Cobalt Coordination Compound Name / date?

Purpose:

- **Synthesize trans cobalt coordination compound**
  - **Oxidize $Co^{2+}$to Co^{3+}through the reaction $2Co^{2+}+2H^{+}+H_2O_2$->2 $Co^{3+}+2H_2O$**
  - **Bond Co^{3+} to ligand ethylene diamine through reaction $Co^{3+}+2H_2NCH_2CH_2NH_2+3Cl^{-}$-> $[Co(H_2NCH_2CH_2NH_2)_2Cl_2]Cl$**
- **Isolate trans cobla coordination compound through vacuum filtration and determine percent yield**
- **Isomerize solution of trans isomer to cis isomer both partially and fully**
- **Determine the differnace.. in absorbance of isomers through wavelength of max absorbance**

Reference: How did you decide the limiting reagent?

(1) Kateley, L. J., *Introduction to Chemistry in the Laboratory*, *20th Ed.*, Lake Forest College, **2021,** Experiment Cobalt Coordination Compound, Appendix D_LabEquipment

Synthesis of Trans

- 0.5001g of solid dark pink $CoCl_2•6H_2O$ weighted on analitical balance and added to 25mL Erlenmeyer Flask
- 1mL of deionized water measured in 10mL graduated cylander and a stir bar added to flask
- Solution is a clear pink red akin to cranberry juice

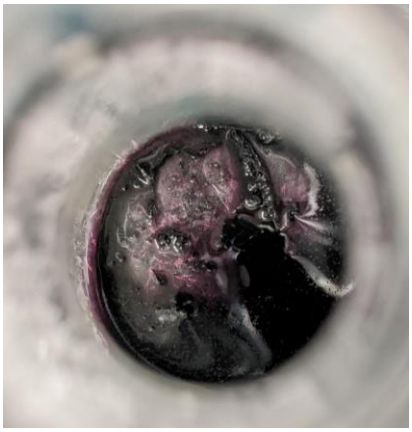
- 700 µL ethylene diamine solution measured with blue Eppendorf pipet and added to flask while stirring
- Solution turned deep red

- 5mL of 3% H_2O_2(hydrogen peroxide) added to flask
- Solution turned darker red, akin to soy sauce

- Mixture stirred for 15 minutes to allow for evaporation

- 3mL of concentrated HCl (hydrochloric acid) measured in graduated cylander and added to flask
- Solution heated to boiling point for 20 minutes reducing to volume to ~3 mL and turing the solution a dark blue green

- Mixture was cooled on countertop and then in ice bath as it cooled it turned back to a deep red/purple indication that it was overheated into cis isomer, bypassing trans isomer



Isolation of Trans through Vacuum Filtration

- After cooling mixture was filtered through vacuum filtration separating a shiny dark green solid and dark blue filtrate

- Mixture is washed with twice ~2mL of CH_3COCH_3(acetone), once with ~1mL of CH_3OCH_3(dielhylether), and twice with ~1mL of acetone again
- Solid is transfered to petri dish in tared anylitical balance and weighed in at 0.3082g
- Percent yield = 100 x experimental/actual = 100 x .3082g/0.482g = 63.9%

CALCULATIONS AND RESULTS

compound	MM g/mol	conc mass %	density g/mL	volume	mass, g	moles available (mass ÷ MM)
cobalt chloride hexahydrate	237.93	NA	NA	NA	0.50g	.0021mol
ethylenediamine	60.10	30.0	1.00	700 µL	0.700 mL x 1.00 g/mL x 0.300 = 0.210	.003419 mol
hydrogen peroxide	34.01	3.0	1.00	5.0 mL	5.0mL x 1.00g/mL x .03 = 0.15	.0044mol
trans-dichlorobisethylenediamine-cobalt(III) chloride	275.41	NA	NA	NA	.3082g	.00112 mol

