

Chemistry 209

Introductory Spectroscopy & Structure

Lectures: 11:30 – 12:20 M,W,F B1-271

Tutorials: 2:30-3:20 F AI-113

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Molecular spectroscopy is our most powerful tool for determining molecular structure. Chemistry 209 will introduce you to several aspects of this broad field of study. We will be exploring a number of the analytical spectroscopic techniques commonly employed in modern scientific laboratories, while at the same time investigating the underlying chemistry and physics that gives rise to the shapes and structures of molecules. The material presented in this course represents the basis of our understanding of matter. Given this and the fact that spectroscopy has become vital to most areas of chemistry, it is important for you to learn about its principles and applications early in your scientific career. To date, we are the only University in Canada to present a course of this type at this stage in a scientific program.

Chemistry 209 will be managed using the Desire2Learn (D2L) learning management system, which can be accessed via the UW-ACE facility at <http://uwangel.uwaterloo.ca>. This site will provide course information, problem set postings and solutions, schedules, supplementary lecture material, practise quizzes, and other information that you might find useful. Please subscribe to notifications from the D2L CHEM 209 page.

The text for this course is a comprehensive set of printed notes entitled “*A Spectroscopy Primer: An introduction to Atomic, Rotational, Vibrational, Raman, Electronic, Photoelectron and NMR Spectroscopy*”. The text is available for \$30 from Chemistry Stores (ESC 109), which is located on the ground floor of the ESC building across from the 1st year lab. We will follow these notes relatively closely, but they will be supplemented with additional content which you can find on D2L. You are advised to read ahead before each class and keep track of our progress with the workbooks provided on D2L. Note that although essentially all of the course material may be found in the primer and on D2L, most students will need to regularly attend lectures to master the subject!

A *glossary of terms and symbols* encountered in this course is posted on the course website. These are broken down into Units. Your ability to understand and identify these terms is one measure of your grasp of the course material. One exam question will ask you to define or identify several of the glossary entries. I recommended that you print a copy of the glossary and make a point of defining/explaining the glossary terms as we encounter them in the course.

A large number of equations and formulae are presented and used throughout the course. You will not be expected to memorize them! However, *you will be expected to recognize them and the variables appearing therein, and to know how to use them*. A copy of a *standard formulae/data sheet* will be provided for tests and exams. This formula will also be broken down into units and will be posted on the course website. I recommend that you print a copy of this page and make a point of identifying each

equation, and ensuring that you learn when and how to use each expression as we encounter them in the course.

The course website will host a **discussion board** which I recommend you make use of should you have any questions that are not addressed during the lectures or during my office hours. The discussion board will be monitored by the course instructor and teaching assistants, and material posted on it will be addressed in review classes. The lectures will also make use of **iClickers** as a means of monitoring student progress and tailoring course material to address conceptual difficulties. iClickers are available from the computer store in the Student Life Centre.

Absences from exams or missed problem sets may be accommodated *only if* a completed Verification of Illness form (available from the “About Us” link at <http://www.healthservices.uwaterloo.ca>) is turned in to the Science Undergraduate Office in ESC-252. Absence for other reasons will result in a grade of **zero** for that component of the coursework.

You are expected to be familiar with the UW expectations of Academic Integrity, and you are encouraged to complete the online quiz at <http://www.lib.uwaterloo.ca/ait/>.

Course Outline

- Unit 1 – Spectroscopic Theory (*ca.* 7-8 Lectures)
- Unit 2 – Pure Rotational Spectroscopy (*ca.* 5-6 Lectures)
- Unit 3 – Vibrational Spectroscopy (*ca.* 5-6 Lectures)
- Unit 4 – Raman Spectroscopy (*ca.* 2 Lectures)
- Unit 5 – Electronic Spectroscopy (*ca.* 3 Lectures)
- Unit 6 – Photoelectron Spectroscopy (*ca.* 3 Lectures)
- Unit 7 – Nuclear Magnetic Resonance Spectroscopy – (*ca.* 6 Lectures)

Grades

Assignments: 10 – 15 % (5 or 6, at roughly bi-weekly intervals)

Mid-term Exams: 10 – 15 % each (two scheduled during tutorial period at 2:30 – 3:20 Friday, October 21st and Friday, November 18th in AL-113/208/211)

Final Exam: 55 – 70 % (scheduled by the Registrar during the December exam period)

Supplementary Material

The Handbook of Chemistry and Physics is available both in paper format and electronically on reserve in the Davis Centre Library (**call number QD65.H3**).

The following books have been placed on library-use reserved and will provide helpful insight and alternate viewpoints on the course material:

The Quantum Physicists and an Introduction to Their Physics by William Cropper is a history of the origins of quantum physics. **QC 174.1.C7**

Fundamentals of Molecular Spectroscopy by C. N. Banwell is a very useful reference book that gives a more detailed look at some of the topics. **QD 96.M65B36**

Modern Spectroscopy by J. M. Hollas is also a very useful reference book that gives a more detailed look as some of the topics, and includes a good discussion of lasers. **QC 451.H65**

Molecular Spectroscopy by J. M. Brown provides an in depth look at diatomic molecule spectroscopy. **QD 96.M65 B76**

Introductory Raman Spectroscopy by J. R. Ferraro, K. Nakamoto and C. W. Brown does what is says on the cover. **QC 454.R36 F47**

NMR and Chemistry by J. W. Akitt gives a good higher-level introduction to NMR Spectroscopy. **QD 96.N8 A37**

A Complete Introduction to Modern NMR Spectroscopy by R. S. Macomber does what it says on the cover. **QD 96.N8 M3**

And for real Punters / Heros:

Spectra of Atoms and Molecules by P. F. Bernath **QC454.A8 B47**

Microwave Spectroscopy by C. H. Townes and A. L. Schalow **QC454.M5t68x**

Molecular Spectra and Molecular Structure by G. Herzberg **QC451.H46**