Course Outline

CHEM1011

Chemistry 1A: Atoms, Molecules and Energy

School of Chemistry

Faculty of Science

Term 2, 2021

1. Staff

Position	Name	Email	Contact Details
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2. Course information

Units of credit: 6

Pre-requisite(s): none (see assumed knowledge below for recommended background)

Total course contact hours: 72

2.1 Course summary

This course builds on an elementary knowledge of chemistry (equivalent to HSC chemistry, or Foundation Studies Chemistry at UNSW Global) to explore the quantum mechanical structure of atoms leading to an understanding of the periodic trends in the properties of the elements. This knowledge is applied to understanding chemical bonding and intermolecular forces which together are responsible for determining the properties of materials. General principles of chemical equilibrium are developed and applied to chemical reactions involving acids and bases. The applications of the laws of thermodynamics to chemical processes are described and ultimately linked to chemical equilibrium and chemical reactions involving electron transfer.

2.2 Course aims

Chemistry 1A aims to give a basic understanding of the principles of chemistry that underlie the behaviour of matter. The course seeks to provide a basic understanding of the structure of atoms and molecules, explores the basic types of chemical reactions and provides some models for understanding structures of molecules, and how structure relates to bonding and properties. The course also treats phases of matter and solution behaviour, equilibrium and redox reactions. Thermochemistry is also important, examining heat, enthalpy, entropy, Hess' Law, Gibbs energy, and its relationship to equilibrium position, and to the potential of electrochemical and electrolytic cells. This background supports higher level study not only in chemistry, but also in engineering and technology, physics, biology and other areas.

The laboratory component of the course equips you with the necessary skills to safely handle chemicals and laboratory equipment, perform accurate measurements, meaningful analyses, and to manipulate and present data.

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Apply the language of chemistry to the naming and formulae of chemical substances and to chemical reactions.
2. Perform calculations to quantify substances relating to chemical reactions.
3. Apply theory and laws to predict properties and behaviour of chemical substances.
4. Demonstrate proficiency in defined core chemistry laboratory skills by safely investigating chemical reactions in first-hand scientific investigations.
5. Gather, analyse, and interpret data from first-hand scientific investigations to draw valid conclusions.

2.4 Relationship between course and program learning outcomes and assessments

CLO	CLO Statement	Program Learning Outcome (PLO)	Related Tasks & Assessment
CLO 1	Apply the language of chemistry to the naming and formulae of chemical substances and to chemical reactions.	Demonstrate confidence and skill in approaching problems and in treating both qualitative and quantitative data. Develop the ability and disposition to think logically and communicate clearly by written and oral means.	Online quizzes and Validation tests. Final Exam Laboratory Practicals
CLO 2	Perform calculations to quantify substances relating to chemical reactions.	Apply curiosity, imagination, and speculation to solving problems. Demonstrate confidence and skill in formulating problems and in treating both qualitative and quantitative data. Develop the ability and disposition to think logically and communicate clearly by written and oral means.	Online quizzes and Validation tests. Final Exam Laboratory Practicals
CLO 3	Apply theory and laws to predict properties and behaviour of chemical substances.	Demonstrate an understanding of the significance of science and technology in modern society. Develop the habit of seeking and recognising relationships between phenomena, principles, theories, conceptual frameworks and problems.	Online quizzes and Validation tests. Final Exam Laboratory Practicals
CLO 4	Demonstrate proficiency in defined core chemistry laboratory skills by safely investigating chemical reactions in first-hand scientific investigations.	Apply a working knowledge of fundamental scientific principles, methods of investigation, and an appreciation for objectivity and precision. Demonstrate confidence and skill in approaching problems and in treating both qualitative and quantitative data.	Laboratory Practicals
CLO 5	Gather, analyse and interpret data from first-hand scientific investigations to draw valid conclusions.	Apply a working knowledge of fundamental scientific principles, methods of investigation, and an appreciation for objectivity and precision. Apply curiosity, imagination, and speculation to solving problems, constructing hypotheses, and designing experiments. Develop the ability and disposition to think logically and communicate clearly by written and oral means.	Laboratory Practicals

2.5 Course syllabus

The syllabus is divided into “Threshold” and “Mastery” content. You must demonstrate that you have all of the Threshold knowledge in order to be eligible to pass the course. Mastery concepts are the more sophisticated content in the syllabus; they build on the Threshold material and serve to integrate the principles and provide real-world applications of chemistry. Mastery knowledge will allow you to earn a merit grade in the course.

2.5.1 Recommended chemistry background and assumed knowledge

Either of the courses CHEM1011 (Chemistry 1A) or CHEM1031 (Higher Chemistry 1A) may be taken as the first half of level one chemistry. Chemistry 1A assumes year 11 NSW HSC (or equivalent) syllabus knowledge while Higher Chemistry 1A (available in Term 1 only) assumes year 12 NSW HSC (or equivalent) syllabus knowledge. Both courses have some overlap with year 11 NSW HSC chemistry and extend on these concepts. Either course may be taken as a stand-alone course by students who require only one course of level one Chemistry. If you do not meet this assumed knowledge requirement, the School of Chemistry strongly recommends that consider enrolling in CHEM1001 – Introductory Chemistry, before entering CHEM1011.

