Course Instructor: Michael Mombourquette, mjim5@queensu.ca, CHERNF209, Phone 613-533-2612
Office Hours: Monday and Thursday mornings 9:00 – 11:00 am. Other hours I may be available too.

**TA Information:**

**Tutorial Teaching Assistants**

The Tutorial TA’s are mainly upper year undergraduate students. They are responsible for leading the Tutorials, administering and marking the two quizzes. The list of TAs will be published on OnQ.

The goal of the course is two-fold:

- *To strengthen the student’s understanding of basic chemistry, important for any well-rounded applied science student, and directly applicable in every field of engineering.*
- *To apply chemical principles to a number of selected material science concepts and basic chemical engineering issues.*

**Intended Student Learning Outcomes**

By the end of this course students should be able to:

- Know and understand basic microscopic models of Matter so they can build up macroscopic models of materials
- use concepts of gas theory to calculate system conditions and measure changes.
- Understand the development of mathematical models of microscopic level properties
- Understand and use Thermodynamics to determine energy changes in isobaric, adiabatic and isothermal system processes, both chemical and physical
- Recognise and describe phase diagrams for single and multi-component (solutions) systems, including distillations, fractional melting and alloys

**Lecture Set 1**

**Introduction**

3 lectures

Topics

- Generalized introduction to basic concepts needed throughout first-year chemistry
- Definitions
  - Matter and classification of matter
  - Physical and chemical properties,
  - Intensive and extensive properties
- Homogeneous and heterogeneous properties
- Physical and chemical changes
- Nomenclature
  - Inorganic compounds
  - Oxidation numbers, charges
  - Binary compounds
  - Chemical formulae
  - Systematic naming conventions
- Basic Mathematic and Measurement calculations and data handling
  - Dimensional analysis, units prefixes
  - Precision accuracy and uncertainty
  - The Mole, molar mass, molar volume
- Balancing and using Chemical Equations
  - Balancing reactions
  - Limiting reagent calculations
  - Percent yield

**Lecture Set 2**

**Gases and their behaviours**

3 lectures

Topics
- Overview of the Gaseous state
  - Properties of gases
  - Pressure, volume, temperature, amount
  - Gas Laws, Boyle's Law, Charles' Law, Avagadro's Law,
    - The Ideal Gas Law
  - Mixtures of gases, Dalton's Law of partial pressures
  - Real Gases: Van der Waals equation, compressibility factor
  - Kinetic Molecular theory of gases.

**Lecture Set 3**

**Thermodynamics**

6 lectures

Topics
- Introduction to Thermodynamics, definitions
- Standard state
- Laws of thermodynamics
  - Zeroth, first and second laws.
- Internal energy
- Heat and work
- Exothermic and endothermic processes
- Measurement of energy processes
  - Constant pressure and constant volume systems
  - Reversible systems
  - Calorimetry
  - Isothermal and adiabatic processes
- Enthalpy
• More Kinetic molecular Theory
• Thermodynamics in Chemical reactions
  o Formation reactions,
  o Standard enthalpy of formation
  o Standard enthalpy change
  o \(\Delta H\) versus \(\Delta U\)
• Practical applications of thermodynamics

Lecture Set 4
Atomic Structure and Quantum Mechanics

5 lectures
Topics
• Quantum Mechanics definitions
  o Light, particles, waves
• Electromagnetic spectrum
• Quantization
• Duality of nature
  o Wave-like and Particle-like behaviour
  o De Broglie equation
• Atomic spectroscopy
  o The hydrogen atom
  o The Rydberg equation
  o Bohr’s model of the atom
  o Heisenberg uncertainty principle
• Wave Harmonics
  o One-dimensional oscillator (particle in a box)
  o Two-dimensional oscillators (drum skin)
  o Three-dimensional oscillators (spherical harmonics and atomic orbitals)
  o Nodes and nodal surfaces
  o Quantum numbers and selection rules
• The hydrogen-like wave functions
• Multi-electron atoms
  o Penetration and shielding
  o Aufbau Process
  o Pauli exclusion principle
  o Hund’s Rule
• Periodic Table
  o Overview of the table
  o Trends: atomic radii, ionization energy, electron affinity
  o Families in the table

