Standard electrode potentials and practical 6 & 7	سلسلة جهود الاختزال القياسية والتجارب العملية 6 & 7
Chemistry	مادة الكيمياء
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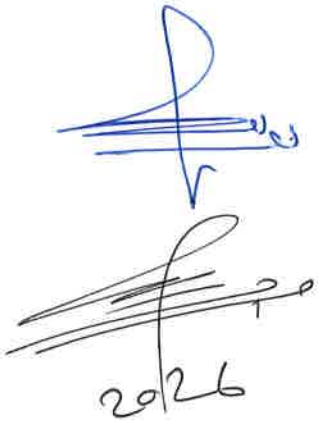

Contents

Appendix 1

Standard electrode potentials

Electrd reaction	E^{θ}/V
$F_2(g)+2e^- \rightleftharpoons 2F^-(aq)$	+2.87
$S_2O_8^{2-}(aq)+2e^- \rightleftharpoons 2SO_4^{2-}(aq)$	+2.01
$H_2O_2(l)+2H^+(aq)+2e^- \rightleftharpoons 2H_2O(l)$	+1.77
$Pb^{4+}(aq)+2e^- \rightleftharpoons Pb^{2+}(aq)$	+1.69
$MnO_4^-(aq)+8H^+(aq)+5e^- \rightleftharpoons Mn^{2+}(aq)+4H_2O(l)$	+1.52
$PbO_2(s)+4H^+(aq)+2e^- \rightleftharpoons Pb^{2+}(aq)+2H_2O(l)$	+1.47
$Cl_2(g)+2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36
$Cr_2O_7^{2-}(aq)+14H^+(aq)+6e^- \rightleftharpoons 2Cr^{3+}(aq)+7H_2O(l)$	+1.33
$O_2(g)+4H^+(aq)+4e^- \rightleftharpoons 2H_2O(l)$	+1.23
$Br_2(l)+2e^- \rightleftharpoons 2Br^-(aq)$	+1.07
$VO_2^+(aq)+2H^+(aq)+e^- \rightleftharpoons VO^{2+}(aq)+H_2O(l)$	+1.00
$VO_3^-(aq)+4H^+(aq)+e^- \rightleftharpoons VO^{2+}(aq)+2H_2O(l)$	+1.00
$ClO^-(aq)+H_2O(l)+2e^- \rightleftharpoons Cl^-(aq)+2OH^-(aq)$	+0.89
$NO_3^-(aq)+10H^+(aq)+8e^- \rightleftharpoons NH_4^+(aq)+3H_2O(l)$	+0.87
$NO_3^-(aq)+2H^+(aq)+e^- \rightleftharpoons NO_2(g)+H_2O(l)$	+0.81
$Ag^+(aq)+e^- \rightleftharpoons Ag(s)$	+0.80
$Fe^{3+}(aq)+e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$I_2(s)+2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$Cu^+(aq)+e^- \rightleftharpoons Cu(s)$	+0.52
$O_2(g)+2H_2O(l)+4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq)+2e^- \rightleftharpoons Cu(s)$	+0.34
$VO^{2+}(aq)+2H^+(aq)+e^- \rightleftharpoons V^{3+}(aq)+H_2O(l)$	+0.34

Electrde reaction	E^{θ}/V
$SO_4^{2-}(aq)+4H^+(aq)+2e^- \rightleftharpoons SO_2(g)+2H_2O(l)$	+0.17
$Cu^{2+}(aq)+e^- \rightleftharpoons Cu^+(aq)$	+0.15
$Sn^{4+}(aq)+2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S_4O_6^{2-}(aq)+2e^- \rightleftharpoons 2S_2O_3^{2-}(aq)$	+0.09
$2H^+(aq)+2e^- \rightleftharpoons H_2(g)$	0.00
$Fe^{3+}(aq)+3e^- \rightleftharpoons Fe(s)$	−0.04
$Pb^{2+}(aq)+2e^- \rightleftharpoons Pb(s)$	−0.13
$Sn^{2+}(aq)+2e^- \rightleftharpoons Sn(s)$	−0.14
$Ni^{2+}(aq)+2e^- \rightleftharpoons Ni(s)$	−0.25
$V^{3+}(aq)+e^- \rightleftharpoons V^{2+}(aq)$	−0.26
$Co^{2+}(aq)+2e^- \rightleftharpoons Co(s)$	−0.28
$Fe^{2+}(aq)+2e^- \rightleftharpoons Fe(s)$	−0.44
$Cr^{3+}(aq)+3e^- \rightleftharpoons Cr(s)$	−0.74
$Zn^{2+}(aq)+2e^- \rightleftharpoons Zn(s)$	−0.76
$2H_2O(l)+2e^- \rightleftharpoons H_2(g)+2OH^-(aq)$	−0.83
$Cr^{2+}(aq)+2e^- \rightleftharpoons Cr(s)$	−0.91
$Mn^{2+}(aq)+2e^- \rightleftharpoons Mn(s)$	−1.18
$V^{2+}(aq)+2e^- \rightleftharpoons V(s)$	−1.20
$Mg^{2+}(aq)+2e^- \rightleftharpoons Mg(s)$	−2.38
$Na^+(aq)+e^- \rightleftharpoons Na(s)$	−2.71
$Ca^{2+}(aq)+2e^- \rightleftharpoons Ca(s)$	−2.87
$K^+(aq)+e^- \rightleftharpoons K(s)$	−2.92

