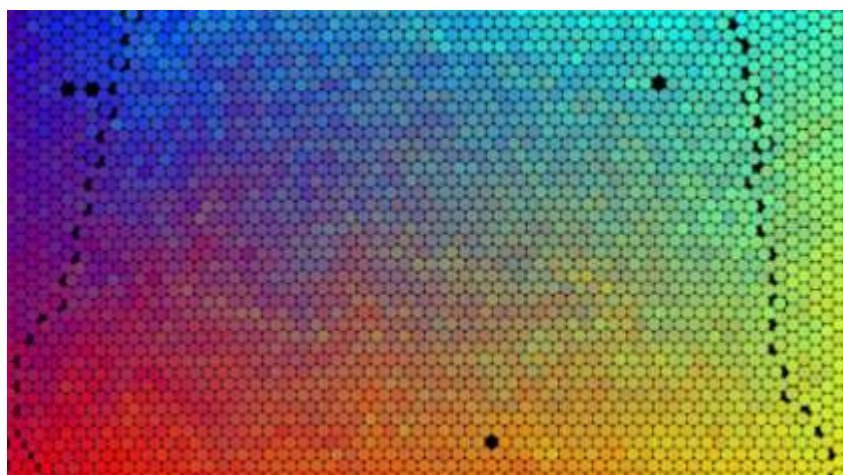




University
of Glasgow | School of
Chemistry

Class Handbook and Course Documentation
2019-2020



Chemistry-2

Chemistry-2X Course
and
Chemistry-2Y Course

Welcome from the Head of School

Welcome to second year Chemistry at the University of Glasgow. The School of Chemistry is one of the leading UK Centres of research; the lecturers you will encounter during your time here will often be leaders in their field, researching and publishing papers as well as lecturing and tutoring our undergraduates. Whether your intention is to stay with us to complete an Honours BSc or an MSci degree in one of the Chemistry options, or to study for some other degree, we hope you will enjoy and benefit from your time spent studying chemistry, one of the central sciences with many links to other disciplines.

The Chemistry 2 courses have been designed to be both useful and interesting to all students by providing a firm basis for later courses in Chemistry and other subjects. The Chemistry-2 courses build upon your level-1 course and will be more challenging than your previous studies in chemistry. In addition to lectures and laboratory courses, you will be required to attend interactive teaching units and tutorials. You will also complete an on-line Maths for Chemists course designed to help you get a better understanding of some of the concepts introduced during the lectures and labs.

As you pass through university, you will notice a shift in the way that you are taught. One key objective of a university is to create autonomous learners, this means that you will take more and more responsibility for your own learning. **It will be up to you to organise your own study time, to check your own progress and identify where you have difficulties, and up to you to ask for help.** Nobody is penalised for asking for help or further explanation. Staff are here to help you, but we can only help if we know you have a problem. There are regular tutorials where you can ask questions. You can also ask the lecturer or any member of staff if you require help, or send an e-mail to your lecturers. For any matters relating to administration or personal problems please consult the class head, Dr Daniel Price (Office A4-38; Daniel.Price@glasgow.ac.uk).

It is essential that you read this Handbook carefully and thoroughly. I would draw your attention, particularly, to the sections dealing with the Award of Credits and Absence. It is important that we have full details of any absences through illness or other problems during the year in order that these may be taken into account in the assessment of your work at the end of the course.

I am sure that you will find the Chemistry 2 courses interesting and enjoyable and that you will be successful at the end of the course. We look forward to welcoming many of you into the Chemistry 3 course in a year's time.

Professor Graeme Cooke
Head of School

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Key Information

FIRST POINT OF CONTACT FOR 2ND YEAR STUDENTS:

Class Secretary: Mrs Catherine McGarrigle
Room: A4-30; Joseph Black Building
Phone: 0141-330-6438
Email: Cathrine.Mcgarrigle@glasgow.ac.uk

Year-2 Chemistry Class Head: Dr Daniel Price
Room: A4-38, Joseph Black Building
Phone: 0141-330-8794
Email: Daniel.Price@glasgow.ac.uk

Deputy Year-2 Chemistry Class Head: Dr Frances Docherty
Room: A2-20, Joseph Black Building
Phone: 0141-330-3460
Email: Frances.Docherty@glasgow.ac.uk

ENROLMENT

All students in the class must register and enrol on MyCampus, complete a student information form and pay a fee of £20 (paid via MyCampus) for the lab manuals and other materials provided.

NOTICES

All Chemistry-2 course information will be posted on **MOODLE**. Check it regularly for changes. Your student email account may also be used for notices so you must maintain sufficient space in your account to permit receipt of incoming messages.

STUDENT REPRESENTATIVES

Class representatives will be appointed early in semester one. Contact details of your reps will be posted on Moodle. Your reps will have an opportunity to raise any issue with the course at the biannual Staff Student Liaison Committee meetings. If you are interested to become a Class Representative please contact the Head of Year, Dr Price by the end of week one.

Course Structure

Level two chemistry comprises two courses:

Chemistry-2X *Molecules Matter: The Fundamentals* (30 credits)

Chemistry-2Y *Chemistry of the Natural World* (30 credits)

- Each course (2X and 2Y) consists of seven lecture courses, two laboratory courses, one interactive teaching unit (ITU), on-line maths support workshops and small group tutorials.
- Please check **MOODLE**, regularly for any announcements or changes to the timetable.
- While the **lectures** form the core of each course, all of the components are **compulsory**.
- Students are expected to build upon their knowledge and understanding through private study
- You are required to show your student card to *any staff member* when requested.

LECTURES

- Lectures begin at 11:00 am each day (See timetable for details).
- In general: The **Chem-2X** course lectures are on Tuesdays, Thursdays and some Mondays. The **Chem-2Y** course lectures are on Wednesdays, Fridays and some Mondays.

<i>Mon</i>	<i>Tues</i>	<i>Wed</i>	<i>Thurs</i>	<i>Fri</i>
2X or 2Y	2X	2Y	2X	2Y

- Talking during lectures is a distraction to both the lecturer and your fellow students. *Students who disrupt lectures will be asked to leave.*
- **Mobile phones** are to be **switched off** during lectures, labs, tutorials and in the library.
- Lecture notes will normally be posted on Moodle in advance of the lecture.
- All course content delivered in lectures (not just the lecture notes) is potentially examinable.

Chemistry-2X – Molecules Matter: The Fundamentals		
Courses & Staff		
	Course Title	Lecturer
X1	Quantum Mechanics and Chemical Bonding	Dr Steven Magennis
X2	Isomerism and Stereochemistry	Dr Andy Sutherland
X3	Organometallic Chemistry	Dr Joy Farnaby
X4	Principles of Spectroscopy	Dr Smita Odedra
X5	Solids and Surfaces	Dr Alexey Ganin
X6	Main Group Chemistry	Dr Mark Symes
X7	Enols and Enolates	Dr Linnea Soler

Your understanding of the lecture course content will be examined by both Class Tests and by the final degree exam in April/May.

