KINGSBOROUGH COMMUNITY COLLEGE
The City University of New York

CURRICULUM TRANSMITTAL COVER PAGE

Department: Physical Sciences **Date:** March 2021

Title Of Course/Degree/Concentration/Certificate: CHM 3000 - Principles of Chemical Reactivity

Change(s) Initiated: (Please check)

- ☐ **Closing of Degree**
- ☐ **Closing of Certificate**
- ☐ **New Certificate Proposal**
- ☐ **New Degree Proposal**
- ☒ **New Course**
- ☐ **New 82 Course (Pilot Course)**
- ☐ **Deletion of Course(s)**
- ☐ **Change in Degree or Certificate**
- ☐ **Change in Degree: Adding Concentration**
- ☐ **Change in Degree: Deleting Concentration**
- ☐ **Change in Prerequisite, Corequisite, and/or Pre/Co-requisite**
- ☐ **Change in Course Designation**
- ☐ **Change in Course Description**
- ☐ **Change in Course Title, Number, Credits and/or Hours**
- ☐ **Change in Academic Policy**
- ☐ **Pathways Submission:**
  - ☐ **Life and Physical Science**
  - ☐ **Math and Quantitative Reasoning**
  - ☐ **A. World Cultures and Global Issues**
  - ☐ **B. U.S. Experience in its Diversity**
  - ☐ **C. Creative Expression**
  - ☐ **D. Individual and Society**
  - ☒ **E. Scientific World**
- ☐ **Change in Program Learning Outcomes**
- ☐ **Other (please describe):** _____

PLEASE ATTACH MATERIAL TO ILLUSTRATE AND EXPLAIN ALL CHANGES

DEPARTMENTAL ACTION

Action by Department and/or Departmental Committee, if required:

Date Approved: March 2021 **Signature, Committee Chairperson:** John Mikalopas

If submitted Curriculum Action affects another Department, signature of the affected Department(s) is required:

Date Approved: _____ **Signature, Department Chairperson:** _____

Date Approved: _____ **Signature, Department Chairperson:** _____

I have reviewed the attached material/proposal

Signature, Department Chairperson: John Mikalopas March 2021

Revised/Augl.2018/AK

Kingsborough Community College

The City University of New York

New Course Proposal Form

1. Department, Course Number, and Title (Speak with Academic Scheduling for assignment of a new course number): **PHYSICAL SCIENCES --- CHM3000: PRINCIPLES OF CHEMICAL REACTIVITY**

2. Does this course meet a General Education/CUNY Common Core Pathways Category? ***Note: 82XX (Pilot) courses CANNOT be considered for Pathways**

   - ☐ Life and Physical Science
   - ☐ Math and Quantitative Reasoning
   - ☐ A. World Cultures and Global Issues
   - ☐ B. U.S. Experience in its Diversity
   - ☐ C. Creative Expression
   - ☐ D. Individual and Society
   - **X** E. Scientific World

   If **YES**, complete and submit with this proposal a CUNY Common Core Pathways Submission Form. **ATTACHED**

3. Describe how this course transfers (required for A.S. Degree course). If A.A.S. Degree course and does not transfer, justify role of course, e.g. describe other learning objectives met. **Required pre-Organic Chemistry course at Brooklyn College (CHEM 2110 Principles of Chemical Reactivity) required for BA/BS Chemistry degree. See Articulation Agreement Chemistry Brooklyn College – Kingsborough College 2019 on file Academic Affairs.**

4. College Catalog description of course: **Basic and advanced concepts of chemical reactivity, molecular geometry and electronic distribution in molecules. Topics include: Atomic theory, the periodic table, periodic trends and properties (with a focus on main group elements), bonding theories, Lewis structures and formal charges, valence bond theory, polar and non-polar molecules and bonds, resonance theory, molecular orbital theory: general principles; molecular orbitals for homo-nuclear and heteronuclear diatomic molecules, molecular orbital theory for organic molecules focusing on functional groups, principles of symmetry in molecules, chirality, isomerism, stereoisomerism, naming chiral centers; Newman, sawhorse and fisher projections, free-energy diagrams, reaction coordinates and transition states, reaction mechanisms: curved arrow symbolism, elementary steps.**
   Prerequisite: Chemistry 1100

Credits and Hours Based on *College Credits Assigned for Instructional Hours* - ***Hours are hours per week in a typical 12-week semester** (Please check **ONE** appropriate box below based on credits) :

1-credit:	☐ 1 hour lecture ☐ 2 hours lab/field/gym
2-credits:	☐ 2 hours lecture ☐ 1 hour lecture, 2 hours lab/field ☐ 4 hours lab/field
3-credits:	**X 3 hours lecture** ☐ 2 hours lecture, 2 hours lab/field ☐ 1 hour lecture, 4 hours lab/field ☐ 6 hours lab/field
4-credits:	☐ 4 hours lecture ☐ 3 hours lecture, 2 hours lab/field ☐ 2 hours lecture, 4 hours lab/field ☐ 1 hour lecture, 6 hours lab/field ☐ 8 hours lab/field
More than 4-credits:	☐ Number of credits: ____ (explain mix lecture/lab below) ___ Lecture ____Lab Explanation:_____

5. Number of Equated Credits in Item #5 **NOT APPLICABLE** (For Developmental Courses ONLY)

6. Course Prerequisites, Corequisites, and Selected Populations (If NONE, please indicate "NONE" for each):
   A. Prerequisite(s): **Chemistry 1100**
   B. Corequisite(s):
   C. Pre-/Co-requisite(s):
   D. Open ONLY to selected Students (specify population):

