Tutorial Letter 101/2/2018

Practical Inorganic Chemistry (III)
CHE3721

Semesters 2

Department of Chemistry

This tutorial letter contains important information about your module.
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1 INTRODUCTION

Dear Student

We are pleased to welcome you to this module (CHE3721) and hope that you will find it both interesting and rewarding. We shall do our best to make your study of this module successful. You will be well on your way to success if you start studying early in the semester/ year and resolve to do the practical work properly. This tutorial letter is our way of communicating with you about the modus operandi of our laboratory teaching, learning and assessment.

You will receive the lab manual, which has detailed work programs for the laboratory work when you come to the practicals by the beginning of June.

We have also included certain general and administrative information about laboratory work in this module. Please study this section of the tutorial letter carefully.

Please note that this module deals with the practical aspects of the theory module CHE3701. We hope that you will find the module interesting and rewarding. We shall do our best to make your study of this module successful. You will be well on your way to success if you start studying early in the semester and resolve to do the assignments properly.

2 PURPOSE AND OUTCOMES

2.1 Purpose

The purpose of this course is to motivate students to understand the fundamental concepts of electronic structure and spectra in d metal complexes and coordination compounds and organometallic chemistry.

Learning outcomes

(i) The students will be introduced to the basic experimental foundations of electronic structure and spectra of d-metal complexes by using synthetic methods and instrumental techniques such as Uv-Vis and infrared spectrophotometry.

(ii) The experiments will be designed in such a way that students will get a better insight in to the theoretical principles covering the following concepts:

a) Werner coordination compounds
b) Ligand field theory
c) Structure and bonding
d) Inorganic reaction mechanisms
e) Organometallic compounds
(iii) The students will be given the opportunity to apply their knowledge and skills gained to practical situations in advanced inorganic chemistry.

2.2 Outcomes

GOALS OF THIS LABORATORY COURSE:

1. **Strengthen theoretical knowledge**: expansion your understanding of the principles you have learned, or are learning, in the lecture component of this course.

2. **Strengthen experimental competence and confidence**: You will get the chance in this laboratory component to increase your exposure to various kinds of synthetic methods and analytical instrumentation. Where you use instruments which you have been previously exposed to, you will learn new applications for them.

3. **Learn how to write reports**: You will write complete reports for all of the experiments which you will perform in this laboratory class. Use A.C.S. style; look in the *Journal of the American Chemical Society* or *Inorganic Chemistry* for examples.

3 LECTURER(S) AND CONTACT DETAILS

3.1 Lecturer(s)

The lecturer responsible for this module is

Lecturer's name: Prof. Fikru Tafesse

Department of Chemistry

College of Science, Engineering & Technology

Eureka Building, Block K- M 028

[tafesf@unisa.ac.za](mailto:tafesf@unisa.ac.za)

011 670 9302 / 012 429 8716

Unisa is dedicated to service. Students are advised to resend their queries to the respective lecturers and then carbon copy the Chair of Department ([mphahmj@unisa.ac.za](mailto:mphahmj@unisa.ac.za)) on queries that are not addressed by the lecturers within 3 working days.
3.2 Department

Department of Chemistry

College of Science, Engineering & Technology
Eureka Building, Block K- M 042
chemistry@unisa.ac.za
011 670 9318/9327
Chemistry department

3.3 University

Communication with the University

If you need to contact the University about matters not related to the content of this module, please consult the publication *My studies @ Unisa* that you received with your study material. This booklet contains information on how to contact the University (e.g. to whom you can write for different queries, important telephone and fax numbers, addresses and details of the times certain facilities are open).

Always have your student number at hand when you contact the University.

PLEASE NOTE: Letters to lecturers may not be enclosed with or inserted into assignments.

