Chemistry 073-201 Section PQR Course Information Fall 2012

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Course Title General Chemistry I. **Credit Hours:** 5 **Contact Hours:** 8

Description The material covered in this 16 weeks course consists of three sections. Basics of chemistry: Elements; compounds; the periodic table; atoms; molecules; the subatomic particles; chemical formulas and nomenclature; reactions and chemical equations; oxidation numbers; acid-base theory; the gas laws and the KMT; specific heat and heats of reaction. Atomic and molecular structure: The Bohr model of hydrogen atom; orbitals; quantum numbers; the Aufbau principle and the periodic table; valence electrons; ionic and covalent bonds; electronegativity; Lewis structures; molecular shapes; valence bond theory and molecular orbitals. Condensed phases and solutions: Phase diagrams; intermolecular forces; hydrogen bonds; properties liquids; solutions; enthalpy and entropy of solvation; vapor pressure; colligative properties; and crystal structure. *A more detailed topics list is provided in the* **Syllabus of Topics**.

Audience The course is intended for students pursuing degrees in chemistry, pharmacology; biology; engineering; nursing; and premed.

Prerequisites Eligibility for MATH 140 and a grade of C or better in Chemistry 121 (or pass the chemistry placement test).

Objectives Upon successful completion of the course the student will be adequately prepared to take the subsequent general chemistry course: Chemistry 203. The student will also be able to apply the general principles of chemistry to other related fields of science like biology; engineering; and medicine.

Student Learning Outcomes Upon successful completion of the course the student should be able to:

1. Describe, explain, and model, chemical and physical processes at the molecular level and their relationship to macroscopic phenomena.
2. Classify material substances by their state and chemical nature, using bonding behavior and the periodic table as reference.
3. Solve quantitative chemistry problems and demonstrate clear reasoning when cumulative skills are required.
4. Apply important theories like the kinetic molecular theory of gases and the quantum mechanical atom model to explain chemical phenomena and to solve general problems in chemistry.
5. Perform chemistry experiments using standard laboratory glassware and equipment; and implement appropriate safety procedures.
6. Record, graph, and chart experimental data; and use the information to interpret and/or analyze the results for unknown substances.

Textbook General Chemistry, 10th edition, by R. H. Petrucci, F. G. Herring, J. D. Madura, and C. Bissonnette (Pearson Canada, 2011).

Lab Manual Provided though the course Blackboard site.

Lecture Mon 6:00 PM – 9:30 PM; Room 3831.

Laboratory Wed 6:00 PM – 9:30 PM; Room 3831.

Office Hours Mon & Wed 5:00 PM – 5:45 PM.

Calculator A scientific calculator with exponential notation and logarithms is **required** for homework, lab reports, quizzes, and examinations.

Quizzes Eight (8) quizzes are planned to take place during the course. Only the **best 75%** (6) quizzes will figure in reckoning the final grade. A quiz generally covers material presented in prior lectures not covered by an earlier quiz or exam. Quizzes will begin 5 minutes after the scheduled starting time of a lecture class and lasts approximately 20 to 25 minutes. **NO make-up quizzes** are allowed regardless of the circumstances. A missed quiz counts toward the 25% of dropped lowest-score quizzes.

Exams Comprehensive final examination, a department final assessment test, and three one-and-a-half hour exams are scheduled. These five exams count toward the final grade.

Make-ups A missed examination must be made up before the second class after the original exam date. A make-up exam will be given **ONLY** to students who have an acceptable **excuse**, such as a physician letter. **No make-up is allowed for the final examination or the department assessment test**. Both of which must be taken so as to be eligible for grade higher than F.

Homework A list of exercise assignments is provided. The assignments are organized synchronously with the course progress, and are arranged according to the topics covered in the quizzes and the exams. Each assignment comprises between 15 to 30 exercises from the textbook as well as handout exercises that should be downloaded from **Assignments** section in the Blackboard site of the course. **The assignments are not to be turned in**. Rather, the exercise assignments are intended to guide the student in studying and reviewing the course material.