7. Brief rationale to justify proposed course, include:
   A. Enrollment Summary if previously offered as an 82XX-Pilot Course (include Complete 4-digit 82 course number): **NOT PREVIOUSLY OFFERED**
   B. Projected Enrollment: **50 STUDENTS PER YEAR**
   C. Suggested Class Limits: **25 STUDENTS**
   D. Frequency course is likely to be offered: **ONCE A SEMESTER**
   E. Role of course in Department's Curriculum and College's Mission:
   Required pre-Organic Chemistry course at Brooklyn College (CHEM 2110 Principles of Chemical Reactivity) required for BA/BS Chemistry degree. See Articulation Agreement Chemistry Brooklyn College – Kingsborough College 2019

AND

Serve a 3 credits of the 6 available advanced electives available in AS Degree in Chemistry and AS Degree Physics

8. List course(s), if any, to be withdrawn when course is adopted (Note: this is NOT the same as deleting a course): **NONE**

9. If course is an internship, independent Study, or the like, provide an explanation as to how the student will earn the credits awarded. The credits awarded should be consistent with the student efforts required in a traditional classroom setting. **NOT APPLICABLE**

10. Proposed textbook(s) and/or other required instructional materials(s):

No Additional Cost to Students in Organic Chemistry Series *CHM3100 & CHM3200*

Chemistry 2e, P. Flowers, OpenStax, 2019.
This text is available as a free PDF at https://openstax.org/details/books/chemistry-2e
It is also available free for Kindle at http://www.amazon.com
If you would prefer to purchase a hard copy, you may order from http://www.amazon.com

Organic Chemistry *textbook used for CHM3100 & CHM3200*
Earlier editions may be used, other Organic Chemistry textbook, check chapter and subject headings for each section to match up required reading.

11. Is the course REQUIRED for a Major, Concentration, or Certificate? **NO**

If **YES**, – Submit a separate Curriculum Transmittal Cover Page indicating a "Change in Degree or Certificate" as well as a Proposal that MUST include a rationale for inclusion of the course within the curriculum and the following additional information:

A. "Current" Degree with all proposed deletions (strikeouts) and additions (bolded) clearly indicated.
B. "Proposed" Degree, which displays the degree as it will appear in the *College Catalog*

For a copy of the most up-to-date degree/certificate requirements contact Amanda Kalin, ext. 4611, Amanda.Kalin@kbcc.cuny.edu

The Following NYSED Guidelines must be adhered to for **ALL** Degree Programs:

45 credits of Liberal Arts Course work for an Associate of Arts Degree (A.A.)
30 credits of Liberal Arts Course work for an Associate of Science Degree (A.S.)
20 credits of Liberal Arts Course work for an Applied Associate of Science (A.A.S.)

12. Explain what students will know and be able to do upon completion of course:

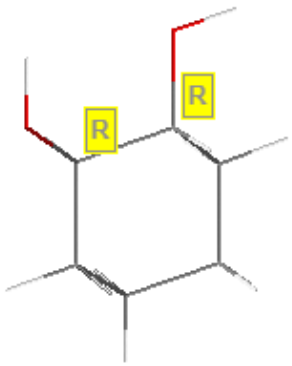
- **Students will draw Lewis structures of molecules by applying concepts in valency, formal charges, and resonance theory.**
- **Students will discuss how the different bonding theories (valence bond theory, resonance theory, molecular orbital theory) contribute to our understanding of molecular shape and properties.**
- **Students will apply molecular shape and polarity to predict their physical properties. These predictions will be tested against experimental data from chromatographic separations.**
- **Students will work collaboratively to interpret and produce different representation of chiral molecules (Newman, Sawhorse, Fisher projections).**
- **Students will discuss how molecular shape is critical in the development of drugs and therapeutics, and how altering molecular shape could attenuate its potency or toxicity.**
- **Students will use reaction product distributions to deduce possible mechanistic pathways.**
- **Students will discuss the relationship of molecular shape to molecular properties and how these could affect their toxicity. For example, what are the key differences between benzene and toluene that make the former a carcinogen and the latter not?**

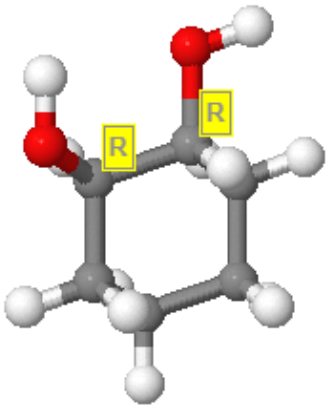
13. Methods of Teaching – e.g. lectures, laboratories, and other assignments for students, including any of the following: demonstrations, group work, website or email interactions and/or assignments, practice in application skills, etc.: **Lecture course. I makes use of atomic and molecular computer modeling software (available to students) including:**

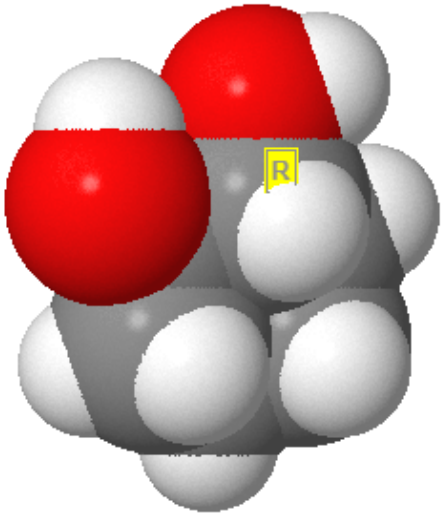
Visualization**: Structural Features of Organic Molecules**
Visualization**: Molecular Representations**
Visualization**: Atomic Orbitals**
Visualization**: Hybrid Atomic Orbitals**
Visualization**: Formation of a sigma C-H bond**
Visualization**: Formation of a double bond (sigma + pi)**
Visualization**: Molecular Orbitals methane,ethene, ethyne**
Visualization**: Chiral and achiral objects**
Visualization**: Symmetry elements**
Visualization**: Stereogenic Atoms**
Visualization**: Meso Compounds and Chiral Compounds with No Stereocenters**
Visualization**: Assigning R and S**
Visualization**: Enantiomers and Diastereomers**
Visualization**: Demonstration of the optical rotation of corn syrup**
Visualization**: The Fischer Projection**