Lecture Set 5
Molecular structure

8 lectures
Topic
• Lewis Dot structures
- Valences and hypervalences
- Ionic and covalent bonding
- Octet rule
- Multiple Bonds
- Formal Charges
- Resonance
- Lewis acids and Bases
- Radicals
- VSEPR theory
  - Basic geometries
  - AXE classification
  - Structures and shapes
- Valence-bond Theory
  - Hybridization
    - sp, sp\(^2\), sp\(^3\), sp\(^3\)d, sp\(^3\)d\(^2\).
  - Multiple bonds and hybridization
    - \(\sigma\) and \(\pi\) bonds.
- Molecular orbital Theory
  - Linear Combination of Atomic Orbitals (LCAO)
  - Molecular orbitals
    - \(\sigma\) and \(\pi\) bonds \(\sigma^*\) and \(\pi^*\) anti-bonds.
    - Diatomic molecules
  - Band Theory
    - Conductors, semiconductors and insulators
    - Doping of semiconductors
    - Diodes and LEDs
  - Bond Energies
  - Electronegativity and dipole moments
- Structure of Solids
  - Classification of solids
  - Point groups, Lattices and Unit cells
  - Metals and ionic solids
  - Calculation techniques

**Lecture Set 6**

**States of Matter and Phase Transitions**

1 lecture

**Topic**

- Phase change overview
- Vapour pressure
  - Clausius Clapeyron equation
- Intermolecular forces (van der Waals forces)
  - London forces
  - Dipole-dipole forces
  - Hydrogen bonding
  - Viscosity
  - Surface tension
- Liquid-vapour phase transitions (Boiling/condensing)
  - One-component Phase diagrams
Lecture Set 7

Solutions
3 lectures

Topic

- Enthalpy of solution
- Liquid solutions
  - Composition/calculation
- Liquid-vapour equilibrium
  - Dalton’s Law
  - Raoult’s Law
  - Binary phase-diagrams
    - Tie-lines
    - Distillation
    - The Lever Rule
    - Azeotropes
- Solid-liquid phase transitions
  - Binary phase diagrams
    - Eutectic points
    - Crystallization from a melt
- Solubility
- Henry’s Law
- Colligative Properties
  - Vapour pressure lowering
  - Boiling point elevation
  - Freezing point depression.
  - Osmotic pressure.

Textbooks/Readings
Petrucci Herring Madura Bissonette, General Chemistry Principles and Modern Applications 11e, Pearson Toronto, Canada, 2016

Grading Scheme

- Quizzes (Weeks 4 and 11) 15%
- Midterm exam (Week 6) 35%
- Final examination 45%
- Mastering Chemistry on-line Work* 5%

* Note that the Mastering Chemistry on-line assignments will be due each week on Monday morning at 8:30 am. The first assignment will be due on Sept. 18 and there will be one assignment due every Monday following (including Thanksgiving Monday so do it early). To access the on-line component, you will need an access code. There are two options to getting an access code:

1. Bound text book purchased new from the book store: Inside the package for the new text book you will find the printed answer key to all the end of chapter questions in the text. You will also find an access code, included free, that will give you access to the e-book (for on-line reference) and the Mastering site.
2. Loose-leaf text purchased from the book store. Other items in this package are identical to Package 1.
3. If you purchase a used book, you will still need to purchase the access key to the Mastering Chemistry Site. You can purchase this key on line or at the bookstore. Be careful to work that into your costs. It may be cheaper to go with option 1 or 2.

**Grading Method**

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen’s Official Grade Conversion Scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Numerical Course Average (Range)</th>
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<tbody>
<tr>
<td>A+</td>
<td>90-100</td>
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<tr>
<td>A</td>
<td>85-89</td>
</tr>
<tr>
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<td>D-</td>
<td>50-52</td>
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<td>F</td>
<td>49 and below</td>
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</tbody>
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**Evaluation Late Policy**

- Weekly homework assignments that are past due will receive a grade of zero.
- Quizzes are done in tutorial. You are either present or not for those.
- Midterm exams are to be on Tuesday,
- Final Exams are administered by the exams office. Please make sure you have contacted them for any accommodations you may need. Delaying contacting them may result in your not receiving any consideration.

