Reg No: KEGA03/20261

Faculty of Health, Science and Technology
Chemistry

Syllabus

Fundamental Chemistry

Course Code:	KEGA03
Course Title:	Fundamental Chemistry *Grundläggande kemi*
Credits:	30
Degree Level:	Undergraduate level
Progressive Specialisation:	First cycle, has only upper-secondary level entry requirements (G1N)

Major Field of Study:
KEA (Chemistry)

Course Approval
The syllabus was approved by the Faculty of Health, Science and Technology 2025-09-03, and is valid from the Spring semester 2026 at Karlstad University.

Prerequisites
General admission requirements plus upper secondary level Chemistry 2 and Mathematics 4/Mathematics E, or registered for the Biomedical scientist programme, or Chemistry level 2 and Mathematics level 2, or registered for the Biomedical scientist programme, or equivalent

Learning Outcomes
The aim of the course is for students to develop solid and professionally relevant knowledge in fundamental chemistry.

Module 1: Introductory Chemistry (7.5 credits)
Upon completion of this module, students should be able to:
1. explain the principles behind the periodic table,
2. use different models to describe chemical bonding,
3. explain key concepts in introductory chemistry,

4. perform calculations on cubic unit cells,
5. determine molecular geometry and identify the intermolecular forces acting between molecules and how these affect molecular properties,
6. act and work safely in a laboratory environment,
7. plan, carry out, and report chemical laboratory work according to instructions within a given timeframe,
8. name ionic compounds with simple and polyatomic ions, and
9. explain concepts in basic chemical thermodynamics.

Module 2: Chemical Calculations (7.5 credits)
Upon completion of this module, students should be able to:
1. use correct units and the appropriate number of significant figures in chemical calculations,
2. apply the ideal gas law,
3. determine empirical and molecular formulas,
4. balance chemical equations, define different ways to represent them, and calculate yields,
5. define and use the concepts of activity and equilibrium,
6. define the concept of pH and calculate pH in solutions,
7. use titration as an analytical technique,
8. perform calculations and explain concepts in kinetics, and
9. prepare, conduct, and report results from laboratory work within a given timeframe.

Module 3: Biochemistry (7.5 credits)
Upon completion of this module, students should be able to:
1. describe the structure of different cell types,
2. explain the function of macromolecules in the cell based on their structure and chemical properties,
3. describe the flow of genetic information, from DNA to protein,
4. describe some common biochemical methods for protein analysis and separation and within genetic engineering, and provide examples of their applications,
5. describe some of the metabolic pathways of a cell,
6. explain the principles of oxidative phosphorylation and photophosphorylation,
7. perform simple experiments for protein separation and use some basic methods in DNA technology, and
8. document and present, both orally and in writing, the execution of experimental work with a scientific approach.

Module 4: Organic Chemistry (7.5 credits)
Upon completion of this module, students should be able to:
1. give an account of how basic bonding theory can be used to describe electron structure and chemical bonding in organic molecules,
2. give an account of the principles of systematic nomenclature in organic chemistry and apply IUPAC nomenclature rules for naming simple organic molecules,
3. use different structural representations to describe organic molecules, including the occurrence of stereoisomerism and geometric isomerism,
4. give an account of the main functional groups and their properties, and provide examples of the synthesis and use of various functional groups,
5. analyse the relationship between molecular structure and physical and chemical properties,
6. give an account of the main mechanisms for substitution, elimination, and addition reactions and describe factors that influence reactivity in such reactions,
7. give an account of electron structure in conjugated and aromatic systems,
8. provide examples of oxidation and reduction of organic compounds and reagents that can be used for such reactions,
9. give an overview of the preparation and use of Grignard and organolithium reagents, and

10. perform simple syntheses and use unit operations such as extraction, filtration, recrystallisation, and distillation in small-scale laboratory work, including assessment of safety and impact on the work environment and external environment.

Content

Module 1: Introductory Chemistry (7.5 credits)

The module is divided into two parts: a theoretical component and a laboratory component.
- The periodic table and its background: periods, groups, electron configuration, Pauli exclusion principle, Hunds rule, Aufbau principle, trends in the periodic table regarding atomic radius, ionic radius, ionization energy, electron affinity, electronegativity, and description of the properties of the most common elements.
- Chemical bonding: Lewis structures (including resonance structures and formal charge), ionic bonding, covalent bonding, hybridization, electron sharing, LCAO-MO theory.
- Empirical formula, formula unit, dipole moment, band theory, ligand theory, crystal structure, cubic unit cell.
- Simple cubic unit cell (SCC), body-centered cubic unit cell (BCC), face-centered cubic unit cell (FCC).
- Lewis structures, determining geometry based on electron groups, bonding electron groups, lone pairs. Based on molecular geometry and possible dipole moment, determine the type of intermolecular forces between molecules: van der Waals forces and solubility.
- Safety lecture and safety test: how to work in a laboratory and identify common equipment in a chemical laboratory.
- Before a laboratory session: understand instructions and perform a safety analysis. Carry out the laboratory work practically and report the results in the prescribed manner within the given timeframe.
- Zeroth, first, second, and third laws of thermodynamics: work, heat, internal energy, enthalpy, entropy, temperature, isobaric process, isochoric process, isothermal process, adiabatic process, heat capacity, reaction heat.