As a minimum we have designed the course assuming you are confident with the following:

- Use the periodic table to identify an element’s symbol, atomic number, and relative atomic mass. Describe important features of the periodic table and their significances (arrangement into groups and periods, important subsets of elements such as the noble gases, halides, transition metals, lanthanides…).
- Name the constituent parts of an atom, together with their relative masses and charges and locations within the atom [according to the Bohr model]..
- Calculate numbers of protons, neutrons, electrons in atoms of a specified isotope of any element and interpret [isotope/nuclear/AZE] notation (e.g. $^{12}_{6}C$)
- Name common inorganic and organic compounds and write the formula for simple compounds from their name, including common polyatomic ions (e.g. NH_4^+, MnO_4^-, SO_4^{2-}, HSO_4^-, OH^-…).
- Write and balance simple chemical equations.
- Calculate molecular weight from chemical formula and perform mole calculations from mass.
- Calculate % by mass of each element in a compound and determine empirical formula and molecular formulae from % by mass.
- Calculate concentration of solutions in various units and perform dilution calculations.
- Perform calculations involving density (D=m/V), and recall the density of water is 1 g/mL.
- Perform calculations involving the quantity of an element/compound within a mixture: percentage compositions by mass (%w/w), %w/v, %v/v, mole fraction
- Relate the concept of a mole to number of particles using Avagadro’s constant. Use the mole ratio of a chemical equation to perform stoichiometric calculations involving quantities of solids, solutions and gases (n, m, C, V, T, P, number of particles).
- Identify the limiting reagent in a chemical reaction and perform stoichiometric calculations restricted by this limitation.
- Calculate expected and percentage yield for a chemical reaction.
- Describe the properties which distinguish gases from other states of matter and define Charles’ Law, Boyle’s Law, Gay-Lussac’s Law and Avogadro’s Law and use them to calculate quantities of gases.

- Identify acids and bases using the Arrhenius definition.
- Know the names and formulae of common acids and bases (from the list provided).
- Predict the products of reactions of acids and bases with acids and bases. (neutralisation), metals, and carbonates.
- Describe in simple terms the concept of atoms forming bonds to become molecules (covalent bonding). Recognise that diagrams displaying element symbols connected by straight lines (e.g. O=C=O) are approximate representations of the bonding within molecules.
- Recognise key organic functional groups: alkanes, alkenes, alkynes, alcohols, carboxylic acids, esters, ketones, aldehydes, ethers, amines and amides
- Conversions between common scientific units e.g. °C to K, atm to Pa to Torr, kJ to J, mL to L
- Fundamental knowledge of mathematical principles including:
    - Common numerical abbreviations (eg. nano, milli etc)
    - Rearranging simple algebraic formulae including manipulations of exponents and logarithms (including $\log_{10}$ rules)
    - Numerical rounding and use of significant figures
    - Use and manipulation of scientific notation.
    - Calculation and manipulation of percentages

2.5.2 Diagnostic Test

At the start of term, an online diagnostic test will be available via Moodle, which will enable you to assess whether your chemistry background is sufficiently strong to allow you to continue in the course you have enrolled in or whether you should transfer to a lower level chemistry course. This test is WILL NOT contribute to your assessment. Nevertheless, it is your best interest to attempt it and to do as well as you can so that you can make a realistic decision about which first year chemistry course suits your background.

If you are studying CHEM1011 in Term 1, and you score a poor mark or a very good mark in the diagnostic test, you could consider changing to a less demanding course (CHEM1001), or the higher-level course (CHEM1031). In Term 2 or Term 3, when CHEM1031 and CHEM1001 are not offered, if you score a poor mark in the diagnostic test, you could consider deferring first year chemistry and taking a chemistry bridging course over summer and taking Chem 1A next year. If you are considering changing CHEM courses, you should obtain advice from the First Year Director before changing your enrolment.

2.5.3 Syllabus

The syllabus for this course is split into two categories: Threshold theory, which is the minimum PASS level material you need to learn and Mastery theory, which is the theory you need to learn to earn merit grades (and to excel in higher year chemistry courses).

Threshold	***Mastery***
1. Quantisation of Energy and Hydrogen Atoms	
T1.1a. Describe and use the following terms appropriately: ● Photon ● Ionisation energy ● Ground state ● Excited state ● Energy level ● Emission ● Absorption	M1.1a. Describe and use the following terms appropriately: ● Emission spectrum ● Absorption spectrum ● Spectroscopic transition ● Rydberg constant ● Atomic spectra
T1.2a. Calculate the energy, frequency, and wavelength of a photon from any one of these quantities. T1.2b. Identify and rank the sections of the electromagnetic spectrum based on energy, wavelength or frequency.	
T1.3a. Recognise that for electrons restricted in their motion, quantum mechanics restricts their energy to specific values. T1.3b. For hydrogen-like atoms, label the allowed energy levels with the appropriate value of the principal quantum number. T1.3c. Interpret the energy diagram of hydrogen like atoms to recognise electrons in the ground state, excited state and the mechanism of a transition (emission of absorption of a photon) including ionisation. T1.3d. Interpret the energy diagram of hydrogen like atoms to calculate the energy of a photon absorbed or emitted for a given transition.	M1.3a. Relate the lines and series in the emission and absorption spectra of hydrogen atoms to energy transitions and use the Rydberg equation to calculate the wavelengths. [*Depth*] M1.3b. Recognise that orbitals have nodal surfaces. [Depth]
	M1.4a Describe the uses of atomic spectra in science, technology, and industry [*Applications of Chemistry*].