4 RESOURCES

4.1 Prescribed books

There is no prescribed textbook for CHE3721. This means that you do not have to buy any additional books for CHE3721. You need only study your study guide, prescribed textbook for the theory module, CHE3701 and the tutorial letters. The prescribed textbook for CHE3701 is Shriver, Atkins, Overton, Rourke, Weller and Armstrong *Inorganic chemistry*, 6th edition, 2014 (ISBN 9780199641826), Oxford university press.
The University does not provide copies of this book. Students are expected to obtain their own copies. As most of the study material for this module is included in this book, it is essential to have access to a copy of the textbook. You may use the fourth and fifth edition as well if you are unable to get hold of the sixth edition. However note that the page numbers and arrangement of the chapters is different. The content of the chapters is more or less similar.

4.2 Recommended books

The following are publications that you may consult in order to broaden your knowledge of inorganic chemistry.

S.F.A. Kettle, Physical inorganic chemistry: A coordination approach, Oxford

The following books are useful reference books:

N. N. Greenwood and A. Earnshaw, Chemistry of the Elements, Pergamon Press.

4.3 Electronic reserves (e-reserves)

There are no e-reserves for this module.

4.4 Library services and resources information

For brief information, go to www.unisa.ac.za/brochures/studies

For detailed information, go to http://www.unisa.ac.za/library. For research support and services of personal librarians, click on "Research support".
The library has compiled a number of library guides:

- finding recommended reading in the print collection and e-reserves – http://libguides.unisa.ac.za/request/undergrad
- requesting material – http://libguides.unisa.ac.za/request/request
- postgraduate information services – http://libguides.unisa.ac.za/request/postgrad
- finding, obtaining and using library resources and tools to assist in doing research – http://libguides.unisa.ac.za/Research_Skills
- how to contact the library/finding us on social media/frequently asked questions – http://libguides.unisa.ac.za/ask

5 STUDENT SUPPORT SERVICES

General information about student support systems appears in your my Studies @ UNISA brochure.

5.1 Study Groups

Students who wish to form study groups can obtain the addresses of fellow students in a specific area from the:

The Directorate: Student Administration and Registration

PO Box 392
UNISA
0003

6 STUDY PLAN

The myUnisa Learning Management System

The myUnisa Learning Management System is the online campus network that enables each student to communicate via the internet with academic staff, fellow students and the administrative departments within UNISA. Students can also access resources and information from the university.

Use your my Studies @ Unisa brochure for general time management and planning skills.
7 PRACTICAL WORK AND WORK-INTEGRATED LEARNING

Students are required to attend a compulsory practical course CHE3721 of five day’s duration to complete the requirement for the third level inorganic chemistry module. Students can co-register with the theory component CHE3701 or may opt to take the practical component after successfully passing the theory module. The admission criteria to the practical session are given below. The venue for the practical is Inorganic chemistry lab. Eureka building, CSET Florida campus. Tentatively, the dates for the practical are slotted for the first week of September 2018.

7.1 ADMISSION TO PRACTICALS

Students who have already passed the theory module from previous semester/years will be granted automatic admission to the practical. If you have already passed the theory module in previous years you don’t need to submit the first assignment for purposes of admission. The successful passing of the theory module in previous years will grant you admission to the practical module automatically. Please inform the instructor before the first assignment deadline when you passed the theory module and the mark you obtained by e-mail so that your name will be included in the qualifying list. For those students who have concurrently registered for both the theory (CHE3701) and practical (3721) during the second semester, admission to the third year Inorganic practical (CHE3721) depends on getting a minimum of 50% in the first assignment of the second semester theory module (CHE3701). Eligible students will be informed about the practical dates in due course by the department.

Students who are unable to attend the practicals at the scheduled time may do the practicals at another university. Such students have to request approval from the Head of Department of Chemistry at UNISA to ascertain whether a particular practical course will be accredited by UNISA. However, gaining access to a specific institution is solely the responsibility of the student. Under normal conditions exemptions from any of the third level chemistry modules is not allowed.
Students who have completed any third year level Chemistry practical course at another university may apply for exemption from the practical component of the corresponding sub-discipline of Chemistry at UNISA. Such applications must be accompanied by a statement from the Department of Chemistry at the other university indicating that the student attended the practical course, details of the syllabus of the practical course, the year in which it was attended and the mark obtained.

All applications for exemption must be made in writing to the Head of the Department of Chemistry at UNISA.

