

BSc (Hons) & MChem Chemistry

Degree overview

The BSc (Hons) degree is a four-year degree, and the MChem is a five-year integrated masters. A designated BSc can be awarded after three years.

Students are required to achieve 120 credits each year, which is nominally 1200 hours work.

In the first two years 50% of a student's curriculum is compulsory Chemistry courses, with the rest their choice of Enhanced Study courses.

<https://www.abdn.ac.uk/study/undergraduate/enhanced-study-options-1518.php>

Details of all undergraduate courses can be found online in the catalogue of courses.

<https://www.abdn.ac.uk/registry/courses/undergraduate>

| Level | Semester 1 | | Semester 2 | |
|---------------------|---|---------|---|---------|
| | Course | Credits | Course | Credits |
| 1 | CM1021: Chemistry for the Physical Sciences 1 | 15 | CM1513: Chemistry for the Physical Sciences 2 | 15 |
| | CM1022: Elements of Chemistry 1 | 15 | CM1522: Elements of Chemistry 2 | 15 |
| | Enhanced Study | 2 × 15 | Enhanced Study | 2 × 15 |
| 2 | CM2015: Chemical Kinetics & Thermodynamics | 15 | CM2514: Organic & Biological Chemistry | 15 |
| | CM2016: Analytical Chemistry & Spectroscopy | 15 | CM2519: Inorganic Chemistry | 15 |
| | CM2012: Introduction to Materials | 15 | Enhanced Study | 2 × 15 |
| | Enhanced Study | 15 | | |
| 3 | CM3037: Inorganic & Solid State Chemistry | 30 | CM3534: Organic & Biological Chemistry | 30 |
| | CM3041: Energy and the Environment | 15 | CM3536: Molecular Structure & Reactivity | 30 |
| | CM30PS: Professional Skills for Physics & Chemistry | 15 | | |
| 4 BSc & MChem | CM4037: Honours Inorganic & Physical Chemistry | 15 | CM4537: Advanced Honours Chemistry | 15 |
| | CM4038: Honours Analytical & Organic Chemistry | 15 | CM4538: Integrated Chemistry | 15 |
| | Enhanced Study | 15 | | |
| BSc | CM4028: Honours Chemistry Research Project, across both terms | | | 45 |
| MChem | CM4036: MChem Group Practical | 15 | CM4535: MChem Research Project | 30 |
| 5 | CM5003: MChem Chemistry Applications | 60 | CM5555: MChem Research Project | 60 |

Course overviews & descriptions

Level 1

CM1021: Chemistry from the Physical Sciences 1

The fundamentals of chemistry are important across the physical sciences and engineering. Starting with atomic structure and the Periodic Table, this course moves on to chemical bonding theory, building to the structure of organic molecules. Moving from the molecular level, acid-base theories, phase equilibria and solution chemistry are covered. The properties of ideal and non-ideal gases are then discussed. The energetics of chemical processes completes the course.

Teaching includes lectures and class workshops that put chemical concepts into a real-world context. Laboratory classes introduce important practical techniques, with experiments that support and complement the taught material.

This course covers the foundations of chemistry in the physical sciences and engineering. Topics covered:

- Atomic structure and its description by quantum mechanics. Basic principles of chemical bonding.
- Introduction to organic chemistry: nomenclature, functional groups and stereochemistry.
- Acids and bases, solutions and phase equilibria.
- The Gas Laws (ideal and non-ideal gases) and thermochemistry

CM1022: Elements of Chemistry 1

This course will inspire students to investigate the scope and power of chemistry and to develop the necessary skills for success in undergraduate Chemistry and beyond.

Students will develop an appreciation of the essentially limitless scope of chemistry in understanding and controlling the material world. Students will also be more confident learners - in particular they will develop enhanced competences in:

- Literacy and numeracy
- Communication (written and oral)
- Data collection, analysis and interpretation
- Discussion and presentation of complex ideas
- Laboratory methods.

By getting to know other students studying chemistry and finding out about lecturers' research interests, students will feel more part of the "Chemistry team".

CM1513: Chemistry for the Physical Sciences 2

Chemistry plays a central role in modern science and engineering, not only because of the insights it gives on the composition, properties, and reactivity of matter but also because of its wide-ranging applications. This course seeks to consolidate some of the important fundamentals of chemistry that underlie many topics and principles across the physical sciences and engineering, bringing together molecular structure, reaction mechanisms, the driving forces behind chemical reactions, and methods of chemical analysis and structure determination.

Workshops and laboratory classes complement lectures by consolidating learning and developing problem-solving and hands-on practical skills.

- Chemical bonding in multi-atom molecules; molecular shape.
- Chemical equilibrium, entropy and the Second Law of thermodynamics.

- Principles of analytical and spectroscopic methods for quantitative analysis and structure determination.
- Organic reaction mechanisms.

CM1522: Elements of Chemistry 2

To encourage students to integrate their knowledge in chemistry and apply basic knowledge to more complex but widely applicable topics in chemistry; to further develop the necessary study, communication and practical skills for success in undergraduate Chemistry and beyond.

Students will develop an appreciation of the interconnected nature of the traditional branches of chemistry thus enhancing their confidence in using their basic chemistry knowledge. Students will (further) develop enhanced competences in:

- Literacy and numeracy
- Communication (written and oral)
- Data collection, analysis and interpretation
- Discussion and presentation of complex ideas
- Laboratory methods.

Lectures, workshops and directed reading will introduce and discuss a range of topics that demonstrate the applicability of key ideas across a range of chemistry. Content will include historical background and present day theories and applications of fundamental topics in Chemistry including intermolecular forces, molecular modelling, and isotopes. Numerical and communication skills will also be discussed and practised in workshops and small group tutorials. The research activities of the Chemistry Department will be demonstrated in visits to the specialised laboratories (also in small groups) and hands-on lab skills practised in the undergraduate labs.

Level 2

CM2012: Introduction to Materials

This course provides a grounding in basic materials science. There will be five areas covered, with an emphasis on directed learning. These areas will be, for example: Nanomaterials, Electronic materials, Functional Polymers, Liquid Crystals, Medical Materials. The impact of materials science on everyday life will be considered and explored throughout the course, using these general headings to investigate both the fundamentals of materials and their development into useful and functional products. Each of these areas will cover a two week period and be introduced and facilitated by one of the course team. In course assessments will be on topics of interest under these broad headings, often covering topical concerns, examples being materials for energy and body implant materials. Thus wider issues, including ethics & politics, are drawn into the discussion.

CM2015: Chemical Kinetics & Thermodynamics

This course covers key concepts in physical chemistry which underpin our understanding and ability to control chemical and biological processes. The principal points include thermodynamics (enthalpy, entropy and free energies), chemical kinetics (zero, 1st and 2nd order reactions, rate laws and half-lives and the relationship of rate laws to reaction mechanisms), and basic principles of electrochemistry (redox chemistry and the Nernst equation). A strong emphasis on calculations helps students get to grips with the course material and develops numeracy skills. Laboratory experiments support and complement the taught material.

This course provides a grounding in basic physical chemistry. The principal points include:

- Thermodynamic parameters: enthalpy, entropy and Gibbs energies.
- Chemical kinetics: Zero, 1st and 2nd order reactions, partial and reaction orders and relationship of rate laws to mechanism.
- Basic principles of electrochemistry including redox chemistry and Nernst equations.

CM2016: Analytical Chemistry & Spectroscopy

In this course you will learn how to determine trace element patterns or the presence of a compound by using modern analytical methods. The course covers the underlying theory for analysis and identification using structure determination by spectroscopic methods like UV, IR, NMR, mass spectrometry and chromatographic separations. Atomic spectrometry is covered for trace metal determination. In practical classes, students get hands-on training with modern analytical instrumentation.

The course covers the underlying theory of the identification and determination of, for example, poisons such as pesticides or heavy metals in biological fluids, and of alcohol and drugs of abuse in mixtures of organic compounds including their structure determination by spectroscopic methods. This will involve study of the chemical reactions useful in analytical chemistry such as acid-base, complex formation, precipitation, redox and separation by transfer between phases, and also an introduction to both theory and practical experience of modern instrumental methods of analysis, with particular reference to forensic chemistry, and also to the closely related topic of environmental monitoring.

CM2514: Organic & Biological Chemistry

Modern organic and biological chemistry comprise the chemistry of carbon-containing compounds, which are natural (e.g. foods, fuel, perfumes) as well as synthetic (e.g. soaps, textile fabrics, pharmaceuticals). This course investigates some key areas in organic chemistry: shape, conformation, stereochemistry, and chemical properties of organic and biological compounds. Reactions and reactivity of aliphatic derivatives, olefins and aromatic compounds will be considered with particular reference to spatial and electronic effects. The experiments performed in the lab will help students understand key organic concepts and develop their synthetic/analytical skills.