Chemistry-2Y– Chemistry of the Natural World		
Courses & Staff		
	Course Title	Lecturer
Y1	Introduction to Spectroscopy	Prof Peter Skabara
Y2	Co-ordination Chemistry	Dr Stephen Sproules
Y3	Aromatic Chemistry	Dr Linnea Soler
Y4	Solutions and Electrochemistry	Dr Beth Paschke
Y5	Organic Synthesis	Prof Rob Liskamp
Y6	Chemical Thermodynamics	Dr Frances Docherty
Y7	Applied Organic Chemistry	Prof Stephen Clark

Your understanding of the lecture course content will be examined by both Class Tests and by the final degree exam in April/May.

LABORATORY CLASSES

You will select your laboratory classes on MyCampus.

The sessions run for **three hours** each day, from **2 – 5 pm**.

Students taking both Chem-2X and Chem-2Y will attend labs for two afternoons each week, while students on a Chemical Physics programme or students doing a single component (Chemistry-2X Single or Chemistry-2Y Single) will be normally allocated one afternoon per week. Laboratory classes are a compulsory part of the course, and the applied nature of chemistry in this component will help to consolidate your knowledge and understanding of the subject.

Labs begin in Week 3, Semester 1.

Refer to the laboratory manual for detailed information about the laboratory sessions.

The laboratories are in the Joseph Black Building (Chemistry Building).

Quantitative-2 Chemistry Laboratory: Speakman Laboratory (A3-06) Sem. 1 (weeks 3-5 and 7-11)

Synthesis-2 Chemistry Laboratory: Connolly Laboratory (A4-31) Sem. 2 (weeks 18-21 and 23-27)

TUTORIALS

You will select your tutorial sessions on MyCampus. Tutorial sessions for Chemistry 2X **begin in week 4** and Chemistry 2Y **begin in Week 5**, semester one and continue as shown in the timetable for both semesters.

Tutorial assignments will be posted on Moodle one week in advance of the tutorial. It is important that you complete and submit the tutorial by 12 noon on the Monday of the week of the tutorial. Tutorials are designed to help you explore and develop your understanding material primarily covered in lectures.

The grade that you are given for a tutorial constitutes a formative assessment. It does not contribute to your final course assessment, but gives you an idea of how to improve your own learning.

Tutorial attendance and participation is monitored.

INTERACTIVE TEACHING UNITS (ITU)

There is one ITU associated with the Chemistry-X course and one with the Chemistry 2Y course.

ITU 1 for **all** students doing **Chemistry 2Y** (Semester 1, Week 6)

ITU 2 for **all** students doing **Chemistry 2X** (Semester 2, Week 22)

Your ITU will be scheduled for one afternoon (14:00-17:00) of the ITU week.

You must attend the ITU session that you have been allocated. The ITU is compulsory. At the ITU session you will work in small groups on an industrial problem. Afterwards you must write a report on the conclusions of your ITU group. The grade that you receive will contribute to your continual assessment.

ON-LINE MORE MATHS FOR CHEMISTS

In Semester one there will be a series of weekly on-line (**MOODLE**) workshops covering mathematical concepts that are essential to your understanding of chemistry and of science more broadly. At the end of each workshop is an on-line assessment. You **must complete** and **pass** each weekly Maths for Chemists assignment. You may re-take the assessment as many times as you like, but the questions may be different each time.

COURSE TEXTBOOKS

We recommend three chemistry textbooks at level-2. These books substantial undergraduate text books treat chemistry at a depth and breadth to make very useful at all levels of undergraduate chemistry.

1. Atkins' Physical Chemistry, P Atkins & J dePaulo, OUP, 11th Edition
2. Organic Chemistry, J Clayden, N Greeves & S Warren, OUP, 2nd Edition
3. Inorganic Chemistry, M Weller, T Overton, J Rourke & Armstrong, OUP, 7th Edition

Note: a discounted price is available if all three are purchased from the John Smiths Bookshop on campus.

ASSESSMENT COMPONENTS

The assessment for the both Chemistry-2X and Chemistry-2Y courses can be separated into two parts, a continual assessment contribution (40%) and the final examination (60%).

Chemistry 2X

Quantitative laboratory (Sem-1)	7.5%
Synthesis laboratory (Sem-2)	7.5%
ITU-2 (Sem-2)	5%
Class Test-2Xa (Sem-1)	10%
Class Test-2Xb (Sem-2)	10%
Chem-2X exam (April/May)	60%

Chemistry 2Y

Quantitative laboratory (Sem-1)	7.5%
Synthesis laboratory (Sem-2)	7.5%
ITU-1 (Sem-1)	5%
Class Test-2Ya (Sem-1)	10%
Class Test-2Yb (Sem-2)	10%
Chem-2Y exam (April/May)	60%

The Chemistry-2X Class Tests will take place in December (covering X1, X2 and X3) and in March (covering X4, X5 and X6). The end of year exam will cover all topics (X1-X7).

The Chemistry-2Y Class Tests will take place in December (covering Y1, Y2 and Y3) and in March (covering Y4, Y5 and Y6). The end of year exam will cover all topics (Y1-Y70).

TIMETABLE

CHEMISTRY-2 TIMETABLE: 2X and 2Y (2018-2019) v2

		SEMESTER ONE																	
Week		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 to 16			
begins on:		10 Sept	17 Sep	24 Sept	1 Oct	8 Oct	15 Oct	22 Oct	29 Oct	5 Nov	12 Nov	19 Nov	26 Nov	3 Dec	10 Dec	17 Dec	31 Dec		
MON	11-12 am		Induction	X1	X1	X2	X2	X3	X3	X3	Y3	Y3	Y4	EXAMS	C H R I S T I A N S	V A R C I A N S			
	2-5 pm				Q	Q	Q	ITU 1	Q	Q	Q	Q	Maths w/s						
TUES	11-12 am		X1	X1	X1	X2	X2	X3	X3		X4	X4	X4						
	2-5 pm				Q	Q	Q	ITU 1	Q	Q	Q	Q							
WED	11-12 am		Y1	Y1	Y1	Y1	Y2	Y2	Y2	Y2	Y3	Y3	Y4						
	2-5 pm				Q	Q	Q	ITU 1	Q	Q	Q	Q	Maths w/s						
THUR	11-12 am		X1	X1	X2	X2	X2	X3	X3	X4	X4	X4	X4						
	2-5 pm				Q	Q	Q	ITU 1	Q	Q	Q	Q							
FRI	11-12 am		Y1	Q-Lab Intro	Y1	Y1	Y2	Y2	Y2	Y3	Y3	Y3							
	2-5 pm				Q	Q	Q	ITU 1	Q	Q	Q	Q	Maths w/s						
Tutorial						Tute 1	Tute 1		Tute 2		Tute 2	Tute 3	Tute 3						
Maths4Chem					M4C-1	M4C-2	M4C-3	M4C-4	M4C-5	M4C-6	M4C-7								
Class Test																			2X + 2Y
ITU-1 (2Y)								ITU = no lab				ITU-1 due Mon 11am							

