SOLVED EXAMINATION QUESTIONS

A.

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA

RAIN SEMESTER EXAMINATION 2012/2013 SESSION
CHM 316 - EXPERIMENTAL INORGANIC CHEMISTRY

ANSWER ALL QUESTIONS **TIME ALLOWED: 40 minutes**

Instructions:
Write your Name, Registration Number and Department on your answer scripts. Also append your signature on the answer scripts.

1a(i). What species of iron is expected to be present in alum as at the time of production? Give reasons for your answer. In what form was soluble iron determined and why?

(ii). Why are most reactions involving complex formation carried out in water and in what forms are their metallic cations obtained. Give equation of the reaction.

(iii). What property of complex ions will make them get involved in reactions?

(iv). Most of the cobalt complexes prepared were reddish-pink while those of copper were blue. What was responsible for these colours and why are they different?

(v). Purple $[Co(NH_3)_5Cl]Cl_2$ was produced from reddish $[Co(NH_3)_5H_2O]Cl_3$. What was responsible for the difference in their colours and why? Likewise, why was the heating done through asbestos coated wire gauze?

b(i). Explain what was responsible for the different colours obtained in the alum produced in one of your experiments.

(ii). Different levels of spillages were observed on the addition of concentrated H_2SO_4 to aluminium foil during the production of alum. Briefly explain what happened stressing what was responsible for this observation.

(iii). How was it ascertained that the product obtained in the last experiment was alum?

(iv). What are the sources of the insoluble matter in alum and how were they ascertained in their determination in the produced alum?

SOLUTIONS:

1a. i.

- Fe^{2+} ion is expected to be present in Alum
- This is because on the addition of 2M HCl, Ferric chloride ($FeCl_3$) was formed.
- Soluble iron was determined in the (+III) oxidation state because $K_2Cr_2O_7$ was added which oxidized Fe^{2+} to Fe^{3+}

(ii)

- Water serves as a minimum of ionization where there metallic part of the salt was released in the ionic form.
- Metallic ions are obtained in the hydrated form $[(M(H_2O)_6]^{n+}$, the tetrahedral or square planar derivatives. It can be expressed in the equation below:

$$MCl_2 + 6H_2O \longrightarrow [M(H_2O)_6]^{2+} + 2Cl^-$$

(iii) Complex ions are usually labile in nature.

(iv) Presence of unpaired elections usually in their d-orbitals. They both have different numbers of unpaired electrons which resulted in different frequencies of absorption and emission of energy when they are excited and otherwise.

(v)

- The two complexes have their central metals in the (+III) oxidation states therefore, the difference in colour is associated with the ligands directly connected to the central metals (inner coordination sphere) while one was electronegative in nature, the other was neutral.
- The asbestos lined gauze was to prevent directed heat or naked heat on the complex so as to prevent the denaturing of the ligand which could lead to the total destruction of the ligands.

2 (i) Sample preparation. It had to do with the extent of the removal of the impurities and the oxides coating the surface of the aluminum.

(ii) Purity of the aluminum sample used and the particle size (surface area).

The purer the aluminum sample and the finer the particles used, the higher or greater the rate of reaction resulting a higher level of spillages observed.

(iii) When the product was placed in the oven, it did not melt.

(iv) Insoluble matter originated from impurities.
They were ascertained because the aluminum was soluble in concentrated H_2SO_4, leaving the impurities in solution to be filtered off.

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA

RAIN SEMESTER EXAMINATION 2011/2012 SESSION
CHM 316: EXPERIMENTAL INORGANIC CHEMISTRY

ANSWER ALL QUESTIONS **TIME ALLOWED: 30 minutes**

Instructions:

•Write your Name and Registration Number on your answer scripts.

1a. (i) Differentiate between Labile and Inert complexes?

(ii) Which of the two types of complexes mentioned above is expected to be more stable?

(iii) What role(s) do Bond Length and Bond Strength, existing between the central metal and ligands. play in determining whether a complex will be labile or inert?