Grading Final grades will be based on the weighted formula described below.

25% - The comprehensive final examination grade.
5% - The department assessment grade.
30% - The average grade of the three long exams.
20% - The average grade of the best 75% quizzes.
20% - The laboratory grade based on attendance and reports.

Evaluation To evaluate individual exams, quizzes and lab reports, a percentage (or hundred point) system is used. The final weighted grades are then converted as follows:

"A" grade is from 90% to 100%
"B" grade is from 79% to 89%
"C" grade is from 68% to 78%
"D" grade is from 57% to 67%
"F" grade is 56% and below

Attendance **Classes begin ON TIME and students are expected to be ON TIME** and attend each session wholly. Be aware that that poor attendance normally reflects poor grades. A student that is excessively absent, and is not actively pursuing the course will be dropped at mid-term.

Participation Students are required to actively pursue the course. The threshold for pursuit is 75% of the course work. This includes, quizzes; assignments; all the exams; attendance; and participating in at least 7 labs. Students who **by midterm are not actively pursuing the course**, **will receive an ADW midterm grade**, and be dropped from the course. Students who are determined to be not actively pursuing only at the course end, shall receive an F final grade. **Lab participation** means timely submission of the lab report in addition to performing the experiment and collecting data. Be aware that a student missing four (4) or more course sessions without a valid excuse, by 03/14/2012, will automatically receive ADW midterm grade, and be dropped from the course.

CCC Rules 1. Food consumption and/or smoking in the classroom are prohibited.
2. **Turn off** all cell phones and beepers while in class.
3. Electronic dictionaries, palm pilots, laptops, and cell phones are **not allowed** during exams and quizzes.
4. Be familiar with the CCC Student Policy Manual, viewable at the web site www.ccc.edu/departments/Documents/studentpolicymanual.pdf.
Cheating of any kind will not be tolerated, and will **AT LEAST** result a **ZERO** grade for the test, quiz, or the lab report involved.

Computer Based Learning Tools The Chemistry 201 PQR course has a **Blackboard** (Bb) site accessible via the Truman website. Three links to internet study sites are available in the External Links section of course Bb site, which also includes the following downloadable materials:

1) Syllabus. 2) Handout exercises (and their solutions) in sync with the course progress. 3) A set of 8 laboratory experiments. 4) Some lecture notes. 5) Solutions of quizzes and exams. 6) 27 PDF files of the power point lecture presentations available in sync with the course progress.

Remarks

1. The syllabus and the schedule shown above are not etched in stone. Small changes are possible depending on the course progress. For example, a scheduled quiz may cancel due to time constraints.

2. Quizzes usually cover topics in exercise assignments, and start **exactly** 5 minutes after the scheduled class beginning (6:00 PM). A quiz will generally last 20 to 30 minutes, so it is important to arrive **on time**.

3. The final examination is planned over an entire session. The three one-half-hour exams would take place at the session beginning, after which the scheduled lecture will resume.

4. Examinations and quizzes are evaluated based on a grade range from 0 (zero) to 100 (hundred) points.

5. To improve learning, it is highly recommended that students review the scheduled textbook chapter ahead of each class.

6. In order to prepare for upcoming quiz or exam, it is advisable to review the material after each lecture; and solve the exercises from the relevant textbook chapter and also the handout exercises provided on the course Blackboard site. An assignment list of exercises specific to each quiz or exam is provided along with the lectures schedule.