limiting reactant: Ethylenediamine

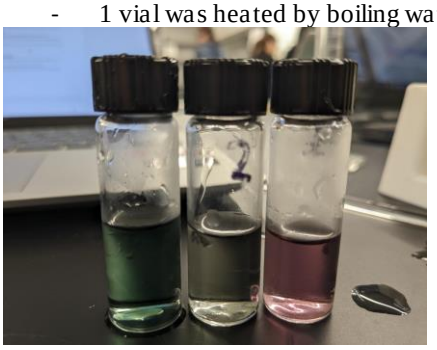
theoretical yield: .00175 mol or 0.482g

actual yield: .3082g or .00112 mol

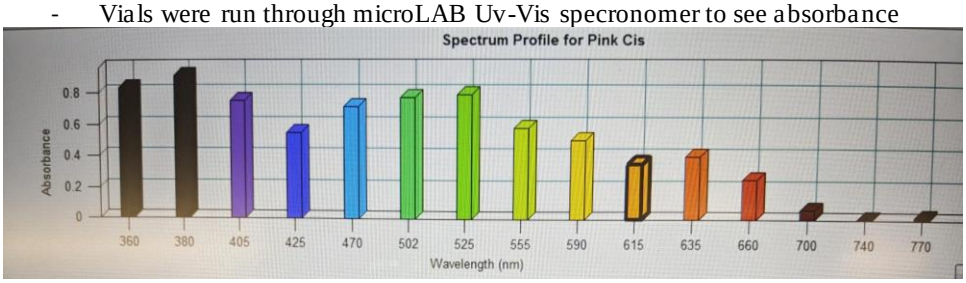
% yield = 100% × $\frac{\text{experimental yield}}{\text{theoretical yield}}$ = 63.9 %

Isomerization and Visible Spectra

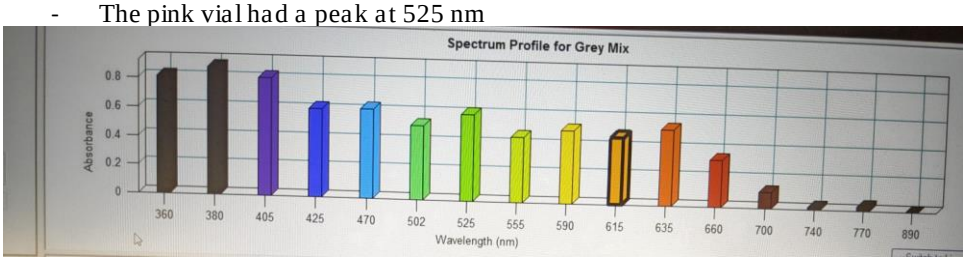
- 50mg (0.0588g)of synthesised trans isomer was disolved in 10mL of deionized water creating a pale mint green solution
- The solution was equally divided into 3 spectroscopy vials
- 1 vial was packed with ice to make sure it remains as trans isomer, the solution remained green
- 1 vial was heated in a boiling water bath to create cis isomer, the solution turned grey pink and got pinker as it sat
- 1 vial was heated by boiling water for a short time and then put in the ice bath to stop conversion



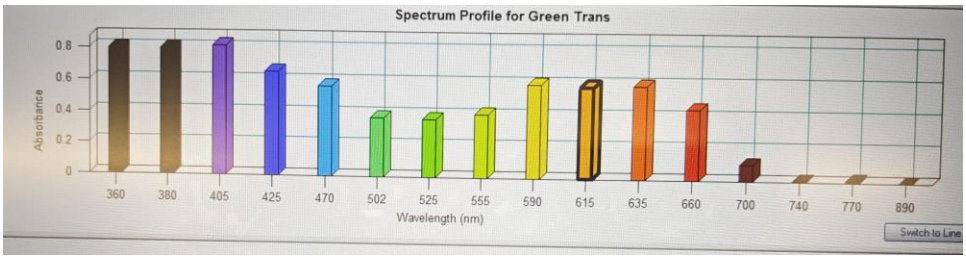
- Vials were run through microLAB Uv-Vis specronomer to see absorbance



- The pink vial had a peak at 525 nm



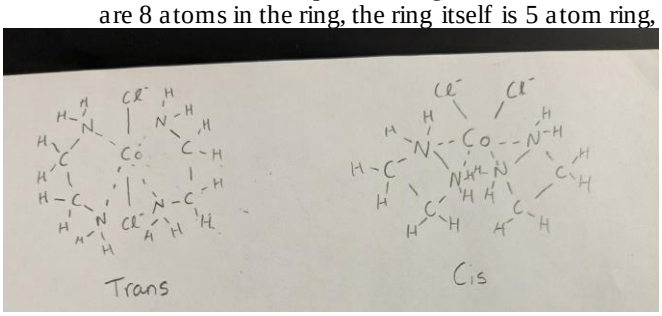
- The grey vial was relativly equal overall



- The green solution vial had a peak around 615 nm, orange red range

Models and Drawing, 2 possible structures for the cis, that are mirror images

- Models B and D are models of the trans isomer. Thet can be super imposed on each other and have one ring
- Models A and C are cis isomers. They are mirror images of each other and have two rings
- In the models Co is pink, Cl is green, black is C, and blue is N. The rings are made of C and N and there are 8 atoms in the ring, the ring itself is 5 atom ring, Co, N, C, C, N



Conclusion:

- **The yeild was not 100% because not all of the reactants reacted and some of the product was left behind in various equipment.**
- **One clear indicator is that the color of the compound is different. We do not have any good indicators of purity.**
- **Oxidation state change is another possible explination for color change.**
- **The pink cis isomer had a larger max absorbance as it has a larger peak at 525 nm [blue green range] then the green trans did at 615nm, [red orange range. The grey mix has slightly more cis iosmer as it absorbs more green (525nm) light then orange/red (615nm) light**