SAULT COLLEGE
of Applied Arts and Technology
Sault Ste. Marie

COURSE OUTLINE

Physical Chemistry (Theory)

CHM 208-2

revised May, 1979 by D. Heggart

Physical Chemistry (Theory)

CHM 208-2

Introductory physical chemistry is designed to continue the concepts introduced in General Chemistry and in Physics and is taught concurrent with Chemical Processes. The theory includes, kinetic theory of gases, solution chemistry, elementary thermodynamics and thermochemistry.

The laboratory work is related to the physical testing performed in the laboratories of the petroleum, plastics and paint industries.

TEXT BOOKS

1. Physical Chemistry - Scott L. Kittsley - Barnes & Noble Publ. (1965)
2. Chemical Principles - Masterton & Slowinski-Saunders (1969)

REFERENCE TEXTS

1. Physical Chemistry - Gordon M. Barrow - McGraw-Hill (1961)
2. Problems for Introductory University Chemistry - Buller, Danell & Harrison - Addison-Wesley (1967)
3. Laboratory Manual of Physical Chemistry - Crockford & Nowell - Wiley (1967)
4. Experimental Physical Chemistry - Daniels et al.

Physical Chemistry - Theory

CHM 208-2

A student guide for CHM 208-2

Table 1 - Physical Chemistry

- conceptual units for fourth semester physical chemistry course. You will be required to complete each of the following.

1. Introduction and Review of units.
2. Nuclear Chemistry - an insight into the nature of radioactivity.
3. The Ideal Gas Laws and Introduction to the Kinetic Theory of Gases.
4. Liquids - a look at phenomena in liquids
5. Solids - a view of crystal forms and X-ray investigation
6. Heat, Work, Energy & Enthalpy. The First Law of Thermodynamics.
7. Thermochemistry and Calorimetry
8. Randomness, Maximum Work, Entropy.
9. Entropy and Free Energy
10. Nuclear Chemistry - an insight into the nature of radioactivity.

Course Objectives as related to Table 1

1) Review of Units

It will be necessary for the student to review the units of energy, force, pressure; also a knowledge of algebra and graphic representation of data is essential.

Assignment #1

Conversion of Units & Graphing

Ref: K-p 1-2

2. Nuclear Chemistry

The student will complete assignment #9 on radiochemistry (obtainable from instructor).

The student should be able to explain the following:

1. radioactive emissions types
2. nature of emissions
3. nuclear chemistry equations
4. transmutation
5. $t_{1/2}$
6. measurement of radioactivity
7. decay constant
8. construction and operation of a Geiger-Mueller tube

3. The Ideal Gas Laws & Kinetic Theory of Gases

The student should understand the theory associated with and apply it to the following type of problems:

1. Calculations based on PV = nRT and molecular weights

2. Calculations of V, P, T and number of molecules.

3. Per Cent of dissociation in the Gaseous State.

4. Average Velocity of Molecules.

5. Heating gases at constant V and constant P

6. Rates of Effusion.

7. Van der Waal's Equation

Assignment #2 - B & T p.13

Review Questions and Problems K--p.17
Problems - B p.21-24, p.56-58
Test #1 The Gaseous State

4. Liquids

The student will understand the theory associated with and apply it to the following problems:

1. Vapor Pressure as a function of Temperature

2. Dührings Rule

3. Critical constants from Van der Waal's Equation.

4. Capillary Rise and Surface Tension

5. Relative and absolute viscosity

6. Surface Tension from data based on the Drop Method.

7. Trouton's Rule

8. Critical Temperature & Temperature Co-efficients of Surface Tension

Assignment #3 B & T p.31

Review Questions & Problems K - p.27
Problems B - p.537

Test #2

The Liquid State

5. Solids

A view of crystal forms & X-ray investigation

The student should understand the theory and solve problems of the following type:

1) Calculation of Interplanar Distances in crystal from X-ray data.

2) Calculation of wave length of X-rays.

3) Type of cubic lattice from X-ray data.