		SEMESTER TWO																		
Week		22	23	24	25	26	27	28	29	30	31	32	28 to 30		31	32 to 36				
begins on:		8 Jan	15 Jan	22 Jan	29 Jan	5 Feb	12 Feb	19 Feb	26 Feb	5 Mar	12 Mar	19 Mar	26 Mar	9 Apr	16 Apr	23 Apr	21 May			
MON	11-12 am	Y4	Y4	Y5	Y5	Y5	Y6	Y6	X7	X7	2Y:CT(b)	2X:CT(b)	S P R I N G B R E A K	V A C A T I O N	R E S T A U R A N T	E X A M S				
	2-5 pm		S	S	S	S	ITU 2	S	S	S	S	no lab								
TUES	11-12 am	X5	X5	X5	X5	X6	X6	X6	X7	X7	X7	Tute X7(I)								
	2-5 pm		S	S	S	S	ITU 2	S	S	S	S	no lab								
WED	11-12 am	S Lab Intro	Y4	Y5	Y5	Y6	Y6	Y6	Y7	Y7	Y7	Y7								
	2-5 pm		S	S	S	S	ITU 2	S	S	S	S	no lab								
THUR	11-12 am	X5	X5	X5	X6	X6	X6	X6	X7	X7	Careers	revision								
	2-5 pm		S	S	S	S	ITU 2	S	S	S	S	no lab								
FRI	11-12 am	Y4	Y4	Y5	Y5	Y6	Y6		Y7	Y7	Y7	Tute Y7(O)								
	2-5 pm		S	S	S	S	ITU 2	S	S	S	S									
Tutorial			Tute 4	Tute 4		Tute 5	Tute 5		Tute 6	Tute 6										
Class Test			X4 (P)	Y4 (P)		X5 (I)	Y5 (O)		Y6 (P)	X6 (I)							Y4,Y5, Y6	X4,X5,X6		
ITU-2 (2X)							ITU = no labs			ITU-2 due Mon 11am										

Chemistry-2X Course: Modules and Lecturers		
Semester	Chem-2X Module	Lecturer
1	X1 Elementary Quantum Mechanics & Bonding	Dr Steven Magennis
	X2 Isomerism & Stereochemistry	Dr Andy Sutherland
	X3 Organometallic Chemistry	Dr Joy Farnaby
	X4 Principles of Spectroscopy	Dr Smita Odedra
2	X5 Solids and Surfaces	Dr Alexey Ganin
	X6 Main Group Chemistry	Dr Mark Symes
	X7 Enols and Enolates	Dr Linnea Soler

Chemistry-2Y Course: Modules and Lecturers		
Semester	Chem-2Y Module	Lecturer
1	Y1 Introduction to Spectroscopy	Prof Peter Skabara/Dr Neil Findlay
	Y2 Co-ordination Chemistry	Dr Stephen Sproules
	Y3 Aromatic Chemistry	Dr Linnea Soler
1 & 2	Y4 Solutions & Electrochemistry	Dr Beth Paschke
2	Y5 Organic Synthesis	Prof Rob Liskamp
	Y6 Chemical Thermodynamics	Dr Frances Docherty
	Y7 Organic Chemistry in the Natural World	Prof Stephen Clark

Q = Quantative laboratory class	S = Synthetic laboratory class
M4C = Maths for chemists	ITU = Interactive teaching Unit

FEEDBACK AND ASSESSMENT

Throughout the course you will be given feedback though tutorials, marks in tests, lab reports and class examination, together with verbal feedback in laboratories. This will enable you to see how you are doing in chemistry and enable you to seek help when necessary.

Details of the timeframe for the return of assessment is given in the **Assessment Calendar** on Moodle

Where possible we grade using the Universities 22 point scale (see below).

Grade	Grade Points
A1	22
A2	21
A3	20
A4	19
A5	18
B1	17
B2	16
B3	15
C1	14
C2	13
C3	12
D1	11
D2	10
D3	9
E1	8
E2	7
E3	6
F1	5
F2	4
F3	3
G1	2
G2	1
H	0

At the end of the course you will be awarded a final grade based on this scale. This grade is very important in determining your academic options as you move forward into third year and beyond. The grade point average and credit level requirement for BSc and MSci are given in full in the University of Glasgow Calendar and the Catalogue of Courses. Please consult your adviser of studies for full details.

GRADE POINT AVERAGES: GUIDELINES

The grade awarded at the end of the course contributes towards your Grade Point Average. See University Calendar page Gen.16 which can be found on the following web page: <http://www.gla.ac.uk/services/senateoffice/calendar/>

Total grade points = sum of credits x grade points

Grade point average (GPA) = Total grade points/Total credits

1. Your grade point average should normally be at **9** or above in each year of study.
2. Entry into level-3 courses requires a grade point average **over the first two years** of at least **9** for BSc(Hons) and at least **12** for MSci
3. Entry to many level-3 courses is on a competitive basis with a preference given to those students with a high grade point average.
4. **In addition** level-3 courses have a minimum grade requirement for entry.

Entry to Chemical Studies; BSc requires a minimum of **D3** in both **chem-2X** and **chem-2Y**

Entry to Honours Chemistry degrees; BSc(Hons) requires a minimum of **C3** in both **chem-2X** and **chem-2Y**.

Entry into Chemistry Masters degrees (MSci) requires a minimum of **B3** in both **chem-2X** and **chem-2Y**.

It is therefore important that you make sure you work steadily throughout the year in every subject. Low grades may cause problems with progress.

ABSENCE REPORTS

Significant absence is defined as absence of more than seven consecutive days or one which prevents a student from attending an examination or fulfilling any **other requirement** for the award of credit. This might be missing compulsory laboratory class, ITUs, tutorials etc. It is a significant absence if it affects your ability to complete or submit any piece of assessment on time.

Students must complete a MyCampus absence report for any significant absence and are recommended to complete an absence report for any absence for which they would like the University to take account.

Documentary evidence is required for any significant absence. MyCampus has the facility for documentary evidence to be scanned in by the student to their record. It is the responsibility of the student to keep all additional documentation and submit it to the Head of School or nominee on request. **Scanning facilities are available on Level 3 of the University Library.**

Further details are available at the following link:

<http://www.gla.ac.uk/services/registry/support/policies/>

For the overall assessment of the course, attendance credits will only be given if absence was adequately explained by this route.

If you are absent for a significant time, you may not be awarded credit at the end of the year. In this case a student will be awarded one of the following categories:

MV: This means that the assessment was void, usually on medical grounds. In this case you have an opportunity to retake the assessment as if it were your first attempt (i.e. no cap on grade point).

CW: This means credit withheld. In this case you have not completed enough assessment to be awarded credit. You may be able to remedy this by re-taking some assessment – usually a re-sit examination.

CR: This means credit refused. This is usually associated with an unacceptably low attendance and participation. A re-sit examination is not offered in this case because it still would not be enough to award any grade.

GOOD CAUSE CLAIMS

If you miss **any examination** or **any assessment deadline**, or if you believe **your assessment performance** has been affected by adverse circumstances, you must submit a Good Cause Claim, and this must be via MyCampus.

Submission of a Good Cause Claim is the mechanism which allows your circumstances to be considered by the Board of Examiners. Please note all Good Cause Claims must be submitted within **a week** of the date of the affected assessment.

To submit a Good Cause Claim* on MyCampus:

1. Go to the 'Student Center' and select *My Good Cause* from the Academics menu.
2. Select the relevant course(s).
3. Complete the report in MyCampus (there is provision for particularly sensitive information to be provided separately, outwith the system, but a claim report must still be entered into MyCampus).
4. Add supporting evidence by uploading documents. (Scanners are available on level 3 of the University Library or on the photocopiers in A4-03 and the Conference room.)