Services

1. A Tutoring Center is available for students who need help with their assignments. It is located at L129; phone (773)907-4785; web site www.trumancollege.edu/studentservices/tutoring.
2. TRIO Student Support Services is available for low-income, first generation students, or students with disabilities, who need academic support. Located at room 162, Larry McKeon Administrative Building; phone (773)907-4797; web site www.trumancollege.edu/trio.
3. Disability Access Center verifies needs pursuant to the American Disabilities Act, determines student academic accommodations, and issues accommodation letters. Room 1428; phone (773)907-4725; web site www.trumancollege.edu/studentservices/dac.
4. SSLI Student Success and Leadership Institute is for students who need various support services to achieve their educational goals. Room 162, Larry McKeon Administrative Building; phone (773)907-4737; web site www.trumancollege.edu/ssli.

Laboratory Outline for Chemistry 201

Objectives:

1. Introduce the student to basic laboratory techniques and experimentation.
2. Develop the student's ability to make measurements and draw conclusions.
3. Provide the student experience in the collection and processing of data.
4. Reinforce in a practical manner the important concepts acquired in the lecture.

Laboratory and Safety Rules:

1. Wear **protective goggles** at all times in the laboratory work area.
2. Children are not allowed in the laboratory.
3. No eating and drinking in the laboratory.
4. Wash your hands any time you get chemicals on them and before leaving the lab.
5. Avoid wearing loose clothing like scarves or sleeves. Long hair must be gathered and pinned or covered with a hat.
6. Never look down into the open end of test tube (or beaker) that is being heated or in which a reaction is taking place.
7. Immediately dispose of broken glass in the broken glass boxes.
8. Know the lab locations of fire extinguishers, fire blankets, and the eyewash.
9. Do not heat graduated cylinders, burettes, pipettes, or bottles with burner flames.
10. Do not perform unauthorized experiments.
11. Do not take reagent bottles to your lab work area. Use test tubes, beakers, or paper to obtain chemicals from the dispensing area. Use small reagent quantities.
12. Carefully check the labels on bottles to make sure you have the correct reagents.
13. Keep your work area neat. If you spill or break something, clean it up promptly.
14. Empty nontoxic liquids into the sink and wash them down with water. Pour toxic liquids into the waste bottles provided.
15. Dispose of solid chemicals as directed by your instructor.
16. Discard insoluble waste such as filters or litmus paper in a waste basket, not the sink.
17. To avoid contamination, never return unused chemicals to the reagent bottles.
18. To avoid contamination, do not insert medicine droppers into reagent bottles.
19. Keep the balances and the area around them clean. Never place chemicals directly on the balance pans. Place a piece of weighing paper or small container first, then weigh your sample. Do not weigh anything that is hot.
20. After completing your experiments, clean and put away your glassware and equipment. Before leaving, make sure your work area is clean and the gas and water are turned off.

Student Duties, Advanced-Study Assignments, and Lab Reports:

1. Study the experiment of the day carefully before coming to class, so that you don't have to spend a lot of time finding out what the experiment is all about.
2. The student must complete the **advance-study assignment** prior to each lab. He or she must hand the pre-lab report to the instructor to be allowed to proceed with the experiment of the day.
3. All experimental data are to be recorded in **ink** on a separate data sheet which should also include the following: (i) your name; (ii) name of the experiment; and (iii) date performed. Also, provide any unknown number if the experiment included an unknown sample. The data sheet (in ink) must be initialized by the instructor prior to leaving the lab. The original data sheet is to be attached to the final lab report submitted later.
4. Lab reports must follow the attached guidelines below and must be **clear** and **neat**. Report pages must be **numbered**, **named** and include the student ID. Pages should be **stapled** together. Points will be **deducted** for a messy disorganized report. If for some reason the experiment has failed, an explanation should be given why.
5. A lab report is due one week after each experiment is performed. The student may submit his or her report at the end of the lab session.
6. No report will be accepted more than one week after the deadline. This generally means **grade reduction**.
7. There are positively **NO make-up experiments.** An experiment missed is lost. A report will not be accepted when the lab session has been missed.
8. Students must work alone unless otherwise instructed.
9. Three (3) points will be deducted from your lab grade if you let someone **copy** any part of your report or study assignment. Any lab report or study assignment that has been **copied** from someone else's shall be awarded zero points.