8 ASSESSMENT

8.1 Assessment criteria

CHE3721 is a second semester module and is offered during the first week in September. The assessment is done by two assignments (i.e assignment 1 and 2) and Practical work and lab reports which are considered as assignment 3. The two assignments count 20% and the third assignment (practical work and lab reports) count 80% for the final mark.

8.2 Assessment plan

The final mark is composed of 20% year mark (from assignments 1 and 2) and 80% of portfolio (lab report and practical work).

Please note: Although students may work together when preparing assignments, each student must write and submit his or individual assignment. In other words, you must submit your own ideas in your own words, sometimes interspersing relevant short quotations that are properly referenced. It is unacceptable for students to submit identical assignments on the basis that they worked together. That is copying (a form of plagiarism) and none of these assignments will be marked. Furthermore, you may be penalized or subjected to disciplinary proceedings by the University.
8.3 Assignment numbers

8.3.1 General assignment numbers
The two assignments contribute 20% to your final mark. The lab report and practical work contribute the remaining 80% for the final mark. Please note that your admission to the practical depends on your performance in the first assignment of semester 2 if you are registering for both the theory and practical module during the second semester. Also note that the assignments are identical to those of the theory module. The only difference is the unique numbers.

8.3.2 Unique assignment numbers
Assignment 1: Unique no: 843829
Assignment 2: Unique no: 757629

8.4 Assignment due dates
Assignment 1: 10 August 2018
Assignment 2: 11 September 2018

8.5 Submission of assignments
You may submit written assignments either by post or electronically via myUnisa. Assignments may not be submitted by fax or e-mail. For detailed information and requirements as far as assignments are concerned, see the brochure Unisa: Services and Procedures that you received with your study material.

To submit an assignment via myUnisa:

• Go to myUnisa.
• Log in with your student number and password.
• Select the module.
• Click on assignments in the left-hand menu.
• Click on the assignment number you want to submit.
• Follow the instructions on the screen.
8.6 The assignments

Assignment 1 (compulsory for admission to the practical for students that have registered both theory and practical concurrently in the second semester).

Semester 2. Note that the assignments are identical to CHE3701 semester 2. It is only the unique number that is different

SEMESTER 2

Assignment 1:

Due date: 10 August 2018 Unique no: 843829

Before doing this assignment study the following: Units 1 and 2 from the study guide and chapters 7, 8 and 20 from the course textbook.

Part I. Multiple choice questions: Write the letter of your choice in your answer book

Each question is worth two marks

1. What is the coordination number of [Coen(OH)₂]³⁺?
   (a) 0     (b) 2     (c) 4     (d) 5     (e) 6

2. What type of isomerism does the compound [Pt(NH₃)₂Br₂] show?
   (a) optical   (b) linkage   (c) geometric   (d) coordination sphere

3. If each Ni²⁺ atom in NiCl₂ (s) is coordinated octahedrally by Cl⁻ ions, crystal field theory predicts
   the number of unpaired electrons on each Ni²⁺ atom to be
   (a) 2     (b) 3     (c) 4     (d) 5

4. According to the crystal field theory, which list contains only strong field ligands?
   (a) CN⁻, CO, Cl⁻, Br⁻
   (b) CN⁻, NO₂⁻ (N-bonded)
   (c) H₂O, Br⁻, NCS⁻ (N-bonded)
   (d) I⁻, CN⁻, CO, OH⁻
5. Which list contains only ligands that can form linkage isomers?
(a) CN\(^{-}\), SCN\(^{-}\), Cl\(^{-}\)  
(b) SCN\(^{-}\), NO\(_2\)^{-}  
(c) en, C\(_2\)O\(_4\)^{2-}  
(d) NH\(_3\), en, CN\(^{-}\)

6. Which statement is CORRECT?
(a) Strong field ligands cause complex ions to be high spin.
(b) Strong field ligands cause complex ions to be low spin.
(c) Large ligands favor formation of octahedral complex ions.
(d) A small number of ligands causes complexes to be low spin.