Shape, conformation, and stereochemistry in organic and biologically relevant compounds. Reactions and reactivity of both aliphatic and aromatic compounds will be considered with particular reference to spatial and electronic effects.

CM2519: Inorganic Chemistry

This course investigates some key areas of inorganic chemistry. An introduction to simple crystal structure types is given and important solid state materials such as high temperature superconductors, photocatalysts and zeolites are described. The concept of symmetry is introduced. Redox chemistry is developed in terms of Latimer, Frost and Ellingham diagrams: their applications in modern technology and industry are emphasised, including batteries, fuel cells, corrosion, electrolysis and water purification. The key properties of transition metal complexes - shapes, colours and magnetism are described and analysed in terms of crystal field theory. Laboratory experiments are closely tied to the lecture materials.

Level 3

CM3037: Inorganic & Solid State Chemistry

This course introduces students to the fascinating properties of inorganic materials through a series of lectures, tutorials and laboratory experiments. An introduction to crystallography and crystal diffraction is given. The students will also learn about solid state synthesis and the properties of important solid state materials such as high temperature superconductors, zeolites and ferroelectric materials.

In the laboratory practicals the students will synthesise some of the key materials described within the course such as coloured glass, high temperature superconductors and photocatalysts. Students will also gain hands on experience in powder X-ray diffraction.

This course deals with the crystalline state and will provide theoretical and practical coverage of crystal structures and methods for their characterisation. The concepts of solid state synthesis, and the applications to chemistry will be introduced. Key concepts include:

- Crystal symmetry
- X-ray, Neutron and electron diffraction
- Perovskites - structure and properties
- Solid state synthetic methods.

CM3041: Energy and the Environment – New recently updated course!

This advanced course describes how humanity has impacted the environment and how chemistry can be used to produce innovative solutions for the energy crisis.

Topics covered will include: ozone generation in troposphere and ozone depletion in stratosphere, an introduction to the chemistry and applications of carbon capture and storage, the chemistry of solar cells, Li and post-Li ion batteries and hydrogen fuel cells.

Material will be introduced and discussed in lectures and tutorials. Laboratory practicals will be used to learn advanced instrumental and analytical techniques, and students will apply their knowledge of lab techniques to design experiments which reinforce the lecture material.

CM30PS: Professional Skills for Physics & Chemistry

professional skills necessary for success in Honours level

Chemistry/Physics and beyond. The course will include working with scientific literature, computer programming and the use of software tools in research and activities to enhance employability. Students will develop an appreciation of the power of state of the art computer programs to assist the user to understand complex data sets. Students will also become more confident in communicating and assessing scientific ideas.

By considering their own skills development, students will feel more able to identify and compete for exciting graduate employment opportunities.

Lectures, workshops, directed reading and self-study projects will introduce a range of computer software important in modern physical sciences research and afford opportunities to develop technical skills in using these programmes and in computer programming. The classes and other activities will also explain issues relevant to reporting, citing and critical assessment of scientific results. Finally, the course will include topics to enhance employability.

Content will include:

- hands-on experience with specialised software for data processing and visualisation (two of MatLab, Excel, Mathematica, Discovery Studio Visualiser, electronic structure calculation)
- problem solving using a high-level programming language (one of Python, Fortran, MatLab ...)
- scientific literature searching and critical appraisal
- writing and presentation skills
- employability training, including one-to-one discussion with a Careers Adviser and assessing and presenting personal skills set and graduate attributes.

CM3534: Organic & Biological Chemistry

This course introduces important fundamentals of organic chemistry. You will gain a firm grounding in NMR spectroscopy and mass spectrometry which are vital analytical tools to determine if the correct organic molecule has been synthesised. Biological chemistry such as DNA/RNA and genome sequencing will be introduced. Organic synthesis lectures will concentrate on chemistry of the carbonyl group, aromatic synthesis.

Students will gain expertise in the synthesis of a number of different organic compounds such as dyes, compounds that change colour with temperature and an antibiotic during the laboratory practicals which accompany this course.