Laboratory Grades:

The final laboratory grade is worth 20% of the total course grade. Each lab Experiment is worth twenty five (25) points and the final lab grade is the average of the top seven (7) experiment grades. An experiment missed without a valid excuse counts as zero points. An experiment grade is calculated as follows: (i) Advanced study assignment – 5 points. (ii) Attending the lab while performing the experiment and collecting the data with the instructor-initialized data sheet submitted – 7.5 points. (iii) The lab report – 12.5 points.

Chemistry 201 PQR Lectures Schedule

Date	Lecture	Topics Covered	Textbook Chapters[1]
08/20	1	Mathematical Review	App. A
		Introduction to Chemistry	1
		Physical Measurements I	
08/22	2	Physical Measurements II	
		Assessment Test	
		The Components of Matter I	2 and App. B
08/27	3	The Components of Matter II	
		Elements and Compounds	2 and 3
09/05	4*	Nomenclature of Inorganic Compounds	3
		Quantitative Composition of Compounds I	2.7 and 3
09/10	5	Quantitative Composition of Compounds II	
		Chemical Equations I	4
09/17	6*	Chemical Equations II	
		Fundamentals of Solution Stoichiometry	
09/24	7	Examination # 1 on lectures 1−6	
		Aqueous Solutions and Electrolytes	5
		Precipitation and Acid-Base Reactions I	
09/26	8	Precipitation and Acid-Base Reactions II	
		Oxidation-Reduction Reactions I	
10/01	9*	Oxidation-Reduction Reactions II	
		The Gaseous State of Matter I	6
10/03	10	The Gaseous State of Matter II	
		Real Gases	
10/08	11*	Kinetic Molecular Theory	
10/15	12	Thermochemistry I	7
10/22	13	Thermochemistry II	
		Examination # 2 on lectures 7−12	
10/24	14	The Bohr Model of Hydrogen Atom I	8
		The Bohr Model of Hydrogen Atom II	
10/29	15	Quantum Mechanics of Hydrogen-Like Atoms	
		Theory of Many-Electron Atoms	
		Periodic Properties of the Elements	9 and 10

*A **quiz** is scheduled at the start of each asterisked lecture.

[1]**Textbook**: General Chemistry, 10th Edition, by R. H. Petrucci, F. G. Herring, J. D. Madura, and C. Bissonnette (Pearson Canada, 2011).

Date	Lecture	Topics Covered	Textbook Chapters[1]
11/05	16*	Ionic and Covalent Bonds	10 and 11
		Lewis Structures and Formal Charges I	10
11/07	17	Lewis Structures and Formal Charges II	
		Molecular Geometry and the VSEPR Model I	
11/12	18	Molecular Geometry and the VSEPR Model II	
		Theories of Covalent Bonding I	11
11/14	19*	Theories of Covalent Bonding II	
		Phase Diagrams I	12
11/19	20	Examination # 3 on lectures 12−19	
		Phase Diagrams II	12
		Liquids and Intermolecular Forces	
	20	Liquids and Intermolecular Forces II	
11/21	21*	Solids and Crystal Structure	11.7 and 12
11/26	22	Physical Properties of Solutions I	13
11/28	23*	Physical Properties of Solutions II	
12/03	24	Review and Wrap up	
		ACS Review Test	
12/05	25	Final Examination covering the entire course material	

*A **quiz** is scheduled at the start of each asterisked lecture.

[1]**Textbook**: General Chemistry, 10th Edition, by R. H. Petrucci, F. G. Herring, J. D. Madura, and C. Bissonnette (Pearson Canada, 2011).

