

90696

Level 3 Chemistry, 2005

90696 Describe oxidation-reduction processes

Credits: Three

You should answer ALL the questions in this booklet.

Show all working for all calculations.

A periodic table is provided at the end of this paper.

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

QUESTION ONE: COBALT AND CHROMIUM IN REDOX REACTIONS

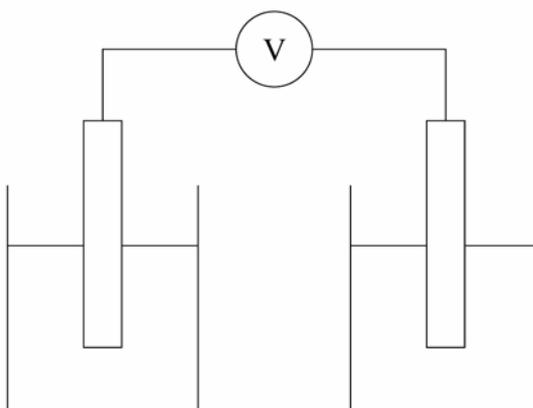
An electrochemical cell is set up using appropriate electrodes and solutions of potassium dichromate and cobalt(II) nitrate. It is based on the following half-cell reactions:



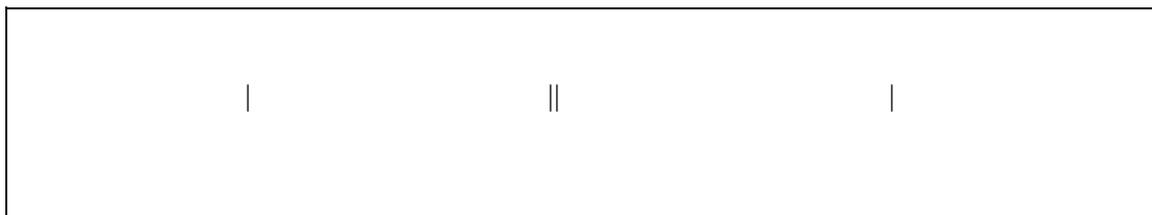
- (a) Write a balanced equation for the spontaneous reaction that would occur in the cell.

- (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.



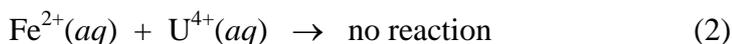
- (e) Cobalt is a transition metal that exists in both the +2 and +3 oxidation states.

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+} .

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

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



QUESTION TWO: CAR BATTERIES

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



- (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.

- (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

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:

