CHEMISTRY 3.3 Paper 2

Describe oxidation-reduction processes

Credits: Three

INSTRUCTIONS

Answer **ALL** questions

You are advised to spend 30 minutes answering these questions.

Question One (Bursary 2000 Question 11: modified)

Sulfur dioxide gas causes a colour change when it passes through a dilute solution of potassium dichromate, $K_2Cr_2O_7$. This is due to the reduction of the dichromate ion to Cr^{3+}.

a   State what this colour change is. **A**

_____

b   Write the half equation for the reduction of $Cr_2O_7^{2-}$. **A**

_____

The ion produced by the oxidation of SO_2 can be detected by the formation of a precipitate when a solution of barium chloride is added to the products of the reaction above.

c   Give the name and formula of the ion produced in the oxidation of SO_2. **A**

Name:_____

Formula:_____

d   Write the half equation for the oxidation of SO_2. **A**

_____

e   Combine the two half equations in **a** and **c** above to give the overall balanced equation for the reaction between SO_2 and $Cr_2O_7^{2-}$. **A**

_____

_____

_____

f   Circle the species below that could not act as a reductant. **A**

SO_2 SO_3^{2-} SO_3 $S_2O_3^{2-}$

Question Two (Bursary 2001 Question 8: modified)

1: Cleaning silver

The tarnish on silver cutlery and ornaments is silver(I) sulfide. One way to clean the silver(I) sulfide off silver cutlery is to wrap the cutlery tightly in aluminium foil and submerge it in a solution of baking soda ($NaHCO_3$) for between one and five hours.

a   The half equation for the reaction on the surface of the silver is:

$$Ag_2S(s) + 2e^- \rightarrow 2Ag(s) + S^{2-}(aq)$$
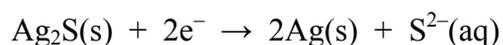
Is this oxidation or reduction? **A** _____

b   Explain why the aluminium foil is required. **A M**

_____

_____

**c**   Write a balanced equation for the overall reaction. **A**

_____

_____

2 Electrochemical cells

An electrochemical cell is to be set up using the IUPAC convention with two half cells:

    silver metal in 1.0 mol L^{-1} silver nitrate solution $E°(Ag^+/Ag) = 0.80V$

    nickel metal in 1.0 mol L^{-1} nickel nitrate solution $E°(Ni^{2+}/Ni) = -0.23$ V

a   Complete the diagram below by labelling the solutions and the metals in the boxes. **A M**
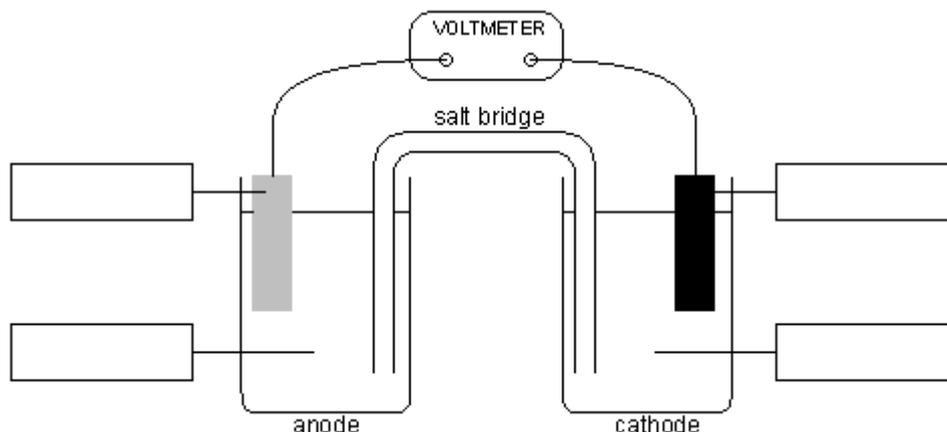
b   Name a solution that could be used in the salt bridge. **A**

c   Calculate the expected cell voltage. **A M**

d   Discuss the **flow of charge** in this cell, both in terms of **species** and **direction** of movement. Include the role of the salt bridge. **A M E**

e   Describe what would be **observed** in each half-cell as the cell discharges and explain these observations in terms of any chemical reactions taking place. **A M E**

Question Three (Bursary 2001 Question 6: modified)

1 Arsenic-eating Bacteria

Arsenic is an extremely poisonous metal often found in waterways. A strain of bacteria has been found which oxidises arsenic compounds. Relevant reactants and products in acidic conditions and reduction potentials are given below.

$$AsO_4^{3-}(aq) \rightarrow AsO_2^-(aq) \qquad\qquad E° = +0.14 \text{ V}$$
$$O_2(aq) \rightarrow 2H_2O(l) \qquad\qquad E° = +1.23 \text{ V}$$

a   What are the oxidation numbers of arsenic in the two species shown? **A**

_____

_____

_____

b   Use the above information to write a balanced ionic equation for the oxidation of AsO_2^- to AsO_4^{3-} by oxygen. **A M E**

_____

_____

_____

c   Use the reduction potential values given above to explain why oxidation of arsenic compounds can take place in waterways. **A M**

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