*If you miss an examination due to adverse circumstances submit a Good Cause Claim instead of an Absence report.

If you encounter any difficulties with this process please contact Susan Johnston, (ext 6438 or susan.johnston@glasgow.ac.uk) immediately to let them know you have a problem with your Good Cause Claim.

What will happen to your Good Cause Claim

The Course Administrator and/or Course Co-ordinator will ensure that your claim is considered and this will be in accordance with the section of the Code of Assessment which covers incomplete assessment and good cause (paragraphs 16.45 to 16.53). The outcome of your claim will be posted into the Approval Information section on your Good Cause Claim in MyCampus. If it is accepted that your assessment was affected by good cause, the work in question will be set aside and you will (as far as is practicable) be given another opportunity to take the assessment with the affected attempt discounted.

PLAGIARISM

Plagiarism is defined as the submission or presentation of work, in any form, which is not one's own, without acknowledgement of the sources. The University's degrees and other academic awards are given in recognition of the candidate's personal achievement. Plagiarism is therefore considered as an act of academic fraudulence and as an offence against University discipline.

Allegations of plagiarism will be treated very seriously and referred to the Head of School. A full statement of the University of Glasgow procedure for dealing with cases of suspected plagiarism can be found in the General Section (page Gen. 31) of the University Calendar <http://www.gla.ac.uk/services/senateoffice/calendar/>.

The University reserves the right to use plagiarism detection systems, which may be externally based, in the interests of improving academic standards when assessing student work. This regulation applies to all work submitted for assessment, including lab reports, class tests, and research projects unless you have specifically been told otherwise, for example, in the case of a group project or when a number of students share experimental data. Special cases of plagiarism can arise from one student copying another student's work or from inappropriate collaboration.

STAFF-STUDENT COMMITTEE AND OPINION SURVEYS

At the start of the session we will appoint Chemistry-2 class representatives. Class Reps are then invited to the Chemistry Staff-Student Liaison Committee meetings to discuss courses and other School business twice a term. Class Reps have a special responsibility to alert staff of any problems that develop in the running of the Chemistry-2 course.

All students will have an opportunity at some time to comment on aspects of the course *via* questionnaires. Any difficulties are most quickly resolved by informing Dr Price.

ALCHEMISTS' CLUB

The chemistry students club organises lectures, sports events and social events. The Alchemists also run a tutorial service (web site <http://www.chem.gla.ac.uk/alchemist/>).

CHEMISTRY BEYOND LEVEL 2

Admission to Chemistry-3 requires the successful completion of **both** Chemistry-2X **and** Chemistry-2Y.

Admissions to Honours is not automatic. Decisions on admission to the Honours degrees are not made until the end of your second year of study. To guarantee admission students must satisfy the general requirements shown in the Degree Regulations, and in their Level 2 courses (and in some

cases in Level 1 courses as well) obtain the grades shown under the Honours course entries in this Catalogue.

This means that the main criterion for entry to:

a master-level chemistry degree is a minimum of B3 in both the Chemistry-2X and Chemistry-2Y;
an honours-level chemistry degree is a minimum of C3 in both Chemistry-2X and Chemistry 2Y
and the designated chemistry degree course is a minimum of D3 in both Chemistry-2X and Chemistry 2Y.

There is a wide range of “chemistry” options available beyond level-2. Some degrees are also available with Work Placement or European Placement opportunities. The following list gives all the possibilities. Final decisions about degree choice are made at the end of second year.

Master in Science (M.Sci.) degree programmes:

Chemistry with Work Placement
Chemistry with European Placement
Chemistry with Medicinal Chemistry with Work Placement
Chemistry with Medicinal Chemistry with European Placement
Chemical Physics
Chemical Physics with Work Placement
Chemistry and Mathematics

Honours B.Sc. degree programmes: (4 year courses)

Chemistry
Chemistry with Medicinal Chemistry
Chemical Physics
Chemistry and Mathematics

B.Sc. designated degree programme: (3 year course)

Chemical Studies

More details about these courses will be given in the careers talk in Semester 2

RE-TAKING LEVEL-2 CHEMISTRY

Should you fail to attain the grades that you desire in level-2 chemistry, you should be aware that there is no process that automatically allows you the opportunity to re-sit the level-2 courses.

Permission to re-sit the year is considered on a case-by-case basis, and one of the criteria that we apply, is to examine your previous level of participation and engagement with the course, up to and including making full use of the opportunity to improve your grades in re-sit examinations.

STUDENT LEARNING SERVICE

Students who are finding the maths side of chemistry difficult are strongly advised to seek help from the NUMBER unit (part of the Student Learning Service) see

<http://www.gla.ac.uk/services/sls/slscontacts/mathsadviser/>

The Student Learning Service also runs workshops and individual appointments to help you with various aspects of academic skills. See the site:

<http://www.gla.ac.uk/services/sls/informationforstudents/>

STAFFING

Chemistry-2 Administrative Staff			
		Phone	Room*
Class Head	Dr Daniel Price	0141-330-8794	C5-07
Depute Class Head	Dr Frances Docherty	0141-330-3460	A2-29
Class Secretary	Mrs Catherine McGarrigle	0141-330-6438	A4-30
Teaching Administrator	Mrs Angela Woolton	0141-330-7704	A4-27

* All room numbers refer to the Joseph Black (Chemistry) Building.

Email: see chemistry website for details (<http://www.gla.ac.uk/schools/chemistry/staff/>)

Key Chemistry-2 Staff			
		Phone	Room
More Maths for Chemists	Dr Daniel Price	0141-330-8794	C5-07
Quantitative Lab Head	Dr Alexey Gannin	0141-330-4443	A4-42
Synthesis Lab Head	Dr Daniel Price	0141-330-8794	C5-07
ITU Administrator	Dr Drew Thomson	0141-330-8284	A3-15
Tutorial coordinator	Dr Daniel Price	0141-330-8794	A4-38

* All room numbers refer to the Joseph Black (Chemistry) Building.

Email: see chemistry website for details (<http://www.gla.ac.uk/schools/chemistry/staff/>)



University of Glasgow | School of Chemistry

2019-2020

Intended Learning Outcomes (ILOs)

Chemistry-2

Chemistry-2X Course

Title: Elementary Quantum Mechanics and Chemical Bonding (X1)

Lecturer: Dr S Magennis

Aims: To introduce the fundamentals of quantum mechanics, as they relate to atomic structure and molecular bonding, in an essentially non-mathematical, qualitative manner. To build up a description of the structure of light atoms and diatomic molecules in terms of orbitals and quantum numbers, stressing the physical properties that these describe.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Describe the link between the Rydberg equation and the atomic spectrum of hydrogen.
2. Recognize the successes and limitations of the Bohr model of the atom and the link to the Rydberg equation. Calculate principal quantum numbers from transition energies and *vice versa*.
3. Recognize the wave nature of matter and the significance of the de Broglie relationship.
4. Utilize the physical interpretations of the wavefunction (Born and Schrödinger).
5. Describe the meaning of the term 'orbital' in the context of the hydrogen atom.
6. Recall the shape of radial wavefunctions and spherical harmonics for orbitals 1s to 3d. Describe the meaning of the term 'radial node' and calculate the position of such nodes, given the radial wavefunction (1s to 3d only).
7. Formulate the nature of the LCAO approximation and its role in molecular orbital theory.
8. Describe the nature of bonding and antibonding interactions between atomic orbitals, and their consequences in terms of energy and electron distribution.
9. Recognise the complications caused by the presence of more than one electron in an atom and the importance of the orbital approximation.
10. Formulate the importance of the Aufbau principle, the Pauli principle and Hund's rule in building up the Periodic Table of the elements.
11. Utilise correctly the terms 'shielding', 'penetration', and 'effective nuclear charge' in the context of atomic electronic structure and periodic trends.
12. Rationalise trends in electronegativity, ionisation energy, and electron affinity.
13. Appreciate the differences between σ and π overlap.
14. Assign electronic configurations for 2nd-period diatomics and calculate their bond orders.
15. Describe the origin of paramagnetism in O₂.
16. Predict, at a qualitative level, the composition of molecular orbitals in heteronuclear diatomics and describe the relationship to familiar properties like bond polarity.
17. Apply the above to previously unseen examples.