A static example of a visualization of a enantiomer in Wireframe, Ball &Stick and Spacefilling model is below.

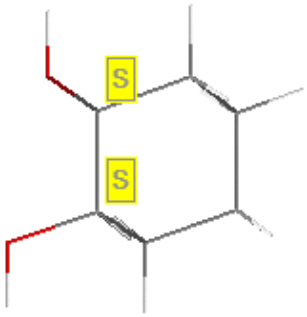
(R, R)-cyclohexane-1,2-diol

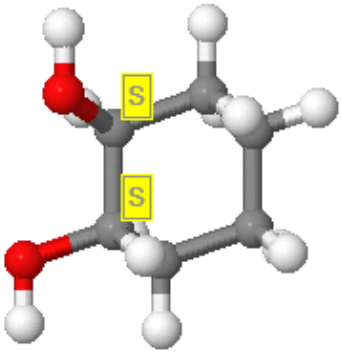


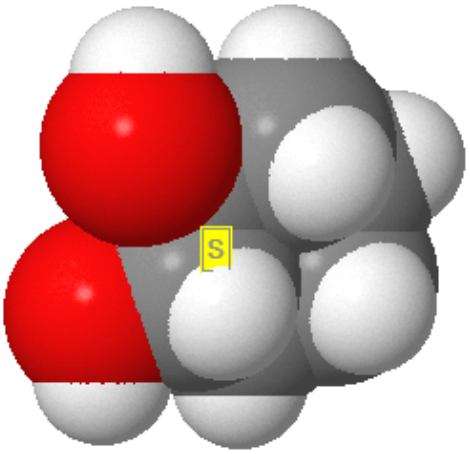




(S, S)-cyclohexane-1,2-diol







Revised/July.2020/AK

Students discussions and group work report assignments will include practice of skills including:

- How the different bonding theories (valence bond theory, resonance theory, molecular orbital theory) contribute to our understanding of molecular shape and properties.
- Interpretation and production of different representation of chiral molecules (Newman, Sawhorse, Fisher projections).
- how molecular shape is critical in the development of drugs and therapeutics, and how altering molecular shape could attenuate its potency or toxicity.
- The relationship of molecular shape to molecular properties and how these could affect their toxicity. For example, what are the key differences between benzene and toluene that make the former a carcinogen and the latter not?

14. Assignments to students:
    SEE TOPICAL COURSE OUTLINE BELOW
    SEE DISCUSSION AND GROUP WORK REPORTS ABOVE

15. Describe method of evaluating learning specified in #14 – include percentage breakdown for grading. If a Developmental Course, include how the next level course is determined as well as Next Level Placement.
    30% Assignments, Quizzes and Reports (Group and Individual.)
    40% Exams (20% each)
    30% Final Exam
    Course Grade to be determined Catalog Grading Scale

16. Topical Course Outline for the 12-week semester. This should be specific regarding topics covered, learning activities and assignments:

WEEKS 1-2 Atomic Theory and Bonding -- Electrons in Atoms --- n, l, ml, ms

- Understand the Quantum mechanical description of electrons in an atom and the four quantum numbers that form the basis for completely specifying the state of an electron in an atom
- Derive the predicted ground-state electron configurations of atoms
- Identify and explain exceptions to predicted electron configurations for atoms and ions
- Relate electron configurations to element classifications in the periodic table
- Describe and explain the observed trends in atomic size, ionization energy, and electron affinity of the elements
- Explain the formation of cations, anions, and ionic compounds
- Predict the charge of common metallic and nonmetallic elements, and write their electron configurations

Readings
C2e: Secs 6.3- 6.5, 7.1-7.3, 7.6
OC: Secs 1.2, 1.4-1.6, 2.1
Assignments from Readings
C2e: Chap 6: 35, 37, 41, 43, 49, 51, 55, 57, 67, 68, 76, 77, 79,81
Chap 7: 7a-e, 11, 13, 14, 15a-d, 28, 29, 39,85, 89, 91, 93, 95, 99, 101
OC: Chap 1: 1.21, 1.25, 1.27, 1.29, 1.33, 1.35, 1.39

WEEKS 3-4 Valence Bond Theory --- Lewis Dot, Sigma & Pi Molecular Orbitals, VSEPR

- Describe the formation of covalent bonds
- Define electronegativity and assess the polarity of covalent bonds
- Write Lewis symbols for neutral atoms and ions
- Draw Lewis structures depicting the bonding in simple molecules
- Predict the structures of small molecules using valence shell electron pair repulsion (VSEPR) theory