4) Density of cubic crystals from X-ray data.

5) Heat capacity of solids - Debye equation

Assignment #4 - B & T p.43

Review Questions K-p.35
Problems B - p.387-389

6. The Laws of Thermodynamics

The student should be able to complete problems of the following type:

1. Calculation of Thermodynamics Entities for simple changes - E for reversible and irreversible processes.

2. Compressions and expansions with variable pressure-isothermal.

3. Heat Capacities - Cp and Cv of Ideal Gases

Assignment #5 - B & T p.182 (first half)

Review problems K - p.60-61, B - p.137

7. Thermochemistry & Calorimetry

The student should be able to do problems of the following type:

1. Heats of reaction from calorimeter data.
2. Heats of reaction from Hees's Law.
3. Heats of formation.
4. Heats of combustion.
5. Heats of dissociation of bonds
6. Heats of reaction at constant pressure.
7. Variation in heat of reaction with temperature.
8. Heats of Solution.
9. Heats of Ionization

Assignment #6 B & T p.114

Review Problems K - p.60-61
Problems B - p.160
M-S p.84

Test #3

Thermochemistry

8 & 9. Randomness, Maximum Work, Entropy and Free Energy

The student will do problems of the type above and complete:

Assignment #5

B - p.185

Test #4

Thermodynamics

GAS CHROMATOGRAPHY

General Objectives:

The student will be able to:

1) Operate a gas chromatograph.

2) To analyze an organic liquid mixture qualitatively and identify the components.

Specific Objectives:

1) Draw a calibration curve of gas flow rate in ml/min on the abscissa and tank pressure in lbs/sq. in. on the ordinate.
N.B. Do this for each of the three gases and draw a graph for each.

2) Prepare a column for use in the analysis.

3) Select and set the proper operating parameters for temperature, carrier gas flow and sample injection.

4) Run chromatograms on samples of
a. leaded gasoline
b. non leaded or low leaded gasoline
c. pure toluene
d. pure hexane
e. pure heptane

5) Measure in cm. the adjusted retention times of pure toluene, hexane and heptane.

6) Using the adjusted retention times, identify these components in the gasoline samples.

7) Calculate the areas of the toluene peaks in both gasoline samples.

8) Compare the toluene content of the gasoline samples, which area is the greatest, by how many times.

9) Write a report and submit it together with copies of all chromatograms to the instructor.

SPECTRONIC 20 COLORIMETER

General Objectives:

The student will study the Spectronic 20 colorimeter as an introduction to optical methods of analysis. The emphasis to be mainly on the following.

a) Study the laws of absorption of light
b) Study the fundamental theory of optical methods of analysis.
c) Study of the function of the basic components found in colorimeters.
d) To learn the operation and use of the Spectronic 20 as an optical method of analysis.

SPECTRONIC 20 COLORIMETER

Specific Objectives:

The student should be able to.

1. State the rules for the handling of cuvettes.
2. Determine the optimum wavelength to use in an analysis.
3. Determine the relative response of the phototube.
4. Determine the relative response of the colorimeter.
5. Determine the relative lamp intensity.
6. Draw a graph of items 2 to 5.
7. Obtain data and draw a graph of the absorption spectra for 0.0200 M. Cr (III) NO_3.
8. Indicate, along the top of the graph for items 3 to 5, the colors observed for the various wavelengths of light.
9. Study the Beer and Lambert laws of absorption and make use of them in calculations.
10. Obtain Beer's Law plots for known Cr $(NO_3)_3$ solutions at each of the six selected wavelengths.
11. Determine the concentration (in moles per liter) of an unknown Cr (III) solution.
12. Determine the effect of interferences in optical methods by analysis of a two component mixture.
13. Determine the additivity of absorbancy of Cr (III) and Co (II) solutions.
14. Determine the K's (slope) from Beer's Law plots.
15. Calculate the concentration (moles per liter) of each of the components in a two component mixture (Cr-Co solutions).