Chemistry Programs Goals
(Revised 4Apr2016)

The mission of the Chemistry major is to educate chemists who are ready for employment or graduate school. We aim to give our graduates a firm foundation in each of the sub-disciplines of chemistry (Organic, Inorganic, Physical, Analytical, and Biochemistry) and an appreciation for the relationships between these sub-disciplines.

1. **Students will be able to retrieve, evaluate and communicate scientific information.**
2. **Students will be prepared to work safely in a modern laboratory.**
3. **Students will be able to use their knowledge, skills and experience to solve problems.**
4. **Students will work in an ethical and professional manner.**
5. **Students will demonstrate a working knowledge of structure and bonding.**
6. **Students will demonstrate a working knowledge of intermolecular interactions.**
7. **Students will demonstrate a working knowledge of chemical reactivity.**
8. **Students will demonstrate a working knowledge of kinetics and thermodynamics**

Chemistry Programs Goals w/ Learning Outcomes

1. **Students will be able to retrieve, evaluate and communicate scientific information.**
   1.1. To retrieve chemical information using print and electronic media.
   1.2. To organize, present and explain chemical information orally and in writing.
   1.3. To critically read a scientific paper and understand the major points of the paper.
   1.4. To properly cite the literature.

2. **Students will be prepared to work safely in a chemical laboratory.**
   2.1. To follow standard chemical handling and disposal procedures.
   2.2. To synthesize, purify and characterize compounds.
   2.3. To use modern chemical instrumentation and have a working knowledge of the principles behind their operation.
   2.4. To make precise and accurate measurements in the laboratory and use standards to validate data.
   2.5. To maintain a laboratory notebook.
   2.6. To make calculations using data collected in the laboratory, discuss the limitations of that data, draw conclusions and present results it in a formal report.
   2.7. To develop independence in the laboratory in planning and performing experiments.

3. **Students will be able to use their knowledge, skills and experience to solve problems.**
   3.1. To clearly define the problem to be solved.
   3.2. To use reasonable assumptions and approximations.
   3.3. To apply previously acquired knowledge to new chemical problems.
   3.4. To derive chemical equations, choose the appropriate equation for a given set of conditions and make meaningful calculations.
   3.5. To evaluate and analyze trends in data, to calculate quantities of interest, and draw conclusions based on theoretical models and experience.
   3.6. To demonstrate critical thinking by the application of previously acquired knowledge to new chemical problems.

4. **Students will work in an ethical and professional manner.**
   4.1. To work in a courteous, professional manner with fellow students and faculty in a diverse environment.
   4.2. To record, analyze and report data honestly.
   4.3. To apply chemical principles to practical problems and societal issues.
   4.4. To understand the responsibility of science to society including outreach and education,
   4.5. To minimize the negative impact on the environment by implementing the principles of green chemistry.

5. **Students will demonstrate a working knowledge of structure and bonding.**
   5.1. To derive and explain the quantum mechanical basis for the structure of atoms and molecules.
   5.2. To use Lewis theory, valence bond theory and molecular orbital theory to predict molecular geometry, bond order, bond strength and related quantities.
   5.3. To explain the principles and limitations of spectroscopic methods and to interpret spectra.
   5.4. To explain relationship between the structure and properties of substances including metals, inorganic materials, organic compounds, organic macromolecules, polymers, biological molecules.

6. **Students will demonstrate a working knowledge of intermolecular interactions.**
   6.1. To interpret phase diagrams and make predictions using phase diagrams.
   6.2. To identify the intermolecular forces in a system (London, dipole/dipole, ionic, hydrogen bonding).
   6.3. To identify, predict and explain the role of intermolecular forces in the physical and chemical properties of substances including inorganic materials, organic compounds, organic macromolecules, polymers, biological molecules.

7. **Students will demonstrate a working knowledge of chemical reactivity**
   7.1. To predict the products of chemical reactions: acid/base, redox, precipitation, addition, elimination, substitution, rearrangement.
   7.2. To understand the role and use of catalysts in chemical synthesis.
   7.3. To propose reasonable syntheses for target compounds.
   7.4. To use arrow pushing formalism to solve problems in organic and biochemical reactions.
   7.5. To identify the role of nucleophiles and electrophiles in organic and biochemical reactions.
   7.6. To make stoichiometric calculations.

