| EXPERIMENT NUMBER | 14 |
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| THE NAME OF THE EXPERIMENT | CARBONATOTETRAAMMINE COBALT(III) NITRATE |
| FORMULA | $[Co(NH_3)CO_3]NO_3$ |

## EXPERIMENTAL PROCEDURE

*In a 100 mL flask, 20 g (0.21 mole) of $(NH_4)_2CO_3$ is dissolved in 60 mL of water, and 60 mL of concentrated ammonia solution is added to the flask. 15 g (0.052 mole) of $Co(NO_3).6H_2O$ in another beaker is dissolved in 30 mL of water. The previously prepared solution is added to this solution by mixing. Then, 8 mL of 30% $H_2O_2$ solution is added to this solution. The solution is evaporated to a final volume of 90-100 mL (without boiling). 5 g of $(NH_4)_2CO_3$ is added several times to the solution during evaporation. The hot solution is filtered and filtered. $[Co(NH_3)CO_3]NO_3$ precipitate is washed with a few mL of water, then with ethanol.*

## QUESTIONS

1. *Write and balance the chemical equation.*
2. *Write the open formula of the complex, explain the hybridization type of the central atom. What can be said about its magnetic properties?*
3. *Write the Lewis formulas of $NH_4^+$ and $CO_3^{2-}$ ions and specify the hybridization types of the central atoms.*
4. *Explain why $H_2O_2$ is used in the experiment.*

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| ***EXPERIMENT NUMBER*** | ***15*** |
| ***THE NAME OF THE EXPERIMENT*** | ***CHLOROPENTAAMMINE COBALT(III) CHLORIDE*** |
| ***FORMULA*** | ***$[Co(NH_3)_5Cl]Cl_2$*** |

## *EXPERIMENTAL PROCEDURE*

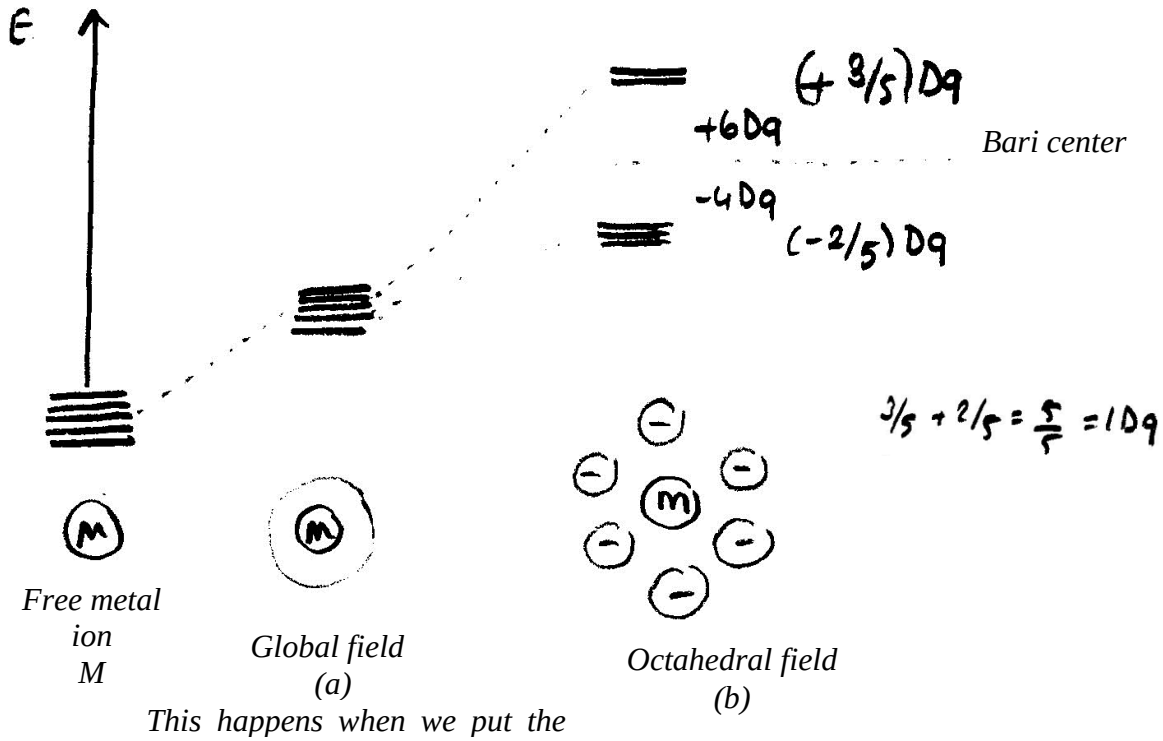
*5 g of $[Co(NH_3)_4.CO_3]NO_3$ is dissolved in 50 ml of water and 5-10 mL of concentrated HCl acid is added until all $CO_2$ is removed. The solution is neutralized with concentrated $NH_3$ solution and then 5 mL excess of ammonia is added. The solution is heated 20 minutes without boiling, $[Co(NH_3)_5.H_2O]^{3+}$ occurs. The solution is slightly cooled and 75 mL of concentrated HCl acid is added to the solution. The solution is heated 20-30 minutes again, meanwhile change in color is observed. When the solution is cooled to room temperature, purple-red crystals are observed. Crystals are washed several times with ice-cold water and filtered in a vacuum, washed with several mL of ethanol, and are dried at 120 °C.*

## *QUESTIONS*

1. *Write and balance the chemical equation.*
2. *Show the crystal field splitting in $[Co(NH_3)_5Cl]Cl_2$ complex.*
3. *What can you say about the magnetic moment of the complex?*
4. *Is isomer observed in the complex, why?*
5. *Draw the crystal field splitting diagrams for $[Co(NH_3)_6]^{3+}$ and $[Co(NH_3)_6]^{2+}$ complexes. Find the magnetic moments of the complexes. Which complex is more stable, why?*

## GENERAL INFORMATION

### The Orbital Splitting Diagram for Octahedral Complexes




*Free metal ion M*

*Global field (a)*

*This happens when we put the center atom at the center of the sphere loaded with electricity*

*Octahedral field (b)*

*In the octahedral field, ligands approach the central atom in the direction of the x, y, z axes. Therefore, the ligands interact more with d-orbitals ($d_{x2-y2}$ and $d_{z2}$) on the x, y, z axes. As a result, the $d_{x2-y2}$ and $d_{z2}$ orbitals on the axes increase their energies as they interact more with ligands (negative charges). In contrast, the energies of the $d_{xy}$, $d_{xz}$ and $d_{yz}$ orbitals between the axes are reduced so that the total energies of the orbitals remain the same. Briefly, under the influence of an octahedral field, the d orbitals split into triply degenerate orbitals ($t_{2g}$) with less energy and another as doubly degenerate orbitals ($e_g$) with higher energy. The main energy level between these two sets of orbitals is taken as zero, which is called* ***Bari center****. The splitting between these two orbitals is called crystal field splitting ($\Delta_o$). $_o$ at $\Delta_0$ indicates that the split is in the octahedral field. The crystal field splitting energy or crystal field stabilization is indicated by $\Delta_o$=10Dq.*