SYLLABUS

DATE OF LAST REVIEW: 02/2016
CIP CODE: 24.0101
SEMESTER: Departmental Syllabus
COURSE TITLE: College Chemistry II and Lab
COURSE NUMBER: CHEM-0112
CREDIT HOURS: 5
INSTRUCTOR: Departmental Syllabus
OFFICE LOCATION: Departmental Syllabus
OFFICE HOURS: Departmental Syllabus
TELEPHONE: Departmental Syllabus
EMAIL: Departmental Syllabus

KCKCC-issued email accounts are the official means for electronically communicating with our students.

PREREQUISITES: CHEM-0111, College Chemistry I and Lab

REQUIRED TEXT AND MATERIALS: Please check with the KCKCC bookstore, http://www.kckccbookstore.com for the required text for your particular class.

COURSE DESCRIPTION:
College Chemistry II is a continuation of College Chemistry I. It is designed for the student who needs more than five hours of credit in chemistry or is going to take advanced chemistry courses or pre-professional programs such as pre-med and pre-dentistry. Normally, in Chemistry II, the topics covered are chemical thermodynamics, chemical kinetics, chemical equilibrium, electrochemistry, nuclear chemistry, descriptive chemistry, introductory organic chemistry and other topics if time permits.

METHOD OF INSTRUCTION: A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, and panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE:
Outline of the course topics normally covered:

I. Colligative Properties
   A. Describe the origins and relative magnitudes of intermolecular forces.
   B. Relate phase behavior to nature of intermolecular forces.
   C. Define saturated solution, unsaturated solution, supersaturated solution, solubility, solute, and solvent.
   D. Understand and perform calculations using Henry's Law
E. Calculate concentration in molality, molarity, mole fraction, and percent composition, and interconvert between these units.

F. Explain and calculate vapor pressure using Raoult's Law.

G. Explain other colligative properties, including freezing point depression, boiling, point elevation, and osmotic pressure.

H. Perform calculations using colligative properties, including molecular weight, freezing point depression, boiling point elevation and osmotic pressure.

I. Differentiate between the behaviors of non-ionizing and ionizing compounds in solution.

II. Kinetics

A. Discuss the meaning of the rate of a reaction.

B. Explain the factors that affect reaction rates.

C. Use the initial rate method to determine reaction order from experimental data.

D. Determine orders of reaction for reactants from data expressing changes in concentration as a function of longer times.

E. Use the rate law to determine the overall order of a reaction.

F. Determine a reaction rate law from initial rate data.

G. Describe the relationship between order of reaction and molecularity.

H. Use experimental data to determine the rate law for a reaction.

I. Use an integrated form of the rate expression to perform calculations relating reactant or product concentration with reaction time.

J. Compare zero, first and second order rate reactions.

K. Discuss the collision theory of a reaction rate.

L. Use the Arrhenius equation to illustrate the relationship between energy of activation and rate law constant.

M. Describe the relationships among the mechanism, the overall reaction and elementary steps.

N. Identify reaction intermediates and catalysts in reaction mechanisms.

O. Draw and interpret energy diagrams and illustrate the affect of a catalyst on the energy diagram.

III. Equilibrium Principles

A. Explain the relationship between the terms reversible reaction and dynamic equilibrium.

B. Write the general equilibrium constant expression and explain its significance.

C. Calculate Keq given equilibrium concentrations of reactants and products.

D. Calculate equilibrium concentrations of reactants and products given the equilibrium concentration of other reactants and products.

E. Calculate new equilibrium concentrations of reactants and products after an increase or decrease in the concentration of one of the reactants or products.

F. Explain why the concentrations of pure liquids and solids are never used in equilibrium constant expressions.

G. Show how the numerical value of the equilibrium constant changes when the stoichiometric coefficients are changed or the reaction is reversed.

H. Explain the differences between the terms Kc and Kp and the relation of either to Qc.
I. Explain the difference between an equilibrium position and an equilibrium constant.
J. Given \( K_{eq} \) and initial concentration of reactants and/or products, calculate the final concentrations of reactants and/or products.
K. List and explain the external factors that can affect equilibria.
L. Using LaChatelier’s Principle, explain how changes in temperature, pressure, volume, or concentration affect the equilibrium position for a chemical reaction.

