FOUN008 Chemistry - Reactivity

Section 1: General Information

1.1 Administrative Details

Subject:	Chemistry
Code:	FOUN 008
Stream	Science
Points	12
Pre-requisite	None

1.2 Subject Workload

Number of timetabled hours per week	Number of Personal study hours per week	Total workload hours per week
4	4	8

1.3 Pre-requisites

Students are not required to have undertaken a pre-requisite subject.

1.4 Other resource requirements

List specialist facilities and/or equipment required for the delivery of this subject:

- Suitable calculator, but without communication function.
- Lab coat required
- University-level chemistry lab with technical support

Section 2: Academic Details

2.1 Subject Overview

The principle topics in Modules One and Two are Redox, Equilibrium, Aqueous (to include acid/base plus solubility), and Thermochemistry. Sufficient skills will be imparted such that students will have a head start on Chemistry 191 at University, which is a pathway course for medical school and related fields.

We emphasize the following general areas: background knowledge, computational skills, correct use of English language in science, and chemistry laboratory skills.

2.2 Learning Objectives and Outcomes

By the end of each lecture and tutorial you should be able to:

MODULE 1

Lecture 1 / Tutorial 1: The Chemical World. Measurement and formulae

1. Understand the particle nature of matter
2. Recall the standard units and be able to use the system of prefixes to indicate the magnitude of a given unit
3. Calculate the number of significant figures in a measurement and round a value according to the number of S.F.
4. Use chemical symbols correctly
5. Name covalent and ionic compounds given their formulae and write formulae for given compounds (A table of ions will not be included in any assessment tasks)

Lecture 2 / Tutorial 2: Electron Transfer Reactions

1. Recognise redox equations or half equations in terms of loss or gain of electrons.
2. Identify **the** oxidising or reducing agent.
3. Recall the properties/colour of common oxidising and reducing agents.
4. Discuss the halogens as oxidising agents (electron takers), including their reactions with other elements.

Lecture 3 / Tutorial 3: Balancing Redox Equations and Oxidation Numbers

1. Write balanced equations for redox reactions by the ion-electron method in acid conditions.
2. Calculate the oxidation number of a given compound or ions.
3. Use oxidation numbers to determine if redox has occurred.

Lecture 4 / Tutorial 4: Solutions

1. Express the concentration of solutions in grams per litre, grams per 100mL (solution percentage) and moles per litre.
2. Convert concentration from one unit to another.
3. Learn the three percentages used in chemistry, under what circumstances each is required, and perform calculations.
4. Calculate the concentration of an unknown solution given its volume (L) together with the mass (g) and molar mass (M) of the solute.
5. Recall and use the formulae relating the mass (m), concentration (c), amount in moles (n), and volume (V).
6. Understand and calculate parameters of standard solutions.
7. Solve simple quantitative chemistry problems involving solutions.
8. Use the fact that moles have not changed to calculate concentrations of diluted solutions.

Lecture 5 / Tutorial 5: Volumetric Analysis

1. Name and recall the appropriate techniques for using volumetric glassware, including pipettes, burettes, conical flasks, and volumetric flasks, especially cleaning.
2. Carry out acid-base titration calculations.
3. Select average concordant results.
4. Calculate the concentration of a solution from titration data.
5. Use titration data to find the mass of substance present.

Lecture 6 / Tutorial 6: Redox Titrations

1. State the characteristics or reagents suitable as a primary standard.
2. Describe in detail redox titrations and any special conditions and how the end point is detected;
3. Learn basic titration terms.
4. Perform redox calculations based on titration data.

Lecture 7 / Tutorial 7: Electrochemistry 1

1. Show that any redox reaction can be separated into oxidation and reduction half-reactions.
2. Describe how a cell can be constructed using a redox reaction in which half reactions are contained in half-cells joined by a salt bridge.
3. Explain Standard Reduction Potentials as the conventional voltage of a cell compared with the standard hydrogen electrode.
4. Describe and use the IUPAC convention for standard reduction potentials.
5. Write a "cell diagram" from a picture diagram of connected cells, whether the reaction is spontaneous or not.

Lecture 8 / Tutorial 8: Electrochemistry 2

1. Use SRP to compare the relative strengths of reducing agents.
2. Calculate cell potential and predict any spontaneous redox reaction.
3. Realise that the prediction of spontaneity does not extend to the prediction of rate.
4. Label a diagram for electrolysis of a given solution, including the direction of electron movement, and write equations for the reaction occurring at each electrode.

