UNL21 Chemistry – Course Outline

About the Course

The unit is a preparatory chemistry unit designed to help you gain the necessary knowledge to enter into a tertiary degree for careers in the sciences or health sector. The concepts covered in this unit are: chemical bonding; stoichiometry; acids and bases; quantitative analysis; gas laws; oxidation and reduction; the periodic table; organic chemistry; rates of reaction; energy; and chemical equilibrium.

This unit includes individual tutorial support with an experienced high school chemistry teacher. Tutorial support is via email, phone or video communication.

The unit has flexible enrolment dates to meet your needs. Start your study when you want and complete the unit any time within the 12 month enrolment window. This unit is equivalent to years 11/12 Chemistry. This unit requires a minimum of 220 hours or 18 weeks to complete.

Aim

The main aim of this course is to assist the learner to obtain the skills and knowledge in chemistry that are the equivalent of the skills and knowledge gained in a typical Australian high school level chemistry course, which would be required for commencing studies in tertiary programs.

The course also aims to:

- Give students an understanding of some of the aspects of chemistry that affect their daily lives
- Communicate chemical ideas effectively using various methods, including written, graphical and diagrammatic forms
- Develop critical thinking skills, especially with relation to issues involving science and technology.

At the end of this course the learner should be able to:

- Use correctly significant figures and scientific notation
- Name correctly a range of inorganic and organic chemicals
- Recall and describe a wide range of qualitative and quantitative chemical relationships, ideas and information

- Understand basic bonding theories and relate the bonding within materials to their structure and properties
- Predict the products of various types of reactions and write appropriate balanced equations for those reactions.
- Apply algorithms and link concepts to solve both straightforward and complex problems
- Express and interpret chemical information in diagrammatic and graphical form

The student should have acquired the pre-requisite knowledge and confidence to undertake studies which require a higher level of competence in chemical science and be motivated to continue with lifelong learning where skills in chemistry are required.

Structure

The UNL21 Chemistry course was written specifically for Unilearn and is designed for students who study online. It consists of 25 chapters. Questions are included within each chapter and exercises follow each chapter so that the learner can work through them to develop experience in problem solving. Worked Solutions for the questions and exercises are provided at the end of each chapter.

Progress Tests and lab activities are also provided at appropriate points in the course. Students are required to successfully complete eleven (11) of these progress tests and eleven (11) lab activities to be eligible to sit for the final examination.

Tutorial Support is available from the UNL21 Chemistry Teacher. This support, which can be accessed by email, phone or video communication, is designed to help students clarify understanding of concepts to provide details of solutions to exercises and to answer other relevant queries.

Pre-requisite knowledge

Candidates for UNL21 Chemistry must be competent in mathematics including algebraic manipulation, solutions of linear equations, the concepts of ratio and proportion and the interpretation and drawing of graphs. Students who feel they need to develop their mathematical skills are referred to UNL31 Introductory Mathematics. An understanding of junior science, especially scientific terminology relating to chemistry, could also be advantageous.

Specimen Examination

The Specimen Exam, a practice for the final exam, is available once you have completed approximately 80% of the course. The Specimen Exam gives students the opportunity to work through, under exam conditions, problems similar to those they will face on the final exam. It also helps them to see if they are pacing themselves appropriately. Most students who are successful on the Specimen Exam find they are successful on the final exam as they are prepared for the types of questions and the format of the final exam.

Hours of Study

In general the course should be completed in a minimum of 220 hours of study. The actual time required by an individual student to receive a successful result, however, will depend on the background, time available and needs of the learner. A majority of students take 540 hours to complete the course over the 12 months.

Assessment

The chapter questions, the end-of-chapter exercises, the learning checklist after each chapter, the progress tests and the Specimen Examination are designed to help students prepare for the final examination for UNL21 Chemistry. Examinations are assessed by the UNL21 Chemistry Teacher.

To be eligible to sit for the final, closed book examination, students are required to achieve a mark of 60% or higher each on each of progress tests and on each of the Labs. The formal, supervised examination covers all of the course materials. To achieve a Pass grade for the course, students must also score at least 50% on the Final Exam. Candidates who successfully complete the course are awarded a Statement of Achievement which lists the percentage mark gained and a grade of Pass, Credit, Distinction or High Distinction. Students who fail to obtain the minimum mark required for a Pass grade, after submitting a reasonable attempt, may then be eligible to sit a second examination at the teachers' discretion.

Examinations are not held at set times. Rather, they are arranged through the Unilearn office after the student has successfully completed the required materials with a score of 60% or higher on each.

Practical Components

UNL21 Chemistry consists of eleven practical lab activities that provide you with the foundation required for most medical programs. These activities include both hands-on and virtual labs. The hands-on component uses materials available either in the home or that are relatively inexpensive and easily purchased. These lab activities count towards your final grade and can be done at home. Lab activities are hosted through our online classroom, so there is no need to go to a campus or book a room anywhere; they have been developed to be conveniently accessible online.

