THE COLLEGE OF THE BAHAMAS
SCHOOL OF NATURAL SCIENCES & ENVIRONMENTAL STUDIES
CHEMISTRY DEPARTMENT

CHEM 235 – INORGANIC CHEMISTRY

COURSE OUTLINE

As far as possible the principles of Physical Chemistry encountered in CHEM 135 and 225 should be applied to the study of inorganic compounds, and chemical reactivity and should be related to chemical structure.

1. **Bonding**
   A brief review of the types of bonding discussed in CHEM 135. Molecular orbital theory. Formation of J and π bonds. Estimation of covalent character of ionic substances by comparing theoretical and measured lattice energies. Polarity of covalent bonds. Polarization of ionic bonds.

2. **Crystal Structures** (Suggestion: can be covered in Lab)
   Metallic—hexagonal close packing, cubic close packing, body centered cubic structure.

   Ionic: e.g. sodium chloride and caesium chloride structure
   Covalent: e.g. iodine, ice and solid carbon dioxide
   Giant covalent: e.g. graphite, diamond
   Interstitial compounds.

3. **Periodicity** as exemplified by the first twenty elements of the periodic table.

   a) **Physical periodicity**
   A review of the periodicity of some physical properties encountered in CHEM 135 (ie atomic radius, ionization energy, electron affinity, electronegativity) and an extension to include melting point, boiling point, and atomic volume.

   b) **Chemical periodicity amongst the oxides, chlorides and simple hydroxides of the elements Li to Cl**

   Oxides: Stoichimetric composition, state at room temperature and pressure, bonding and structure, reaction with water and acid/base behavior. General methods of preparation of the oxides.

   Chlorides: Stoichimetric composition, state at room temperature and pressure, bonding and structure, reaction with water and general methods of preparation of the chlorides.

   Hydrides: Stoichiometric composition, state at room temperature and pressure, bonding and structure, reaction with water, acid/base character, electrolysis of ionic hydrides.

4. **A Systematic Study of the Main Groups of Elements In the Periodic Table**

   a) **Groups I & II:**
   Fixed oxidation states. Trends within the groups – ionization energies electrode potentials, thermal stabilities & soluabilities of hydroxides, carbonates and nitrates; basic strength of oxides, the formation of oxides, peroxides and superoxides. The exceptional properties of the first member of each group. The diagonal relationship between Li and Mg.

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b) **Group III:**
A comparative study of the first two members, their chlorides and hydroxides to illustrate their non-metallic and metallic character respectively. The relationship between Be and Al.

The acidic behavior of the [Al $(H_2O)_6]^{3+}$ ion and its reaction with hydroxide ions. The amphoteric nature of Al_2O_3 and $Al(OH)_3$

c) **Group IV:**
A study of trends in physical and chemical properties down the group including the transition from non-metallic to metallic character catenation and multiple bonding, the stability of the +2 oxidation state and the inert pair effect, the tendency to form ionic compounds, the composition and hydrolytic behavior of the chlorides, the acid/base behavior of the principle oxides, the stability of the dioxides the stability of the dioxides, the range of hydrides and their stability. The reducing action of Su^{2+}.

d) **Group V:**
The transition from non-metallic to metallic behavior. The considerable differences in the physical properties of nitrogen and phosphorus. A comparative study of the principal oxides, chlorides, hydrides and oxo-onions of N and P.

e) **Group IV**:
A comparison of the physical properties of oxygen and sulphur. The formation of oxides and sulfides by direct combination. Comparison of the physical properties of the hydrides of 0 and S. Precipitation of sulphides and conditions necessary for the precipitation of certain sulphides. Classification of oxides as acidic, basic, neutral, amphoteric, and peroxides if not already covered. Preparation of SO2 and SO3. The principal oxo-anions of sulphur. Redox reactions involving:
SO_3^{2-}, SO_2, SO_4^{2-}, $S_2O_3^{2-}$, $S_2O_8^{2-}$.

The reactions of sulphuric acid as an acid, a dehydrating agent, an oxidizing agent, and a sulphonating agent.

f) **Group VII:**
Trends in the properties of F, Cl, Br, and I including atomic radius, state at room temperature and pressure, electron affinity, electronegativity, standard electrode potential, thermal stability for the series of compounds X_2 and HX. The acidic properties of the hydrogen halides and the abnormal behavior of HF(aq) and F^- (aq). Displacement reactions of the halogens. Disproportionation of Cl_2 and OCL^-. The oxides, oxyacids and oxo-anions of chlorine to illustrate variable oxidation states. Acid strength for series HCLO, $HCLO_2$, $HCLO_3$, $HCLO_4$.

g) **Group VIII:**
Trends in ionization energy-atomic radius. General inertness. The existence of a few xenon compounds.

5. **Transition or d-block**
The first row of d-block elements (Sc to Zn) will be studied. Electronic configuration and characteristic features—metallic character, variable oxidation states, formation of colored ions and complexes, catalytic activity, paramagnetism.
Complexions—nomenclature, definition of the terms ligan'd, coordination number, monodentate, bidenate etc. Hybridization bonding and shapes of complexes, stability constants, isomerism in complexes—geometrical, optical and ionization
$[Fe(H_2O)_6{}^{3+}]$, $[Fe(H_2O)_6]^{2+}$. $[Ni(NH_3)_6]^{2+}$, $[CuCl_4]^{2-}$, $[Zn(H_2O)_6]_{2+}$, & $[Zn(OH)_4]^{2-}$ should be included in the study of complex ions.

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Formation of coloured compounds and paramagnetism explained by the ligand field or crystal field theory. The spectrochemical series. Variable oxidation states explained in terms terms of electronic configuration. Redox chemistry of Fe^{2+}, Fe^{3+}, Cu^{2+}, Zn^{2+} including their preparation from the metal by the action of acids, the precipation of the hydroxides, interconversion between oxidation states, and the disproportionation of Cu^{2+}.

PROJECT

An essay on the extraction of a commercially important metal from its ore or the manufacture of a commercially important compound. The essay should include a consideration of the following:

Physical features affecting yield e.g. temperature and pressure, the availability and cost of raw materials, disposal of waste products and pollution control, cost of running the plant, energy requirements, separation of by products from products, location of the plant in relation to pollution effects, ease of obtaining raw materials and distributing products.

EVALUATION

Assignments and Tests	10%
Projects	5%
Mid-term Exam	15%
Laboratory	20%
Final Examination	50%

TEXT BOOK

Brown, LeMay & Bursten, Chemistry 9th edition, Prentice Hall, 2003.

READING LIST

Basic Inorganic Chemistry, Cotton, Wilkinson & Gaus, 2nd edition, Wiley, 1987
A-Level Chemistry by E.N. Ramsden (1985), Stanley Thornes, Ltd. (Pub)
Chemistry of the Elements, Greenwood & Earnshaw, Pergamon
Descriptive Inorganic Chemistry, Rayner-Canham, Freeman
Concepts and Models of Inorganic Chemistry, Douglas, McDaniel & Alexander, Wiley