(iv) Mention one labile and one inert complex among the ones synthesized in the practical classes. Give reasons for your choices.

(v) Why must it be ensured that the transition metal salt be properly dissolved in water or any appropriate solvent before complexation is carried out.

b Some of your prepared complexes are presented below: use them to answer the next set of questions.

•$[Co(NH_3)_4]SO_4$, •$[Co(NH_3)_5H_2O]Cl_3$, •$[Co(NH_3)_6]Cl_3$ and •$[Co(NH_3)_5Cl]Cl_2$

(i) From the set of complexes, list the spectator and counter ions. How would you differentiate amongst these set of ions?

(ii). Which of them will be the least stable and why?

(iii) How many ions are present in each of the complexes? Arrange them in an increasing order of conductivity.

(iv). In the production of alum from waste aluminum, what can be done to ensure that the aluminiun shreds are properly dissolved after the addition of concentrated tetraoxosulphate (v) acid? What is/are the disadvantage(s) of the non-dissolution of the shreds.

(vi) Explain how 70%v/vol of the provided tetraoxosulphate (VI) acid solution was prepared.

SOLUTIONS:

1a(i) **Labile complexes**

Reactions are completed within milliseconds and a minute so they are very fast.
Crystal field stabilization energy is very low
Low thermodynamic and Kinetic stability

(ii). Inert Complexes

(iii) The shorter the bond length, the higher the bond strength and it results in a relatively more inert complex,

(iii) Shorter bond length, weak bond strength result in liability.

(iv) Labile: $[Cu(NH_3)_4SO_4$
Inert: $[Co(NH_3)_6]Cl_3$

(iv) Proper dissolution results in the total ionization or release of the metal ion into solution which produces an electron deficient centre for the nucleophilic ligands to get attached to.

b.

Complex ions	Counter ions
$[Co(NH_3)_4]^{2+}$	SO_4^{2-}
$[Co(NH_3)_5H_2O]^{3+}$	$3Cl^-$
$[Co(NH_3)_6]^{3+}$	$3Cl^-$
$[Co(NH_3)_5Cl]^{2+}$	$2Cl^-$

(i) The anionic parts can be tested for both sulphate and chloride ions. Since the chloride ions present in two of the complexes differ, the with a higher concentration of $AgNO_3$ precipitate produced is expected to be for those with cobalt in the +3 oxidation state

(ii) $[Co(NH_3)_5Cl]Cl_2$ This is because cobalt is existing in the +2 oxidation state thus exhibiting the d^7 configuration theat is less stable than the d^6 in the +3 oxidation state.

(iii) (1) 2 (ii) 4 (iii) 4 (iv) 3

$[Co(NH_3)_4]SO_4 < [Co(NH_3)_5Cl]Cl_2 < Co(NH_3)_5H_2O]Cl_3 < Co(NH_3)_6]Cl_3$

(iv). Addition of conc. H_2SO_4 activated the digestion process of the aluminum particles. Addition of water enhanced the mobility of the acid around the undigested aluminum particles thus covering a larger surface area and increasing the rate of digestion accompanied by the evolution of gases.

- Product is usually impure and a lower yield is obtained.

(iii) To 70cm^3 of the concentrated acid, make it up to the mark in a standard 100 cm flask.

C.

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA
DEPARTMENT OF CHEMISTRY

CHM316: EXPERIMENTAL INORGANIC CHEMISTRY
RAIN SEMESTER EXAMINATION (2016/2017)

Answer ALL. **Time allowed: 1h 30 min**

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1. In order to prepare an ammine complex, copper $CuSO_4 \cdot 5H_2O$ and conc NH_3 were used with no heating:

a. What changes will be observed when
   - i. a few drops of the ammonia is added to the aqueous solution of copper sulphate
   - ii. the ammonia is added in excess

b. Write the reaction equations for each step above

c. Draw the structure of the final product after excess conc NH_3 is added

2a. Generally in lab preparation of transition metal complexes even before the products are taken for instrumental analysis, what observations would be made to indicate that a product has been formed.

b. To prepare pentaamineaquocobalt(III) chloride using $CoCl_2$, ammonium chloride and concentrated ammonia, what is the role of
   - i. Activated charcoal
   - ii. Hydrogen peroxide

c. Show using chemical equation how you would convert pentaamineaquocobalt(III) chloride to pentaamminechlorocobalt(III).