- Explain the concepts of polar covalent bonds and molecular polarity
- Assess the polarity of a molecule based on its bonding and structure
- Compute formal charges for atoms in any Lewis structure
- Describe the formation of covalent bonds in terms of atomic orbital overlap
- Define and give examples of σ and π bonds
- Explain the concept of atomic orbital hybridization
- Determine the hybrid orbitals associated with various molecular geometries
- Describe multiple covalent bonding in terms of atomic orbital overlap
- Relate the concept of resonance to π-bonding and electron delocalization
- Outline the basic quantum-mechanical approach to deriving molecular orbitals from atomic orbitals
- Describe traits of bonding and antibonding molecular orbitals
- Calculate bond orders based on molecular electron configurations
- Write molecular electron configurations for first- and second-row diatomic molecules
- Relate these electron configurations to the molecules' stabilities and magnetic properties

Readings

C2e: Secs 7.4, 8.1-8.4

OC: Sec 1.7

Assignments from Readings

C2e: Chap 8: 1, 5,7, 8, 10, 12, 13, 23, 24, 25, 26, 27a-d, 30, 35, 36, 37, 38, 39, 41, 45, 49

OC: Chap 1: 1.56, 1.57, 1.61, 1.62, 1.63

WEEKS 5-6 Resonance and Formal Charge

- Compute formal charges for atoms in any Lewis structure
- Use formal charges to identify the most reasonable Lewis structure for a given molecule
- Explain the concept of resonance and draw Lewis structures representing resonance forms for a given molecule

Readings

C2e: Secs 7.4(again)

OC: Sec 1.2 (Formal Charge), 1.8-1.9

Assignments from Readings

C2e: Chap 7: 44, 48, 56, 57, 59, 62

OC: Chap 1: 1.31, 1.51, 1.52, 1.53, 1.54, 1.55, 1.69, 1.70, 1.73, 1.74, 1.75

WEEKS 7-8 Organic Structure: Hydrocarbons, functional groups, and simple nomenclature

- To know the major classes of organic compounds and identify important functional groups.
- Provide correct IUPAC names for alkanes, halocarbons, alkenes, and aromatics, including cyclic molecules and including stereochemistry.

Readings

OC: Sec 1.3, 2.1-2.2, 2.3A (not B or C), 5.1 (alkene cis-/transisomerism)

Assignments from Readings

OC: Chap 1: 1.41, 1.42(a), 1.45, 1.48 Chap 2: 2.16, 2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 2.23, 2.26a-d, 2.27a-d, 2.31a-c Chap 5: 5.9, 5.10

WEEKS 9-10 Symmetry and Stereochemistry

- Differentiate chiral and achiral molecules.
- Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.
- Identify the stereocenters in a molecule and assign the configuration as R or S.
- Know the relationship between enantiomers and their specific rotations.

Readings

OC: Secs 2.4A, 2.5, 2.6A (not B, no bicycloalkanes), 3.1-3.4 Module 5 Handout

Assignments from Readings

OC: Chap 2: 2.40, 2.41, 2.42, 2.43, 2.44 Chap 3: 3.11, 3.13, 3.14, 3.15a-c, 3.16, 3.17, 3.20, 3.21, 3.22, 3.24, 3.26, 3.28, 3.30

WEEKS 11-12 Basic Mechanism Organic Chemistry

- Acid-base (proton transfer) reaction

- One-step nucleophilic substitution reaction
- Two-step Nucleophilic Substitution reaction

Reading
OC: Sec 4.1-4.7
Assignments from Readings
OC: Chap 4: 4.13, 4.14, 4.15, 4.16, 4.19,4.20, 4.22, 4.24, 4.26, 4.29, 4.31, 4.32, 4.33, 4.42, 4.45, 4.46, 4.48
Also: MCAT Practice at the end of Chapter 4

C2e: Chemistry 2e, P. Flowers, OpenStax, 2019
OC: Organic Chemistry, Brown, 8th Ed
Students discussions and group work report assignments will include practice of skills including:

- How the different bonding theories (valence bond theory, resonance theory, molecular orbital theory) contribute to our understanding of molecular shape and properties.
- Interpretation and production of different representation of chiral molecules (Newman, Sawhorse, Fisher projections).
- how molecular shape is critical in the development of drugs and therapeutics, and how altering molecular shape could attenuate its potency or toxicity.
- The relationship of molecular shape to molecular properties and how these could affect their toxicity. For example, what are the key differences between benzene and toluene that make the former a carcinogen and the latter not?

17. Selected Bibliography and Source materials:

- Clayden ---*Organic Chemistry*
- Klein ---*Organic Chemistry*
- *Organic Chemistry as Second Language*
- *Advanced Organic Chemistry*
- *An Introduction to General, Organic and Biological Chemistry*
- Bruice --- *Organic Chemistry*
- Vollhardt -- *Organic Chemistry: Structure and Function*
- McMurry -- *Organic Chemistry*
- Wade -- *Organic Chemistry*
- Solomons -- *Organic Chemistry*

ARTIFACTS PRODUCED BY STUDENTS FOR ASSESSMENT OF LEARNING OUTCOME BY EXAMPLE

Students will draw Lewis structures of molecules by applying concepts in valency, formal charges, and resonance theory. Students will discuss and report how the different bonding theories (valence bond theory, resonance theory, molecular orbital theory) contribute to our understanding of molecular shape and properties.	Gather, interpret, and assess information from a variety of sources and points of view.

Students will apply and report molecular shape and polarity to predict their physical properties. These predictions will be tested against experimental data	Evaluate evidence and arguments critically or analytically.

from chromatographic separations.	

Students will work collaboratively to interpret and report different representation of chiral molecules (Newman, Sawhorse, Fisher projections).	Produce well-reasoned written or oral arguments using evidence to support conclusions.