<table>
<tr><th colspan="2">2. Atomic structure</th></tr>
<tr><td>T2.1a. Describe and use the following terms appropriately:
● Electron density
● Atomic orbital
● Quantum number
● Electronic configuration
● Aufbau Principle
● Hund’s Rule
● Pauli Exclusion principle
● Paramagnetic and diamagnetic</td><td>M2.1a. Describe and use the following terms appropriately:
● Atomic radius
● Ionic radius
● Electron affinity
● Electronegativity
● Molecular Orbital
● Bonding and</td></tr>
<tr><td>T2.2a. Recognise, sketch and calculate the number of atomic orbitals in levels up to n = 3 (1s, 2s, 2p, 3d).</td><td>M2.2a. Recognise atomic orbitals as emerging from solutions to the Schrödinger equation for hydrogen-like atoms and relate orbitals to the probability of finding an electron at a point in space. [Depth]</td></tr>
<tr><td>T2.3a. Recognise each of the four quantum numbers and their roles in describing the shapes and sizes of atomic orbitals (s, p, d).
T2.3b. Know what combinations of quantum numbers are allowed.
T2.3c. Use quantum numbers together with the Pauli exclusion principle to identify the number of electrons allowed within an energy level.</td><td></td></tr>
<tr><td>T2.4a. Apply Pauli’s exclusion principle, Hund’s rule, and the Aufbau principle, to give ground state electron configurations of isolated atoms and ions using ‘arrows in boxes’ and 1s notation.</td><td>M2.3a. Explain how trends in properties of atoms across the periodic table arise from electron configurations. [Depth]
M2.3b. Predict (relative to position in the periodic table) trends in: atomic radius, ionic radius, ionisation energy, electron affinity and electronegativity. [Depth]
M2.3c. Relate shielding to effective charge and relate to ‘anomalies’ in periodic trends. [Depth]</td></tr>
<tr><td></td><td>M2.4a. Define bond formation in terms of the energy change as two atoms approach. Relate this to orbital overlap in the context of valence bond theory. [Breadth]
M2.4b. Recognise that orbitals involved in bonding in molecules will be different to those in atoms and that bonding and antibonding molecular orbitals exist. [Breadth]
M2.4c. Describe how Mos can be approximated by combinations of atomic orbitals. [Breadth]</td></tr>
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3. Bonding	
T3.1a. Describe and use the following terms appropriately: ● Chemical bond ● Bond energy ● Bond length ● Lone pair electrons ● Bonding electrons ● Valence shell ● Electron-deficient species ● Sigma bond, pi bond ● Formal charge ● VSEPR ● Bond order ● Core electrons	M3.1a. Describe and use the following terms appropriately: ● Delocalisation ● Resonance ● Bond order
T3.2a. Describe the electrostatic interactions between electrons and nuclei to rationalise chemical bonding and bond energy. T3.2b. Use potential energy diagrams to rationalise bond length.	
T3.3a. Draw Lewis diagrams given the chemical formula of common inorganic (including ions) and organic species *(alkanes, alkenes, alkynes, alcohols, carboxylic acids, esters, ketones, aldehydes, ethers, amines and amides).* T3.3b. Determine the most realistic Lewis structure by assigning formal charge rationalising multiple bonds and octet exceptions. (no resonance structures). T3.3c. Identify lone electron pairs and bonding electron pairs. For a given atom in a molecule, determine the number of bonding domains and the total number of electron domains.	M3.2a. Describe the delocalisation of electrons over a molecule in terms of molecular orbitals and use resonance structures to show how this can be represented in Lewis diagrams. [*Depth*]
T3.4a. Apply valence bond theory to describe bonding; identify and sketch covalent σ and π bonds based on orbital overlap (including identifying areas of electron density and relative bond lengths and energies).	
T3.5a. Apply VSEPR theory to determine electron domain geometry and molecular shape (up to 6 coordinate) including species with multiple bonds and ions (from molecular formula) and predict bond angles.	M3.3a. Describe the difference between atomic orbitals and hybrid orbitals as a model to explain observed molecular shapes. Name and sketch hybrid orbitals up to *sp*3. [*Breadth* – link to VSEPR] M3.3b. Define, identify and sketch covalent σ and π bonds using hybrid orbitals and orbital overlap. [*Breadth* – link to VSEPR]