- NMR and Mass spectroscopy
- Organic synthesis; Basic mechanisms and synthetic methods
- Chemistry of the carbonyl group; Synthetic strategies. Aromatic synthesis and methodology.
- Biological chemistry: Introduction to DNA/RNA, gene, genome sequence, bioinformatics and protein chemistry. Enzymes as biocatalysts in the biotransformation industry.

CM3536: Molecular Structure & Reactivity

Students will be introduced to the fundamentals of spectroscopy and will gain an understanding of the nature of chemical bonding. The thermodynamics and applications of electrochemical systems will be explained, as well as the basic theories describing electrolytes and their electric conductivity. We will show how variables such as pressure and temperature affect reaction rates and how this can lead to a better understanding of reaction mechanisms, in particular, industrially important polymerization reactions. The physical chemistry of interfaces, as well as the fundamentals and applications of gas adsorption on solid surfaces, will also be introduced. The course is structured around lectures, tutorials and laboratory practicals.

- Fundamentals of spectroscopy and bonding
- Surface chemistry
- Electrochemistry
- Chemical kinetics

Level 4 BSc & MChem

CM4037: Honours Analytical & Physical Chemistry

Honours level topics in inorganic and physical chemistry. This course will cover important aspects of physical chemistry such as chemical bonding and catalysis, and the structure and properties of inorganic compounds.

This course will build upon previous courses to cover advanced material in the fields of modern inorganic and physical chemistry.

Inorganic chemistry will cover the study of the transition metals including the rare earth and radioactive elements, and also the reactions, structure, and properties of inorganic compounds.

Physical chemistry will deepen the understanding of atomic and molecular structure and chemical bonding. The study of catalysis will be developed and applied to green chemistry and industrial processes.

CM4038: Honours Analytical & Organic Chemistry

Honours level topics in environmental-analytical and organic chemistry. This course will cover analytical methods related to environmental chemistry, and the organic reactions and structures in synthetic compounds, as well as the use of spectroscopic methods to determine the structure of organic molecules.

This course will build upon previous courses to cover advanced material in the fields of modern environmental-analytical and organic chemistry.

Analytical chemistry will cover modern and advanced methods in mass spectrometry and trace analysis, and environmental toxicology.

Organic chemistry will cover a range of reactive intermediates and syntheses required for modern organic synthesis. Mass spectrometry and 1D and 2D nuclear magnetic resonance spectroscopy applied to structure determination of organic molecules will be covered.

CM4537: Advanced Honours Chemistry

The Advanced Chemistry module is composed of a series of high-level lecture courses usually closely related to the research specialities of the lecturers. This gives students opportunities for in-depth study of advanced topics, whilst the variety of inorganic, physical, organic, materials, environmental and analytical chemistry covered in Advanced Chemistry ensures that students have a good breadth of experience in the subject.

Lectures on a variety of advanced topics in inorganic, physical, organic, materials, environmental and analytical chemistry, related to lecturer research interests and current topics in chemistry. Topics include inorganic biomaterials, chemical biology, medicinal chemistry, natural products, catalysis, materials for energy applications, liquid crystals, and molecular thermodynamics. **Students have a choice of which lecture topics to attend based on their interests.**

CM4538: Integrated Chemistry

This module aims to help students assimilate materials studied at different points during the whole undergraduate Chemistry degree programme. The course consists of a series of lectures and workshops, held in the second half session, covering material studied in the earlier years of the course. The workshops are intended to review fundamental topics and ideas in the context of the more advanced material studied at Honours level. Reflective writing will ask students to look at the 'big picture' of chemistry in context and their own chemical identity.

Level 4 BSc

CM4028: Honours Chemistry Research Project

The final-year research project for BSc Honours students extends over both half-sessions and affords the opportunity to learn modern research techniques and to develop some expertise in the topic of the project. As far as possible, projects are allocated in accordance with student preferences. Every project has a named supervisor and there is considerable scope for students to use their initiative in experimental design and interpretation of results. The development of a variety of transferrable skills is an important feature of this module, including project planning, presentation of results, time management, report writing and verbal communication.

A research-level laboratory project, extending over both half-sessions, and including a literature review and critical assessment of previous work in the area, experimental design, data collection and analysis using a variety of techniques. Preparation of a final report summarising the year's work, and giving a presentation of the findings.

