CHEMISTRY 3.3 Paper 1

Describe oxidation-reduction processes

Credits: Three

INSTRUCTIONS

Answer **ALL** questions

You are advised to spend 30 minutes answering these questions.

Question One (Bursary 2003 Question 9: modified)

The table below gives some standard electrode potentials that may be used in the questions that follow.

Reduction half equation	***E*°/V**
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.34
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.00
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	–2.37
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O$	+0.96

a Identify the species from the table that is the strongest reductant. A

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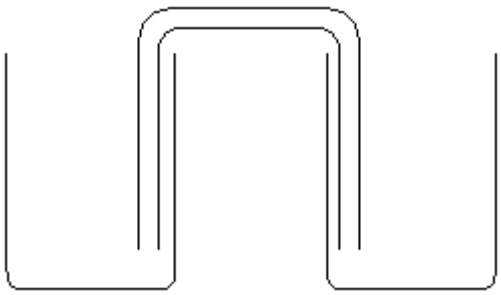
The following electrochemical cell is required: $Mg(s)/Mg^{2+}(aq)$ // $Cu^{2+}(aq)/Cu(s)$

b Complete and label the diagram below to show how such a cell could be constructed. A M



The salt bridge could be made using a piece of paper soaked in a solution of potassium chloride.

c Explain the role of the salt bridge in the cell. A M

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d Write the net ionic equation for the overall cell reaction. A

e Calculate the voltage of the cell in standard conditions. A M

Copper metal reacts with dilute nitric acid but, unlike magnesium, has no reaction with dilute sulfuric acid.

f Account for the above observations using the standard reduction potentials in the table. A M E

g Write a balanced equation for the reaction of copper metal with dilute nitric acid. A M

h What observations could be made when copper reacts with dilute nitric acid? A M E

Question Two (Bursary 2003 Question 4: modified)

Bromine can be made from a concentrated solution of bromide ions derived from sea water. Chlorine gas is injected into acidified sea water and the bromine is produced by an oxidation-reduction reaction.

a Describe what would be observed as the reaction proceeds. A

b Explain why this is an oxidation-reduction reaction. A M

Acidification of the sea water is necessary because, at higher pH values, the chlorine would react with water.

c Write an equation for the reaction of chlorine gas with water. A

d This reaction of chlorine with water is sometimes referred to as an **auto oxidation-reduction** reaction. Discuss this statement with regard to the reaction in **c.** A M E

Question Three (Bursary 2000 Question 8: modified)

1 Oxalic acid is a dicarboxylic acid ($H_2C_2O_4$). On reaction with the MnO_4^- ion under acidic conditions, oxalic acid is converted to CO_2.

a Write the balanced half equation for the conversion of oxalic acid to CO_2. A

b Circle the words that correctly complete the sentence.

In its reaction with MnO_4^-, oxalic acid is acting as

an oxidant. a reductant.

Justify your answer in terms of oxidation numbers. A M

2 Solutions of potassium permanganate can be standardised by reaction with oxalic acid. The reaction occurring during titration is given below.

$$5H_2C_2O_4(aq) + 6H^+(aq) + 2MnO_4^-(aq) \rightarrow 10CO_2(g) + 2Mn^{2+}(aq) + 8H_2O(l)$$

In the reaction for the equation given above, how many moles of electrons are transferred?

Justify your answer. A M

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3 The titration in part **2** above is generally carried out by placing the potassium permanganate in a burette and the oxalic acid in a flask.

a What colour is the solution in the flask at the point when exactly enough MnO_4^- has been added to react with all of the $H_2C_2O_4$? A

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b What is the colour of the solution in the flask after the first drop of excess MnO_4^- has been added? A

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The reaction of MnO_4^- with $H_2C_2O_4$ is catalysed by Mn^{2+}. The usual procedure is to heat the oxalic acid solution in a titration flask above 60 °C before adding the first portions of permanganate.

c Why is heating not required during the remainder of the titration? A M

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