Title: Isomerism and Stereochemistry (X2)

Lecturer: Dr A Sutherland

Aims: To give an understanding of molecular shape, and to introduce the importance of stereochemistry in organic reactions.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Describe the different types of isomerism in organic chemistry including structural, conformational and configurational isomerism.
2. Illustrate the conformations available to acyclic and cyclic organic molecules, and their relative energies.
3. Draw accurate representations of the common conformational isomers available to cyclohexanes (including conformational ring inversion or ring flip), with substituents, and label the substituents correctly as axial or equatorial.
4. To draw and interpret accurate representations of three-dimensional molecules using various conventions, including stereo-drawings, perspective drawings, Newman and sawhorse projections.
5. Define chiral and assign the absolute configuration of a stereo-centre as *R* or *S* using the Cahn-Ingold-Prelog sequence rules, and list and use the meanings of the D/L and +/- conventions for labelling chiral compounds.
6. Define enantiomers, diastereomers, meso compound; identify in these terms the stereo-chemical relationships between isomeric compounds.
7. Recall that diastereomers have different physical properties and can usually be separated, whereas enantiomers have identical physical properties and are difficult to separate.
8. Apply the rules of the Cahn-Ingold-Prelog sequence rules for determining the configuration of alkenes.
9. Explain the importance of isomerism and stereochemistry in predicting the outcome of organic reactions.
10. Define and show an example of a stereospecific and a stereorandom reaction.
11. Recall that bimolecular nucleophilic substitution (S_N2) proceeds with inversion of configuration, whereas unimolecular substitution (S_N1) may proceed with complete racemisation; illustrate both processes using curly arrow mechanisms.
12. Draw curly arrow mechanisms for, and recall the stereochemical course of, the reactions of alkenes with reagents such as bromine, peracids, and osmium tetroxide.

Course Outline: Different types of isomerism. Conformational isomerism including a reminder about conformational analysis of ethane, butane, and related compounds. Cyclohexane conformations; substituents on cyclohexanes; "ring flip" and its prevention. Definition of stereochemistry. Chirality, enantiomers and the Cahn-Ingold-Prelog sequence rules for *R/S* assignment. Compounds with more than one chiral centre: diastereomers, *meso* compounds. Physical properties of enantiomers and diastereomers contrasted. Isomers of alkenes and their assignment. Substitution reactions: reminder of the mechanism and stereochemical consequences of S_N1 and S_N2 reactions. *E* and *Z* double bonds, *syn* and *anti* additions to alkenes: some examples, with mechanisms, and discussion of the stereochemical consequences.

Title: Organometallic Chemistry (X3)

Lecturer: Dr J Farnaby

Aims: To introduce the chemical diversity and value of organometallic compounds of both the main group and transition elements.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Recognise the range of organometallic compounds of main group metals (groups 1, 2, 12 - 15) and relate their reactivity to the metal electronegativity (e.g. reactions with water, oxygen, donor solvents).
2. State the main methods of synthesis of main group organometallic compounds, and construct appropriate methods to prepare a stated compound.
3. State and explain the nature of Grignard reagents in solution, and show the evidence for this.
4. List which organometallic compounds are likely to be electron deficient, and explain the structural, bonding and reactivity consequences of electron deficiency.
5. Describe how the reactivity of organometallic compounds can be modified to suit particular objectives.
6. Reproduce the stoichiometries and structures of transition metal carbonyl complexes, and explain the bonding of these compounds in terms of synergic systems involving π -bonding.
7. Apply the 18-electron rule to explain or predict the stoichiometries of low oxidation-number transition metal complexes.
8. Show how the principles of 6 and 7 can be applied to transition metal compounds containing nitrosyl, alkene and other π -bonded ligands.
9. State and explain the operation of the β -process, oxidative addition/reductive elimination and insertion reactions of σ -bonded (η^1) organo-transition metal complexes, and explain the role of spectator ligands in stabilising σ -bonded organo-transition metal compounds.
10. Describe how the above reactions feature in processes catalysed by transition metal compounds, and list the key steps in the hydroformylation reaction catalysed by $\text{Co}_2(\text{CO})_8$.
11. Recognise and show how the knowledge and principles embodied in the above can be extended to solve previously unseen examples and situations.

Course Outline:

The chemistry of main group element organometallics will be developed first, as many of the principles encountered here also apply to transition metal derivatives. Reactivity patterns, structures and bonding will be related to periodic position of the elements involved, and examples of applications and uses cited throughout. Preparative methods will be explained.

Title: Principles of Spectroscopy (X4)

Lecturer: Dr S Odedra

Aims: The course will cover the principles of molecular spectroscopy: specifically, pure rotational spectroscopy (microwave spectroscopy), vibrational spectroscopy (IR and Raman), and electronic spectroscopy (UV/visible). Only diatomic molecules will be discussed. Examples will be provided of how and where these spectroscopic techniques are applied. The course aims to cover the basic theoretical aspects of these spectroscopies and builds on the Level 2 courses on Elementary Quantum Mechanics and Bonding (X1) and Introduction to Spectroscopy (Y1).

Intended Learning Outcomes:

By the end of this course, students will be able to:

1. Describe evidence for the wave-particle nature of electromagnetic radiation.
2. Convert units between wavelength, wavenumber, frequency and energy.
3. Explain the link between energy quantisation, selection rules and observed lines in spectra.
4. Describe the factors that influence line width in a spectrum.
5. Describe the factors that influence line intensity in a spectrum; be able to calculate Boltzmann population distributions and use the Beer-Lambert Law.
6. Describe the energy levels and transitions found in pure rotational (microwave) spectroscopy; be able to determine diatomic bond lengths from rotational spectra.
7. Distinguish between the rigid rotor and non-rigid rotor models of a rotating molecule.
8. Describe the energy levels and transitions found in infra-red (vibrational) spectroscopy; be able to determine bond force constants and diatomic bond lengths from vibrational spectra.
9. Distinguish between the simple harmonic oscillator (SHO) and anharmonic oscillator models; calculate the classical vibrational frequency and anharmonicity constant from the position of a fundamental and overtone band.
10. State how Raman spectroscopy differs from IR spectroscopy and microwave spectroscopy; discuss its selection rules and applications.
11. Explain the origin of fine-structure in an IR spectrum using energy level diagrams.
12. Describe how and why electronic spectroscopy differs from both pure rotational and infra-red spectroscopies.
13. Apply the theory and techniques introduced in this course to related exercises and solve problems linked to content from other Chemistry 2X lecture courses.