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<tr><td></td><td>M3.4a. Give the molecular orbital energy diagram, electron configuration and bond order for homonuclear diatomic molecules and ions. [Breadth]
M3.4b. Use bond order to evaluate if a homonuclear diatomic molecules or ions is likely to be stable. [Breadth]
M3.4c. Describe the strengths and weaknesses of the MO and VBT bonding models – use examples to describe the applications of both models. [Depth]</td></tr>
<tr><td colspan="2">4. Intermolecular forces and states of matter</td></tr>
<tr><td>T4.1a. Describe and use the following terms appropriately:
• Polarity
• Polarisability
• Dipole
• Ionic bond
• Covalent bond
• Polar covalent bond
• Partial pressure
• Mole fraction
• Miscibility
• Van der Waals forces
• Dispersion forces
• Dipole-dipole forces
• Hydrogen-bonding</td><td>M4.1a. Describe and use the following terms appropriately:
• Henry’s law
• Viscosity
• Surface tension
• Capillary action
• Vapour pressure
• Liquid vapour equilibrium
• Non ideal gas
• Raoult’s law
• Solute
• Solvent
• Solution</td></tr>
<tr><td>T4.2a. Use the relative electronegativity of two bonded atoms to predict bond polarity (ionic, polar covalent and covalent bonding). Indicate the direction of the dipole for polar covalent bond.
T4.2b. Assign the polarity of molecules from the vector sum of individual bond dipoles where the shape is determined by VSEPR.</td><td>M4.2a. Describe the intra and intermolecular bonding, shape and polarity of a given molecule from its chemical formula (common inorganic and organic). [Breadth]</td></tr>
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T4.3a. Identify types of intermolecular forces (dispersion, dipole-dipole, hydrogen bonding) for a pure substance and relate to the relative charge, polarity and 11olarizability in terms of molecule size and number of electrons. T4.3b. Describe the relative strengths of intermolecular forces and where ionic bonding fits into this model. T4.3c. Predict the type/s of intermolecular forces which could exist between two chemical species and if these species are miscible.	M4.3a. Rationalise the properties of pure substances including melting point, boiling point, viscosity, surface tension and vapour pressure, in terms of intermolecular forces. [*Depth, Applications of Chemistry*] M4.3b. Apply Raoult's law to calculate the vapour pressure and gaseous mole fraction of binary liquid mixtures. [*Depth*] M4.3c. Use IMFs to rationalise examples of positive and negative deviations from Raoult's law. [*Breadth*] M4.3d. Describe the implications and applications of IMF (liquid-vapour equilibrium of pure substances and mixtures, vapour pressure, etc) in real life contexts. [*Applications of Chemistry*]
T4.4a. Use the ideal gas law, $pV = nRT$ and Dalton's law of partial pressures to calculate the pressure, volume, temperature, or amount of a pure or mixed gas. Interconvert common units (pressure: Pa, kPa, atm and bar; temperature: K or °C; volume: mL or L).	M4.4a. Explain the origins of the correction factors (a, b) in the van der Waals equation for a non-ideal gas and predict the relative sizes of a, b for given gases. [*Breadth*] M4.4b. Apply Henry's law to calculate the solubility of a given gas dissolved in water. [*Depth*]
5. Chemical Equilibria	
T5.1a. Describe and use the following terms appropriately: • Dynamic equilibrium • Equilibrium constant • Equilibrium expression • Reaction quotient • Le Chatelier's principle	M5.1a. Describe and use the following terms appropriately: • Van't Hoff equation • Solubility product • Complex equilibria
T5.2a. Describe chemical equilibrium in terms of concentration of reactant/products over time and rates of forward/reverse reactions. T5.2b. Write an expression for the equilibrium constant for a homogeneous and heterogeneous reactions in terms of the concentrations of reactants and products at equilibrium. T5.2c. Identify that the value of K for a given reaction is constant for a given temperature.	M5.2a. Introduce Acids and base, and solubility as applications of equilibrium and other types of equilibrium constants, e.g. K_a, K_b, K_W, K_{sp} etc. [*Breadth – links to many other topics*]

T5.3a. For a system at equilibrium, calculate *K* from concentrations of reactants and products and calculate concentrations of reactants and products from *K* (including reading concentrations from a concentration vs time graph). T5.3b. Calculate *Q* to determine if a system is at equilibrium (by comparing to *K*) and determine the direction of chemical change to reach equilibrium. T5.3c. Calculate *K* from concentrations of initial reactants (ICE tables). T5.3d. Calculate the equilibrium concentration of a given reactant or product from initial concentrations and *K* (ICE tables). T5.3e. Determine K for a reaction, based upon a provided value for *K* for the same reaction with different reaction coefficients.	M5.3a. Interconvert *Kc* and *Kp* values [*Depth*] M5.3b. Use the small *x* approximation to calculate *K* or equilibrium concentration of a given reactant or product from initial concentrations and *K* (ICE tables). Identify when small x approximation is appropriate to use. [*Depth*] M5.3c. Calculate the overall value of *K* for combinations of reactions (introduction to complex equilibria). [*Depth*]
T5.4a. Apply Le Chatelier's principle to predict the direction of change for systems following a disturbance (conceptually and graphical examples).	M5.4a. Use ICE tables to calculate new concentrations of reactants and products following a disturbance.
	M5.5a. Apply the van't Hoff equation to demonstrate the temperature dependence of *K*. Explain the relevance of this relationship for chemical and biological applications. [*Depth*]
	IM5.6a. Identify equilibrium concepts in industrial and environmental contexts (mainly explored in tutorials). [*Applications of Chemistry*]
Acids and Bases	
T6.1a. Describe and use the following terms appropriately: • Acid dissociation constant • Base dissociation constant • Weak acid/ base • Strong acid/base • Conjugate acid/base • pH and pOH • K_W • Buffer • Henderson-Hasselbalch equation • Brønsted-Lowry acid/base	M6.1a. Describe and use the following terms appropriately: • Buffer capacity • Buffer range • Speciation Curve • Lewis acid/base • Buffer region (titration curve)
T6.2a. Identify common acids and bases according to the Brønsted-Lowry definition and classify them as weak or strong. T6.2b. Identify the conjugate species for Brønsted-Lowry acids/bases.	M6.2a. Define and identify Lewis acids and bases. [*Depth*]

T6.3a. Calculate the pH and pOH of aqueous solutions of strong acids and bases and use K_w to convert between $[OH^-]$ and $[H^+]$, pH and pOH. T6.3b. Calculate K_a, K_b, pK_a and pK_b for a conjugate acid-base pair from any one of these values.	
T6.4a. Calculate the pH and pOH of aqueous solutions of weak acids and bases from the K_a, K_b, pK_a or pK_b and vice versa.	M6.3a. Predict if a given salt of a weak acid and base forms an acidic, basic, or neutral solution and calculate the pH of salt solutions. [*Breadth*]
	M6.4a. Identify the type (strong/weak) of an acid/base system from a titration curve and annotate relevant features including pK_a, equivalence point, buffer region. [*Breadth*]
T6.5a. Describe the mechanism of action of buffers and identify reagents which can be used to make a buffer solution including the use of strong acids and bases. T6.5b. Calculate the pH of a buffer system given a ratio of conjugate acid base pair using the Henderson-Hasselbalch equation.	M6.5a. Describe how to choose the components of a buffer to optimise buffer capacity and range. [*Breadth*] M6.5b. Draw a speciation (or distribution) curve to demonstrate the buffer range available from a given buffer system. [*Depth*] M6.5c. Design a buffer system for a given pH using a specified set of reagents. [*Breadth*] M6.5d. Discuss the significance of buffer systems in the context of biological systems and other applications. [*Applications of Chemistry*]
Thermochemistry	
T7.1a. Describe and use the following terms appropriately: ● System ● Surroundings ● Universe ● Heat, *q* ● Work, *w* ● Internal energy, *U* ● Heat capacity ● Standard state, ° ● Hess' Law ● Enthalpy, *H* ● Entropy, *S* ● Gibbs energy, *G* ● Spontaneity ● First law of thermodynamics	M7.1a. Describe and use the following terms appropriately: ● State function ● Bond enthalpy ● Isolated system ● Closed system ● Open system ● Second law of thermodynamics ● Third law of thermodynamics
T7.2a. Calculate *q* for the temperature change of a substance using specific and molar heat capacities.	