Students will discuss and report on how molecular shape is critical in the development of drugs and therapeutics, and how altering molecular shape could attenuate its potency or toxicity.	Demonstrate how tools of science, mathematics, technology, or formal analysis can be used to analyze problems and develop solutions.

Students will use reaction product distributions to deduce and report possible mechanistic pathways.	Articulate and evaluate the empirical evidence supporting a scientific or formal theory.

Students will discuss and report on the relationship of molecular shape to molecular properties and how these could affect their toxicity. For example, what are the key differences between benzene and toluene that make the former a carcinogen and the latter not?	Articulate and evaluate the impact of technologies and scientific discoveries on the contemporary world, such as issues of personal privacy, security, or ethical responsibilities.

CUNY Common Core
Course Submission Form

Instructions: All courses submitted for the Common Core must be liberal arts courses. Courses submitted to the Course Review Committee may be submitted for only one area of the Common Core and must be 3 credits. Colleges may submit courses to the Course Review Committee before or after they receive college approval. STEM waiver courses do not need to be approved by the Course Review Committee. This form should not be used for STEM waiver courses.

College	Kingsborough Community College
Course Prefix and Number (e.g., ANTH 101, if number not assigned, enter XXX)	**CHM3000**
Course Title	**Principles of Chemical Reactivity**
Department(s)	**Physical Sciences**
Discipline	**Chemistry**
Credits	**3**
Contact Hours	**3**
Pre-requisites (if none, enter N/A)	**CHM1100**
Co-requisites (if none, enter N/A)	**CHM1200 (optional) CHM3100 (optional)**
Catalogue Description	**General background in basic and more advanced concepts of chemical reactivity, molecular geometry and electronic distribution in molecules.**
Special Features (e.g., linked courses)	**CE, Honors Enrichment Component**
Sample Syllabus	**Syllabus must be included with submission, 5 pages max recommended**

Indicate the status of this course being nominated:

☐ current course ☐ revision of current course **X** a new course being proposed

CUNY COMMON CORE Location

Please check below the area of the Common Core for which the course is being submitted. (Select only one.)

Required
- ☐ English Composition
- ☐ Mathematical and Quantitative Reasoning
- ☐ Life and Physical Sciences

Flexible
- ☐ World Cultures and Global Issues
- ☐ US Experience in its Diversity
- ☐ Creative Expression
- ☐ Individual and Society
- X Scientific World

Learning Outcomes **In the left column explain the course assignments and activities that will address the learning outcomes in the right column.**	
I. Required Core (12 credits)	
A. English Composition: Six credits A course in this area must meet all the learning outcomes in the right column. A student will:	
	• Read and listen critically and analytically, including identifying an argument's major assumptions and assertions and evaluating its supporting evidence.
	• Write clearly and coherently in varied, academic formats (such as formal essays, research papers, and reports) using standard English and appropriate technology to critique and improve one's own and others' texts.
	• Demonstrate research skills using appropriate technology, including gathering, evaluating, and synthesizing primary and secondary sources.
	• Support a thesis with well-reasoned arguments, and communicate persuasively across a variety of contexts, purposes, audiences, and media.
	• Formulate original ideas and relate them to the ideas of others by employing the conventions of ethical attribution and citation.
B. Mathematical and Quantitative Reasoning: Three credits A course in this area must meet all the learning outcomes in the right column. A student will:	
	• Interpret and draw appropriate inferences from quantitative representations, such as formulas, graphs, or tables.
	• Use algebraic, numerical, graphical, or statistical methods to draw accurate conclusions and solve mathematical problems.
	• Represent quantitative problems expressed in natural language in a suitable mathematical format.
	• Effectively communicate quantitative analysis or solutions to mathematical problems in written or oral form.
	• Evaluate solutions to problems for reasonableness using a variety of means, including informed estimation.
	• Apply mathematical methods to problems in other fields of study.

C. Life and Physical Sciences: Three Credits A course in this area must meet all the learning outcomes in the right column. A student will:	
	• Identify and apply the fundamental concepts and methods of a life or physical science.
	• Apply the scientific method to explore natural phenomena, including hypothesis development, observation, experimentation, measurement, data analysis, and data presentation.
	• Use the tools of a scientific discipline to carry out collaborative laboratory investigations.
	• Gather, analyze, and interpret data and present it in an effective written laboratory or fieldwork report.
	• Identify and apply research ethics and unbiased assessment in gathering and reporting scientific data.
II. Flexible Core (18 credits) Six three-credit liberal arts and sciences courses, with at least one course from each of the following five areas and no more than two courses in any discipline or interdisciplinary field.	
A. World Cultures and Global Issues	
A Flexible Core course must meet the three learning outcomes in the right column.	
	• Gather, interpret, and assess information from a variety of sources and points of view.
	• Evaluate evidence and arguments critically or analytically.
	• Produce well-reasoned written or oral arguments using evidence to support conclusions.
A course in this area (II.A) must meet at least three of the additional learning outcomes in the right column. A student will:	
	• Identify and apply the fundamental concepts and methods of a discipline or interdisciplinary field exploring world cultures or global issues, including, but not limited to, anthropology, communications, cultural studies, economics, ethnic studies, foreign languages (building upon previous language acquisition), geography, history, political science, sociology, and world literature.
	• Analyze culture, globalization, or global cultural diversity, and describe an event or process from more than one point of view.
	• Analyze the historical development of one or more non-U.S. societies.
	• Analyze the significance of one or more major movements that have shaped the world's societies.
	• Analyze and discuss the role that race, ethnicity, class, gender, language, sexual orientation, belief, or other forms of social differentiation play in world cultures or societies.
	• Speak, read, and write a language other than English, and use that language to respond to cultures other than one's own.