Title: Solids and Surfaces (X5)

Lecturer: Dr A Ganin

Aims: To examine the packing arrangements of atoms/ions in metals, ionic crystals, covalent crystals and some minerals and to develop an appreciation of some of their surface properties/structures.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Recognise, list and explain the characteristics of hexagonal and cubic close packing and body centred cubic arrangements.
2. Explain, illustrate and compare the key structures of some inorganic ionic crystals (sodium chloride, caesium chloride, zinc blende, wurtzite, fluorite, anti-fluorite).
3. Explain, illustrate and compare the structures of selected covalent/network crystals (silicas and allotropes of carbon).
4. Compare the chemical and physical differences between the surface of a solid and the bulk.
5. Explain the concepts of physical and chemical adsorption at the surface of a solid. List and summarise the differences between the two processes.
6. Use the concepts and methods outlined here to solve unseen problems related to the course material.

Course Outline: Study of the structures of various common inorganic solids and an introduction to their surface to their surface properties, following on from the concepts described in the first year course.

Title: Main Group Chemistry (X6)

Lecturer: Dr M Symes

Aims: The aim of this course is to introduce the students to main group chemistry, and in particular the chemistry of elements in groups 1, 2 and 15. Many of the concepts within this course are fundamental to a basic understanding of chemical behaviour and reactivity. This course also provides a foundation for subsequent courses on main group chemistry in years 3 and 4.

Intended Learning Outcomes: By the end of this course the student should be able to:

1. Compare the reactivities of the Group 1 elements and their compounds by reference to the ionization energies of the Alkali metals, and use Born-Haber cycles to rationalize trends in reactivity within the group
2. Rationalize the properties of the Group 1 elements and their compounds
3. Compare and contrast the reactivity of Group 2 elements with that of Group 1 elements on the basis of ionization energies, solvation energies and ionic radii
4. Rationalize the properties of the Group 2 elements and their compounds and discuss the concepts of hard/soft ions and partial covalency/iconicity
5. Rationalize the reactivity and properties of nitrogen in its various oxidation states
6. Rationalize the reactivity, properties and structures of various phosphorous-containing compounds, including phosphorous halides and oxides, phosphazenes, and organo-phosphorous species
7. Discuss Lewis pairs and Frustrated Lewis pairs with reference to N and P-containing compounds
8. Rationalize the reactivity, properties and structures of halides and oxides of As, Sb and Bi, and explain the inert pair effect on the reactivity and properties of Bi compounds
9. Use VSEPR theory to determine the structures of compounds of the main group elements

Course Outline: Over seven lectures, we will explore the reactivity of elements in Groups 1,2 and 15, and rationalize the trends that emerge. Special attention will be paid to contrasting the behaviour of elements within and between groups. Concepts such as Lewis acidity, hard/soft donors, ionization energy and VSEPR theory will be introduced or expanded upon from earlier courses. Examples of properties and applications of some of the compounds

Title: Enols and Enolates (X7)

Lecturer: Dr L Soler

Aims: To explore the reactivity of the carbonyl group and to show how it reacts with nucleophiles. To describe how the carbonyl group can also be used to generate carbanions and to function as nucleophiles in carbon-carbon bond forming reactions. To apply this knowledge for the total synthesis of organic molecules.

Intended Learning Outcomes: By the end of this course, the student will be able to:

1. Recognise the **structure of the carbonyl group** and recall its importance in the natural occurrence of aldehydes, ketones, carboxylic acids, esters and amides. Predict, illustrate (using curly arrow mechanisms), and explain the reaction of nucleophiles at the carbonyl carbons of these compounds. Classify and explain the differing reactivities of these carbonyl compounds.
2. Explain and illustrate **keto-enol tautomerisation** and state and illustrate why **enolisation** occurs using curly arrow mechanisms. Explain the acidity of protons on carbons adjacent to the carbonyl group and compare their relative pKa values. Reproduce, explain and illustrate, using curly arrow mechanisms, how enols are formed under both acidic and basic conditions. Recall, explain and illustrate, using curly arrow mechanisms, the **formation of enolates**, how enolates stabilise negative charge on carbon through resonance and how enolates react as nucleophiles.
3. State, explain, and illustrate, using curly arrow mechanisms, the mechanisms of **α -deuteration**, **α -racemisation**, **α -halogenation** (acid catalysed) and **α -alkylation** reactions, including the use of lithium enolates in α -alkylation reactions to avoid self-condensation reactions. Identify reagents, starting materials and products of each reaction. Recognise, compare and predict the outcome of the hard/soft interactions between nucleophiles and electrophiles in enol and enolate chemistry.
4. Recall the importance and applications of enolates formed from the 1,3- dicarbonyl compounds, ethyl acetoacetate (EAA) and diethyl malonate (DEM), in the synthesis of an asymmetrical methyl ketone product and a carboxylic acid product, respectively. State, explain, and illustrate, using curly arrow mechanisms, how EAA and DEM are used in the **Acetoacetic Ester Synthesis** and the **Malonic Ester Synthesis reactions**, respectively, listing the reagents for each step. Explain and illustrate, using curly arrow mechanisms, each step in the syntheses including the **α -alkylation** step, the **ester hydrolysis** step, and the **decarboxylation** of a β -keto acid step. Explain and show how **α -dialkylation** can be incorporated into these syntheses and how α -dialkylation can be used to form ring systems.
5. State, explain, and illustrate, including curly arrow mechanisms and a list of reagents, the **Aldol Reaction** showing its reversibility, and the subsequent (both acid- and base-catalysed) **dehydration** (elimination) sequence of the aldol product (a β -hydroxyl carbonyl compound) to generate an enone (α,β -unsaturated ketone) or an enal (an α,β -unsaturated aldehyde). Recognise the distinction between **self-condensation** and **cross-condensation aldol reactions** and assess, list, and describe which reagents and reaction conditions are needed for a successful cross-condensation Aldol reaction. Summarise and show, using curly arrow mechanisms, how lithium enolates are used in directed aldol reactions. Recognise, show and illustrate how **intramolecular aldol reaction** can be used to form a cyclic product. State and explain, using curly arrow mechanisms, the role of the intramolecular aldol reaction in the **Robinson Annelation reaction**.

6. State, explain, identify, and illustrate, using curly arrow mechanisms, reactions involving the acylation of enolates, namely the **Claisen Ester Condensation Reaction**, the **Cross-Claisen Ester Condensation Reaction** and the **Dieckmann Cyclisation Reaction**. Compare and contrast the Aldol and the Claisen reactions with respect to the reaction conditions, mechanisms, and products. Summarise and illustrate how control can be exerted in the Cross-Claisen ester condensation. Recall the reaction conditions and reagents of the Dieckmann reaction.
7. Show how enolates are used in the **Michael Addition Reaction** and show how this reaction is used to synthesise 1,5 dicarbonyl compounds. Show how the Michael Addition reaction is used in the **Robinson Annelation Reaction**. State, explain, and illustrate, using curly arrow mechanisms, the Robinson Annelation reaction to give the α,β -unsaturated hexanone product.
8. Apply the theory and principles above to targeted organic synthesis.