7. Which complex ion can have geometrical isomers?
(a) [PtCl\(_2\)Br\(_2\)]\(^{2-}\)  
(b) [CoF\(_6\)]\(^{3-}\)  
(c) [CuCl\(_4\)]\(^{2-}\)

8. Which statement about octahedral complex ions is CORRECT?
(a) The \(eg\) orbitals are destabilized by +2/5 \(D_o\).
(b) Ligand electrons make occupancy of the \(eg\) orbitals by metal electrons unfavorable.
(c) The \(t2g\) orbitals point directly toward the ligands.
(d) The C3 rotation axis causes the \(dxy\) and \(dx^2-y^2\) orbitals to be degenerate.

9. Which compound probably contains a complex ion?
(a) KAl(SO\(_4\))\(_2\)  
(b) CH\(_3\)COOH  
(c) CuSO\(_4\) 5H\(_2\)O  
(d) NaC\(_2\)H\(_3\)O\(_2\)

10. Select the CORRECT formula for the compound sodium aquatrichloroethylenediaminecobaltate(II)
(a) Na[Co\(_{en}\)(OH\(_2\))\(_3\)Cl]  
(b) [Co(OH)\(_{en}\)Cl\(_3\)]Na  
(c) Na[Co(NH\(_3\))(OH\(_2\))Cl\(_3\)]  
(d) Na[Co\(_{en}\)(OH\(_2\))Cl\(_3\)]
Part II. Short answer questions. Question 1 carries 20 marks. The rest of the questions carry 10 marks each

1. Fill the following table for octahedral complexes. Refer to the Tanabe-Sugano diagrams given in the appendix of your text book

<table>
<thead>
<tr>
<th>$d^n$</th>
<th>Ground state term symbol for free ion</th>
<th>Ground state term symbol for complex</th>
<th>Excited state term symbols for allowed transitions (see note* below)</th>
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<td>7 (HS)</td>
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<td>7 (LS)</td>
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* If there is more than one allowed transition, list them in order of increasing energy.

2. Answer the following questions about the transition-metal complex hexaamminecobalt(II) chloride.

   a) Find the number of unpaired electrons in the transition-metal complex hexaamminecobalt(II) chloride and draw the molecular orbital (MO) diagram for the complex with the correct number of electrons. Show just the occupied energy levels. Label each energy level as bonding, non-bonding, or antibonding.

   b) Compared with other complexes, is the metal-ligand bond in the cobalt-ammonia complex relatively strong or weak? Explain.
c) Air must be excluded in the preparation of the complex as the cobalt is easily oxidized from cobalt(II) to cobalt (III). Provide an explanation for the ease of oxidation.

d) Will the complex be lightly or darkly colored? Explain.

e) Suppose that the substance is heated in an oven until all the ammonia is driven off. Would the color of the resulting product be different? Briefly discuss.

3. Explain why an electronic transition for high spin [MnF₆]⁴⁻ is spin-forbidden, but for [CoF₆]⁴⁻ is spin-allowed.

4. Why are d-d electronic transitions forbidden in octahedral coordination entities? Why are they weakly absorbing and why do they occur at all?

5. There are three transitions in the UV-visible spectrum of [Ni(NH₃)₆]²⁺ at 900, 550 and 325 nm. Using the Tanabe Sugano diagram and the above data calculate B and Δo. What colour is the complex?

6. How many d-d bands would you expect in the electronic spectrum of an octahedral Cr³⁺ complex?

7. Account for the observation that the colour of trans-[Co(en)₂F₂]⁺ is less intense than those of cis-[Co(en)₂F₂]⁺ and trans-[Co(en)₂Cl₂]⁺
Assignment 2:
Due date: 11 September 2018  Unique no: 757629

Assignment 2 covers units 2, 3, and 4 of the study guide and chapters 20, 21 and 22 of the course textbook. Please study the above before you attempt the questions

Part I. Multiple choice questions: Write the letter of your choice in your answer book

Each question is worth 2 marks

1. The volume (in mL) of 0.1 M AgNO₃ required for complex precipitation of chloride ions present in 30 mL of 0.01 M solution of [Cr(H₂O)₅Cl]Cl₂, as silver chloride is close to
   A. 3  B. 3  C. 5  D. 6