Chemistry consists of the following lab activities:

Lab Activities	Type of Lab	Hours
Bonding	Hands-on	4
Concentration of solutions	Virtual	2
Colorimetry	Hands-on	2
Crystal growing	Hands-on	2
Titration of NaOH against KHP	Virtual	3
pH changes during a titration	Virtual	2
Relative reactivity of metals	Virtual and Hands-On	2
Structural isomers of hydrocarbons	Hands-On	3
Geometric isomers of alkenes	Hands-On	2
Equilibrium and Le Chatelier's Principle	Virtual	2
Temperature and equilibrium constant	Virtual	2
	Minimum Total Hours	26

Grading Scheme

Students are required to complete all required materials (progress tests and lab activities) with a score of 60% or above on each in order to be eligible to sit the final exam. They must also score a minimum of 50% on the final exam to pass the course. A student's final grade is an accumulation of all required assessment items and will be weighted as follows:

Progress Tests	10%
Lab Activities	10%
Final Exam	80%
	100%

Grade	% required
High Distinction (HD)	85% and above
Distinction (D)	75 - 84%
Credit (C)	65 – 74%
Pass (P)	50 - 64%
Fail	0 – 49%

Content

Chapter 1 – What is Chemistry

This chapter covers:

- Evidence of a chemical reaction
- Qualitative and quantitative observations
- Dimensional analysis
- Random and determinate errors
- Precision and accuracy
- Significant figures
- Scientific notation

Chapter 2 – A Particle View of Matter

This chapter covers:

- Models of atoms
- Atomic number and mass number
- Names and symbols of the first 18 elements of the periodic table and other common elements
- The organisation and usefulness for the periodic table
- Electron configurations of the first 18 elements of the periodic table
- The meaning of chemical formulas
- Pure substances and mixtures
- Properties of solids, liquids and gases

Chapter 3 – Metals

This chapter covers:

- The metallic bond
- Physical and chemical properties of metals
- The relationship between the properties of metals and the bonding within them

Chapter 4 – Ionic Compounds

This chapter covers:

- The ionic bond
- The physical properties of ionic compounds
- The relationship between the properties of ionic compounds and the bonding within them
- The names and formulas of common ions
- Rules for assigning oxidation number
- Calculation of oxidation number
- Formulas and names of ionic compounds
- Balancing equations

Chapter 5 – Molecular Covalent Substances

This chapter includes:

- The molecular covalent bond
- Lewis structures for simple covalent elements and compounds

- The shapes of molecules based on the number of bonded atoms and the number of electron groups
- Polar and non-polar covalent bonds and molecules
- The rules for naming covalent substances
- The names of the first ten straight-chain alkanes
- The physical properties of molecular covalent compounds
- The relationship between the properties of molecular covalent compounds and the bonding within them
- Intramolecular bonding and intermolecular bonding

Chapter 6 – Network Covalent Substances
This chapter covers:

- The network covalent bond
- Carbon, Silicon and Compounds that have network covalent bonds

Chapter 7 – Intermolecular Forces
This chapter covers:

- Dispersion forces, dipole-dipole forces and hydrogen bonding
- The effect of the size and shape of the electron cloud on dispersion forces
- A comparison of the physical properties of substances based upon the types of intermolecular forces involved

Chapter 8 – The Structure of Materials – Revision of Atomic Structure and Bonding Theory
This chapter covers a review of:

- Atomic and molecular structure
- The various types of intramolecular and intermolecular bonds and the properties associated with each type of bond
- The types of formulas used for substances with various types of bonds
- Identifying the type of bonding in a substance

Chapter 9 – Basic Reacting Quantities
This chapter covers:

- Calculations of relative atomic mass and isotopic abundance
- Conversion between atomic mass units and grams
- Calculations of molecular mass and molar mass
- Calculations involving moles and number of particles
- Calculations of percent composition, empirical formulas and molecular formulas
- Calculations involving number of moles, mass and molar mass
- Dilute, concentrated, saturated and unsaturated solutions
- Calculations based on solubility curves
- Calculations of parts per million, parts per billion.
- Calculations involving number of moles, molarity and volume
- Calculations needed to prepare solutions from solids and from more concentrated solutions

Chapter 10 – Calculations from Chemical Equations

This chapter covers:

- Balanced Equations
- Calculations based on mass, moles, balanced equations, molarity and volume
- Limiting reagents

Chapter 11 – Acids and Bases

This chapter covers:

- Bronsted-Lowry and Lewis definitions of acids and bases
- Typical strong and weak acids and bases
- Equations for typical acid-base reactions
- Conjugate acid-base pairs
- pH and pOH calculations for strong acids and bases
- The relationship between pH and pOH at $25^{o}C$
- Calculation of the concentration of H^{+} and/or OH^{-} at $25^{o}C$ from pH and/or pOH data

Chapter 12 – Quantitative Analysis

This chapter covers:

- Volumetric Analysis
- Volumetric equipment
- Primary standards
- Titrations
- Equivalence point and endpoint
- Calculations including the preparation of primary standards and titrations
- pH changes during a titration
- Indicators for titrations
- Back titrations
- Gravimetric analysis
- Calculations of gravimetric analyses where the reaction is known and for hypothetical reactions

Chapter 13 – Reacting Quantities Summary

This Chapter covers:

- A review of all previous calculations involving reacting quantities

Chapter 14 – Gases of the Atmosphere

This chapter covers:

- The structures and properties of oxygen, nitrogen and carbon dioxide
- Preparations and uses of oxygen, nitrogen and carbon dioxide
- The main greenhouse gases

Chapter 15 – Gas Laws

This chapter covers:

- The Kinetic Theory of gases
- The properties of gases
- Units of pressure, volume and temperature

- Avogadro's Hypothesis, Boyle's Law, Charles's Law, the Ideal Gas Law and Dalton's Law of Partial Pressures and calculations involving these laws
- The relation between partial pressure and mole fraction
- Calculations involving collecting a gas over water

Chapter 16 – Oxidation and Reduction
This chapter covers:

- Identifying oxidation-reduction reactions
- Balancing redox reactions using the ionic half equation method
- For a given reaction, identifying which species are oxidised and reduced and the oxidising and reducing agents
- The design and limitations of the electrochemical series
- Using the electrochemical series and/or experimental data to determine whether or not a reaction should occur spontaneously

Chapter 17 – Electrochemical Cells
This chapter covers:

- Drawing fully labelled electrochemical cells
- The shorthand representation of an electrochemical cell
- Dry cell batteries and rechargeable batteries

Chapter 18 – Electrolysis
This chapter covers:

- The differences between electrochemical and electrolytic cells
- Drawing fully labelled diagrams for the electrolysis of molten salts and of salts in aqueous solution
- Faraday's First and Second Laws of Electrolysis and calculations based on them
- Some important uses of electrolysis

Chapter 19 – Chemical Periodicity and the Periodic Table
This chapter covers:

- The construction and usefulness of the periodic table
- Electron configurations of elements up to and including krypton, Kr.
- The difference between the main block elements, transition elements and inner transition elements
- The prediction of properties based upon an element's position in the periodic table

Chapter 20 – Organic Chemistry Part 1 – Hydrocarbons
This chapter covers:

- Alkanes, alkenes, alkynes, dienes and alkyl groups
- Molecular, structural and semi-structural formulas
- Physical and chemical properties of hydrocarbons
- Structural isomers
- IUPAC system of nomenclature for naming hydrocarbons and halogenated hydrocarbons

- Preparations and reactions of hydrocarbons
- Different conditions required for addition and substitution reactions of alkenes with halogens
- Geometric isomers of alkenes

Chapter 21 – Organic Chemistry Part 2 – Other Organic Compounds
This chapter covers:

- Functional groups for alcohols, carboxylic acids and esters
- Preparations and reactions of alcohols, carboxylic acids and esters
- The physical properties of organic compounds as a function of their bonding
- Addition and condensation polymerisation
- Equations for the formation of addition and condensation polymers
- Number of monomer units and average molar mass of polymers
- The differences between polyesters, polyamides and polypeptides
- The general formula of amino acids
- Differences between proteins, carbohydrates, fats and oils
- Stoichiometric and other calculations involving organic compounds

Chapter 22 – Energy
This chapter contains:

- Exothermic and endothermic reactions
- Heat of reaction, Q, and change in enthalpy, ΔH
- Calorimetry
- Hess's Law of Heat Summation
- Formation and combustion reactions
- Calculations of ΔH using enthalpy of formation and average bond energies

Chapter 23 – Rate of Reaction
This chapter covers:

- Ways of following reaction rates experimentally
- Ways of increasing and decreasing reaction rate
- Energy level diagrams showing ΔH and the activation energy
- Determination of reaction rate from graphical and/or experimental data
- The rate determining step in a multi-step reaction

Chapter 24 – Equilibrium and Equilibrium Constant
This chapter covers:

- How rate and concentration change as a system approaches equilibrium
- The difference between equilibrium and steady state systems
- Characteristics of a system at equilibrium
- Equilibrium constant expressions
- Calculations involving equilibrium constant expressions
- Le Chatelier's Principle, including predictions based on the Principle and graphical interpretations

Chapter 25 – Equilibria in Aqueous Solution

This chapter covers:

- Equilibrium constant expressions for the ionisation of weak acids and bases
- Calculations involving equilibrium constant expressions for the ionisation of weak acids and bases
- Ionisation constants for multi-step ionisation reactions
- The common ion effect
- The value of the ionisation constant of water, Kw, at $25^{o}C$
- Relationships between Kw, $[H^{+}]$, $[OH^{-}]$, pH and pOH
- Calculation of pH and pOH of both strong and weak acids and bases
- Calculation of pH and pOH using Kw
- Solubility product constant expressions
- Calculations involving the solubility of a salt and Ksp
- Using Ksp to predict the formation of a precipitate
- Ksp calculations involving common ions