3a. Some complexes are described as being labile, what does this mean?

b. Arrange the following complexes in the order of increasing lability - $[Co(NH_3)_6]Cl_3$, $K_3[Co(CN)_6]$, $[Cu(NH_3)_4SO_4H_2O]$

c. Explain why your choice for the least labile complex.

4. To be able to estimate the % of Co in a sample of $[Co(NH_3)_6]Cl_3$ (0.1 g), the reaction equations below summarizes process to achieving this. Calculate the amount of Co in the complex if 1.54 mL was the average titre value of 0.025 M sodium thiosulphate that was used in the titration.

$$[Co(NH_3)_6]Cl_3 + 3NaOH \xrightarrow[\Delta]{} Co(OH)_{3(s)} + 3NaCl + 6NH_3 \quad (1)$$

$$Co(OH)_{3(s)} + 3KI + 3HCl \rightarrow CoI_{2(s)} + 3KCl + \tfrac{1}{2}I_2 + 3H_2O \quad (2)$$

$$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^- \quad (3)$$

5a. What is a double salt?

b. What is the formula of chrome alum?

c. $KCeF_4$ is a double salt and $K_4[YbI]$ is complex salt, write out for each the ions that exist in solution.

SOLUTIONS:

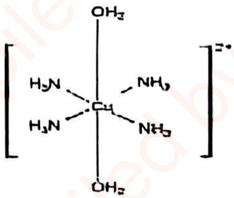
1ai. Pale blue precipitate

ii. Deep blue solution

b. $[Cu(H_2O)_6]SO_4 + 2NH_4OH \rightarrow [Cu(OH)_2(H_2O)_4]_{(s)} + (NH_4)_2SO_4 + 2H_2O$

$[Cu(H_2O)_6]SO_4 + 4NH_3 \rightarrow [Cu(H_2O)_2(NH_3)_4]SO_{4(aq)} + 4H_2O$

c.



2a. Change in colour and a change in state

bi. Activated charcoal - catalyst

ii. Hydrogen peroxide – oxidizing agent

c. $Co(NH_3)_5(H_2O)]Cl_{3(s)} \xrightarrow[\Delta]{} [Co(NH_3)_5Cl]Cl_{2(s)} + H_2O$

3a. Any metal complex that's undergoes reactions with $t_{\frac{1}{2}} \le 1$ min at ordinary conditions (room temperature and about 0.1 M solution) is described as being labile.

b. $K_3[Co(CN)_6]$, $[Co(NH_3)_6]Cl_3$, $[Cu(NH_3)_4SO_4H_2O]$

c. $K_3[Co(CN)_6]$ is the least labile because of the large charge density of Co^{3+} as well as the large crystal field stabilization energy due CN^- being is a strong field ligand.

4. From 0.025M $S_2O_3^{2-}$

$$1000cm^3 = 0.025\ moles$$

$$\therefore 1.54\ cm^3 = \frac{0.025}{1000} \times 1.54\ moles = 3.85 \times 10^{-5}\ moles$$

From reaction equation 3

$$1\ mole\ of\ I_2 = 2\ mole\ S_2O_3^{2-}$$

$$\therefore \frac{3.85 \times 10^{-5}}{2}\ moles\ of\ I_2 = 1.925 \times 10^{-5}\ moles$$

