

90696

Level 3 Chemistry, 2006

90717 Describe oxidation-reduction processes

Credits: Three

You should answer ALL the questions in this booklet.

<i>For Assessor's use only</i>	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.

QUESTION ONE: REACTIONS IN A CELL

Consider the following standard cell diagram for a cell:



(a) Using oxidation numbers, show that the conversion of $\text{Cr}_2\text{O}_7^{2-}$ 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

- (a) Explain why reaction of $\text{Mn}^{2+}(\text{aq})$ and $\text{MnO}_4^{-}(\text{aq})$ under standard conditions would **not** be expected to produce $\text{Mn}^{3+}(\text{aq})$.



- (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.

QUESTION THREE: CONSTRUCTING A CELL

The following chemical reaction is known to be spontaneous.

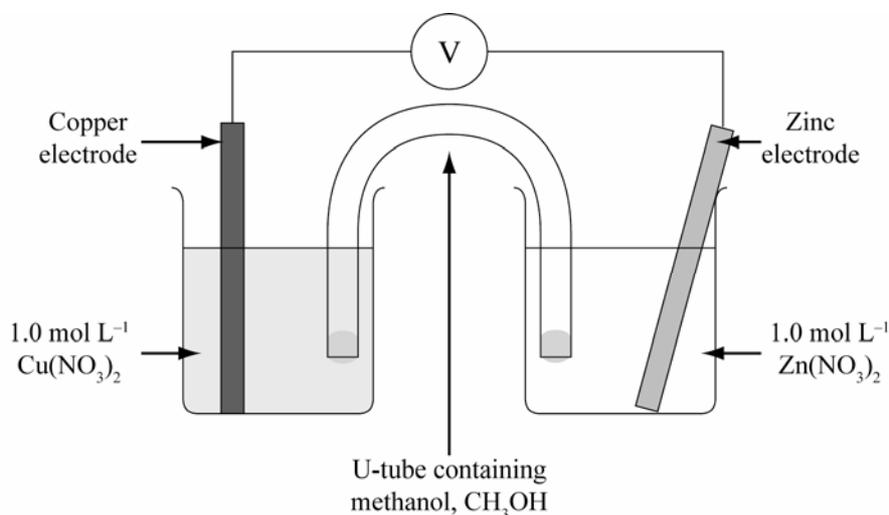


A student wanted to measure the E°_{cell} for the reaction above and set up the following two electrochemical cells. In each case the reading on the voltmeter was 0.0 V.

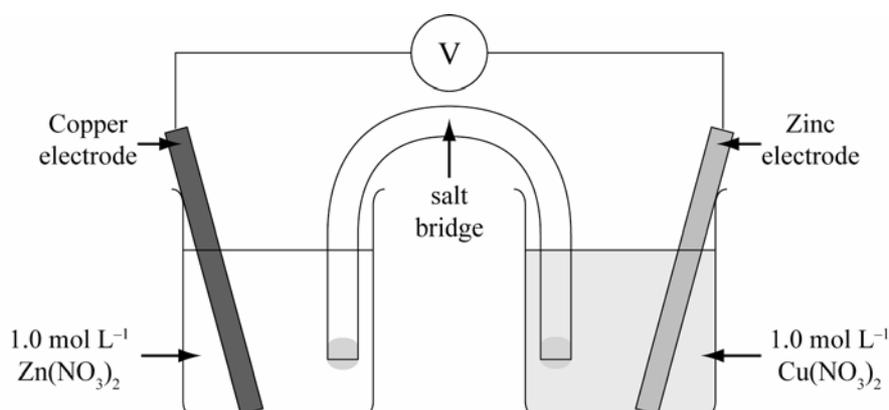
For each of the following two cells:

- 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

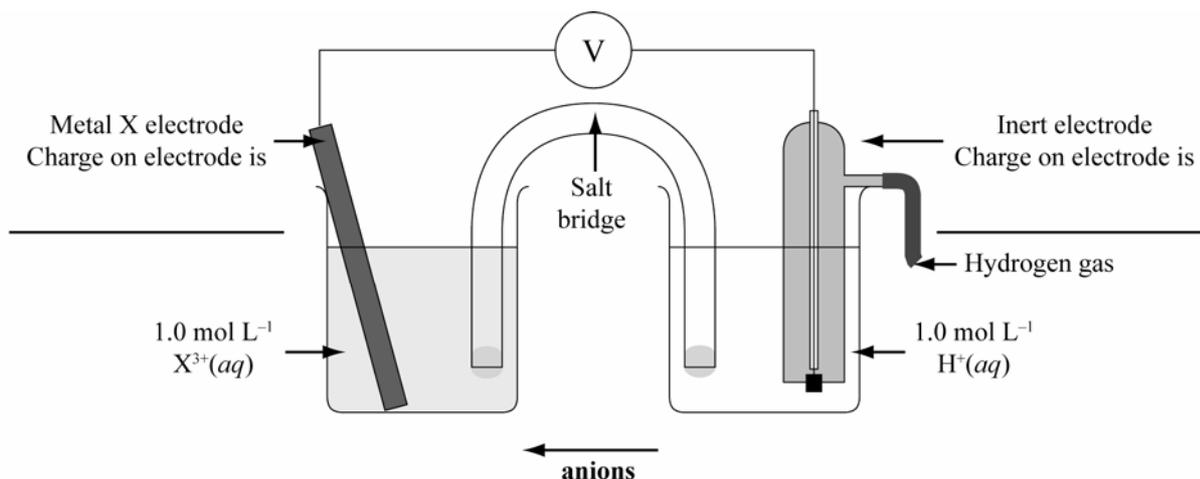


(b) Cell Two



QUESTION FOUR: A CELL IN ACTION

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

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

$$E^\circ(\text{Mn}^{2+} / \text{Mn}) = -1.03 \text{ V.}$$

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.

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

QUESTION FIVE: METALS AS REDUCTANTS

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

	Ga(s)	Fe(s)	Zn(s)		Key
$\text{Ga}^{3+}(\text{aq})$	–	8	4		4 = reaction occurs 8 = no reaction occurs – = no test performed
$\text{Fe}^{2+}(\text{aq})$	4	–	4		
$\text{Zn}^{2+}(\text{aq})$	8	8	–		

- (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 $E^\circ(\text{Ga}^{3+}/\text{Ga})$, $E^\circ(\text{Fe}^{2+}/\text{Fe})$ and $E^\circ(\text{Zn}^{2+}/\text{Zn})$.