Course Outline: Polarity of carbonyl group; dipolar character of esters, carboxylic acids and amides. Nucleophilic attack at the carbonyl carbon. Base induced enolate formation. Acid and base induced enol formation. Tautomerism, racemisation and isomerisation. Acidity of central α -proton in EAA and DEM, reaction of enolates with ketones to give α -hydroxy carbonyl compounds and α, β -unsaturated enones; Additions of nucleophiles to α, β -unsaturated ketones. Aldol, directed aldol and intramolecular aldol reactions. Acylation reactions including Claisen Ester Condensations and Dieckman reactions. Michael additions and Robinson Annelation.



Intended Learning Outcomes (ILOs)

Chemistry-2

Chemistry-2Y Course

Title: Introduction to Spectroscopy (Y1)

Lecturer: Prof P Skabara

Aims: To explain the different ways in which electromagnetic radiation may interact with molecules and how this may be used

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Account for the relationship between light absorption and colour and relate absorbed regions of the electromagnetic spectrum to molecular processes.
2. Recall and apply the equation $E = hc / \lambda$ using appropriate units.
3. Recall and apply the Beer-Lambert Law using appropriate units.
4. Utilise calibration data to graphically relate absorbance to analyte concentration and to find ϵ and the analyte concentration for an "unknown" solution
5. State and apply the equation relating the wavenumber of an IR transition to the force constant and reduced mass.
6. Discuss the idea of group frequencies, list the approximate wavenumber of the IR absorptions of the common functional groups and interpret and explain simple IR spectra.
7. Describe the basis of NMR spectra and discuss the origin of ^1H and ^{13}C chemical shifts in terms of electron density surrounding the nucleus; recall the approximate chemical shifts of common groups.
8. Predict and the spin-spin splitting patterns and relative peak areas of the NMR spectra of simple molecules. Interpret and explain simple ^1H and ^{13}C NMR spectra.
9. Derive the structure of simple compounds from their ^1H and ^{13}C NMR spectra.
10. Explain how the technique of mass spectroscopy works and describe the instrumentation used.
11. Analyse and explain fragmentation patterns from mass spectra and use them to deduce the structure of molecules.
12. Apply the theory and techniques introduced during this course to related exercises.

Course Outline: The electromagnetic spectrum and units of measurement. Vibrational spectra, mathematical interpretation and reduced mass. Group frequencies. Nuclear magnetic resonance spectroscopy, origins and brief theory, NMR active nuclei, chemical shifts for proton and carbon-13 NMR, spin-spin coupling. Interpretation of ^1H and ^{13}C NMR spectra. Mass spectrometry.

Title: Co-ordination Chemistry (Y2)

Lecturer: Dr S Sproules

Aims: To provide an introduction to coordination complexes of the first row d-block elements and to use crystal field theory to explain aspects of structural, magnetic and spectroscopic properties.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. List the first row transition metals and state their common oxidation states; reproduce the electron configurations of the atoms and of the ions in any oxidation state.
2. Recall what denticity of a ligand means and explain why chelate ligands have an increased thermodynamic stability over monodentate ligands (entropy effect).
3. Explain and illustrate the way in which the d-orbital energies split in (a) octahedral (b) tetrahedral and (c) square planar co-ordination.
4. List the spectrochemical series, and explain the factors that affect the size of Δ_{oct} .
5. Explain the origin of the absorption spectra of the Ti^{3+} and Cu^{2+} ions.
6. Summarise the Jahn-Teller effect, and predict when it might apply.
7. Summarise the concept of ligand field stabilisation energy (LFSE); calculate LFSE and use it to explain thermodynamic, structural and kinetic properties of some transition metal complexes.
8. State the spin-only formula and determine the number of unpaired electrons in a complex from the value of its magnetic moment.

Course Outline:

Coordination complexes and coordination numbers; electron configurations; Lewis acids and bases; stability constants; chelate effect; d-orbitals and crystal field theory; absorption spectra and colour; the spectrochemical series; the Jahn-Teller effect; ligand field stabilisation energy; high and low spin complexes; magnetic properties.

Title: Aromatic Chemistry (Y3)

Lecturer: Dr L Soler

Aims: To recognise the principle of aromaticity, the chemistry of aromatic compounds, and their role in our daily lives (flavours, drugs, detergents, insecticides, explosives, etc.)

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Recognise the principles of aromaticity and antiaromaticity.
2. Apply the Hückel ($4n+2$) p-electron rule to determine the aromatic character of organic compounds.
3. Recognise and identify aromatic compounds that contain one or more heteroatoms within the aromatic rings (aromatic heterocycles).
4. Work out the mechanisms of aromatic electrophilic substitution (chlorination, bromination, nitration, sulfonylation, alkylation, and acylation) and to apply them to various aromatic compounds.
5. Predict the activation and deactivation of aromatic compounds caused by substituents and predict the directing effects in electrophilic substitution (*o/p* vs *m* substitution).
6. Develop, explain and illustrate synthetic approaches to aromatic amines via the reduction of nitro derivatives.
7. Apply synthetic approaches to the synthesis of mono- and poly substituted aromatic compounds using primary aromatic amines via their conversion into diazonium salts.
8. Evaluate the acidity of phenols and show how to use this knowledge in order to separate phenols from neutral compounds.
9. Predict the requirements for nucleophilic aromatic substitution and apply them to predict reaction outcomes.
10. Use the knowledge of the reactivity of aromatic compounds in combination with retrosynthetic analysis to devise routes for the synthesis of aromatic compounds with a variety of substituents.

Course Outline:

This course will consider the basis of aromaticity taking into account Hückel's rules and the effect of hybridisation into determining chemical behaviour. The course will also cover the chemical behaviour of aromatic compounds under different reaction conditions and ways to synthesise mono- and poly-functionalised aromatic compounds taking into account directing and activating effects. The role of compound functionalisation and its effects on its physical properties will also be examined.

Title: Solutions & Electrochemistry (Y4)

Lecturer: Dr B Paschke

Aims: To expand upon the basic principles covered in the 1stYear *Aqueous Equilibria and pH* course, to explore the basic principles of electrochemistry and their applicability to daily lives and to apply the theory and techniques introduced to related exercises.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Define and calculate solute concentrations in terms of molarity, molality and mole fraction.
2. Describe concepts such as ideal and non-ideal solutions, examples of colligative properties and factors affecting activity.
3. State Raoult's Law and explain vapour pressure lowering of a solvent, osmosis, elevation of boiling point and depression of freezing point. Apply equations relating vapour pressure lowering of a solvent, osmosis, the elevation of boiling point and depression of freezing point to aqueous solutions.
4. Recall the concept of reduction and oxidation and apply this knowledge to write balanced redox equations.
5. Recognise and apply IUPAC shorthand conventions for voltaic cells.
6. Express and explore differences between electrolytic cells and voltaic/galvanic cells using relevant examples of each. Use tables of standard electrode potentials to predict the direction of spontaneous oxidation and reduction reactions and products (with quantities) and to calculate cell emf. Recall examples of reference electrodes and their function.
7. Calculate the ionic strength of a solution.
8. Define both forms of the Debye-Huckel equation and apply them appropriately to calculate mean ion activity coefficients.
9. State and apply the Nernst Equation to calculate cell emfs and ion activities.
10. Calculate the equilibrium constant, K from cell emfs and vice versa using:
$$nFE_{\text{cell}}^{\circ} = RT \ln K.$$
11. Discuss the advances in technology relating to energy production, storage and applications, with particular reference to fuel cells and batteries. Using fuel cell emfs, calculate the associated free energy change and efficiency of the cell.
12. Describe examples of electrolytic cells used industrially and be able to apply Faraday's Laws.
13. Apply the theory and techniques introduced during this course to related exercises.