2. Total number of geometrical isomers for the complex [RhCl(CO)(PPh₃)(NH₃)] is
   A. 1  B. 2  C. 3  D. 4

3. The oxidation state of iron in K₄[Fe(CN)₆] is
   A. 1  B. 2  C. 3  D. 4

4. The pair of compounds having metals in their highest oxidation state is
   A. MnO₂, FeCl₃  B. [MnO₄]⁻, CrO₂Cl₂  C. [Fe(CN)₆]³⁻, [Co(CN)₃]  D. [NiCl₄]²⁻, [CoCl₄]⁻

5. The spin only magnetic moment value (in Bohr magneton units) of Cr(CO)₆ is
   A. 0  B. 2.84  C. 4.90  D. 5.92

6. The value of the ‘spin only’ magnetic moment for one of the following configurations is 2.84 BM. The correct one is
   A. d⁴ (in strong ligand field)  B. d⁴ (in weak ligand field)
   C. d⁵ (in weak as well as in strong fields)  D. d⁵ (in strong ligand field)
7. When EDTA solution is added to Mg$^{2+}$ ion solution, then which of the following statements is not true?

A. four coordinate sites of Mg$^{2+}$ are occupied by EDTA and remaining two sites are occupied by water molecules

B. All six coordinate sites of Mg$^{2+}$ are occupied

C. pH of the solution is decreased

D. Colorless [Mg–EDTA]$^{2-}$ chelate is formed

8. Which complex can not ionize in solution?

A. [Pt(NH$_3$)$_6$]Cl$_4$  B. K$_2$[pt(F$_6$)]  C. K$_4$[Fe(CN)$_6$]  D. [CoCl$_3$(NH$_3$)$_3$]

9. Which compound is zero valent metal complex?


10. Which has maximum paramagnetic character?

[Fe(CN)$_6$]$^{4-}$  [Cu(H$_2$O)$_4$]$^{2+}$  [Cu(NH$_3$)$_4$]$^{2+}$  [Mn (H$_2$O)$_6$]$^{2+}$

Part II. Short answer questions. Each question carries 10 marks.

1. Predict the spin state (high- or low-spin) for each complex and calculate CFSE. Indicate your reasoning in each case.

a) Fe(H$_2$O)$_6^{2+}$

b) Ru(NH$_3$)$_5^{2+}$

c) Fe(CN)$_6^{4-}$

Which of these complexes should be Jahn-Teller distorted?
2. The experimentally derived magnetic moments of the following complexes are:

- \([\text{Fe(H}_2\text{O)}_6]^{2+}\) 5.35 BM
- \([\text{Co(H}_2\text{O)}_6]^{2+}\) 5.20 BM
- \([\text{Fe(CN)}_6]^{3-}\) 2.40 BM
- \([\text{Cr(H}_2\text{O)}_6]^{3+}\) 3.85 BM

Calculate the spin only magnetic moment of each complex and thus explain in detail the reasons for any significant differences between the calculated and experimentally determined values.

3. Design a selective one-step synthesis for each of the three possible isomers of \([\text{Pt(py)}\text{NH}_3(\text{NO}_2)\text{Cl}].\) Draw the isomers.

4. Why are tetrahedral complexes generally more intensely coloured than octahedral complexes?

5. What molecular structural features control the intensity of an infrared absorption?

6. Give the formal oxidation state and \(d^n\) configuration for the transition metal atom in each of the following:

   i) \(\text{Ti(acac)}_3\) (acac = acetylacetonate anion)
   ii) \([\text{MnCl}_4]^{2-}\)
   iii) \(\text{Ni(CO)}_4\)
   iv) \([\text{Fe(CN)}_6]^{4-}\)
   v) \(((\eta^6-\text{C}_6\text{Me}_6))\text{TiCl}_3]^+\) (Me = methyl)

7. Consider hexacyanochromate(III) and hexaaquachromium(III) ions. Find the LFSE for each; which will be larger? Estimate the spin-only magnetic moment for each ion in units of Bohr-Magnetons.

