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| **KNUST LOGOKWAME NKRUMAH UNIVERSITY OF**  **SCIENCE AND**  **TECHNOLOGY** |
| **CHEM 280**  **PRACTICAL CHEMISTRY II**  **FORMULA OF A COMPLEX SPECIES** |
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**OBJECTIVES**

Students will determine the absorption spectra and formula of a complex iron (III) species containing water and thiocyanate ligands by using Beer’s Law and the Method of Continuous Variation.

**INTRODUCTION**

In the practice of qualitative inorganic analysis ample use is made of reactions which lead to the formation of complexes. A complex ion or molecule comprises a central atom (ion) and a number of ligands closely attached to the former. The relative amount of these components in a stable complex seems to follow a well defined stoichiometry, although this cannot be interpreted into the classical concept of valency. The central atom can be characterised by the coordination number, an integer figure, which shows the number of (monodentate) ligands which may form a stable complex with one central atom. In most cases, the coordination number is 6 (as in the case of Fe2+, Fe2+, Fe3+, Zn2+, Cr3+, Co3+, Ni2+, Cd2+) sometimes 4 (Cu2+, Cu+, Pt2+) and 8 (some ions in the platinum group) do group.

The coordination number represents the available space around the central atom or ion in the so-called coordination sphere each of which can be occupied by one (monodentate) ligand. The arrangement of ligands around the central ion is symmetrical. Thus, a complex with a central atom of coordination number of 6, comprises the central ion, in the centre of an octahedron while the five ligands occupy the spaces defined by the vertices of the octahedron. To the coordination number 4, tetrahedron symmetry normally corresponds, although a planar (or nearly) a planar arrangement where the central ion is in the centre of a square and the four ions occupy the four corners of the latter, is common as well.

An ion is a charged atom or molecule that results from the loss or gain of electrons. A complex ion is an ion containing a central metal cation bonded to one or more molecules or ions. Complexes are very important in many chemical and biological reaction and processes.

Transition metals however have the tendency to produce complex ions because they have the ability to form more than one oxidation state. This property helps them easily to form complex ions.

In acidic aqueous solution, hydrated Fe3+ ion interacts with thiocyanate ion SCN- to establish a series of equilibria.

1. [Fe(H2O)6]3+ + SCN- → [Fe(SCN)(H2O)5]2+ + H2O

2. [Fe(SCN)(H2O)5]2+ + SCN- → [Fe(SCN)2(H2O)4]+ + H2O

… Etc.

6. [Fe(SCN)5(H2O)]+ + SCN- → [Fe(SCN)6]3- + H2O.

The main aim of the experiment is to find out the most stable iron thiocyanate complex. This complex absorbs blue light and the resulting solution has a deep red colour. The formula can therefore be determined by measuring the absorbance of light with a spectrophotometer and analysing the data using the method of continuous variation technique in which the stable complex ion is found from a selected wavelength.

**APPARATUS AND CHEMICALS**

Burette Solution containing Fe3+

Test Tube Solution containing SCN-

Test tube rack

UV spectrophotometer

Wash bottle

**PROCEDURE**

**PREPARATION OF THE SOLUTIONS**

The solution was prepared in a stock room, and buffered with a pH of 2.

Solution A contained iron (III) ions and was prepared by dissolving 7.715 g of FeNH4(SO4)2.12H2O in the buffer solution.

Solution B contained SCN- ions and was prepared by dissolving 1.218 g of NH4SCN in the buffer solution.

Eleven test tubes were numbered from 0 to 10.

Two burettes were filled with solutions A and B separately.

An exact volume of each of the two solutions was delivered into each test tube as specified in the table.

Each solution was mixed and was allowed to equilibrate for at least 10 minutes.

The solutions were later taken to the UV spectrophotometer where the absorption spectra.

**DISCUSSION**

According to Beer’s Law, concentration of a dilute compound is proportional to its absorbance of light. To examine this absorbance, the UV spectrophotometer is used

In this experiment, the concentration of the unidentified complex is examined by the absorption procedure. This concentration is dependent on the relative amounts of Fe3+ and SCN- in solution.

The least absorbencies were observed when the solutions contained only one of the ions under consideration (i.e. Fe3+ and SCN-). This is because the complex which gives the colour and hence absorbs light is not formed.

It can also be observed that as the amount of the thiocyanate increased, the absorbance also increased until it got to a peak value where it begun to fall. This can be explained by the fact that, the ratio (SCN-/Fe3+) for maximum amount of the complex to be formed was being neared as the amount of thiocyanate increased and the iron (III) decreased. The peak value for absorbance was observed when the ratio equalled n, the ratio for the highest amount of complex that could be formed under the given conditions. From the graph, this absorbance occurred at the point where the amounts of Fe3+ and SCN- were the same.

**CONCLUSION**

With amounts of the thiocyanate and iron (III) being the same, n equals 1. The general formula for the complex is [Fe(SCN)n(H2O)6-n]3-n. With n=1, the stable complex formed under the given conditions of this experiment is [Fe(SCN)(H2O)5]2+.

**PRECAUTIONS**

* All volumes were read at the meniscus.
* All apparatus were washed before the experiment to minimise any errors.
* Solutions were carefully disposed off in the hood.
* Hands were washed before leaving the laboratory.

**REFERENCES**

General Chemistry Practical.

Concise Inorganic Chemistry, Fifth Edition by J.D Lee

**Rest of Pre-Lab**

3. A species which is completely transparent to a wavelength with **I**o=**I**, would mean the species did not absorb any light and should have absorbance A of zero and a percent transmittance (T %) of 100%.

4. A completely opaque species with **I** equal to zero, absorbs all the light passing through it and should have an absorbance of 1 and percent transmittance (T %) of 0%.