Chemistry 201 PQR Laboratory Schedule

Date	Experiment	Experiment
08/29/2012	1	Lab Safety Lecture & Check in
		Densities of Solids and Liquids
09/12/2012	2	Determination of a Chemical Formula
09/19/2012	3	Standardization of a Basic Solution and the Molar Mass of an Acid
10/10/2012	4	Molar Mass of a Volatile Liquid
10/17/2012	5	Heat Effects and Calorimetry
10/31/2012	6	Atomic Spectrum of Hydrogen
11/07/2012	7	Geometrical Structure of Molecules
11/28/2012	8	Molar mass Determination by Depression of the Freezing Point
		Lab Clean up & Check out

Chemistry 201 Topics Syllabus

The course covers chapters 1 to 13 in the textbook: *General Chemistry*, 10th edition, by R. H. Petrucci, F. G. Herring, J. D. Madura, and C. Bissonnette (Pearson Canada, 2011). There are three sections of lectures: (i) Basics of Chemistry; (ii) Atomic and Molecular Structure; and (iii) States of Matter and Solutions. The course topics are listed below.

Basics of Chemistry	
1	**Introduction to Chemistry**
Chapter 1 & Appendix B	The science of chemistry and its various fields.
	Physical and chemical properties of matter
	Pure substances an mixtures
	Heterogeneous and homogeneous mixtures: System and phase
	The three states of matter: Phase transitions
	Chemical and physical processes: Energy and heat
	The scientific method: Facts, theories and laws
2	**Mathematical Review**
Appendix A	Powers and exponents
	Logarithms
	Exponential notation
3	**Physical Measurements**
Chapter 1	Property measurement: The standard physical units
	Fundamental and derived physical properties
	The metric (SI) system of units
	Conversion factors
	Principles of physical measurements: Significant figures
	Calculations involving significant figures
	Measurements: Mass, length, volume, temperature, and density
4	**The Components of Matter**
Chapter 2 & Appendix B	Elements and compounds: The names and symbols of elements
	The laws of mass conservation and definite proportions
	Mass % composition of compounds
	Dalton's atomic theory: Molecules and the law of multiple proportions
	Electric and magnetic forces
	The atom: Electrons, nucleus, ions
	Radioactivity
	The nucleus: Protons, neutrons, atomic number, mass number
	Nuclides and isotopes
	Mass spectrometry

5	**Elements and Compounds**
Chapters 2 & 3	The periodic table of the elements
	Relative atomic masses: Atomic weight
	Molecular and ionic compounds: Introduction to bonding
	The Chemical formula: Structural formula and isomers
	Formula weight and molecular weight
	Mass % formula from chemical formula
6	**Nomenclature of Inorganic Compounds**
Chapter 3	Names of monoatomic ions and binary compounds
	Names of polyatomic ions and pseudobinary compounds
	Nomenclature of acids and bases
	Organic compounds nomenclature primer
7	**Quantitative Composition of Compounds**
Section 2.7 and Chapter 3	The mole concept: Avogadro's number and the molar mass
	Calculating the mass of atoms or molecules
	Converting between moles, mass, and atoms or molecules
	Elemental analysis: Mass percent formulas of compounds
	Empirical and molecular formulas
	Calculating the empirical formula from the mass % composition
	Converting empirical to molecular formula using the molar mass
8	**Chemical Equations**
Chapter 4	Writing and balancing chemical equations
	Mole and mass relations in balanced chemical equations
	Sequence chemical reactions
	Stoichiometry: Quantitative relations in chemical reactions
	Equivalent moles and the reaction equivalent
	Nonstoichiometric reaction mixtures
	Limiting and excess reactants
	Limiting reactant stoichiometry
	Theoretical reaction yields and actual percentage yield
	Stoichiometry calculations in reaction sequences
9	**Fundamentals of solution Stoichiometry**
Chapter 4	Types of solutions
	Solute concentration units: Molarity, molality, mass percent etc.
	Preparation of molar solutions
	Dilution calculations
	Stoichiometry in solutions
	Volumetric analysis: Titrations