From reaction equation 2

$$\frac{1}{2}\ mole\ of\ I_2 = 1\ mole\ Co(OH)_3$$

$$\therefore 1.925 \times 10^{-5}\ moles\ of\ I_2 = 2 \times (1.925 \times 10^{-5})\ Co(OH)_3$$

$$3.85 \times 10^{-5}\ moles\ of\ Co(OH)_3$$

From reaction equation 1

$$1\ mole\ Co(OH)_3 = 1\ mole\ [Co(NH_3)_6]Cl_3$$

$$\therefore 3.85 \times 10^{-5}\ moles\ of\ [Co(NH_3)_6]Cl_3$$

From 1 mole $[Co(NH_3)_6]Cl_3$ has 1 mole of Co^{3+}

AN

Instructions:

Write your Name, Regis

1a. i. Draw the structures of the following complexes.

i. $[Cu(NH_3)_4Cl_2]$ ii. Cis-$[Cu(en)_2Cl_2]$ iii. Trans-$[Cu(en)_2Cl_2]$

Arrange the compounds according to an increase in:

- their thermodynamic stability and kinetic inertness.
- their rate of reacting with the CO ligand.

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ii. What determines the amount of ligands involved or used up in complex formation?

iii. Name the process associated with the dissolution of salt essential for complex formation in the preparation of $[Co(NH_3)_6]Cl_2$. Also express the process in an equation if hydrated cobalt chloride is involved in the synthesis.

iv. What was responsible for the colours displayed by the $[Co(NH_3)_6]Cl_2$ and $[Cu(NH_3)_4]SO_4$ synthesized in your experiments.

b. i. If you were provided with two unlabeled reagent bottles containing dilute and concentrated sulphuric acid solutions respectively. Use the reactions of the contents of these bottles with aluminium foil to identify them contents of these bottles? Use equations to back up your answers.

ii. *Why were domestically* used Al foil used in the production of alum and not its bauxite ore?

iii. Write the equation that represent the preparation of chrome alum and show the evidence of reduction in the process. State with reasons why the temperature of the reaction must be regulated in the preparation of chrome alum?

iv. Why is Na^+ ion not appropriate for use in alum.

c. i. Name the organic compound common to the polyethylene and kerosine that enhanced their interaction with eachother?

ii. Which of the complexed or uncomplexed polyethylene particles would exhibit:

- a higher density
- a higher surface area if the same quantity of starting material was involved in the production of the two substances.
- Why was the weight of the recrystallized polyethylene particles greater than that of the fresh polyethylene samples?
- What is the effect of incomplete removal of residual kerosine on the particles of the calcium complexed and the uncomplexed polyethylene particles? Which of these two would be more affected by the effect of residual kerosine.

Give reasons for all your answers.

1a. The equations **(a) and (b)** below summarise the production of chrome alum

$$K_2Cr_2O_{7(aq)} + 3C_2H_5OH_{(l)} + H_2SO_4 \longrightarrow K_2SO_{4(aq)} + Cr_2(SO_4)_{3(aq)} + 3CH_3CHO_{(l)} + 7H_2 \quad (a)$$
$$K_2SO_{4(aq)} + Cr_2(SO_4)_{3(aq)} + 24H_2O \longrightarrow K_2SO_4.Cr_2(SO_4)_3.24H_2O \quad (b)$$

- Identify the reducing agent in the equations above. Give reasons for your choice
- Which of the important species in the alum produced was reduced. How did you arrive at your choice?
- Why was the temperature of the experiment kept between 30 °C and 50 °C ?

b.i. Predict the products **A** and **B** of the reaction between the cobalt complex and the cyano compound as expressed in the equation below.

$$[Co(NH_3)_5Cl]Cl_2 + CN^- \longrightarrow A + B$$

- Would the cobalt complex behave as a labile or inert compound? Give reason(s) for your answer.
- Draw the structure of compound A indicating the position of the leaving and incoming species. Give reasons for your answers.

i *In the syntheses of* $[Co(NH_3)_6]Cl_3$ and $[Co(NH_3)_5H_2O]Cl_2$ in the just concluded *CHM316 classes:*

- State the roles of NH_4Cl and concentrated NH_3
- Why was a smaller quantity of HCl used in the production of the former than the latter?

i. What is responsible for the difference in colour observed in the complexes $[Co(NH_3)_5Cl]Cl_2$ and $[Co(NH_3)_5H_2O]Cl_2$ exhibiting purple and red colours respectively despite the fact that the cobalt ions in the two complexes are in the +3 oxidation states.