B. U.S. Experience in its Diversity A Flexible Core course must meet the three learning outcomes in the right column.	
	• Gather, interpret, and assess information from a variety of sources and points of view.
	• Evaluate evidence and arguments critically or analytically.
	• Produce well-reasoned written or oral arguments using evidence to support conclusions.
A course in this area (II.B) must meet at least three of the additional learning outcomes in the right column. A student will:	
	• Identify and apply the fundamental concepts and methods of a discipline or interdisciplinary field exploring the U.S. experience in its diversity, including, but not limited to, anthropology, communications, cultural studies, economics, history, political science, psychology, public affairs, sociology, and U.S. literature.
	• Analyze and explain one or more major themes of U.S. history from more than one informed perspective.
	• Evaluate how indigenous populations, slavery, or immigration have shaped the development of the United States.
	• Explain and evaluate the role of the United States in international relations.
	• Identify and differentiate among the legislative, judicial, and executive branches of government and analyze their influence on the development of U.S. democracy.
	• Analyze and discuss common institutions or patterns of life in contemporary U.S. society and how they influence, or are influenced by, race, ethnicity, class, gender, sexual orientation, belief, or other forms of social differentiation.
C. Creative Expression	
A Flexible Core course must meet the three learning outcomes in the right column.	
	• Gather, interpret, and assess information from a variety of sources and points of view.
	• Evaluate evidence and arguments critically or analytically.
	• Produce well-reasoned written or oral arguments using evidence to support conclusions.
A course in this area (II.C) must meet at least three of the additional learning outcomes in the right column. A student will:	
	• Identify and apply the fundamental concepts and methods of a discipline or interdisciplinary field exploring creative expression, including, but not limited to, arts, communications, creative writing, media arts, music, and theater.
	• Analyze how arts from diverse cultures of the past serve as a foundation for those of the present, and describe the significance of works of art in the societies that created them.
	• Articulate how meaning is created in the arts or communications and how experience is interpreted and conveyed.
	• Demonstrate knowledge of the skills involved in the creative process.
	• Use appropriate technologies to conduct research and to communicate.

D. Individual and Society A Flexible Core course must meet the three learning outcomes in the right column.	
	• Gather, interpret, and assess information from a variety of sources and points of view.
	• Evaluate evidence and arguments critically or analytically.
	• Produce well-reasoned written or oral arguments using evidence to support conclusions.
A course in this area (II.D) must meet at least three of the additional learning outcomes in the right column. A student will:	
	• Identify and apply the fundamental concepts and methods of a discipline or interdisciplinary field exploring the relationship between the individual and society, including, but not limited to, anthropology, communications, cultural studies, history, journalism, philosophy, political science, psychology, public affairs, religion, and sociology.
	• Examine how an individual's place in society affects experiences, values, or choices.
	• Articulate and assess ethical views and their underlying premises.
	• Articulate ethical uses of data and other information resources to respond to problems and questions.
	• Identify and engage with local, national, or global trends or ideologies, and analyze their impact on individual or collective decision-making.
E. Scientific World A Flexible Core course must meet the three learning outcomes in the right column.	
Students will draw Lewis structures of molecules by applying concepts in valency, formal charges, and resonance theory. **Students will discuss how the different bonding theories (valence bond theory, resonance theory, molecular orbital theory) contribute to our understanding of molecular shape and properties.**	• Gather, interpret, and assess information from a variety of sources and points of view.
Students will apply molecular shape and polarity to predict their physical properties. These predictions will be tested against experimental data from chromatographic separations.	• Evaluate evidence and arguments critically or analytically.
Students will work collaboratively to interpret and produce different representation of chiral molecules (Newman, Sawhorse, Fisher projections).	• Produce well-reasoned written or oral arguments using evidence to support conclusions.
A course in this area (II.E) must meet at least three of the additional learning outcomes in the right column. A student will:	
	• Identify and apply the fundamental concepts and methods of a discipline or interdisciplinary field exploring the scientific world, including, but not limited to: computer science, history of science, life and physical sciences, linguistics, logic, mathematics, psychology, statistics, and technology-related studies.
Students will discuss how molecular shape is critical in the development of drugs and therapeutics, and how altering molecular shape could attenuate its potency or toxicity.	• Demonstrate how tools of science, mathematics, technology, or formal analysis can be used to analyze problems and develop solutions.
Students will use reaction product distributions to deduce possible mechanistic pathways.	• Articulate and evaluate the empirical evidence supporting a scientific or formal theory.
Students will discuss the relationship of molecular shape to molecular properties and how these could affect their toxicity. For example, what are the key differences between benzene and toluene that make the former a carcinogen and the latter not?	• Articulate and evaluate the impact of technologies and scientific discoveries on the contemporary world, such as issues of personal privacy, security, or ethical responsibilities.

	• Understand the scientific principles underlying matters of policy or public concern in which science plays a role.