Lecture 9 / Tutorial 9: Equilibrium 1

1. Give examples of reversible reactions.
2. Use examples to explain what is meant by dynamic equilibrium.
3. List the features of a system in a condition of dynamic equilibrium.
4. Write the equilibrium expression (K) for a given equation.
5. Classify a reaction as reactant favoured or product favoured according to the value of the equilibrium constant.

Lecture 10 / Tutorial 10: Equilibrium 2

1. Predict the effects on a system in equilibrium of changing the concentration of a reactant or product, adding catalyst or inert gas, changing temperature, or changing pressure.
2. Apply the principles of equilibrium systems to industrial processes.

Module 2:

Lecture 11 / Tutorial 11: Acids and Bases

1. List the characteristic properties of acids and bases.
2. Define acids and bases in terms of proton transfer.
3. Correctly identify the acids and bases in proton transfer reactions.
4. Write equations to show why aqueous solutions containing the HCO_3^-, CO_3^{2-}, NH_4^+ and CH_3COO^- are not neutral.
5. Recognise the difference between strong and weak acids and bases.
6. Explain the behaviour of strong and weak acids and bases in terms of their reaction with water and the concentration of H_3O^+ and OH^- ions.
7. Describe acidic or basic solutions appropriately using the terms strong, weak, concentrated and dilute.
8. Explain why equal amounts of monoprotic strong and weak acids will neutralise the same amount of a given base.

Lecture 12/ Tutorial 12: pH - Introduction

1. Recognise water dissociates to a very small extent, write the equilibrium reaction and equilibrium constant for this dissociation and identify the equilibrium constant as K_w.
2. Use the expression for K_w to convert between $[H_3O^+]$ and $[OH^-]$.
3. Recognise the relationship between pH and $[H^+]$ and recall the two formulae: $pH = -\log_{10}[H^+]$ and $[H^+] = 10^{-pH}$.
4. Calculate the pH of a strong acid or base and calculate the concentration of strong acid or base from pH.

Lecture 13 / Tutorial 13: pH of weak acids and bases

1. Write an equation for the dissociation of a monoprotic acid weak acid and write an expression for K_a from it.
2. Define and use appropriately pH, K_a, pK_a, K_b, pK_b and K_w.
3. Use K_a and p K_a to measure acid and base strengths.
4. Calculate the pH of a solution of a weak acid, weak base and a salt given their concentrations and appropriate K_a and K_b values.

Lecture 14 / Tutorial 14: Buffers

1. Define a buffer solution.
2. Explain buffer action by writing equations for the reactions that occur when H_3O^+ or OH^- is added to a given buffer solution.
3. Give examples of buffers.
4. Calculate the pH of a buffer solution given suitable data, or complete calculations to make up a buffer solution of a given pH.
5. Given the pH of a buffer solution, determine the mole ratio of [HA] : $[A^-]$ or [B] : $[HB^+]$.
6. Understand, and calculate, the difference between dilution effects on strong acids *versus* buffers

Lecture 15 / Tutorial 15: Titration curves and Indicators

1. Be able to sketch the general shape of the titration curves for:
    a. Strong acid vs. strong base
    b. Weak acid vs. strong base
    c. Strong acid vs. weak base
2. Discuss the characteristics of the titration curves in 1 and perform appropriate calculations to find the pH at different points on the curve or calculate the concentration of the acid or base.
3. Explain the colour change of acid base indicators by describing each indicator as a weak acid with a certain pK_a.
4. Choose an appropriate indicator for a titration given pH of the equivalence point and the K_a or p K_a.

Lecture 16 / Tutorial 16: Ions in Solution

1. Identify the presence of common ions or complexes from the colour of their solutions.
2. Use simple lab tests to identify the following ions in solution: CO_3^{2-}, $SO_4^{2-}Cl^-$, I^-, OH^-, Na^+, Cu^{2+}, Fe^{2+}, Fe^{3+}, Zn^{2+}, Al^{3+}, Mg^{2+}, NH_4^+, Pb^{2+}, Ag^+, Ba^{2+}.
3. Write balanced ionic equations to describe the formation of precipitates or complex ions.
4. Use a series of supplied observations to identify unknown ions present in a solution, justifying your answer in each case.
5. Distinguish between Cu^{2+}, Fe^{2+}, Fe^{3+}, and Ag^+ using sodium hydroxide reagent.

Lecture 17 / Tutorial 17: Solubility Equilibria

1. Recognise a saturated solution as a system in equilibrium.
2. Define the solubility product, K_s for a sparingly soluble ionic solid in a saturated solution.
3. Calculate solubility in mol L^{-1} using K_s.
4. Calculate K_s using solubility.
5. Define ionic product (Q or Q_{calc}) as an expression similar to K_s.
6. Use ionic product to predict precipitation.
7. Predict the effect of a common ion on the solubility of a sparingly soluble ionic compound.