8. **Students will demonstrate a working knowledge of kinetics and thermodynamics**
   8.1. To explain the effect of catalysts/enzymes for organic, inorganic and biochemical reactions.
   8.2. To understand kinetics and thermodynamics in a chemical reaction.
   8.3. To use experimental data and apply mathematics to establish a rate law, derive the rate law predicted by a given mechanism and propose a reasonable reaction mechanism given an experimental rate law.
   8.4. To calculate and explain the enthalpy, entropy, free energy, heat and work for chemical and physical changes.
   8.5. To calculate the equilibrium constant for a reaction and predict the effect of changes in pressure, temperature and reactant or product concentration.

Curriculum Map

1. Students will be able to retrieve, evaluate and communicate scientific information.

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
1.1 To retrieve chemical information using print and electronic media.	B	B	B	I/A		I	I	I/A	I		I/A	A			A	
1.2 To organize, present and explain chemical information orally and in writing.	B	B	B	B	I	I	I	I/A	I	I	A	I (oral) A (write)	I	A	A	
1.3 To critically read a scientific paper and understand the major points of the paper			B	B			B	I/A			A	A		A	A	
1.4 To properly cite the literature.			B	B	I		B	I/A			A	A	I		A	

(B) BASIC. (I) INTERMEDIATE, (A) ADVANCED. Courses common to all flow sheets are **bold**.

2. Students will be prepared to work safely in a chemical laboratory.

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
2.1 To follow standard chemical handling and disposal procedures.	I	I	B	I		I	I	A	I	A	I/A	I				
2.2 To synthesize, purify and characterize compounds.	B	B	B	I				A			B/I					
2.3 To use modern chemical instrumentation and have a working knowledge of the principles behind their operation.		B		B		I	I	I	I	I/A	I/A	B/I/A[1]				
2.4 To make precise and accurate measurements in the laboratory and use standards to validate data.	I	I	B	I		I	A	A	I	I	I/A					
2.5 To maintain a laboratory notebook.		B	B	I/A		I	A/I	A	I	A	I/A	A				
2.6 To make calculations using data collected in the laboratory, discuss the limitations of that data, draw conclusions and present results in a formal report.	B	B	B	I		I	I	I/A	I	I	A	A				
2.7 To develop independence in the laboratory in planning and performing experiments.	B	B	B	B/I		I	I	I/A	I	I	I/A	I/A				

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[1] Depending on technique.

3. Students will be able to use their knowledge, skills and experience to solve problems.

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
3.1. To clearly define the problem to be solved.	B	B	B	I		I	I	I/A	I	I	I/A	A				
3.2. To use reasonable assumptions and approximations.			B	I		I	I	A	I	I	A	A				
3.3 To apply previously acquired knowledge to new chemical problems.		I	B/I	I	I	I	I	A	I	I	A	A	A	A		
3.4 To derive chemical equations, choose the appropriate equation for a given set of conditions and make meaningful calculations.	B	B	B/I	I	I	I	I[2]	A	I	I	A	I/A[3]	A			
3.5 To evaluate and analyze trends in data, to calculate quantities of interest, and draw conclusions based on theoretical models and experience.	B	B	B	I	I	I	I/A	I/A	I	I	A	A	A	A		
3.6 To demonstrate critical thinking by the application of previously acquired knowledge to new chemical problems.	B	I	B	I	I	I	I	I/A	I	I	A	A	A	A	A	

(B) BASIC. (I) INTERMEDIATE, (A) ADVANCED. Courses common to all flow sheets are **bold**.

[2] No derivations.
[3] No derivations.