T7.3a. Calculate *q* and *q* per mole for calorimetry experiments (constant volume) using heat capacities and temperature changes of the calorimeter and contents.	
T7.4a. Apply the formulated first law of thermodynamics to calculate a change in internal energy (ΔU) from *q* and *w*.	M7.2a. Calculate *w* for pressure-volume work. Identify *U* as a state function. [*Depth*]
T7.5a. Based on the definition of ΔH as the heat associated with a chemical reaction at constant pressure ($\Delta H = q_p$), identify reactions where $\Delta U \approx \Delta H$ based on Δn_{gas}.	M7.3a. Calculate the difference between ΔU and ΔH for a given reaction, based on Δn_{gas}. M7.3b. Identify *H* as a state function. [*Depth*]
T7.6a. Identify the generic reaction type associated with $\Delta_f H$.	M7.4a. Identify the generic reaction types associated with phase transitions, atomisation, ionisation of atoms, electron affinities, bond energies, lattice energies. [*Breadth*]
T7.7a. Calculate $\Delta_r H$ from the $\Delta_f H$ of the products and reactants for a given reaction.	M7.5a Apply Hess' law to determine $\Delta_r H$ from a combination of enthalpy changes for other reactions (including Born-Haber cycle). [*Breadth, Applications of Chemistry*]
T7.8a. Identify entropy as the thermodynamic function associated with the spontaneity of processes. Calculate ΔS for a given reaction using the standard molar entropies of the products and reactants.	M7.6a. Interpret entropy as the dispersal of energy. State the third law of thermodynamics and describe how it allows the determination of the absolute entropies of substances. [*Depth*] M7.6b. State the second law of thermodynamics and write an expression for ΔS(universe) in terms of ΔS(system) and ΔS(surroundings). [*Depth*] M7.6c. Predict the sign of ΔS for changes of phase, temperature and number of particles. [*Depth*]
T7.9a. Calculate ΔG for a given reaction from ΔH and ΔS.	M7.7a.Identify that $\Delta G°$ determines the equilibrium position and use the sign of $\Delta G°$ to predict spontaneity of a reaction. [*Depth*] M7.7b. Relate the two terms in the definition of ΔG to ΔS(system) and ΔS(surroundings). [*Depth*] M7.7c. Calculate *K* from $\Delta G°$ and vice versa. [*Depth*] M7.7d Derive the van 't Hoff equation. Estimate *K* at various temperatures, assuming $\Delta H°$ and $\Delta S°$ do not vary with temperature. Apply this to industrial chemistry. [*Depth, Applications of Chemistry*]

Electrochemistry	
T8.1a. Describe and use the following terms appropriately: ● Oxidation state ● Reduction ● Oxidation ● Oxidising agent ● Reducing agent ● Anode ● Cathode ● Salt bridge ● Electrochemical cell ● Galvanic/voltaic cell ● Electrolytic cell ● Standard hydrogen electrode ● Cell potential	M8.1a. Describe and use the following terms appropriately: ● Electrolysis ● Nernst equation ● Nonstandard conditions ● Corrosion
T8.2a. Calculate oxidation numbers of elements in compounds. T8.2b. Determine which species are oxidised and which are reduced based on changes in oxidation number. T8.2c. Identify the oxidising and reducing agents in a redox reaction.	
T8.3a. Balance redox reactions in aqueous solutions using the half-equation method including under acidic and basic conditions.	
T8.4a. Convert between the redox reaction and standard cell diagram for an electrochemical cell. (including half-cells with an inert electrode). T8.4b. Identify the oxidation and reduction processes in a galvanic cell.	M8.2a. List the various types of half-cells by construction [*Depth*]
T8.5a. For two half equations, use standard reduction potentials to Identify oxidising and reducing agents for the overall spontaneous reaction. T8.5b. For two half equations, use standard reduction potentials to calculate the cell potential for the overall spontaneous reaction. T8.5c. For two half equations, use standard reduction potentials to determine the overall spontaneous equation.	M8.3a. Calculate the potential of a cell under nonstandard conditions using the Nernst equation. [*Depth*] M8.3b. Describe the construction and calculate the cell potential of a concentration cell. [*Depth*] M8.3c. Describe applications of concentration cells. [*Applications of chemistry*]
	M8.4a. Relate $E°$ to K and $\Delta G°$ for a galvanic cell. [*Depth*]

	M8.5a. List the desirable features of batteries. Comment on the suitability of particular batteries, given their chemistry and construction, for particular applications. [*Applications of chemistry*]
	M8.6a. Describe the process of corrosion and its practical consequences. Use electrochemical theory to describe appropriate preventative measures. [*Applications of chemistry*]
	M8.7a. Calculate the amount of product from electrolysis for a given current and time. [*Depth*] M8.7b. Describe applications of electrolysis. [*Applications of chemistry*]

3. Strategies and approaches to learning

3.1 Learning and teaching activities

The learning and teaching activities in this course consist of multiple teaching methods and modes of instruction which are delivered through a blended approach including Lectures, Tutorials, and Laboratories. In addition to online learning activities and private study, weekly small group consultations are available to provide further support.

