution.

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QUESTION THREE: CONSTRUCTING A CELL

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The following chemical reaction is known to be spontaneous.

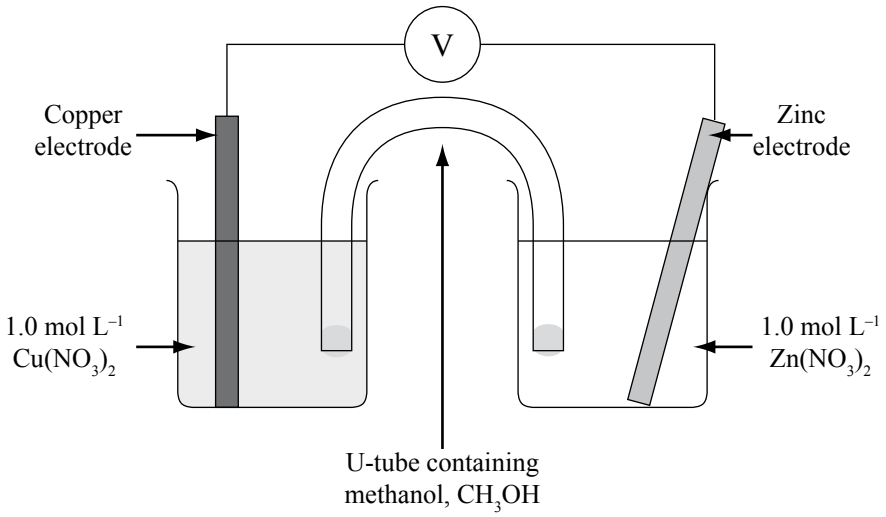
$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

A student wanted to measure the $E°_{cell}$ for the reaction above and set up the following two electrochemical cells. In each case the reading on the voltmeter was 0.0 V.

For each of the following two cells:

- explain why there is **no flow of current** through the external circuit, even when the voltmeter is replaced with a piece of wire
- state how the cell could be altered so that the $E°_{cell}$ can be measured.

(a) Cell One



(b) Cell Two

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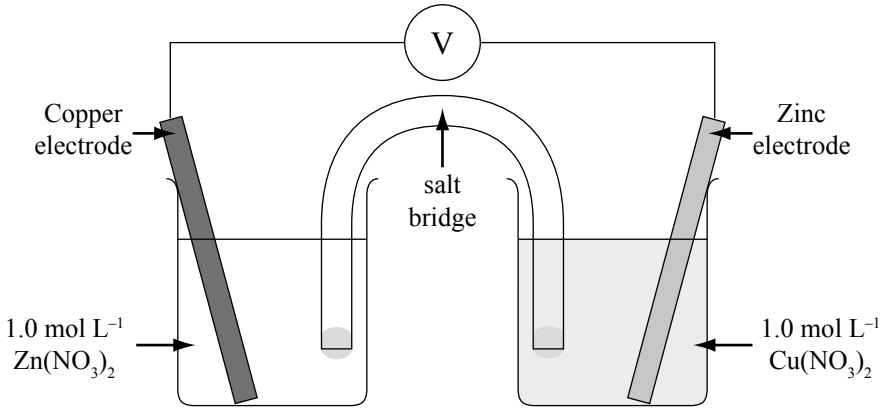

QUESTION FOUR: A CELL IN ACTION

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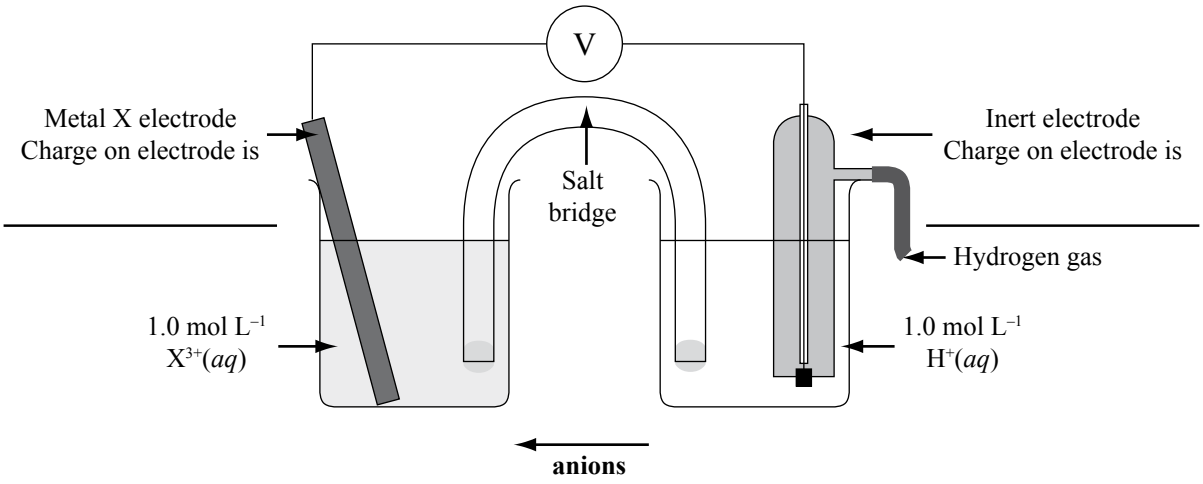
(a) In the apparatus below, the anions move through the salt bridge in the direction shown, from the hydrogen half cell towards the X(*s*) electrode.



(i) On the diagram above:

- draw an arrow to show the **direction** the electrons would move through the external circuit if the voltmeter were replaced with a wire,
- identify whether each electrode is **positive** or **negative**.

(ii) The voltmeter has a reading of +0.74 V.

Calculate $E°(X^{3+}/X)$. Explain how you determined the value, including justification of whether the $E°(X^{3+}/X)$ value is positive or negative.

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(b) The H^+/H_2 electrode is changed to a Mn^{2+}/Mn electrode.

$E°(Mn^{2+}/Mn) = -1.03$ V.

Current is allowed to flow until the Mn electrode has decreased in mass by 200 g, and X^{3+} is converted to metal X.

Calculate the amount, in moles, of metal X produced.

M (Mn) = 54.9 g mol^{-1}

QUESTION FIVE: METALS AS REDUCTANTS

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A student who tested the reactions between various metals and their corresponding ions obtained the following results.

	Ga(*s*)	Fe(*s*)	Zn(*s*)
$Ga^{3+}(aq)$	–	✘	✔
$Fe^{2+}(aq)$	✔	–	✔
$Zn^{2+}(aq)$	✘	✘	–

Key
✔ = reaction occurs
✘ = no reaction occurs
– = no test performed

(a) Place the three metals in order from strongest to weakest reductant.

_____ _____ _____
strongest reductant weakest reductant

(b) Explain how the information in the table supports your decision, **and** make links to the relative values of $E^o(Ga^{3+}/Ga)$, $E^o(Fe^{2+}/Fe)$ and $E^o(Zn^{2+}/Zn)$.

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

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Question number