Name the process involved in the complexation of the pulverised high density polyethylene with metal ions stating the kind of bond that resulted from such an interaction?

If the members of Group 2 (Akanji's group) had used containers that contained ***rust***,

- What effect do you think this would have on their product?
- Diagrammatically show and name the type of polymers produced with calcium ions and the ones contaminated by the rust.

What was responsible for the better digestion observed in the aluminium foils cut into much smaller sizes on reacting with concentrated H_2SO_4 during the production of alum from aluminium foil? , increase area

State the relationship between the insoluble matter present in the produced alum from the aluminium foil and its purity and yield?.

Increased in Si

1a.i. Give a simple equation that describes the formation of an octahedral coordination compound with ligand "**L**" using a water soluble metal salt (**MX_2**).

ii. Give reasons why the first set of coordinated compounds prepared in the just concluded CHM 316 practical classes were not used for subsequent preparations and the lability test.

iii. Classify ligands based on the spectrochemical series. Using the reaction between the complexes prepared with the described ligands above and water, arrange them in an increasing order of labiliy. Give reasons for your answer.

NH_3, H_2O, CN^-, Cl^-, OH^- SO_3^{2-} SO_3^{2-}

b.i. Aluminium foil was used in the production of alum, if Al is the first cation involved, what is the source of the other one responsible for the double salt nature of the alum?

ii. What was the role of the concentrated sulphuric acid in this alum production?

iii. How was it ascertained that the digestion of the aluminium foil was complete in the process?

iv. What is the relationship between the insoluble matter and the percentage yield of the produced alum? How can the percentage yield, to some extent, be used to determine the purity of the alum?

$$\frac{M_1 \times}{M_2 \times 100}$$

c.i. What is responsible for the interaction between the calcium salt and the relatively inert polyethylene?

complex

ii. Using the percentage yield and texture, differentiate between the coordinated and uncoordinate polyethylene giving reasons for your answer.

iii. Would this have been possible if NaCl had been used in place of $CaCl_2$? Give reasons for yo answer.

1a.i. State the relationship between Crystal Field Stabilization Energy (CFSE) and Reactivity in complexes.

ii. What role does the Crystal Field Stabilization Energy play in the lability and inertness of metal complexes?

the higher the lability the

iii. Arrange the following complexes in an increasing order of ***Reactivity*** and ***CFSE (Δ)***.

highest 3 1 1

- $[Co(NH_3)_5H_2O]Cl_3$,
- $[Co(NH_3)_6]Cl_3$
- $[Co(NH_3)_5Cl]Cl_2$

1 2. lowest

b.i. The reversible reaction below showed the preparation of Pentaamminecobalt(III) Chloride from Aquopentaamminecobalt(III)Chloride in which the forward reaction required a regulated amount of heat. Which of the rate constants will be involved in the rate determining step? Give reasons for your answer.

$$[Co(NH_3)_5H_2O]Cl_3 \xrightleftharpoons[k_2]{k_1} [Co(NH_3)_5Cl]Cl_2$$

ii. State what is *usually* responsible for the poor yield observed in the preparation of Aquopentaamminecobalt(III) Chloride (most common mistakes encountered)

c.i. Write the formula of the chrome alum you prepared and show how it can be related to that of a standard alum. How does it also compare with the alum prepared from aluminum foil?

ii. Why was the temperature regulated (controlled) in the production of chrome alum but otherwise in the in the production of alum from aluminum foil?

iii. Which of the uncomplexed and calcium-complexed polyethylene particles is expected to be

- denser
- more biodegradable?

Give reasons for your answers.

KMnO4

Name the gas was released during the digestion of the aluminum foil with the concentrated acid? What was the effect of this gas on potassium permanganate? Express your observation in a chemical equation, stating the nature of the gas and how the process was achieved.

i. Briefly explain the sedimentation action of the alum produced? How did you confirm that the alum produced from aluminum foils was going to be effective in its sedimentation action?