Special emphasis is placed on safety concepts in the laboratory sessions. The course requires the purchase of acceptable protective equipment, which is primarily the responsibility of the student.

Module 2: Chemical Calculations (7.5 credits)

The module is divided into two parts: a theoretical component and a laboratory component.
- Significant figures, rounding, conversion between different units, unit analysis.
- The ideal gas law: pressure, volume, temperature, amount of substance, gas constant.
- Empirical formula, molecular formula.
- Chemical reactions in general, redox reactions in particular: molecular reaction equation, ionic reaction equation, net ionic equation, limiting reagent, yield in chemical reactions, simple electrolysis problems, concentration, amount of substance, mass, molar mass.
- Dynamic equilibrium: activity, activities at equilibrium, concentrations at equilibrium, acid dissociation constant (Ka), base dissociation constant (Kb), conjugate acid-base pairs, solubility product (Ksp), solubility, complex formation constant, equilibrium constant (concentration, Kc, and pressure, Kp), reaction quotient, Le Châteliers principle, common ion effect, autoprotolysis of water, pKa, pKb, pKw.
- pH, pOH, pH indicators, pH calculations, buffer solutions, buffer equation (HendersonHasselbalch equation), preparation of buffer solutions.
- Concentration, amount of substance, mass, molar mass, dilution calculations, redox titration, acid-base titration.
- Kinetics: reaction order, rate constant, half-life, Arrhenius equation, activation energy.

- Practical laboratory work based on parts of the course theory. Laboratory results are reported according to instructions.

Module 3: Biochemistry (7.5 credits)

The module is divided into two parts: a theoretical component and a laboratory component.
- Animal and plant cells, as well as prokaryotic cells.
- Proteins, carbohydrates, lipids, and nucleic acids. Functions of proteins as catalysts, receptors, and transporters. Inhibition of enzymatically catalysed reactions. Functions of carbohydrates and lipids in energy metabolism. Roles of lipids and proteins in membranes. DNA as the carrier of genetic information. RNAs role in the expression of genetic information.
- Replication, transcription, and translation.
- Chromatographic methods such as gel filtration, ion-exchange chromatography, and affinity chromatography.
- Electrophoretic methods such as native and denaturing polyacrylamide gel electrophoresis, isoelectric focusing, two-dimensional electrophoresis, and agarose gel electrophoresis.
- DNA technology methods including PCR, DNA cleavage with restriction enzymes, gene cloning, and DNA sequencing.
- Glycolysis, citric acid cycle, mitochondrial electron transport chain, and the light and dark reactions of photosynthesis. The chemiosmotic principle.
- Laboratory work performed according to instructions.
- Protocols and reports based on the students own laboratory work.

Module 4: Organic Chemistry (7.5 credits)

The module is divided into two parts: a theoretical component and a laboratory component.
- Application of bonding theory to organic molecules.
- Nomenclature of organic molecules and various forms of graphical representations of their structures.
- Properties and main reactions of alkanes, alkenes, alkynes, aromatic compounds, alkyl halides, alcohols, ethers, carbonyl compounds, carboxylic acids and their derivatives, and amines.
- Use of substances from the above groups for synthetic purposes, with examples of products and processes used in society.
- Reaction mechanisms for a selection of addition, substitution, elimination, and rearrangement reactions involving the above groups of substances.
- Safety regulations and protective measures.
- Simple syntheses involving unit operations such as extraction, filtration, recrystallisation, and distillation.
- Thin-layer chromatography and determination of melting point.
- Report writing and procedures for recording notes in a laboratory journal.

Attendance at scheduled laboratory sessions is mandatory.

Reading List
See separate document.

Examination
Modules 1, 2, and 4:
The theoretical component is assessed through an individual written exam. The laboratory component is assessed through an individual written safety test, mandatory attendance and active participation in laboratory sessions, as well as an individual written lab report according to instructions within a given timeframe.

Module 3:
The theoretical component is assessed through an individual written hand-in assignment and an individual written exam. The laboratory component is assessed through an individual written safety test, mandatory attendance and active participation in laboratory sessions, as well as lab reports according to instructions within a given timeframe.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

Grades
One of the grades Distinction (VG), Pass (G), or Fail (U) is awarded in the examination of the course.

Quality Assurance
Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate
A course certificate will be provided upon request.

Additional information
The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.