This course has been designed to engage you in learning by contextualising the material to students' prior experiences and knowledge. In addition, course content will be supplemented with interesting examples from research and industry. The laboratory component of this course will enable you to develop a proficiency in core chemistry laboratory skills while engaging in challenging and interesting laboratory practicals. In addition, this component of the course will contribute to the development of higher-order analytical skills, while providing opportunity for cooperative learning with your peers.

3.1.1 How this course works

We know that chemistry can be a conceptually challenging topic to study and that students in CHEM1011 have mixed chemistry backgrounds. We want each and every one of our students to succeed and to gain valuable skills and knowledge. For these reasons, we have developed a flexible course structure which is dedicated to helping you gain the skills needed to succeed not only in this course but in the rest of your degree.

Please note: The flexibility of the course design is designed with you in mind but has its limitations, inherent to a 9-week teaching period. Though you have multiple opportunities to attempt and pass the core assessments in this course it does not mean that you can put off the course work until last minute. You should always be aiming to sit the first assessment opportunity offered – this will afford you the maximum opportunity to pass.

The format and learning activities are different to many other courses and so we recommend you read all the following information carefully.

3.1.2 Threshold Knowledge and Core Skills

These are the fundamental skills you need to know and do to pass this course. They provide you with the minimum acceptable foundation to continue in your studies. Achieving these skills sets you up to engage with the rest of the course. For this reason, we require you to complete assessment tasks throughout the term which demonstrate to us that you have obtained these skills in order to achieve the pass level marks for the course. We have built the course to give you MULTIPLE opportunities to achieve these tasks. **Once you have demonstrated that you have all these skills you will be awarded up to 50% of the course mark.**

3.1.4 Mastery Knowledge and Non-Core Skills

These are the important skills you need to complete the rest of the course. These concepts explore the applications and value of chemistry in our world and piece together the threshold knowledge to give meaning and context to your studies. Demonstrating your 'mastery' of this knowledge in your final exam and lab non-core skills quizzes will allow you to earn a merit grade (CR, DN, HD) in this course.

3.1.6 Threshold knowledge is taught primarily via weekly topic lessons

A topics lesson (available on Moodle) will teach you the "threshold" concepts for the week. You should complete this lesson and attempt the associated topic quiz (see section 4 for more information about quizzes), BEFORE the first lecture of the week (which will be called the threshold workshop).

3.1.7 Threshold knowledge is supported by a threshold workshop

The first lecture of each week is a workshop-style session in which the "threshold" concepts are reinforced. This session assumes you have completed the topics lesson and have made an attempt at the topics quiz. The lecturer will work through problems and talk over areas of threshold content that students need assistance with. These classes are designed to help you understand the concepts required to pass the quizzes and bridge the threshold content with the mastery content for the week.

3.1.8 Mastery Lectures

Two lectures each week will extend the threshold knowledge from the topics lessons and assume that you have competed the lesson for that week. These classes are delivered online in an interactive lecture style format. The lecturer will work with you to combine threshold concepts and introduce extended concepts to that week's topic. Often the lecturer will work through exam style questions and provide you with opportunities to check your understanding of these concepts throughout the class. Lecture recordings will made available via the Lecture Recordings+ link on Moodle. However, there is no guarantee that the lecture recording software will capture the class correctly or even at all.

3.1.9 Mastery Tutorials

Each week you'll join a small-group tutorial (either online or in a face to face class) in which you will delve more deeply into certain "mastery" topics. These tutorials have been designed to build upon the mastery lectures for that topic. Your tutor will work with you to develop your ability to interpret data, communicate chemistry concepts and apply chemistry to real world problems. The types of problems in your tutorials are very similar to the problems that will be in your final exam.

3.1.10 Laboratory Classes

The laboratory classes provide an opportunity to learn the concepts and practice the calculations presented in lectures. Laboratory classes are also the place to learn practical skills and they are also the place where those skills are assessed.-

You must **READ THE INTRODUCTION IN THE LABORATORY MANUAL** to be aware of all the requirements for passing the laboratory component of this course. Here are some of the main points regarding laboratory classes:

- **The following items of personal protective equipment (PPE) must be worn at all times in the laboratory:**
  - **safety eyewear**
  - **a facemask**
  - **a laboratory coat**
  - **fully enclosed footwear**

You will not be permitted to work in thongs or open-top shoes or sandals or without a laboratory coat, facemask or safety eyewear.

- The schedule of experiments can be found on page 4 of the lab manual.
- All experiments require pre-lab work to be completed before your lab class.
- You must attend the laboratory class shown on your official timetable.
- You must arrive at the laboratory on time or you will be excluded from the class.
- Repeat students must apply to the First Year Laboratory Coordinator if they want exemption from laboratory classes. Exemption is not automatic and is decided on a case-by-case basis.

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3.2 Expectations of students

It is your responsibility to ensure that you keep up to date with the course material, are aware of the assessments times and details and complete all required tasks by the advertised due date.

Occasionally we may be required to make changes to the course details presented in this document for reasons outside of our control (this is especially true during the COVID-19 pandemic). ALL changes will be announced via the important announcements on the Moodle page. You must check your UNSW student email (z1234567@unsw.edu.au) and the course Moodle site **AT LEAST EVERY TWO DAYS** to ensure you are up to date with understand your obligations for the course.