Various colours, different from the expected deep blue of the Tetraammineaquosulphatocopper(II) complex $[Cu(NH_3)_4(H_2O)SO_4]$ in the crystalline form, were obtained by the different groups in the CHM 316 experiments. With the use of equations, show the steps that resulted in the desired colour and briefly explain what could have been responsible for the colour variation in the products

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA
DEPARTMENT OF CHEMISTRY.
RAIN SEMESTER EXAMINATION 2018/2019 ACADEMIC SESSION
CHM 316 - EXPERIMENTAL INORGANIC CHEMISTRY

ANSWER ALL QUESTIONS **TIME ALLOWED: 40 minutes**

Instructions:

Write your Name, Registration Number and append your signature on the answer scripts

1a.i. Give the general formula for the alum prepared from aluminium waste *clearly defining the terms* involved.

ii. What step must be taken to ensure a substantial yield in the alum produced?

iii. Use an equation to express the digestion process of the aluminium waste, stating the role of $KMnO_4$ in the process and also back your answer with an equation. Also state why the baking process must take place at a temperature of 150°C?

b.i. What property does the dissolving solvent and the polyethylene have in common? What effect will a gradual recrystallization of the dissolved have on the product obtained?

ii. Use the detailed structure of the calcium-complexed pulverized polyethylene to differentiate between its texture and that of the uncomplexed product.

iii. What was the role of activated charcoal in the production of the $[Co(NH_3)_6]Cl_3$? Why was activated charcoal not added in the synthesis $[Co(NH_3)_5H_2O]Cl_3$

iv. Using the Crystal Field Stabilization Energy (CFSE), determine the more stable between the octahedral complexes of cobalt in the +2 and +3 oxidation states. Give reasons for your answer.

c.i. In the syntheses of the cobalt complexes, why was hydrogen peroxide added to the $CoCl_2$ solution and not otherwise?

ii. Using the equations below:

$[Co(NH_3)_6]Cl_3 + {}^{-}CN^{-}_{(aq} \longrightarrow [Co(NH_3)_5CN]Cl_{2\,(s)} + Cl^{-}_{(aq)}$ ......eqn. 1

$[Cu(H_2O)_4]^{2+}_{(aq)} + 4NH_{3\,(aq)} \longrightarrow [Cu(NH_3)_4]^{2+}_{(aq)} + 4H_2O_{(l)}$ ......eqn. 2

Classify the products in the equations according to their thermodynamic or kinetic preference. Give reason(s) for your answer.

iii. Which of the starting salts in the syntheses of the cobalt and copper complexes prepared in the just concluded CHM 316 practical classes would produce the required hydrated metal cations more readily? Give reasons for your answer.

iv. Use the amount or concentration of ammonia used in the syntheses of $[Co(NH_3)_6]Cl_3$ and $[Co(NH_3)_5H_2O]Cl_3$ to determine the one that would be labile or not.

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA
DEPARTMENT OF CHEMISTRY.
RAIN SEMESTER EXAMINATION 2018/2019 ACADEMIC SESSION
CHM 316 - EXPERIMENTAL INORGANIC CHEMISTRY

ANSWER ALL QUESTIONS **TIME ALLOWED: 40 minutes**

Instructions:

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1a.i. State the relationship between Crystal Field Stabilization Energy (CFSE) and Reactivity in complexes.

ii. What role does the Crystal Field Stabilization Energy play in the lability and inertness of metal complexes?

iii. Arrange the following complexes in an increasing order of ***Reactivity*** and ***CFSE (Δ)***.