8. Explain why \([\text{Ti(OH}_2)_6]^{3+}\) has red violet color. (you must provide the general origin of color in this compound).
8.7 Other assessment methods
There are no other assessment methods for this module.

8.8 The examination

The practical component contributes a total of 80 marks for the final grade of CHE3721.

9 FREQUENTLY ASKED QUESTIONS

9.1 ACCOMMODATION

UNISA does not provide accommodation for students attending Practicals. Students have to make their own arrangements.

10 SOURCES CONSULTED
None.

11 IN CLOSING

I hope that you will enjoy this module and we wish you success with your studies.

Kind regards

PROF. Fikru Tafesse

12 ADDENDUM

CHEMISTRY LABORATORY RULES AND SAFETY PRECAUTIONS

1. Wear appropriate clothing in the laboratory
2. Lab coat has to be worn at all times
3. No sandals or open shoes are allowed
4. No shorts or skirts are allowed inside the laboratory
5. Never work alone in the laboratory
6. Smoking and eating in the laboratory are not allowed
7. Unauthorized experiments are prohibited.
8. Know the location and use of the fire extinguishers, safety showers and first aid kit

9. It is required that you wear prescription glasses or safety glasses at all times in the laboratory for your own protection. Contact lenses are particularly dangerous and they must not be worn in the laboratory.

10. Report all injuries to your instructor at once

11. Never taste chemicals or solutions

12. Use the fume hoods at the sides of the laboratory for all poisonous reactions or any reactions which produce noxious gases.

13. When diluting concentrated acids or bases always add the concentrate acids or bases to water (never the reverse) while stirring the solution.

14. Keep an orderly clean laboratory desk. Return glassware to the lab drawer when finished using it to keep the work area from becoming cluttered.

15. Leave unneeded books and personal belongs away from the working bench.

16. Waste containers are provided for the disposal of all solid chemicals and paper etc. disposes your waste appropriately.

17. Leave the stock reagent bottles and chemicals at the position you found them.

18. Always read the label twice before taking any chemical from a bottle. If you are not sure if you have the right chemical, ask!

19. When pouring reagents, hold the bottle so that the label points upwards facing the palm of your hand. The accumulation of reagents on bottle lip may be removed by touching the bottle lip to the rim of the receiving vessel.

20. Avoid using an excess of reagent. If you happen to have measured out too much, see if someone else can use the excess.

21. Due to possible contamination of the contents of a whole stock bottle, never return unused chemicals to the stock bottle.

22. Always check your glassware before you use it. If it is broken or cracked, exchange it for another one.

23. There is one container reserved for broken glass. All broken glassware should be placed in this container and no other.

24. If corrosive chemicals or liquids come in contact with the skin or clothing, flood with excess amounts of water for an extended period of time.

25. Spilled chemicals should be wiped up immediately; spilled acid or base should be rinsed with plenty of water and wiped up.

26. Inserting glass tubing or thermometers through a rubber stopper- first lubricate the tube and stopper with glycerol or water, then holding the tube near the end to be inserted insert slowly while rotating the tube. Be very careful!

27. When you are ready to leave the laboratory, your bench area should be wiped up and the water, gas and air valves shut off.
The chemistry store room is out of bounds to students. If you require apparatus, ask your instructor for it.

Disposable polyethylene gloves are provided. Other gloves materials may not protect you against the chemicals handled in the lab.

Never pipette by mouth!

**GENERAL LABORATORY PROCEDURES**

**Use of time**

The efficient use of time is an asset to the student. Plan your experiments so that you will profitably use time which would otherwise be spent. You should be constantly looking for opportunities to use the available time effectively. Remember, if you manage to finish an experiment early, you are free to leave.

**Cleanliness**

Since most of the experiments will involve the use of equipment which other students will also use, it is absolutely essential that all equipment be left in good condition at the end of each session. Any equipment that is broken should be reported to the instructor immediately so that replacement may be sourced. Wash bottles of detergents, alcohol and acetone are provided at the sink to help you clean your glassware.

**Balances and weighing**

Most of the experiments involve weighing. Much time can be wasted over weighing procedures and one of the biggest time waster is the habit of weighing to the degree of accuracy in excess of the requirements of the experiment.