10	Aqueous Solutions and Electrolytes
Chapter 5	The role of the solvent in chemical reactions
	Electrolytes and nonelectrolytes
	Arrhenius theory of electrolytes
	Strong and weak electrolytes
	Aqueous solutions of ionic compounds
	Aqueous solutions of molecular compounds
	Molecular and ionic reactions
	Net ionic equations and their stoichiometry
	Arrhenius theory of acid and bases
	Strong and weak Arrhenius acids and bases
	Acid-base titrations
	Multiprotic acids and amphoteric substances
11	**Precipitation and Acid-Base Reactions**
Chapter 5	Chemical reaction types: Redox, acid-base, and atoms rearrangement
	Types of chemical equations
	Precipitation reactions: Solubility rules
	Other rearrangement reactions: Isomerization and decomposition
	Gravimetric analysis
	Proton transfer reactions
	Brønsted-Lowery theory of acid-base reactions
	Amphoteric (amphiprotic) Brønsted-Lowery species
12	**Oxidation-Reduction Reactions**
Chapter 5	Redox (oxidation-reduction) terminology
	Oxidation numbers and redox reactions
	Oxidation number rules
	Redox half reactions and electrolytic cells
	Balancing redox reactions by the half-reaction method
	Classification of redox reactions
	The electrochemical activity series
	Disproportionation and redox reactions
	Redox titrations
13	**The Gaseous State of Matter**
Chapter 6	Overview of the gaseous state of matter
	Gas pressure and its measurement
	Isotherms, isobars, and isochors
	The empirical gas laws: relations between P, V, T, and n.
	Standard temperature and pressure and the molar volume
	The ideal gas equation: Gas density and molecular weights
	Dalton's law of partial pressures
	Vapor pressure: Collecting gases over water
	Stoichiometry of chemical reactions with gases involved

14	Real Gases and the Kinetic Molecular Theory
Chapter 6	Molar volumes of real gases
	The compressibility factor
	The van der Waal's equation
	The Maxwell-Boltzmann kinetic molecular theory
	The average kinetic energy of gas molecules
	The most-probable and root-mean-square speeds
	Effusion and diffusion
	Graham's law of effusion: Mass effect on relative effusion rates
	The temperature effect on the relative rates of diffusion and effusion
15	**Thermochemistry**
Chapter 7	Work and energy: The SI unit of energy
	Energy forms: Kinetic, potential, chemical, and heat
	Energy transfer: heat flow and work
	System and surroundings
	The law of energy conservation: The first law of thermodynamics
	Heat flow and thermal equilibrium: The calorie unit of heat
	Thermally isolated systems: Adiabatic processes
	Heat capacity and specific heat
	Calorimetry: The measurement of heat flow
	Constant-pressure calorimetry and constant-volume calorimetry
	Pressure-volume work
	The thermodynamic state of a closed system: State functions
	Enthalpy and types of enthalpy change
	Heat of reaction: Exothermic and endothermic reactions
	Thermochemical equations and their stoichiometry
	Hess's Law: Manipulating thermochemical equations
	Standard enthalpies of formation
	Calculating heats of reaction from enthalpies of formation
Atomic and Molecular Structure	
16	**The Bohr Model of Hydrogen Atom**
Chapter 8	Waves and electromagnetic radiation
	Optical phenomena: Interference, diffraction, absorption etc.
	The emission line spectrum of hydrogen atom
	Blackbody radiation and Planck's quantization of energy
	The photoelectric effect and Einstein's introduction of photons
	The Bohr model of the hydrogen atom
	Properties of Bohr orbits of hydrogen-like atoms
	The ionization limit and photoionized electrons