Ignorance of announcements or errors of interpretation of a due date or assessment requirement are not valid excuses for non-completion.

As a general rule, you should plan to do about one hour of independent study for every face-to-face hour of the course (e.g. completing assignments, readings and exam preparation). In addition, you should manage your time so that you can complete your topics lessons and topics quizzes every week throughout the term rather than leaving them to the deadline – you will waste the multiple opportunities we provide to sit the validation tests if you are not prepared early!

3.2.1 Lectures

You are expected to engage with all lectures each week. You should take notes and participate in problem-solving during lectures. The questions asked in lectures are a valuable source of feedback – they will help you to target the areas that will require further clarification in your personal study time.

3.2.2 Tutorials

Attendance at all tutorials is compulsory as no worked answers to tutorial problems are provided outside of these sessions. Tutorial classes are not graded directly but exam questions are linked to the tutorial material.

The purpose of tutorials is to provide activities for you that consolidate the concepts covered in lectures. You are expected to come prepared by having attempted the assigned pre work and to engage in tutorials by seeking help and completing work as directed.

3.2.3 Laboratories

SEE THE LABORATORY MANUAL FOR MORE DETAILS, including what to do if you are unavoidably absent from a lab class, how to complete assessments, and the criteria for grading your laboratory work.

3.3 Academic Misconduct

Students and staff are, of course, governed by the normal laws which regulate our everyday lives. But, in addition, the University has its own code of rules and conduct and can impose heavy penalties on students who breach them. Penalties range from failure in a subject, loss of privileges, fines, payment of compensation, and suspension, to exclusion from study for a certain period or even permanent expulsion from the University.

It is important to realise, however, that misconduct within the University covers a much wider field than simply behaviour which is offensive or unruly, or which may cause damage to other people or property. Misconduct which may lead to a student being disciplined within the University includes anything regarded as academic misconduct according to current academic usage, as well as any conduct which impairs the reasonable freedom of other persons to pursue their studies or research or to participate in University life.

It is most important that students realise just how broad the definition of Academic misconduct may be. It certainly covers practices such as cheating or copying or using another person's work. Sometimes, however, practices which may have been acceptable at school are considered to be misconduct according to current Academic usage within a University. For example academic misconduct can occur where you fail to acknowledge adequately the use you have made of ideas or material from other sources (see the UNSW Student Guide for examples).

The following are some of the actions which have resulted in students being found guilty of academic misconduct in recent years:

- Impersonation in examinations;
- Posting screenshots of digital assessments online
- Seeking answers to assessment questions online through crowd sourcing websites and forums
- Failing to acknowledge the source of material in an assessment
- Taking of unauthorised materials into an examination;
- Submitting work for assessment knowing it to be the work of another person;
- Improperly obtaining prior knowledge of an examination paper and using that knowledge in the examination.
- Providing another students with the means to cheat or collude on an assessment tasks

Students found guilty of academic misconduct are usually excluded from the University for two years. Because of the circumstances in individual cases, the period of exclusion can range from one term to permanent exclusion from the University.

4. Assessments

4.1 Assessment Overview

The assessment components of the course and the proportion of your final course mark allocated to each is as follows:

Component	Threshold knowledge *(required to pass the course)*	Mastery knowledge	Total
Laboratory Assessment	10% (core skills) #	10% (non-core skills)	20%
Weekly topic quizzes	8% (1% each)		8%
In term tests	32% (16% each)	–	32%$
Final Examination	–	40%	40%

CHEM1011 has the following hurdle requirements:

- **You must demonstrate all of the threshold knowledge.**
    - **$ you must score at least 15/20 in each In Term test before the deadline to be eligible for marks for these assessments (see section 4.3 for more details).**
    - **# you must be awarded all core laboratory skills (see laboratory manual for more details).**
- **You must achieve a course mark of at least 50, and**
- **Students must attend a minimum of 6 out of 8 laboratory classes.**

You will receive a course mark of between 0 and 100. A grade (HD, DN, CR, PS, UF or FL) will be awarded depending on your course mark and completion (or lack of completion) of the other criteria described above. Further information about the UNSW grading system can be found here: https://student.unsw.edu.au/grades

4.2 Weekly Topics Quizzes

There are weekly topics quizzes for you to complete most weeks throughout term. These quizzes have been set at a **THRESHOLD level of difficulty (course pass level)**, which is covered by the topics lessons that you are recommended to complete beforehand. Each quiz will be open for two weeks. Each quiz consists of 10 multiple choice questions. **You must score 10/10 on at least one attempt before the due date, in order to successfully complete the quiz and be awarded marks for that quiz.** There is no limit to the number of attempts and your highest scoring attempt will be counted.

If you do not meet these criteria before the due date, you will get a mark of 0 for that quiz. These quizzes will reopen after the due date to allow you opportunity for formative feedback to prepare for the in-term tests, but you will not receive course marks for these additional attempts.

- To attempt a topics quiz, log on to Moodle (https://moodle.telt.unsw.edu.au/), navigate to your course and scroll down to the relevant topic. Open the quiz you wish to attempt.
- After each attempt you will be given feedback based on your answers.
- After submitting a quiz, there will be a short time delay before you can make another attempt. It is recommended that you use this time to review concepts you struggled with before re-attempting the quiz.

4.3 In-term tests

These tests have been set at a **THRESHOLD level of difficulty (course pass level). The hurdle mark for these quizzes is 15/20. If you do not achieve the hurdle mark of 15/20 or higher before the test deadline you will score 0 course marks for that assessment task.**

In term tests will be held online during your SEM class.

- In term test 1: week 5 (topics 1-4)
- In term test 2: week 9 (topics 5-8).