For synthetic work, weighing to 0.1 g or 0.01 g is quite sufficient. Only for analytical work, such as the characterization of some of the compounds, is greater accuracy required on the order of 0.001 or 0.0001 g.

Even if weighing is only carried out to the required degree of accuracy, time can be wasted in the actual process, and unless some method is used whereby weighing is carried out rapidly.
At no time are chemicals to be weighed out onto the pans of the analytical balances. The balances will be irreparably damaged by exposure to the kinds of chemicals you will be handling in this laboratory. For synthetic work you will use only top-loading balances. Should you require a more accurate measurement than allowed by top-loaders, follow the method of weighing by difference described in the following paragraphs. Although they are more robust, even the top loading balances are susceptible to corrosion. Make it a practice to clean up any spilled chemicals on or around the balances immediately. Balances are expensive they cost between 15,000 and 30, 000 Rands and must be treated with respect!

**Weighing by difference**

To weigh an accurate amount of solid (i.e. to the nearest 0.001 g or better) place a weighing bottle on a top-loading balance, tare it, and weigh out an approximate amount of solid as close as possible to the accurate weight required. If the solid contains large crystals or lumps it should be lightly ground in a mortar before weighing. The weighing bottle with its contents is now capped, wiped clean and weighed using the correct procedure on the analytical balance, the weight being recorded in your note book immediately. Tip the contents into the reaction vessel, no attempt being made to remove the traces of solids which will cling to the weighing bottle, replace back the cap and reweigh the empty weighing bottle. The loss in weight is the accurate weight of the solid emptied into the reaction vessel.

**Laboratory Notebook**

A complete accurate record is an essential part of laboratory work and chemical research. The record of each experiment should be sufficiently clear that another chemist reading it could understand what was done, what results were obtained and, if necessary, repeat the work as it was done. Your note book will be judged primarily on how well it meets these criteria. Clarity and completeness are more important than neatness. It is not necessary to adhere to any particular format or organization as long as sufficient details are provided. **It is very important to write down what you do as you do it! Any observation should be recorded immediately. It is not acceptable to fill your lab notebook after completing the entire experiment!**
A bound hard cover lined notebook is required (Please make sure that you are in possession of one). Spiral or loose-leaf notebooks are unacceptable. The pages should be numbered consecutively and some blank pages left at the beginning for table of contents. Begin each experiment on a new page and write only in blue or black ink. Each experiment should be dated. When the experiment extends over more than one day, a date should be entered at the beginning of the entries for each separate day’s work. The laboratory notebook is also a good place to write down your thoughts and speculations as to the progress of your experiments. You may wish to include alternate methods and techniques in order to better achieve the end result. Finally include any notes that may aid you in understanding and writing up the experiment (e.g. structures, references, equations, etc).

**Laboratory reports**
You will be required to provide a short typed report on every experiment you performed. These reports should not be a regurgitation of the information provided in the Laboratory manual, but rather a concise summary with the results included. Three or four pages will be usually sufficient per experiment. Detailed information on how to write an acceptable lab report will be provided in the lab manual.) It is important to remember that your lab report should be written in third person past tense! Use the A.C.S. format for all reports.

You will perform these experiments on your own or in a group. Your reports should be unique. I do not want to see reports that are obviously duplicated. If I do, I will treat this instance as plagiarism, and will penalize all parties to the incident in accordance with the policies of the university, which are spelled out in the student handbook.

**Note**: I recognize that you may work together when answering the questions associated with each experiment. This is O.K., and even useful, but make sure that what you write is in your own words.