Course Outline:

- Revision of solution properties.
- Introduction to alternative ways of representing "concentration".
- Coverage of solution properties such as colligative properties, ionic strength and mean ion activity coefficients.
- Revision of the basics of oxidation and reduction reactions.
- Application of this knowledge to explore important redox reactions and electrochemical cells in terms of for example, their construction, cell emfs, prediction of spontaneous reactions, resulting products, Free Energy, equilibrium constants, the Nernst equation.
- Discussions, with examples, of how these principles are applied and occur in everyday life.
- Exploration of the application of electrochemistry in the development of alternative methods of energy production and storage.

Title: Organic Synthesis (Y5)

Lecturer: Dr E Draper

Aims: To introduce synthetic strategy with particular emphasis on selectivity (chemo-, regio- and stereo-) and protecting group chemistry; to illustrate the course with the synthesis of chemicals used in every day life such as pharmaceuticals.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. Describe how carbonyl groups react with nucleophiles, draw curly arrow mechanisms for these reactions, and illustrate the relative electrophilicity of different carbonyl groups.
2. Design, explain and illustrate syntheses involving reactions of carbonyl groups with nucleophiles (in particular Grignard reagents), oxidations and reductions.
3. Illustrate the importance of selectivity (chemo, region and stereo) in the synthesis of molecules containing many functional groups, recognise when selectivity is possible, and list and use given selective reagents appropriately.
4. Recall the limitations of protecting group chemistry and when to use it; illustrate the principle of orthogonal sets.
5. Recognise a number of protecting groups and recall their use, stability, and the reagents for and mechanisms of protection and deprotection.
6. Recall synthetic schemes for multi-step transformations using protecting groups for aldehydes, ketones or hydroxyl groups.
7. Recall how protecting group chemistry is used in polypeptide synthesis and design syntheses of simple dipeptides.

Course Outline: Revision of nucleophilic addition and nucleophilic acyl substitution reactions; relative reactivity of carbonyl compounds toward electrophiles; Grignard reagents, Organo Lithium reagents; synthetic planning; oxidising and reducing agents; complex functionality and selectivity; Protecting groups – when to use them, requirements for, and the principle of orthogonal sets; a selection of protecting groups for aldehydes, ketones, carboxylic acids, amines, and alcohols and their use in synthesis; polypeptide synthesis, in particular dipeptide synthesis.

Title: Chemical Thermodynamics (Y6)

Lecturer: Dr F Docherty

Aims: To build on the level-1 course on Chemical Energy Changes, and introduce the ideas of chemical thermodynamics through that thermochemistry background. To introduce the importance of Thermodynamics as a core topic in Chemistry and how it relates to the study of the transformations of energy, including examples of chemical reactions, equilibrium systems, the effect of external variables on chemical systems, phase transitions and chemical mixing processes. To gain an appreciation of how thermodynamics enables us to quantify and make predictions about such processes.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. State the simple differential form of the First Law of Thermodynamics and relate this to heat capacities;
2. Derive the concept of enthalpy based on this formalism, this directly relating chemical energy changes to the border concepts of Chemical Thermodynamics;
3. Define entropy with respect to heat capacities and from this, explain the variation of S with T and V , applying this to the understanding of changes in chemical systems;
4. Write the equation defining S in statistical terms, and relate this to the definition of the Third Law of Thermodynamics;
5. State simple differential forms of the Gibbs Free Energy and relate these to chemical changes;
6. Explain the importance of gradients of thermodynamic functions as driving forces for chemical processes;
7. Define the conditions for chemical equilibrium in terms of Gibbs Energies, and describe and calculate the effect of varying conditions on chemical equilibrium with respect to the variation of Gibbs Energy with p and T ;
8. Draw a simple phase diagram for a single component system and explain the existence of different phases. Interpret more general phase diagrams in these terms;
9. Calculate changes in values of thermodynamic functions at phase diagrams, and rationalise these changes;
10. Be aware of the definition of the chemical potential as a molar Gibbs energy;
11. Demonstrate an initial appreciation of the process of mixing in terms of thermodynamic driving forces, and through calculations, decide whether various chemical components will be miscible or not;
12. Carry out a range of calculations on examples illustrating these principles in chemical systems.

Course Outline:

- a. The First Law; Introduction to differentials; Enthalpy
- b. Heat and Enthalpy; Chemical reactions; Specific heats
- c. The Second Law; Entropy and its variation with thermodynamic variables
- d. Gibbs Free Energy; Changes in energies and Thermodynamic driving forces
- e. Chemical Equilibrium and the Gibbs Energy; Effect of external conditions on equilibrium
- f. Phase Transitions
- g. Chemical Potential; Thermodynamics of mixing

Title: Applied Organic Chemistry (Y7)

Lecturer: Prof S Clark

Aims: To provide a general introduction to the applications of organic chemistry including medicinal, biological and supramolecular chemistry and utilisation of natural products and their ecological significance.

Intended Learning Outcomes: By the end of this course, students will be able to:

1. State the properties of organic molecules such as size, charge distribution, polarity, shape and electronic structure and, from these, predict intermolecular interactions involved in medicinal and biological applications.
2. Identify and use the stereochemical descriptors (*R*, *S*, *E*, *Z*) and explain the biodiscrimination of enantiomers and diastereomeric interactions.
3. Relate the structures of membrane components to their properties and explain how membrane active agents function.
4. Define partition coefficient and list the factors that affect lipophilicity.
5. Predict the state of ionisation of various functional groups in a biologically active substance and explain how this affects its properties; estimate the pK_a values and use these estimates to calculate ionisation ratios.
6. Relate the structure of a sunscreen to its function.
7. Recognise the structural and biological diversity of natural products and identify how these substances are involved in inter- and intra-species interactions.
8. List and explain the intermolecular interactions involved in supramolecular chemistry and summarise how such molecules can be used in catalytic or biomimetic applications.
9. State the mechanisms of intercalation and reactions with DNA.
10. Recognise the modern theories of mechanisms involved in taste and smell with reference to sweeteners, flavours and perfumes.
11. Recognise the substances that are used to modify nerve transmission, that act as insecticides or as herbicides and explain how they function.

Course Outline: Intermolecular interactions, stereochemical descriptors, enantiomers and diastereoisomers, biodiscrimination, membrane structure, phospholipids, membrane disrupting agents, partition coefficients, lipophilicity, pK_a values and calculations of the state of ionisation at various pH values, UV absorption of sunscreens, natural product classification in structural and biological terms, pheromones, feeding deterrents, interactions involved in supramolecular chemistry with applications, phase transfer catalysis, biomimetic applications, intercalation of DNA, nitrogen mustards, neighbouring group interactions, olfactory mechanisms, sweetness, aspartame, sugars, acetylcholine, anaesthetics, opiates, insecticides, herbicides.