Each test will consist of 20 multiple choice questions and most questions will be drawn from the same databank as the relevant online topic quizzes, but there will also be some new questions of similar style. If you score between 15-20 on this test, then this will be the grade you receive for that test. e.g a mark of 18/20 = 90% = 14.4/16 course marks.

If you do not achieve the pass minimum of 15/20 in the first sitting, then you will be offered additional opportunities to sit the test to achieve the 15/20 pass mark. **However,** the maximum available grade for these additional sittings will be capped at 15/20 (75%) which is equivalent to a maximum of 12 (out of 16) course marks for each test. Please note multiple additional opportunities will be offered but we make no guarantee that you will be able to attend all of the additional sittings.

In term test <u>completion</u> deadlines

- In term test 1 – 6pm Friday week 7
- In term test 2 – 6pm Friday week 10

Other important things to note about tests:

- Information about how in-term Tests are conducted is provided in the in-term Tests section on Moodle. You need to read this information because it explains when your tests will occur, what materials you may and may not have with you during your test, our expectations of what you may and may not do during the test, and tips on how to prepare your environment before the test.

- If you do not sit the in-term tests on the first sitting offered and do not have special consideration, then the maximum available grade available to you in subsequent sitting will be capped at 15/20 for that test.

- We do not guarantee that you will have access to the theoretical maximum number of additional sittings of the tests. Special consideration for additional opportunities will only be granted in cases where circumstances have prevented you from attending ***<u>all</u>*** sittings offered.

4.4 Laboratory Assessment

This is described in the laboratory manual.

4.5 Final Examination

The exam will focus on the “mastery” content of the syllabus, but it will also require you to remember the “threshold” concepts as a foundation for answering the mastery questions. The final exam will be conducted online via Moodle. You will be advised of the date and time of your final exam after Monday week 9.

If you have applied for special consideration, you should arrange to make yourself available for possible further assessment. Notification of details of the further assessment will be sent via your student email address (z1234567@student.unsw.edu.au).

4.6 Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has be assessed, you will be contacted via your student email address to advise the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

Important note: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control which affect your ability to study, you do not sit an examination or submit an assessment which does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

If you fall ill DURING an assessment and your performance is affected contact s.maisey@unsw.edu.au immediately for advice – it is too late to advise us after the assessment has finished if you have already begun sitting it.

If you are excluded from attending a face-to-face class because you have been instructed to self-isolate due to COVID-19 (including if you live in an area that has been locked down) you are advised to apply for special consideration if it means that you will miss one or more laboratory class as a precaution, However, please carefully read the attendance requirement for the laboratory component in the lab manual as special consideration does not exempt you from this requirement.

4.7 Supplementary Assessment

A supplementary examination may be offered in cases where you have applied for and received special consideration. The supplementary exam period for this term is **Monday 6 September – Friday 10 September inclusive.** The time, date and venue of your test will be confirmed via student email approximately 1 week before the exam date. All students granted a supplementary exam are expected to make themselves available to attend. No alternative dates or times will be guaranteed. A supplementary examination may consist of a written paper and in some cases an oral examination. Averages will not be given in place of a final exam mark or supplementary exam mark.

5. Academic integrity, referencing and plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.

Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits**:** honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and **plagiarism** can be located at:

- The *Current Students* site https://student.unsw.edu.au/plagiarism, and
- The *ELISE* training site http://subjectguides.library.unsw.edu.au/elise/presentation

The *Student Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

6. Readings and resources

6.1 Textbooks and Notes:

- Blackman, Bottle, Schmid, Mocerino and Wille, "Chemistry," 4th Ed., Wiley. This book is available in print through the UNSW Bookshop: https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9780730363286&16202288 or in print or as a digital copy from Wiley Direct Online: http://www.wileydirect.com.au/buy/chemistry-4th-edition/
- Aylward and Findlay, "SI Chemical Data," 6th Ed. or later.
- Term 2, 2021 Laboratory Manual (available for purchase in print as part of course pack at the UNSW Bookshop; also downloadable from Moodle).
- Term 2, 2021 Tutorial Notes (available for purchase in print as part of course pack at the UNSW Bookshop; also downloadable from Moodle).

6.2 Need Help?

There are several people who can help you with problems. The appropriate person may differ depending on the problem.

- First, check the "Important Announcements" and the "Q&A" forums on Moodle – your question may have been asked by another student and answered before.
- For problems relating to lectures – post your question on Moodle, or contact your lecturer.
- For tutorial problems − post your question on Moodle, or ask your tutor during tutorial classes.
- For laboratory problems − post your question on Moodle, or alternatively ask your lab tutor during your lab classes.
- If you are experiencing personal difficulties that may be affecting your academic performance, please contact UNSW Student Support for advice and assistance: https://student.unsw.edu.au/advisors

- For all other enquires (including Moodle issues) − contact Trinah De Leon, the Chemistry Teaching Support Officer (trinah@unsw.edu.au).

7. Administrative matters

If you have any administrative questions, try the following sources of information (in order):

- This course outline
- The Moodle site for this course (including the Important Announcements and FAQ sections)
- Chemistry Student Services:
    - Trinah De Leon; trinah@unsw.edu.au; +61 (2) 9385 4651; Dalton 104
- Science Student Services:
    - +61 (2) 8936 7005; https://nucleus.unsw.edu.au/en/contact-us

8. Additional support for students

Other avenues of support include:

- The Current Students Gateway: https://student.unsw.edu.au
- Academic Skills and Support: https://student.unsw.edu.au/skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Equitable Learning Services: https://student.unsw.edu.au/els
- UNSW IT Service Centre: https://www.myit.unsw.edu.au