The *My Studies @ Unisa* brochure contains an A-Z guide of the most relevant study information.
Useful Data

<table>
<thead>
<tr>
<th>Reagent</th>
<th>%</th>
<th>Molar mass (g/mol)</th>
<th>Molarity (M)</th>
<th>ρ (g/mL)</th>
<th>Aliquot *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrofluoric acid, HF</td>
<td>48.8</td>
<td>20.0</td>
<td>29.0</td>
<td>1.19</td>
<td>34.5</td>
</tr>
<tr>
<td>Hydrochloric acid, HCl</td>
<td>37.2</td>
<td>36.5</td>
<td>12.1</td>
<td>1.19</td>
<td>82.5</td>
</tr>
<tr>
<td>Hydrobromic acid, HBr</td>
<td>48.0</td>
<td>80.9</td>
<td>8.90</td>
<td>1.50</td>
<td>120</td>
</tr>
<tr>
<td>Hydroiodic acid, HI</td>
<td>47</td>
<td>127.9</td>
<td>5.51</td>
<td>1.50</td>
<td>180</td>
</tr>
<tr>
<td>Perchloric acid HClO₄</td>
<td>70.5</td>
<td>100.5</td>
<td>11.7</td>
<td>1.67</td>
<td>86</td>
</tr>
<tr>
<td>Sulfuric acid H₂SO₄</td>
<td>98</td>
<td>98.1</td>
<td>18.0</td>
<td>1.84</td>
<td>55.5</td>
</tr>
<tr>
<td>Nitric acid HNO₃</td>
<td>70</td>
<td>63.0</td>
<td>15.9</td>
<td>1.42</td>
<td>63.5</td>
</tr>
<tr>
<td>Phosphoric acid, H₃PO₄</td>
<td>85.5</td>
<td>98.0</td>
<td>14.7</td>
<td>1.70</td>
<td>69</td>
</tr>
<tr>
<td>Acetic acid CH₃COOH</td>
<td>99.8</td>
<td>60.0</td>
<td>17.4</td>
<td>1.05</td>
<td>57.5</td>
</tr>
<tr>
<td>Ammonia, NH₃(aq)</td>
<td>29</td>
<td>17.0</td>
<td>14.8</td>
<td>0.9</td>
<td>67.5</td>
</tr>
</tbody>
</table>

* aliquot = mL of reagent which dilutes to 1L of 1M solution.

CHE3701 (Inorganic chemistry III) syllabus

I. d-metal complexes: electronic structure and properties

(Metal-Ligand bonding in transition metal complexes (CFT): Limitations of valence bond theory, Splitting of d-orbitals in different fields (Octahedral, tetrahedral, tetragonal distorted octahedral, square planner, trigonal bipyramidal), Consequences and applications of orbital splitting, crystal field stabilization energy, magnetic properties, factor affecting extent of splitting, spectrochemical series, colour of transition metal complexes in terms of d-orbital splitting. Magneto-chemistry: Origin and type of magnetic behavior shown by transition elements and compounds. Magnetic susceptibility, Application of magnetic susceptibility measurement to first row metal complexes. Qualitative idea of orbital contribution and abnormal magnetic momentsElectron Spectra of transition metal complexes: Types of electronic transition, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagrams for d1 and d9 states)
1. Review of an introduction to coordination compounds
   - Nomenclature, Isomerism, thermodynamics of complex formation etc.

2. Electronic structure and spectra
   - Crystal field theory
   - Ligand field theory
   - Russel Saunders coupling
   - Electronic spectra of atoms and molecules
   - Orgel diagrams
   - Tanabe Sugano diagrams
   - Selection rules and intensities
   - Magnetism

II. Coordination chemistry: reactions of complexes

(Thermodynamic and Kinetic Aspect of Metal Complexes: Definition of stability, step wise formation constants and overall formation constants. Kinetic vs Thermodynamic stability, labile and inert octahedral complexes according to valance bond and crystal field theory. Factors affecting stability of complexes in aqueous solutions, nucleophillic substitution reactions and mechanism in square planer complexes. Trans effect and its theories)

- Ligand substitution reactions
- Inorganic reaction mechanisms
- Substitution reactions in octahedral compounds
- Substitution reactions in square planer complexes
- Ligand field effects
- Acid catalyzed and base catalyzed reactions of complexes
- Redox reactions
- Photochemical reactions
III. Introductory d-metal organometallic chemistry


-Bonding
-nomenclature
-structure
-Eighteen electron rule
-organometallic reactions and mechanisms
-Oxidative addition and reductive elimination reactions
- d-block carbonyls
-metalloccenes and metal clusters
-Catalysis