School of Chemistry

Aims and Objectives: Session 2023-2024, Semester 1

Module CH1202: Introductory Chemistry

Duration: 30 x 1h Sessions, either lectures or tutorials

9 (3 x 3) hours laboratory work.

Lecturers: **Inorganic**: Dr B. A. Chalmers, Dr A. N. Price.

Physical: Dr J. B. O. Mitchell*, Dr R. M. Smith, Dr T. van Mourik.

Organic: Dr N. S. Keddie, Dr R. J. Pearson, and. Dr C. M. Young.

(*Module Convenor)

Aims: This module provides an introduction to some of the fundamental aspects of Chemistry and is primarily aimed at students entering the Chemistry BSc and MChem courses directly into 2nd year. The module will cover structure and bonding in inorganic chemistry, fundamental physical chemistry and bonding, stereochemistry and reaction mechanisms in organic chemistry.

Objectives:

To have a knowledge and understanding of the following:

1. The use of Lewis structures to describe molecular structure, and VSEPR theory to predict the molecular shape of small molecules. The concepts of formal charge and oxidation state.

2. Molecular Orbital theory to describe structure and shape of small molecules (homo- and heteronuclear diatomic, and linear triatomic) including the concept of bond order.

3. The basics of Crystal Field Theory relating to octahedral transition metal complexes, and how ligands affect the metal d-orbitals, including the concept of high and low spin complexes and how to determine d-electron counts from magnetic measurements.

4. Isomerism and coordination geometries, ligand types, and isomerism in transition metal complexes.

5. Describing the crystal structures of solid elements. Understanding the relationships between atomic sizes, unit cells and densities of solids, and able to sketch the unit cells for the four basic structures adopted by elements.

6. First Law of Thermodynamics and thermochemistry. Heat capacity and heat transfer. Internal energy and its relationship to heat, work done and enthalpy. Standard states. Enthalpy changes and phase changes, combustion, ionisation and bond dissociation. Hess's Law. Spontaneous processes, entropy and Gibbs energy.

7. The direction of change in chemical reactions. Le Chatelier's Principle. Equilibrium constant.

8. Redox equilibria. The feasibility of a reaction. General aspects of standard cells and half-cells, including conventions and calculations of cell emf.

9. Aqueous strong and weak electrolyte behaviour including calculations of acid, base and salt solutions. Be familiar with K_a, K_b, pK_a, pK_b and K_w. Buffered solutions and calculation of pH. Henderson-Hasselbalch equation.

10. Factors affecting the rate of a reaction. Rate laws, order of a reaction, first and second order kinetics. Temperature-dependence of rate constants, Arrhenius equation, activation energy and pre-exponential factor.

11. Essential mathematical concepts for chemists. Basic mathematical notation, real numbers, algebra, differentiation and integration, exponentials and logarithms. Graph plotting, lines of best fit, linear regression. Different types of experimental errors and methods for propagating them. Precision and rounding.

12. Principles of spectroscopy. Electromagnetic spectrum. Bohr Model and quantisation, X-ray photoelectron spectroscopy, Auger electron spectroscopy and X-ray fluorescence spectroscopy. Applications of spectroscopy in chemistry.

13. The interactions between atoms, molecules and ions, which lead to the occurrence of gases, liquids and solids. The gas laws, the kinetic theory of gases and its principal results.

14. Electronic structure of solids. A simplified description of valence and conduction bands.

15. Structure and bonding in organic chemistry. Discussion of sp, sp^2 and sp^3 hybridisation. Structures in alkanes and alkenes, including configuration and conformation.

16. Introduction of stereochemical conventions. Molecules with one stereogenic centre. Enantiomers, the *R* and *S* convention using the Cahn-Ingold-Prelog rules. Molecules with two stereogenic centres. Diastereoisomers.

17. An introduction to arrow pushing. To appreciate how nucleophiles and electrophiles interact and how arrow pushing can be used to illustrate the movement of electrons during reactions and to understand a range of chemical reactions.

18. Mechanistic aspects of substitution, elimination and addition reactions. Markovnikov addition.

19. Alkene stability and Saytzeff's rule.

20. The chemistry of functional groups including alcohols, amines and thiols.

21. Carbonyl functional groups and reactions of carbonyl compounds with organometallic reagents and other nucleophiles. The structure and formation of acetals/ketals. Understand keto-enol tautomerism.