

## WTCS Repository

# 10-806-129 Chemistry 2

## Course Outcome Summary

### Course Information

**Description** Further study of basic chemical principles (e.g. atomic and molecular structure, reactions, stoichiometry, thermochemistry, and acid/base chemistry) and the application of these principles, including chemical equilibria and kinetics. Introduces properties, structures, and reactions of organic compounds. Elementary aspects of biochemistry are considered.

**Total Credits** 4.00

### Pre/Corequisites

**Prerequisite** Each Wisconsin Technical College determines the General Education course prerequisites used by their academic institution. If prerequisites for a course are determined to be appropriate, the final Course Outcome Summary must identify the prerequisites approved for use by the individual Technical College.

### Course Competencies

#### 1. Use IUPAC nomenclature for naming organic compounds

##### Assessment Strategies

- 1.1. by completing laboratory exercise on nomenclature and functional groups
- 1.2. on an exam

##### Criteria

*Performance will be satisfactory when:*

- 1.1. you use the appropriate naming scheme and select proper IUPAC names for hydrocarbons
- 1.2. you use the appropriate naming scheme and select proper IUPAC names for alcohols
- 1.3. you use the appropriate naming scheme and select proper IUPAC names for ketones
- 1.4. you use the appropriate naming scheme and select proper IUPAC names for carboxylic acids
- 1.5. you use the appropriate naming scheme and select proper IUPAC names for esters
- 1.6. you use the appropriate naming scheme and select proper IUPAC names for aldehydes
- 1.7. you use the appropriate naming scheme and select proper IUPAC names for amines
- 1.8. you use the appropriate naming scheme and select proper IUPAC names for amides
- 1.9. you relate routinely use common name organic compounds to their IUPAC counterpart (examples include: acetone, formaldehyde, and acetaldehyde)
- 1.10. you draw organic compounds using molecular formulas
- 1.11. you draw organic compounds using expanded structural formulas
- 1.12. you draw organic compounds using condensed structures
- 1.13. you draw organic compounds using skeletal structures
- 1.14. you draw organic compounds using line structures
- 1.15. you classify carbons within an organic compound as primary, secondary, tertiary or quaternary
- 1.16. you classify amines as primary, secondary or tertiary
- 1.17. you classify alcohols as primary, secondary or tertiary

## 2. Predict chemical reactions involving organic compounds

### Assessment Strategies

- 2.1. by completing laboratory exercise on organic reactions
- 2.2. on an exam

### Criteria

*Performance will be satisfactory when:*

- 2.1. you relate physical properties of organic compounds to their expected reactions
- 2.2. you predict chemical reactions of organic compounds based on various reactants in both academic and laboratory settings
- 2.3. you identify the reaction types (list to include: oxidation, halogenation, addition, substitution, nitration and reduction)
- 2.4. you identify the organic compounds that undergo these reactions (list to include: oxidation, halogenation, addition, substitution, nitration and reduction)

## 3. Determine solubility of organic compounds

### Assessment Strategies

- 3.1. by completing a group activity on solubility
- 3.2. by completing laboratory exercise involving solubility
- 3.3. on an exam

### Criteria

*Performance will be satisfactory when:*

- 3.1. you investigate how pH affects solubility of some organic compounds
- 3.2. you analyze how intramolecular bonds affect solubility
- 3.3. you analyze how intermolecular bonds affect solubility
- 3.4. you explain the proper chemical disposal based on solubility of various organic compounds

## 4. Determine Rate Laws

### Assessment Strategies

- 4.1. by completing reaction mechanisms group activity
- 4.2. by completing laboratory exercise on kinetics
- 4.3. on an exam

### Criteria

*Performance will be satisfactory when:*

- 4.1. you explain the reaction rate as it relates to chemical reactions
- 4.2. you explain the rate constant as it relates to chemical reactions
- 4.3. you explain the reaction order as it relates to chemical reactions
- 4.4. you explain the elementary reaction as it relates to chemical reactions
- 4.5. you explain the catalyst as it relates to chemical reactions
- 4.6. you explain the collision theory as it relates to chemical reactions
- 4.7. you explain the rate limiting step as it relates to chemical reactions
- 4.8. you explain the zero order reaction as it relates to chemical reactions
- 4.9. you explain the first order reaction as it relates to chemical reactions
- 4.10. you explain the second order reaction as it relates to chemical reactions
- 4.11. you explain the half life as it relates to chemical reactions
- 4.12. you examine experimental data to construct a rate equation
- 4.13. you calculate various components of a rate equation using experimental data
- 4.14. you explain effects of changes in concentration on reaction rates
- 4.15. you explain effects of changes in temperature on reaction rates