Lecture 18 / Tutorial 18: Aqueous solutions

1. List the species present in an aqueous solution in order of concentration.

Lecture 19 / Tutorial 19: Energy and Rates

1. Give examples of endothermic and exothermic reactions and interpret + and – values for Δ*H* correctly.
2. Use an energy diagram to show exo or endo reactions.
3. Classify reactions as exo or endo given the Δ*H*, temp change or energy diagram.
4. Predict the energy absorbed or released in a reaction given the appropriate thermodynamic equation.
5. Calculate the enthalpy change in a reaction using experimental data.
6. Describe how to change the rate of a reaction.
7. Use simple collision theory to explain how the factors of concentration, particle size and temperature can alter the rate of a chemical reaction.
8. Recognise the role of catalysts in lowering the activation energy of a reaction and give examples of catalysed reactions.

Lecture 20 / Tutorial 20: Thermochemistry

1. Describe the changes that take place at melting and boiling points in terms of the changing kinetic and potential energy of the particles.
2. Recall the relationship between absolute temperature and the average kinetic energy of the particles.
3. Define enthalpies of fusion and vaporisation for a pure substance, eg water.
4. Define enthalpies of formation and combustion.
5. Use standard enthalpies of formation to calculate the enthalpy change for a reaction.
6. Use Hess's Law to calculate enthalpy changes for reactions.
7. Calculate the enthalpy change for a reaction, using bond energies and recognise the approximate nature of these calculations.

2.3 Subject Content

Week	Lecture / Tutorial	Lecture / Tutorial	Lab (approx dates)
1	The Chemical World, Measurement and formulae	Electron transfer reactions	
2	Balancing redox equations and oxidation numbers	Solutions	Electron Transfer
3	Volumetric analysis	Redox titrations	
4	Electrochemistry Galvanic Cells	Electrochemistry Predicting spontaneity	
5	Equilibrium 1	Equilibrium 2	Redox Titrations
6	Revision Lecture	Test – 20% (Lectures 1-10)	
7	Acids and Bases	pH Introduction	
8	pH weak Acids and Bases	Buffers	Equilibria
9	Titration Curves and Indicators	Ions in solution	
10	Solubility Equilibria	Aqueous solutions	
11	Thermochemistry 1	Thermochemistry 2	
12	Revision Lecture	Revision Lecture	

2.4 Teaching Method/Strategies

Lectures are face to face instruction. Tutorials start with a recap of the last lecture and then students work through some problems. Lab work is completed in teams of two or three. An "exit text" is administered to individual students at the conclusion of the practical.

2.5 Assessment

Assessment Type	When	Weighting	Learning Outcomes Assessed
Internal Test	Week 7	20%	Outcomes 1-10
Labs	Throughout term	10%	Outcomes 1-20
Final Examination	Week	70%	Outcomes 1-20

2.5.1 Assessment Strategy

Assessment is via timed tests.

2.5.2 Hurdle Requirement

In order to pass this paper, students must obtain an overall mark of 50% (C-) or better.

2.5.3 Assessment Details

Assessment	Content/ Format	Time	Details
Internal Assessment Task 1 20%	45 minute written test. A periodic table is provided.	Week 7	This test covers all material from the first book. It has both calculation questions and short answers questions.
Internal Assessment Task 2	Labs. Students will attend 3 labs of 2 hours each.	Throughout the term.	A 15 minute exit test is given. Students will be given a lab book that they need to use as a guide and to write in their results, as well as some discussion questions
Final Examination		2 hours	This test covers all material from both of the books. It has both calculation questions and short answers questions.

3.1 Weekly Schedule

Week	Lecture / Tutorial	Lecture / Tutorial	Lab (approx dates)
1	The Chemical World, Measurement and formulae	Electron transfer reactions	
2	Balancing redox equations and oxidation numbers	Solutions	Electron Transfer
3	Volumetric analysis	Redox titrations	
4	Electrochemistry Galvanic Cells	Electrochemistry Predicting spontaneity	
5	Equilibrium 1	Equilibrium 2	Redox Titrations
6	Revision Lecture	Test – 20% (Lectures 1-10)	
7	Acids and Bases	pH Introduction	
8	pH weak Acids and Bases	Buffers	Equilibria
9	Titration Curves and Indicators	Ions in solution	
10	Solubility Equilibria	Aqueous solutions	
11	Thermochemistry 1	Thermochemistry 2	
12	Revision Lecture	Revision Lecture	