Appendix 2

Day/Date: ……

EXPERIMENT 6

Precipitation of hydroxides of copper(II), iron(II) and iron(III)

INTRODUCTION

Hydroxide ions (from sodium hydroxide solution) remove hydrogen ions from the water ligands attached to the copper (II), iron (II) or iron (III) ions forming a precipitate of a neutral complex.

AIM

To test for the presence of copper (II), iron (II) or iron (III) ion and cobalt (II) in their solution

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SAFETY

- Wear eye protection at all times.
- Cobalt (II) chloride is toxic if swallowed or by inhalation.
- Sodium hydroxide solution is an irritant.

APPARATUS (PER STUDENT)

- mol dm $^{-3}$ copper (II) sulfate solution
- mol dm $^{-3}$ iron (II) sulfate solution
- mol dm $^{-3}$ iron (III) chloride solution
- mol dm $^{-3}$ cobalt (II) chloride solution
- mol dm $^{-3}$ sodium hydroxide solution
- four test tubes
- test-tube rack
- five graduate droppers

- eyes protection

PROCEDURE

Step 1: Use a graduated dropper to transfer 2 cm^3 of copper (II) sulfate solution into a test tube.

Step 2: Add a similar volume of sodium hydroxide solution drop by drop.

Step 3: Agitate the mixture in the test tube from time to time to ensure thorough mixing.

Repeat the steps (1 – 3) above for iron (II) sulfate solution, iron (III) chloride solution, and cobalt (II) chloride solution

Observations:

Record the state and colour change (if any) in the table below

Reagent	$CuSO_4$ (aq)	$FeSO_4$ (aq)	$Fe2(SO_4)_3$ (aq)	$CoCl_2$(aq)
Colour before adding NaOH				
Colour after adding NaOH				
State before adding NaOH				
State after adding NaOH				

Analysis and interpretation

1. Write a balanced equation for the reaction between copper(II) sulfate and sodium hydroxide

……

2. Write an ionic equation for the reaction between iron(III)sulfate and sodium hydroxide

……

3. Did you notice any further changes in colour from step 3? Give an explanation

……

……

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4. Write the formula of the precipitate formed when cobalt(II) cholide solution reacts with Sodium Hydroxide.

……

Conclusion

Write your conclusion about this experiment

Day/Date: *……*

EXPERIMENT 7

Complexes and ligand exchange

Introduction

The ligands in a complex can be exchanged, wholly or partially, for other ligands. This is a type of substitution reaction. It happens if the new complex formed is more stable than the original complex.

Aim: To study the replacement of water molecule with chloride ions, hydroxide ions or ammonia solution in complex ions.

Apparatus (per student)

- mol dm^{-3}
- copper(II) sulfate solution
- concentrated hydrochloric acid 1 mol dm^{-3}
- sodium hydroxide solution
- concentrated ammonia solution
- four test tubes
- test-tube rack
- four graduated plastic droppers
- white background
- safety goggles

Procedure

Step 1: Add 1 cm3 of copper(II) sulfate solution to each of four test tubes. Use the first test tube as a control. Compare the others with this one.

Step 2: To the second test tube, add concentrated hydrochloric acid (CORROSIVE) drop by drop until there is no further change in colour.

Step 3: To the third test tube, add sodium hydroxide solution (CORROSIVE) drop by drop until there is no further change in colour.

Step 4: To the fourth test tube, add concentrated ammonia solution (CORROSIVE) drop by drop until there is no further change in colour.

Step 5: Record your observations in a suitable table.

Observation:

Record your observation in the following table:

Name of a compound	Colour of a compound after adding		
	Conc. HCl	NaOH	NH3 solution
copper sulfate solution	……	……..	……..

Analysis and interpretation:

1. Give the formula of the complex formed with:

a. Conc. HCl ……..
b. NaOH.....
c. NH3 .....

2. Write the equation for the formation of each complex.

a. …….

b. …….

c. …….

3. What happened when excess ammonia is added to copper sulphate solution?

……..

4. Why is green colour obtained in the reaction of copper sulphate and hydrochloric acid.

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