17	Quantum Mechanics of Hydrogen-Like Atoms
Chapter 8	The de Broglie relation and wave-particle duality
	Heisenberg's uncertainty principle
	The Schrödinger equation of H-like atoms
	Wave functions of H-like atoms: Atomic orbitals
	Born's statistical interpretation of the wave function
	The quantum numbers n, ℓ, and m
	Magnetic and chemical orbitals
	The shapes of the atomic orbitals s, p, d, and f
	Orbital shells and subshells
	Spatial extents of the various orbital shells
	The energy spectrum of the orbitals in H-like atoms
	The anomalous Zeeman effect and the electron spin
18	**Theory of Many-Electron Atoms**
Chapter 8	The Schrödinger equation of a many-electron atom
	The He Atom Schrödinger equation
	The spectral signature of interelectron Coulomb repulsion
	The orbital configuration of a many-electron atomic state
	Pauli's exclusion principle
	The aufbau (building up) principle of the ground states of atoms
	Mean-field orbitals: The mean-field equation for ground-state He atom
	Nuclear charge screening and the effective nuclear charge Z_{eff}
	The energies of mean-field atomic orbitals: The n, ℓ, and $n+\ell$ rules
	Closed and open shells and subshells
	The mean-field orbitals of monoatomic anions and cations
	Core and valence orbitals and electrons
	Electronic configuration and orbital diagrams: Hund's rule
	Valence configurations and the periodic table: Chemical groups
	The electronic configurations of the ground-state neutral atoms
	Valence configurations of ground-state monoatomic anions and cations
	Magnetic properties of ground-state atoms and monoatomic ions
19	**Periodic Properties of the Elements**
Chapters 9 & 10	Atomic volume: Molar mass estimates
	Metallic and covalent radii of atoms
	Ionization energies of neutral atoms
	Ionization energies of cations and anions
	Electron affinities of the elements
	The Mulliken electronegativity definition: Metals and nonmetals
	Photoelectron spectroscopy
	Radii of monoatomic cations and anions
	Chemical periodicity in the main-group elements
	The octet rule
	Lewis formulas of the main-group atoms and ions

20	Ionic and Covalent Bonds
Chapters 10 & 11	Octet-rule ionic bonding between main group elements
	Open-shell and pseudo-noble gas cations
	Chemical formulas and Lewis structures of ionic compounds
	The ionic bond in a gas-phase diatomic molecule
	Lattice enthalpies of solid ionic compounds
	Energy in ionic bonding: The Born-Haber cycle for lattice enthalpies
	Crystalline ionic radii
	Properties of ionic compounds
	Covalent bonding in the H_2 molecule
	The ground-state electronic wave function of H_2
	The interatomic bonding potential and the vibrational spectrum
	The Bond energy and the bond length
	Pure and polar covalent bonds
	The molecular-orbitals and valence bond description of bonding
	The two shape types of covalent bonds: σ and π
	Bond order: Single and multiple bonds
	Coordination single bonds
	Covalent bonds and Lewis structures of homonuclear diatomic molecules
	Polar covalent bonds and dipole moments
	The bonding continuum: Pure covalent, polar covalent, and ionic
	The Pauling electronegativity scale
	Determining polarity of bonds from electronegativity differences
	Determining oxidation number from electronegativities
21	**Lewis Structures and Formal Charges**
Chapter 10	Drawing octet-rule fulfilling Lewis structures of simple molecules
	Isoelectronic Lewis structures
	Incomplete octet Lewis structures
	Lewis structures of free radicals
	Expanded-valence-shell Lewis structures
	Resonance hybrids: Resonance Lewis structures
	Lewis structures of backbone polyatomic molecules
	Isomers and enantiomers
	Structural formulas and functional groups
	The VB wave function and Lewis structures
	Formal Lewis charges
	A Lewis structure likelihood and its distribution of formal charges
	Proton transfer via the formation of a coordination bond
	Lewis type acid-base reactions
	Standard reaction enthalpies
	Calculating standard reaction enthalpies from bond energies