IV. Equilibrium of Aqueous Solutions
A. Use the definition of acids and bases to distinguish between strong and weak acids and bases, equilibrium relationships among them, and the aqueous properties of their salts.
B. Use the concepts of pH, pOH, \( K_a \), and \( K_b \) to calculate the pH of aqueous solutions of acids, bases, and their salts.
C. Determine the specific species present in an aqueous solution and the concentrations of those species.
D. Describe the shape of acid-base titration curves for strong acid-strong base, weak acid-strong base, strong acid-week base and weak acid-week base titrations.
E. Describe the effect of common ions and calculate concentrations of all species present in solutions of weak acids and bases.
F. Describe the ionization of polyprotic acid in aqueous solution.
G. Explain the buffer effect, predict the influence of added acids and bases on buffers, and calculate the concentrations of species in solution (using acid or base dissociation constant expressions, or Henderson-Hasselbach equation).
H. Calculate the pH of a buffer solution outside of the buffer region.
I. Identify titration curves for strong, weak, and polyfunctional acids and bases.
J. Understand the use of volumetric methods to determine the concentrations of species in solution.
K. Understand application of indicators in titration.
L. Write an equation to express the relationship between a solid solute and its constituent ions in a saturated solution.
M. Calculate the \( K_{sp} \) from molar solubility and molar solubility from \( K_{sp} \).
N. Calculate the effect of a common ion on the molar solubility of a salt.
O. Predict whether precipitation will occur when salt solutions are mixed and determine the concentration of ions remaining in solution after precipitation.

V. Thermodynamics
A. Explain the similarities and differences between such terms as enthalpy, entropy, and free energy.
B. Explain how the First, Second, and Third Laws of Thermodynamics apply chemical and physical processes.
C. Predict whether the entropy change in a given process is positive, negative, or near zero.
D. Use data tables to determine enthalpy, entropy, and free energy changes.
E. Explain how \( \Delta H^\circ \), \( \Delta S^\circ \), and \( \Delta G^\circ \) are related to reaction spontaneity.
F. Explain how knowledge of \( \Delta H^\circ \), \( \Delta S^\circ \), and \( \Delta G^\circ \) allows one to predict the conditions under which a reaction will occur.
G. Describe and calculate the relationship between the standard free energy of reaction and the equilibrium constant.
H. Calculate \( \Delta G \) for a chemical reaction that occurs under nonstandard conditions.

VI. Electrochemistry
A. Describe galvanic and electrolytic cells and their operation, including the identification of half reactions at the anode and cathode.
B. Write half reactions given a balanced redox reaction, and generate a balanced redox reaction given redox half reactions.
C. Calculate cell potentials and determine spontaneity of oxidation/ reduction reactions.
D. Understand and use Faraday’s Law.
E. Understand and apply the relationship of thermodynamics to electrochemistry.
F. Understand and use the Nerst Equation.
G. Understand the relationship between the cell potential \( E \) and \( \Delta G \), and use this relationship in problem solving.
H. Give examples of natural and/or commercial applications of electrochemical processes
I. Use the activity series of metals (optional).

VII. Optional Topics (alphabetical)
a. Biochemistry.
b. Coordination chemistry.
c. Descriptive chemistry.
d. Nuclear and radiochemistry.
e. Organic chemistry.
f. Solid state chemistry.

EXPECTED LEARNER OUTCOMES:

Upon successful completion of college Chemistry II:

A. The learner will be able describe and list colligative properties or solutions; and perform calculations involving colligative properties and quantities.
B. The learner will be able explain the meaning of kinetics and perform calculations of concentration, rates of reaction, time of reaction, and order of reaction on theoretical and experimental data.
C. The learner will be able explain the principles of chemical equilibrium and the calculation of equilibrium data.
D. The learner will be able to apply equilibrium considerations and calculations to aqueous solutions in the prediction of acid base, buffer, and precipitation processes.
E. The learner will be able demonstrate an understanding of the thermodynamic terms enthalpy, entropy, and free energy and their application to chemical and physical processes.
F. The learner will be able write representations of galvanic and electrolytic cells and apply electrochemical calculations to their operation.
G. The learner will be able work in the laboratory in accordance with good laboratory practices

COURSE COMPETENCIES:

The learner will be able describe and list colligative properties or solutions; and perform calculations involving colligative properties and quantities.
1. The student will be able to define saturated solution, unsaturated solution, supersaturated solution, solubility, solute, and solvent.
2. The student will be able to understand and perform calculations using Henry’s Law.
3. The student will be able to calculate concentration in molality, molarity, mole fraction, and percent composition, and interconvert between these units.
4. The student will be able to explain and calculate vapor pressure using Raoult’s Law.
5. The student will be able to explain other colligative properties, including freezing point depression, boiling point elevation, and osmotic pressure.
6. The student will be able to perform calculations using colligative properties, including molecular weight, freezing point depression, boiling point elevation and osmotic pressure.
7. The student will be able to differentiate between the behaviors of non-ionizing and ionizing compounds in solution.