Kingsborough Community College
The City University of New York
Department of Physical Sciences
CHM3000: PRINCIPLES OF CHEMICAL REACTIVITY
Generic Common Department Syllabus
(/ Comments to Instructors */)*

CHM3000: PRINCIPLES OF CHEMICAL REACTIVITY
Basic and advanced concepts of chemical reactivity, molecular geometry and electronic distribution in molecules. Topics include: Atomic theory, the periodic table, periodic trends and properties (with a focus on main group elements), bonding theories, Lewis structures and formal charges, valence bond theory, polar and non-polar molecules and bonds, resonance theory, molecular orbital theory: general principles; molecular orbitals for homo-nuclear and heteronuclear diatomic molecules, molecular orbital theory for organic molecules focusing on functional groups, principles of symmetry in molecules, chirality, isomerism, stereoisomerism, naming chiral centers; Newman, sawhorse and fisher projections, free-energy diagrams, reaction coordinates and transition states, reaction mechanisms: curved arrow symbolism, elementary steps. *Prerequisite: Chemistry 1100*

Section:	SECTION NUMBER
Time:	CUNYFIRST SCHEDULE FOR SECTION
Room:	ROOM (S) FOR SECTION
Instructor:	INSTRUCTOR FOR SECTION
Email:	EMAIL ADDRESS FOR INSTRUCTOR FOR SECTION
Office Hours:	OFFICE HOURS AND ROOM FOR INSTRUCTOR FOR SECTION

SOURCE MATERIALS:
(/*Must Be At No Additional Material Cost to Students in Organic Chemistry Series CHM3100 & CHM3200*/)

Chemistry 2e, P. Flowers, OpenStax, 2019.
This text is available as a free PDF at https://openstax.org/details/books/chemistry-2e
It is also available free for Kindle at http://www.amazon.com
If you would prefer to purchase a hard copy, you may order from http://www.amazon.com

Organic Chemistry textbook to be used for CHM3100 & CHM3200 sequence
(/*Earlier editions may be used, other Organic Chemistry textbook may be used, check chapter and subject headings for each section to match up required reading and assignments.*/)*

Scientific Calculator – You may not use a cell phone as a calculator on an exam!

STUDENT LEARNING OUTCOMES Students will:

- Students will draw Lewis structures of molecules by applying concepts in valency, formal charges, and resonance theory.
- Students will discuss how the different bonding theories (valence bond theory, resonance theory, molecular orbital theory) contribute to our understanding of molecular shape and properties.
- Students will apply molecular shape and polarity to predict their physical properties. These predictions will be tested against experimental data from chromatographic separations.

- Students will work collaboratively to interpret and produce different representation of chiral molecules (Newman, Sawhorse, Fisher projections).
- Students will discuss how molecular shape is critical in the development of drugs and therapeutics, and how altering molecular shape could attenuate its potency or toxicity.
- Students will use reaction product distributions to deduce possible mechanistic pathways.
- Students will discuss the relationship of molecular shape to molecular properties and how these could affect their toxicity. For example, what are the key differences between benzene and toluene that make the former a carcinogen and the latter not?

TOPICAL OUTLINE LECTURE, LEARNING ACTIVITIES, AND ASSIGNMENTS

(Approximate and subject to change upon notification)

C2e: Chemistry 2e, P. Flowers, OpenStax, 2019

OC: Organic Chemistry, Brown, 8th Ed

(/ Assignments for Chemistry 2e, P. Flowers, OpenStax, 2019 & Organic Chemistry, Brown, 8th Ed Match up required reading and assignments for different textbooks or editions.*/)*

WEEKS 1-2 Atomic Theory and Bonding -- Electrons in Atoms --- n, l, ml, ms

- Understand the Quantum mechanical description of electrons in an atom and the four quantum numbers that form the basis for completely specifying the state of an electron in an atom
- Derive the predicted ground-state electron configurations of atoms
- Identify and explain exceptions to predicted electron configurations for atoms and ions
- Relate electron configurations to element classifications in the periodic table
- Describe and explain the observed trends in atomic size, ionization energy, and electron affinity of the elements
- Explain the formation of cations, anions, and ionic compounds
- Predict the charge of common metallic and nonmetallic elements, and write their electron configurations

Readings

C2e: Secs 6.3- 6.5, 7.1-7.3, 7.6

OC: Secs 1.2, 1.4-1.6, 2.1

Assignments

C2e: Chap 6: 35, 37, 41, 43, 49, 51, 55, 57, 67, 68, 76, 77, 79,81
Chap 7: 7a-e, 11, 13, 14, 15a-d, 28, 29, 39,85, 89, 91, 93, 95, 99, 101

OC: Chap 1: 1.21, 1.25, 1.27, 1.29, 1.33, 1.35, 1.39

WEEKS 3-4 Valence Bond Theory --- Lewis Dot, Sigma & Pi Molecular Orbitals, VSEPR

- Describe the formation of covalent bonds
- Define electronegativity and assess the polarity of covalent bonds
- Write Lewis symbols for neutral atoms and ions
- Draw Lewis structures depicting the bonding in simple molecules
- Predict the structures of small molecules using valence shell electron pair repulsion (VSEPR) theory
- Explain the concepts of polar covalent bonds and molecular polarity
- Assess the polarity of a molecule based on its bonding and structure
- Compute formal charges for atoms in any Lewis structure
- Describe the formation of covalent bonds in terms of atomic orbital overlap
- Define and give examples of σ and π bonds
- Explain the concept of atomic orbital hybridization
- Determine the hybrid orbitals associated with various molecular geometries
- Describe multiple covalent bonding in terms of atomic orbital overlap
- Relate the concept of resonance to π-bonding and electron delocalization
- Outline the basic quantum-mechanical approach to deriving molecular orbitals from atomic orbitals
- Describe traits of bonding and antibonding molecular orbitals

- Calculate bond orders based on molecular electron configurations
- Write molecular electron configurations for first- and second-row diatomic molecules
- Relate these electron configurations to the molecules' stabilities and magnetic properties

Readings

C2e: Secs 7.4, 8.1-8.4

OC: Sec 1.7

Assignments

C2e: Chap 8: 1, 5,7, 8, 10, 12, 13, 23, 24, 25, 26, 27a-d, 30, 35, 36, 37, 38, 39, 41, 45, 49