**1. Location and Timing of Final Examinations**

The exam dates for each Term are listed on the Faculty of Arts and Science webpage under “Important Dates.” Student exam schedules for the Fall Term are posted via SOLUS immediately prior to the Thanksgiving holiday; for the Winter Term they are posted on the Friday before Reading Week, and for the Summer Term they are individually noted on the Arts and Science Online syllabi. **Students should delay finalizing any travel plans until after the examination schedule has been posted.** Exams will **not** be moved or deferred to accommodate employment, travel/holiday plans or flight reservations. Also, as indicated in Academic Regulation 8.3, students must write all final examination in all on-campus courses on the Kingston campus.
2. **Statement on Academic Integrity**

Academic Integrity is constituted by the six core fundamental values of honesty, trust, fairness, respect, responsibility and courage (see [www.academicintegrity.org](http://www.academicintegrity.org)). These values are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities [http://www.queensu.ca/secretariat/policies/senate/report-principles-and-priorities](http://www.queensu.ca/secretariat/policies/senate/report-principles-and-priorities)).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see [Academic Regulation 1](http://www.queensu.ca/artsci/academic-calendars/regulations/academic-regulations/regulation-1)), on the Arts and Science website (see [http://www.queensu.ca/artsci/academics/undergraduate/academic-integrity](http://www.queensu.ca/artsci/academics/undergraduate/academic-integrity)), and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

3. **Calculator Policy**

As noted in Academic Regulation 9.2, “Calculators acceptable for use during quizzes, tests and examinations are intended to support the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the **Casio 991 series calculator** is permitted and is the only approved calculator for Arts and Science students.”

4. **Copyright of Course Materials**

“This material is designed for use as part of APSC131 at Queen's University and is the property of the instructor unless otherwise stated. Third party copyrighted materials (such as book chapters and articles) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this material for distribution (e.g. uploading material to a commercial third-party website) can lead to a violation of Copyright law. Find out more about copyright here: [http://library.queensu.ca/copyright](http://library.queensu.ca/copyright).”

5. **Privacy Statement for Instructors Who Use External Software in Their Course**

This course makes use of Crowdmark for marking exams. Be aware that by logging into the site, you will be leaving onQ, and accessing Crowdmark’s website. Your independent use of that site, beyond what is required for the course (for example, purchasing the company’s products), is subject to Crowdmark’s terms of use and privacy policy. You are encouraged to review these documents, using the link(s) below, before using the site.
6. **Accommodations for Disabilities**

Queen’s University is committed to achieving full accessibility for people with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. The Senate Policy for Accommodations for Students with Disabilities was approved at Senate in November 2016 (see [https://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/senateandtrustees/ACADAC-COMMPOLICY2016.pdf](https://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/senateandtrustees/ACADAC-COMMPOLICY2016.pdf)). If you are a student with a disability and think you may need academic accommodations, you are strongly encouraged to contact the Queen's Student Accessibility Services (QSAS) and register as early as possible. For more information, including important deadlines, please visit the QSAS website at: [http://www.queensu.ca/studentwellness/accessibility-services/](http://www.queensu.ca/studentwellness/accessibility-services/)

7. **Academic Consideration for Students with Extenuating Circumstances**

Queen’s University is committed to providing academic consideration to students experiencing extenuating circumstances that are beyond their control and are interfering with their ability to complete academic requirements related to a course for a short period of time, not to exceed three months. Students receiving academic consideration must meet all essential requirements of a course. The Senate Policy on Academic Consideration for Students in Extenuating Circumstances was approved at Senate in April, 2017 (see [http://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/senateandtrustees/Academic%20Considerations%20for%20Extenuating%20Circumstances%20Policy%20Final.pdf](http://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/senateandtrustees/Academic%20Considerations%20for%20Extenuating%20Circumstances%20Policy%20Final.pdf)) Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. Arts and Science undergraduate students can find the Faculty of Arts and Science protocol and the portal where a request can be submitted at: [http://www.queensu.ca/artsci/accommodations](http://www.queensu.ca/artsci/accommodations). Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

If you need to request academic consideration for this course, you will be required to provide the name and email address of the instructor/coordinator. Please use the following:
Instructor/Coordinator Name: **Michael Mombourquette**  
Instructor/Coordinator email address: **mjm5@queensu.ca**