The learner will be able explain the meaning of kinetics and perform calculations of concentration, rates of reaction, time of reaction, and order of reaction on theoretical and experimental data.
The student will be able to discuss the meaning of the rate of a reaction.

The student will be able to explain the factors that affect reaction rates.

The student will be able to use the initial rate method to determine reaction order from experimental data.

The student will be able to determine orders of reaction for reactants from data expressing changes in concentration as a function of longer times.

The student will be able to use the rate law to determine the overall order of a reaction.

The student will be able to determine a reaction rate law from initial rate data.

The student will be able to describe the relationship between order of reaction and molecularity.

The student will be able to use experimental data to determine the rate law for a reaction.

The student will be able to use an integrated form of the rate expression to perform calculations relating reactant or product concentration with reaction time.

The student will be able to compare zero, first and second order rate reactions.

The student will be able to discuss the collision theory of a reaction rate.

The student will be able to use the Arrhenius equation to illustrate the relationship between energy of activation and rate law constant.

The student will be able to describe the relationships among the mechanism, the overall reaction and elementary steps.

The student will be able to identify reaction intermediates and catalysts in reaction mechanisms.

The learner will be able explain the principles of chemical equilibrium and the calculation of equilibrium data

The student will be able to explain the relationship between the terms reversible reaction and dynamic equilibrium.

The student will be able to write the general equilibrium constant expression and explain its significance.

The student will be able to calculate $K_{eq}$ given equilibrium concentrations of reactants and products.

The student will be able to calculate equilibrium concentrations of reactants and products given the equilibrium concentration of other reactants and products.

The student will be able to calculate new equilibrium concentrations of reactants and products after an increase or decrease in the concentration of one of the reactants or products.

The student will be able to explain why the concentrations of pure liquids and solids are never used in equilibrium constant expressions.

The student will be able to show how the numerical value of the equilibrium constant changes when the stoichiometric coefficients are changed or the reaction is reversed.

The student will be able to explain the differences between the terms $K_c$ and $K_p$ and the relation of either to $Q_c$.

The student will be able to explain the difference between an equilibrium position and an equilibrium constant.

The student will be able to given $K_{eq}$ and initial concentration of reactants and/or products, calculate the final concentrations of reactants and/or products.

The student will be able to list and explain the external factors that can affect equilibria.

The student will be able to using LeChateleir’s Principle, explain how changes in temperature, pressure, volume, or concentration affect the equilibrium position for a chemical reaction.

The learner will be able apply equilibrium considerations and calculations to aqueous solutions in the prediction of acid base, buffer, and precipitation processes.

The student will be able to use the definition of acids and bases to distinguish between strong and weak acids and bases, equilibrium relationships among them, and the aqueous properties of their salts.

The student will be able to use the concepts of pH, pOH, $K_a$, and $K_b$ to calculate the pH of aqueous solutions of acids, bases, and their salts.

The student will be able to determine the specific species present in an aqueous solution and the concentrations of those species.
38. The student will be able to describe the shape of acid-base titration curves for strong acid-strong base, weak acid-strong base, strong acid-week base and weak acid-weak base titrations.
39. The student will be able to describe the effect of common ions and calculate concentrations of all species present in solutions of weak acids and bases.
40. The student will be able to describe the ionization of polyprotic acid in aqueous solution.
41. The student will be able to explain the buffer effect, predict the influence of added acids and bases on buffers, and calculate the concentrations of species in solution (using acid or base dissociation constant expressions, or Henderson-Hasselbach equation).
42. The student will be able to calculate the pH of a buffer solution outside of the buffer region.
43. The student will be able to identify titration curves for strong, weak, and polyfunctional acids and bases.
44. The student will be able to understand the use of volumetric methods to determine the concentrations of species in solution.
45. The student will be able to understand application of indicators in titration.
46. The student will be able to write an equation to express the relationship between a solid solute and its constituent ions in a saturated solution.
47. The student will be able to calculate the K_{sp} from molar solubility and molar solubility from K_{sp}.
48. The student will be able to calculate the effect of a common ion on the molar solubility of a salt.
49. The student will be able to predict whether precipitation will occur when salt solutions are mixed and determine the concentration of ions remaining in solution after precipitation.