## 5. Relate chemical concentrations and Laws of Chemical Equilibrium to predict chemical reactions

### Assessment Strategies

- 5.1. by completing laboratory exercise on equilibrium
- 5.2. by completing Equilibrium group activity
- 5.3. on an exam

## Criteria

*Performance will be satisfactory when:*

- 5.1. you explain static equilibrium
- 5.2. you explain dynamic equilibrium
- 5.3. you explain heterogeneous reaction
- 5.4. you explain reversible reaction
- 5.5. you explain reaction quotient (Q)
- 5.6. you explain equilibrium constant
- 5.7. you write an equilibrium constant expression from a given equation
- 5.8. you calculate an equilibrium constant from a given equation
- 5.9. you calculate concentrations/pressures of the reactants and/or products of a given equation when the equilibrium constant is provided
- 5.10. you explain La Chatelier's Principle
- 5.11. you predict how change in concentration of a reactant or product would shift equilibrium
- 5.12. you predict how change in pressure would shift equilibrium
- 5.13. you predict how change in temperature would shift equilibrium
- 5.14. you predict how addition of a catalyst would shift equilibrium

## 6. Determine the solubility of a solid product

### Assessment Strategies

- 6.1. by completing laboratory exercise on equilibrium
- 6.2. on an exam

### Criteria

*Performance will be satisfactory when:*

- 6.1. you explain the solubility product constant (K<sub>sp</sub>)
- 6.2. you explain precipitate
- 6.3. you explain saturated solution
- 6.4. you explain unsaturated solution
- 6.5. you explain soluble
- 6.6. you explain slightly soluble and insoluble
- 6.7. you write K<sub>sp</sub> expression for a given compound
- 6.8. you calculate an unknown concentration given the numerical value of the solubility product and the remaining equilibrium ion concentrations
- 6.9. you determine whether a compound is soluble, slightly soluble, and/or insoluble based on mathematical calculations

## 7. Analyze the properties and reactions of acids and bases

### Assessment Strategies

- 7.1. by completing laboratory exercise
- 7.2. on an exam

### Criteria

*Performance will be satisfactory when:*

- 7.1. you explain the Arrhenius acid and base
- 7.2. you explain V Bronsted-Lowry acid and base
- 7.3. you explain conjugate acid
- 7.4. you explain conjugate base
- 7.5. you explain oxyacid
- 7.6. you explain acidity
- 7.7. you explain alkalinity
- 7.8. you explain salt (acidic, basic and neutral)
- 7.9. you explain amphiprotic
- 7.10. you label reactants and products within an acid/base reaction (acid, base, conjugate acid, conjugate base, salt)
- 7.11. you predict the products of acid/base reactions
- 7.12. you predict the relative strengths of acids
- 7.13. you predict the relative strengths of bases

## 8. Determine equilibria for the reactions of acids and bases

### Assessment Strategies

- 8.1. by completing laboratory exercise
- 8.2. on an exam

### Criteria

*Performance will be satisfactory when:*

- 8.1. you explain the acid dissociation constant ( $K_a$ )
- 8.2. you explain the base dissociation constant ( $K_b$ )
- 8.3. you explain the ionization constant for water ( $K_w$ )
- 8.4. you calculate the appropriate constant ( $K_a$ ,  $K_b$  or  $K_w$ ) for given equations
- 8.5. you determine where equilibrium lies based on calculations ( $K_a$ ,  $K_b$  or  $K_w$ ).

## 9. Measure acids and bases in a laboratory setting

### Assessment Strategies

- 9.1. by completing laboratory exercise
- 9.2. on an exam

### Criteria

*Performance will be satisfactory when:*

- 9.1. you determine  $[H_3O^+]$  and  $[OH^-]$  ions for a given acid/base reaction
- 9.2. you perform acid/base reactions in a laboratory setting using titration methods
- 9.3. you explain pH meter use in determining acid/base status of a solution
- 9.4. you explain the use of indicators on pH determination
- 9.5. you select appropriate indicator to determine acid/base status of a given solution