Level 4 MChem

CM4036: MChem Group Project

The aim of this first half-session course is to provide a combination of research experience and group work via research-focused group activities involving experiment planning, teamwork and the collection, sharing and interpretation of data. The group, in consultation with the supervisors, will develop a project plan where the overall aim and the objectives of the individual students are established. The development of a variety of transferrable skills is an important feature of this module, including working in a team, project planning, the presentation of results, time management, report writing and verbal communication.

Learning outcomes: students to work to strict deadlines; students to lead their projects and propose experiments/syntheses/tests/analyses etc.; students to collect, share, analyse and interpret data; students to measure progress against agreed initial objectives; students to provide concise initial and mid-project progress reports; students to give group presentation to their supervisor team; students to prepare individual final reports on their project. Content: Research-focused small-group projects led by supervisor teams.

CM4535: MChem Research Project

The level-4 individual research project for MChem students runs in the second half-session and affords students opportunities to learn modern research techniques and to develop some expertise in the topic of their project. As far as possible, projects are allocated in accordance with student preferences. Every project has a named supervisor and there is considerable scope for students to use their initiative in experimental design and interpretation of results. The development of a variety of transferrable skills is an important feature of this module, including project planning, presentation of results, time management, report writing and verbal communication.

This course introduces students to research-level activities, in terms of a concise literature survey, risk assessment, experiment planning, use of research equipment and report writing. At the end of the course, the student should be able to: find and critically assess previous work in the research area of their project; design experiments and data collection and analysis protocols using research instrumentation; prepare a report at a level equivalent to a research paper; communicate the results of their project to an audience of informed scientists.

Content: literature review and critical assessment of previous work in the area; development of transferable skills including project planning, presentation of results, and time management; experiment design, data collection and analysis using a variety of techniques applicable to the project; preparing a final report summarising the work and giving a presentation to a small group of staff; communication skills, written and verbal.

Level 5 MChem

CM5003: MChem Chemistry Applications

The module consists of three main components including lecture courses chosen to reflect a broad range of advanced topics in chemistry and assessed by examination. These courses are complemented by a number of workshops describing advanced research techniques again drawing from examples across the breadth of chemistry and these are continuously assessed. The workshops involve distinguished visiting lecturers. The final component involves a number of workshops focussed on topics such as how to analyse and critique papers drawn from the literature, how to critically assess research proposals and discussions of topical case studies involving matters of research ethics.

Research-oriented library- and/or laboratory-based group and project work, lectures, report-writing, seminars. Reports, oral presentations, examination.

CM5555

In the second half of Level 5, students gain research experience in a professional research environment, normally in a laboratory on mainland Europe. These projects extend from January to April and students may obtain additional funding from the Erasmus scheme to cover their extra costs associated with living abroad. Students may undertake their placement further afield, for example in North America or Australia, or within Aberdeen, subject to individual circumstances. Students undertake a comprehensive literature review on the topic of their project during the first half-session. The project placement is at the heart of the MChem and richly enhances employability.

A placement in industry or in an appropriate research institute involving an agreed programme of research or project work. Students should be aware that industrial placements are at the discretion of the institution concerned and cannot be guaranteed. Students unable to obtain industrial placements will be able to proceed to the MChem with a project at another host university or in Aberdeen.

Chemistry degree structure showing compulsory Chemistry & Enhanced Study options. BSc & MChem students have different projects in 4th year.

| Level | Term 1 | | | | Term 2 | | | |
|-------|---------------------------------------|-------------------------|---------------------------|--------------------------|---------------------------------------|-------------------------|----------------------------|----------------------|
| 1 | Chemistry for the Physical Sciences 1 | Elements of Chemistry 1 | Enhanced Study | Enhanced Study | Chemistry for the Physical Sciences 2 | Elements of Chemistry 2 | Enhanced Study | Enhanced Study |
| 2 | Analytical Chemistry | Physical Chemistry | Introduction to Materials | Enhanced Study | Organic Chemistry | Inorganic Chemistry | Enhanced Study | Enhanced Study |
| 3 | Energy and the Environment | Inorganic Chemistry | | Professional Skills | Physical Chemistry | | Organic Chemistry | |
| 4 | Analytical & Organic | Inorganic & Physical | Enhanced Study | BSc Honours Project | | | Advanced Chemistry Options | Integrated Chemistry |
| | | | | MChem Group mini-project | MChem Project | | | |
| 5 | MChem Topics & Workshops | | | | Major Research Project | | | |

Blue – Chemistry course, green – choice of other course