The learner will be able demonstrate an understanding of the thermodynamic terms enthalpy, entropy, and free energy and their application to chemical and physical processes.
50. The student will be able to explain the similarities and differences between such terms as enthalpy, entropy, and free energy.
51. The student will be able to explain how the First, Second, and Third Laws of Thermodynamics apply chemical and physical processes.
52. The student will be able to predict whether the entropy change in a given process is positive, negative, or near zero.
53. The student will be able to use data tables to determine enthalpy, entropy, and free energy changes.
54. The student will be able to explain how \( \Delta H^\circ \), \( \Delta S^\circ \), and \( \Delta G^\circ \) are related to reaction spontaneity.
55. The student will be able to explain how knowledge of \( \Delta H^\circ \), \( \Delta S^\circ \), and \( \Delta G^\circ \) allows one to predict the conditions under which a reaction will occur.
56. The student will be able to describe and calculate the relationship between the standard free energy of reaction and the equilibrium constant.
57. The student will be able to calculate \( \Delta G \) for a chemical reaction that occurs under nonstandard conditions.

The learner will be able write representations of galvanic and electrolytic cells and apply electrochemical calculations to their operation.
58. The student will be able to describe galvanic and electrolytic cells and their operation, including the identification of half reactions at the anode and cathode.
59. The student will be able to write half reactions given a balanced redox reaction, and generate a balanced redox reaction given redox half reactions.
60. The student will be able to calculate cell potentials and determine spontaneity of oxidation/reduction reactions.
61. The student will be able to understand and use Faraday’s Law.
62. The student will be able to understand and apply the relationship of thermodynamics to electrochemistry.
63. The student will be able to understand and use the Nernst Equation.
64. The student will be able to understand the relationship between the cell potential \( E \) and \( \Delta G \), and use this relationship in problem solving.
65. The student will be able to give examples of natural and/or commercial applications of electrochemical processes.
66. The student will be able to use the activity series of metals (optional).
The learner will be able work in the laboratory in accordance with good laboratory practices

67. The student will be able gather and record qualitative and quantitative data accurately.
68. The student will be able to list or describe experimental assumptions made and any deviations from the written experimental procedures.
69. The student will be able to use observations of experimental data to present relevant conclusions pertaining to the experimental procedure.
70. The student will be able handle and evaluate data in logical, productive, and meaningful ways.
71. The learner will be able correlate laboratory work with principal topics in College Chemistry II lecture.

ASSESSMENT OF LEARNER OUTCOMES:
Student assessment is evaluated by means of classroom participation, daily preparation, announced exams, quizzes, laboratory reports, laboratory unknowns, homework, and a two-hour final exam.

SPECIAL NOTES:
A. The student is expected to attend class regularly.
B. If the student is not present when an exam or quiz is given, the quiz or exam can only be made up at the discretion of the instructor.
C. The student may be dropped from the class for non attendance.
D. The student is expected to complete all assigned laboratory experiments.

This syllabus is subject to change at the discretion of the instructor. Material included is intended to provide an outline of the course and rules that the instructor will adhere to in evaluating the student’s progress. However, this syllabus is not intended to be a legal contract. Questions regarding the syllabus are welcome any time.

Kansas City Kansas Community College is committed to an appreciation of diversity with respect for the differences among the diverse groups comprising our students, faculty, and staff that is free of bigotry and discrimination. Kansas City Kansas Community College is committed to providing a multicultural education and environment that reflects and respects diversity and that seeks to increase understanding.

Kansas City Kansas Community College offers equal educational opportunity to all students as well as serving as an equal opportunity employer for all personnel. Various laws, including Title IX of the Educational Amendments of 1972, require the college’s policy on non-discrimination be administered without regard to race, color, age, sex, religion, national origin, physical handicap, or veteran status and that such policy be made known.

Kansas City Kansas Community College complies with the Americans with Disabilities Act. If you need accommodations due to a documented disability, please contact the Director of the Academic Resource Center, in Rm. 3354 or call at: 288-7670.