## 10. Prepare buffer solutions

### Assessment Strategies

- 10.1. by completing laboratory exercise
- 10.2. on an exam

### Criteria

*Performance will be satisfactory when:*

- 10.1. you explain buffer
- 10.2. you explain neutralization
- 10.3. you explain the Henderson-Hasselbalch equation
- 10.4. you explain pH
- 10.5. you explain  $pK_a$
- 10.6. you explain  $pOH$
- 10.7. you explain titration
- 10.8. you explain how buffer solutions resist changes in pH
- 10.9. you identify the chemicals that make or do not make good buffers
- 10.10. you calculate pH,  $pK_a$  or concentration of buffer using Henderson-Hasselbalch equation
- 10.11. you predict changes in pH when changing  $[H_3O^+]$  or  $[OH^-]$  using Henderson-Hasselbalch equation
- 10.12. you identify the common buffers used in the biotechnology field

## 11. Explain the use of oxidation-reduction reactions in a chemical setting

### Assessment Strategies

- 11.1. by completing laboratory exercise
- 11.2. by completing homework packet on redox problems
- 11.3. on an exam

### Criteria

*Performance will be satisfactory when:*

- 11.1. you explain half-reaction
- 11.2. you explain oxidation
- 11.3. you explain reduction

- 11.4. you explain oxidizing agent
- 11.5. you explain reducing agent
- 11.6. you explain redox reaction
- 11.7. you explain oxidation number
- 11.8. you explain normality
- 11.9. you determine the oxidation number of each atom of each element in a compound or ion
- 11.10. you write both half-reactions for a given redox reaction
- 11.11. you identify elements in a redox reaction as being oxidized or reduced or as oxidizing or reducing agents
- 11.12. you balance a redox equation
- 11.13. you determine equivalents/mole an oxidizing or reducing agent has
- 11.14. you calculate the change from molarity (moles/liter) to normality (eq/liter).

## **12. Predict behavior of species involved in the redox reactions that occur in electrochemical cells and batteries**

### **Assessment Strategies**

- 12.1. by completing laboratory exercise
- 12.2. on an exam

### **Criteria**

*Performance will be satisfactory when:*

- 12.1. you explain anode
- 12.2. you explain cathode
- 12.3. you explain amperes
- 12.4. you explain coulombs
- 12.5. you explain Faraday
- 12.6. you explain positive electrode
- 12.7. you explain negative electrode
- 12.8. you sketch and label the components of an electrolytic and voltaic (galvanic) cell
- 12.9. you examine the function of the basic components in an electrolytic and voltaic (galvanic) cell
- 12.10. you calculate the standard cell potential for a given redox reaction from a table of standard reduction potentials
- 12.11. you explain the sign a cell potential must have in order to be spontaneous
- 12.12. you explain standard conditions for  $E_o$  values
- 12.13. you examine the process of electroplating

## **13. Correlate the use of thermodynamic properties to predict chemical reactions**

### **Assessment Strategies**

- 13.1. by completing laboratory exercise on equilibrium
- 13.2. on an exam

### **Criteria**

*Performance will be satisfactory when:*

- 13.1. you explain spontaneous
- 13.2. you explain nonspontaneous
- 13.3. you explain entropy
- 13.4. you explain free energy
- 13.5. you explain enthalpy
- 13.6. you explain the three laws of thermodynamics
- 13.7. you explain endothermic
- 13.8. you distinguish between exothermic and endothermic
- 13.9. you predict whether a reaction results in an increase, decrease, or little change in entropy
- 13.10. you calculate change in enthalpy, entropy or free energy for a given equation at standard condition (some values derived from table of  $DH_o$ ,  $DSo$ , and  $DGo$ )
- 13.11. you identify the specific sign (+, -) that implies a spontaneous process
- 13.12. you explore the thermodynamic standard conditions

## 14. Explain the basic concepts of biochemistry as they relate to the biotech industry

### Assessment Strategies

- 14.1. by completing laboratory exercises
- 14.2. on an exam

### Criteria

*Performance will be satisfactory when:*

- 14.1. you explain an amino acid
- 14.2. you explain a protein
- 14.3. you explain a peptide bond
- 14.4. you explain a carbohydrate
- 14.5. you explain a lipid
- 14.6. you explain an enzyme
- 14.7. you explain a triglyceride
- 14.8. you explain a nucleic acid
- 14.9. you draw the basic structures of proteins, lipids, triglycerides and carbohydrates
- 14.10. you draw the structure of a peptide produced from the reaction of two or more amino acids
- 14.11. you identify the peptide bonds of a polypeptide
- 14.12. you identify an enzyme by the -ase suffix
- 14.13. you summarize the effect of pH and/or temperature change on enzyme function
- 14.14. you differentiate between fats and oils
- 14.15. you identify fat or water-soluble vitamins based on polarity
- 14.16. you distinguish between the primary, secondary, tertiary and quaternary structure of proteins