22	**Molecular Geometry and the VSEPR Model**
Chapter 10	Directional bonding and bond angles
	Molecular shapes and polarity
	Polar and nonpolar molecules: Summation of dipoles
	The VSEPR theory: Lone pair effect on bond angle
	The AX_2; AX_3; and AX_2E molecular shapes
	The AX_4; AX_3E; and AX_2E_2 molecular shapes
	The AX_5; AX_4E; AX_3E_2; AX_6; and AX_5E molecular shapes
23	**Theories of Covalent Bonding**
Chapter 11	Valence bond (VB) theory and atomic orbital hybridization
	Hybridized orbitals and molecular shapes
	The hybridized orbitals sp, sp^2, sp^3, sp^3d, sp^3d^2
	Electronic VB configurations of molecules
	Torsional rigidity of multiple bonds
	Molecular orbitals (MO) theory: Bonding and anti-bonding orbitals
	Minimal MO Theory of 1^{st}- and 2^{nd}-row diatomic molecules
	Delocalized bonding
	Hückel of conjugate π systems
	Metallic bonding
States of Matter and Solutions	
24	**Phase Diagrams**
Chapter 12	States of matter: The internal energy of gases, liquids and solids
	Phase transitions and the associated enthalpy changes: Latent heat
	The basic form of intermolecular forces
	Vapor pressure of liquids and solids[1]
	The Clausius-Clapeyron equation for the vapor pressure
	Boiling of liquids and melting of solids
	The peculiar melting point curve of water
	The isochoric phase diagram: The triple point and the critical point
	Complex structure phase diagrams
25	**Liquids and Intermolecular Forces**
Chapter 12	The generic intermolecular potential-energy curve
	Physical properties of liquids
	Classification of intermolecular forces
	Charge-induced and dipole-induced dipole moments
	Instantaneous dipole-dipole interactions: London dispersion forces
	The generic Lenard-Jones potential
	Intermolecular forces between polar molecules
	Intramolecular and intermolecular hydrogen bonds
	Hydrogen bonding and the unusual properties of water
	Surface tension, viscosity, and adhesion
	Chromatography: Adhesion based mixture separation

26	Solids and Crystal Structure
Chapter 12	Crystals and amorphous solids
	The crystal lattice and the unit cell: Long range periodic order
	The seven crystal systems
	Primitive and nonprimitive unit cells: The pc; bcc; and fcc cubic lattices
	Cohesion forces in crystals: Cubic and hexagonal closest packing lattices
	Calculations involving unit cells
	X-rays crystallography and the Bragg diffraction condition
	Ionic crystals and the interstitial sites of cubic lattices
	Covalent crystals: The crystal structure of diamond
	Molecular crystals and hybrid covalent-molecular crystals
	Metallic crystals and band theory
	Physical properties of metals: Conduction of electricity and heat
	Crystal imperfections: Point defects and impurities
	Nonstoichiometric solid compounds and alloys
	Amorphous solids and glasses
27	**Physical Properties of Solutions**
Chapter 13	Gaseous, liquid, and solid solutions
	Mass based solute concentration units and molarity
	Conversions between molarity and mass-based concentrations
	Mole fractions of the solutes and the solvent
	Solubility in liquid solvents: Saturated and supersaturated solutions
	The kinetics of the dissolution of solids in liquid solvents
	The solvation enthalpy and intermolecular forces
	Gaseous solutions: An example of the disorder tendency of nature
	The solvation entropy
	Molecular solutions: The like-dissolves-like rule of thumb
	Liquid molecular solutions of gaseous, liquid, and solid solutes
	Ionic solutions of ionic and molecular electrolytes
	The hydration enthalpy and its role in the solubility of electrolytes
	The effect of temperature and pressure on the solubility
	Reading solubility-temperature curves
	Henry's law: The effect of pressure on the solubility of gaseous solutes
	Raoult's law: The vapor pressure of volatile solution components
	The vapor pressure-composition phase diagram of ideal binary solution
	Fractional distillation of an ideal binary solution
	Real (nonideal) binary solutions: Positive and negative azeotropes
	Colligative properties of solutions: bp elevation and fp depression
	Osmosis and osmotic pressure
	Colligative properties of ionic solutions