- $[Co(NH_3)_5H_2O]Cl_3$;
- $[Co(NH_3)_6]Cl_3$
- $[Co(NH_3)_5Cl]Cl_2$

b.i. The *reversible reaction below showed the preparation of* Pentaamminecobalt(III) Chloride from *Aquopentaamminecobalt(III)Chloride in which the forward reaction* required a regulated amount of *heat.* *Which of the* rate constants *will be* involved in the rate determining step? Give reasons for your answer.

$$[Co(NH_3)_5H_2O]Cl_3 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} [Co(NH_3)_5Cl]Cl_2$$

ii. State what is usually responsible for the poor yield observed in the preparation of Aquopentaamminecobalt(III) Chloride (most common mistakes encountered)

c.i. Write the formula of the chrome alum you prepared and show how it can be related to that of a standard alum. How does it also compare with the alum prepared from aluminum foil?

ii. Why was the temperature regulated (controlled) in the production of chrome alum but otherwise in the in *the production of alum from aluminum foil?*

i. *Which of the uncomplexed and calcium-complexed polyethylene particles is expected to be*

- *denser*
- *more biodegradable?*

Give reasons for your answers.

.i. Name the gas was released during the digestion of the aluminum foil with the concentrated acid? What was the effect of this gas on potassium permanganate? Express your observation in a chemical equation, stating the nature of the gas and how the process was achieved.

ii. Briefly explain the sedimentation action of the alum produced? How did you confirm that the alum produced from aluminum foils was going to be effective in its sedimentation action?

i. Various colours, different from the expected deep blue of the Tetraammineaquosulphatocopper(II) complex $[Cu(NH_3)_4(H_2O)SO_4]$ in the crystalline form, were obtained by the *different groups in* the CHM 316 experiments. With the use of equations, show the steps that resulted in the desired colour and briefly explain what could have been responsible for the colour variation in the products obtained.

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA.
DEPARTMENT OF CHEMISTRY.
B.Sc. DEGREE RAIN SEMESTER EXAMINATION 2023/2024 SESSION
CHM 316: EXPERIMENTAL INORGANIC CHEMISTRY
JULY 2025

ANSWER ALL QUESTIONS **TIME ALLOWED: 50 minutes**

Instructions: Write your Name, Registration Number and append your signature on your answer scripts.

1a.i. In the production of alum using aluminum foil, both the digestion process and the determination of insoluble matter in the alum utilized Tetraoxosulphate (VI) acid. With the aid of detailed equations alone, differentiate between these two processes, clearly stating the conditions of the two reactions.

ii. How was it ensured that adequate amount of Aluminium waste got digested enroute the production of alum?

iii. Briefly explain why the products obtained from different CHM 316 groups exhibited different levels of crystallinity.

iv. Use detailed equations to represent the complexation reaction involving the low-density polyethylene and the following water-soluble salts (a) $CaCl_2$ and (b) $AlCl_3$. Also propose structures for the different complexation products.

- From your proposed structures, determine the product that is expected to be more dense and coarser.
- Which of these resulting products is expected to exhibit a higher melting point?

Give reasons for your answers.

b.i. Arrange the following complexes in an increasing order of electrical conductivity.
(a). $[Cu(NH_3)_4 H_2O\ SO_4]$ (b). $[Co(NH_3)_5 H_2O]Cl_3$ (c). $[Co(NH_3)_6]Cl_3$ (d). $[Co(NH_3)_5Cl]Cl_2$
(e). $[Cu(NH_3)_4Cl_2]SO_4$.
Give reasons for your answer.

ii. What simple tests can be used to differentiate between the following complexes?
- $[Co(NH_3)_5Cl]Cl_2$, • $[Co(NH_3)_5 H_2O]Cl_3$ and • $[Cu(NH_3)_4Cl_2]SO_4$

iii. What is responsible for the difference in the colours displayed by $[Co(NH_3)_6]Cl_3$ and $[Co(NH_3)_5Cl]Cl_2$ even though their central metals are existing in the +3 oxidation states.

iv. In the synthesis of chrome alum;

- State the role played by tetraoxosulphate (VI) acid and the significance of this role.
- Why was the K^+ ion preferred to the Na^+ ion as the monovalent component of the compound?
- Briefly explain why the chrome alum exhibited intense colour when compared to those obtained from aluminium foils? Give reasons for your answer.