OC: Chap 1: 1.56, 1.57, 1.61, 1.62, 1.63

WEEKS 5-6 Resonance and Formal Charge

- Compute formal charges for atoms in any Lewis structure
- Use formal charges to identify the most reasonable Lewis structure for a given molecule
- Explain the concept of resonance and draw Lewis structures representing resonance forms for a given molecule

Readings

C2e: Secs 7.4(again)

OC: Sec 1.2 (Formal Charge), 1.8-1.9

Assignments

C2e: Chap 7: 44, 48, 56, 57, 59, 62

OC: Chap 1: 1.31, 1.51, 1.52, 1.53, 1.54, 1.55, 1.69, 1.70, 1.73, 1.74, 1.75

WEEKS 7-8 Organic Structure: Hydrocarbons, functional groups, and simple nomenclature

- To know the major classes of organic compounds and identify important functional groups.
- Provide correct IUPAC names for alkanes, halocarbons, alkenes, and aromatics, including cyclic molecules and including stereochemistry.

Readings

OC: Sec 1.3, 2.1-2.2, 2.3A (not B or C), 5.1 (alkene cis-/transisomerism)

Assignments

OC: Chap 1: 1.41, 1.42(a), 1.45, 1.48 Chap 2: 2.16, 2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 2.23, 2.26a-d, 2.27a-d, 2.31a-c Chap 5: 5.9, 5.10

WEEKS 9-10 Symmetry and Stereochemistry

- Differentiate chiral and achiral molecules.
- Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.
- Identify the stereocenters in a molecule and assign the configuration as R or S.
- Know the relationship between enantiomers and their specific rotations.

Readings

OC: Secs 2.4A, 2.5, 2.6A (not B, no bicycloalkanes), 3.1-3.4 Module 5 Handout

Assignments

OC: Chap 2: 2.40, 2.41, 2.42, 2.43, 2.44 Chap 3: 3.11, 3.13, 3.14, 3.15a-c, 3.16, 3.17, 3.20, 3.21, 3.22, 3.24, 3.26, 3.28, 3.30

WEEKS 11-12 Basic Mechanism Organic Chemistry

- Acid-base (proton transfer) reaction
- One-step nucleophilic substitution reaction
- Two-step Nucleophilic Substitution reaction

Reading

OC: Sec 4.1-4.7

Assignments

OC: Chap 4: 4.13, 4.14, 4.15, 4.16, 4.19,4.20, 4.22, 4.24, 4.26, 4.29, 4.31, 4.32, 4.33, 4.42, 4.45, 4.46, 4.48
Also: MCAT Practice at the end of Chapter 4

C2e: Chemistry 2e, P. Flowers, OpenStax, 2019
OC: Organic Chemistry, Brown, 8th Ed

GRADES
30% Assignments, Quizzes and Reports (Group and Individual.)
40% Exams (20% each)
30% Final Exam
Course Grade to be determined using Catalog Grading Scale

A+97 – 100 ; A 93 - 96 A- 90 - 92 Excellent
B+ 87 – 89; B 83 – 86; B- 80 – 82 Good
C+ 77 – 79; C 73 – 76; C- 70 - 72 Satisfactory
D+ 67 – 69; D 60 - 66 Passing
F 0 - 59 Failure

MISSED EXAM/ASSIGNMENT POLICY
If you miss an opportunity to demonstrate your knowledge of the subject matter by missing a duly scheduled exam, laboratory or other assignment, the grading scheme does not apply. Your grade will be determined at the discretion of the instructor. By missing a duly scheduled exam, laboratory or other assignment, you accept and recognize that the instructor must determine your grade within the context of determining the grade of students who did not miss a duly scheduled exam, laboratory or other assignment. (/*INSTRUCTOR MAKE-UP POLICY: SUGGESTED: NO MAKE-UP EXAMS AND NO MAKE-UP OTHER ASSIGNMENTS. FINAL EXAM WEIGHTED WITH PENALTY (0-100%) FOR MISSED WORK */)

LECTURE ATTENDANCE
(/*INSTRUCTOR ATTENDANCE POLICY: SUGGESTED: Attending all classes is mandatory. The textbook is a guide for the course additional material will be covered during lecture meetings. If you miss class, you will miss out on taking notes and this ***will*** affect your ability to study for examinations and quizzes. Except in extreme cases there can be no makeup exams and missing one is grounds for failure of the course. At all times, if you have any questions or need help, please ask your instructor. If you are having difficulties with the course, or if your life is affecting your performance in class, or your ability to attend, let me know as soon as problems arise. */)

CONDUCT
Students are required to follow *The Student Code of Conduct* as stated in the *Student Handbook*.

ACCESSIBILITY
Access-Ability Services (AAS) serves as a liaison and resource to the KCC community regarding disability issues, promotes equal access to all KCC programs and activities, and makes every reasonable effort to provide appropriate accommodations and assistance to students with disabilities. You must contact Access-Ability Services if you require such accommodations and assistance. Your instructor will make the accommodations you need, but you must have documentation from the Access-Ability office for any accommodations.

ARTIFACTS PRODUCED BY STUDENTS FOR ASSESSMENT OF LEARNING OUTCOME BY EXAMPLE

Students will draw Lewis structures of molecules by applying concepts in valency, formal charges, and resonance theory. Students will discuss and report how the different bonding theories (valence bond theory, resonance theory, molecular orbital theory) contribute to our understanding of molecular shape and properties.	Gather, interpret, and assess information from a variety of sources and points of view.
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