4. Students will work in an ethical and professional manner.

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
4.1 To work in a courteous, professional manner with fellow students and faculty in a diverse environment.	B	B	I	A	I	I	A	A	I	A	I/A	A	A	A	A	
4.2 To record, analyze and report data honestly.	B	B	I	A		I	I	A	I	A	A	A				
4.3 To apply chemical principles to practical problems and societal issues.	B	B	B	B	I	I	A	I			A	A	A		A	
4.4 To understand the responsibility of science to society including outreach and education			B	B		I	I	I			A	I[4]			A	
4.5 To minimize the negative impact on the environment by implementing the principles of green chemistry.			B	I				I/A			I/A	I				

(B) BASIC. (I) INTERMEDIATE, (A) ADVANCED. Courses common to all flow sheets are **bold**.

[4] No outreach

5. Students will demonstrate a working knowledge of structure and bonding.

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
5.1 To derive and explain the quantum mechanical basis for the structure of atoms and molecules.									I/A			B[5]		A		
5.2 To use Lewis theory, valence bond theory and molecular orbital theory to predict molecular geometry, bond order, bond strength and related quantities.	B	B	B	I	I			I/A	I/A				A	A		
5.3 To explain the principles and limitations of spectroscopic methods and to interpret spectra.				B	A	I		I	I/A		I/A	B	A			
5.4 To explain relationship between the structure and properties of substances including metals, inorganic materials, organic compounds, organic macromolecules, polymers, biological molecules.					I	I	I	B			I		A	A		

(B) BASIC. (I) INTERMEDIATE, (A) ADVANCED. Courses common to all flow sheets are **bold**.

[5] No derivations.

6. Students will demonstrate a working knowledge of intermolecular interactions

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
6.1 To interpret phase diagrams and make predictions using phase diagrams.				I	I			I		I						
6.2 To identify the intermolecular forces in a system (London, dipole/dipole, ionic, hydrogen bonding).		B		I		I	I	I			I/A			A		
6.3 To identify, predict and explain the role of intermolecular forces in the physical and chemical properties of substances including inorganic materials, organic compounds, organic macromolecules, polymers, biological molecules.				I	I	I	I	I			I/A		I	A		

(B) BASIC. (I) INTERMEDIATE, (A) ADVANCED. Courses common to all flow sheets are **bold**.

7. Students will demonstrate a working knowledge of chemical reactivity

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
7.1 To predict the products of chemical reactions: acid/base, redox, precipitation, addition, elimination, substitution, rearrangement.	B	B	B	I	A		A	A			B					
7.2 To understand the role and use of catalysts in chemical synthesis.		B	B	I	I			A			B		A	A		
7.3 To propose reasonable syntheses for target compounds.			B	I							B					
7.4 To use arrow pushing formalism to solve problems in organic and biochemical reactions.			B	I				A		I	I/A			A		
7.5 To identify the role of nucleophiles and electrophiles in organic and biochemical reactions.			B	I		I		I/A			I/A			I/A		
7.6 To make stoichiometric calculations.	B	B	B	I			A	A		A	I/A	A				

(B) BASIC. (I) INTERMEDIATE, (A) ADVANCED. Courses common to all flow sheets are **bold**.

8. Students will demonstrate a working knowledge of kinetics and thermodynamics.

	130	**131**	**212**	**213**	308	**309**	**321**	**340**	**341**	**342**	419	**420/422**	441	442	**560**	572
8.1 To explain the effect of catalysts/enzymes for organic, inorganic and biochemical reactions.		B		I	I	I		I		I	A		A			
8.2 To understand kinetics and thermodynamics in a chemical reaction.		B								I/A	I/A		A			
8.3 To use experimental data and apply mathematics to establish a rate law, derive the rate law predicted by a given mechanism and propose a reasonable reaction mechanism given an experimental rate law.		B		I				I		I/A	B			A		
8.4 To calculate and explain the enthalpy, entropy, free energy, heat and work for chemical and physical changes.		B		N/A		I		N/A		I/A	I/A					
8.5 To calculate the equilibrium constant for a reaction and predict the effect of changes in pressure, temperature and reactant or product concentration		B					A			I/A	I/A					

(B) BASIC. (I) INTERMEDIATE, (A) ADVANCED, Courses common to all flow sheets are **bold**.