#16

INDIANA UNIVERSITY OF PENNSYLVANIA
SENATE CURRICULUM COMMITTEE (B-2)

NEW COURSE PROPOSAL

Department: Chemistry

Persons to Contact for Further Information: Dr. Neil Asting
Dr. Donald McKelvey

Course Affected: None

Desired Effective Semester for Change: Fall 1986

Approvals: Dept. Committee Chairperson: R. R. Kuntz, Jr.

Dept. Chairperson: [signature]

School Committee Chairperson: _____

School Dean: _____

A. Description and Academic Need

A1. Catalog Description:

Department code and number - CH 340

Course title - Physical Chemistry for the Biological Sciences

Credits - 3

Prerequisites - MA 122, 124 or 128 and PY 112 or 132; CH 232

Hours - 3 Lecture Hours per Week

Description - One semester course for Biochemistry and Biology majors. Chemical Thermodynamics, Equilibria, Kinetics; Quantum Mechanics; and Spectroscopy especially as applied to biochemical systems.

A2. Syllabus:

General Description -

This is a one semester course in Physical Chemistry intended primarily for students whose majors are biology or biochemistry. This course will cover the following general topics: chemical thermodynamics, chemical equilibrium, chemical kinetics, quantum mechanics and spectroscopy. With respect to the above topics, special emphasis will be given to show how these areas are applied to biological systems. The development of these topics will primarily depend upon physical ideas rather than the more traditional mathematical approach to Physical Chemistry.

Suggested Text -

Physical Chemistry for the Life Sciences, by Gordon M. Barrow, McGraw-Hill Book Company (Second Edition 1981)

Order of Presentation of Topics -

Week No.	Description
1-2	**Some Properties of Matter and Molecules:** Particle Nature of Light, Macroscopic--Molecular Relations, PVT Behavior of an Ideal Gas, Gas Mixtures, Nonideal Gases, Molecular Motions, Quantum Restrictions, Boltzmann Distribution, Mathematical Review, etc.
3	**Energy Changes in Chemical Reactions:** The First Law of Thermodynamics, Internal Energy and Enthalpy, Heats of Reaction, Heat Capacity, Bond Energies, Molecular Interactions, etc.
4	**Entropy and the Direction of Chemical Change:** The Second Law of Thermodynamics, Reversible and Irreversible Processes, Effect of Phase and Temperature on Entropy Changes, Entropy Changes and Mixing, Molecular Basis for Entropy, The Third Law of Thermodynamics, Entropy Changes and the Direction of Chemical Reactions, etc.
5	**Free Energy:** Introduction to Free Energy, Standard Free Energies for Pure Substances, Dependence of Free Energy on Pressure and Temperature, Free Energy and Solutions, Activities and Activity Coefficients, Partial Molal Quantities, etc.
6	**Chemical Equilibrium and Chemical Driving Forces:** Free Energy and the Equilibrium-Constant Expression, Free Energy and the Extent of Reaction, Temperature Dependence of Free Energy and the Equilibrium Constant Electrochemical Cells, EMF and Free Energy, The Nernst Equation, Standard Electrode Potentials and Activity Coefficients, etc.
7	**Equilibria in Chemical and Biological Systems:** Proton Transfer Reactions, Titration Curves and Degree of Protonation, Acid Dissociation Constants and Degree of Protonation, Buffers, Phosphate Group Transfer Reactions, Simultaneous Equilibria Coupled Reactions, Binding at Individual

Binding Sites, Expressions for Sequential Binding, Independent and Equivalent Binding Sites, etc.

8 **Physical Equilibria & Membrane Phenomena:** Vapor Pressure of a Liquid, Physical Equilibria Involving Solutions, Colligative Properties, Molecular Weights from Osmotic Pressure, Dialysis Equilibria, Donnan Membrane Equilibria, Ion Transport and Membrane Potentials, Active Transport, etc.

9 **Rates of Transport Processes:** Diffusion, Determination of Diffusion Coefficients, Diffusion and the Random Walk, Molecular Interpretation of Diffusion, Ultra-Centrafuge and Sedimentation-Velocity Methods, Sedimentation-Equilibrium Method, Electrophoresis, Shapes of Macromolecules in Solution by Viscosity Measurements, etc.

10 **Rates of Chemical Reactions:** Measurement of Rates of Chemical Reactions, Rate Equations, Fitting Data to a First-Order Rate Equation, Fitting Data to a Second-Order Rate Equation, Enzyme-Catalyzed Reactions, Inhibition of Enzyme Action, Series of Reactions, Relaxation Methods, Temperature Dependence of Rates of Chemical Reactions, Photochemical Reactions, etc.

11 **Reaction Mechanisms:** Elementary Reactions in Liquid Solution, Reaction Mechanism and Rate Law - The Stationary State Method, A Mechanism for Enzyme-Catalyzed Reactions, Mechanisms for Inhibited Enzyme-Catalyzed Reactions, Theories of the Elementary Reaction Process, etc.

12-13 **Spectroscopy and Quantum Mechanics** Uses of Spectroscopy, Beer's Law, The Schrodinger Equation, Three-Dimensional Quantum-Mechanical System, The Hydrogen Atom Wave Functions, Introduction to Bonding, U.V.-Visible Specroscopy, Fluorescence, I.R. and Microwave Spectroscopy, Infrared-Region Vibrational Spectra, Molecular Vibrations and Infra-red Spectra, Microwave-Region Rotational Spectra, Nuclear Magnetic Resonance (NMR) Spectroscopy, Rates of Reaction from NMR Spectroscopy, Optical Rotation, Circular Dichroism, Optical Rotatory Dispersion, etc.

14 **Molecules in Crystals; Molecular Structure:** Classification of Crystals and Their Internal Structures, X-Ray Diffraction and the Determination of Fiber Structure, X-Ray Diffraction Determination of Crystal Structure, The Unit Cell, Intensities of Diffraction and the Structure within the Unit Cell, Structures from Fourier Synthesis, Structural Results and Some Aspects of Protein Structures, etc.

A3. Academic Need:

This course is a required part of a newly proposed major at IUP: B.S. Degree in Biochemistry. In terms of the "how" and "why" of this science, modern biochemistry takes a view that is increasingly "molecular" in its approach. Thus, in order for students of this major to gain full insight into biochemical processes, a firm foundation on the physical laws and principals which govern all "chemical" systems is needed. This special Physical Chemistry Course with emphasis on systems of biological interest is intended to meet this need.

Effect on Dept. Programs:

The proposed course should have little or no effect on department programs. A slight drop in the enrollment of CH 341 (P. Chem. I) is expected because some biology majors who currently take CH 341 would probably take this new course.

Clientele:

Students of the proposed B.S. Biochemistry Program and a few B.S. Biology students who are interested in this topic are the ones most likely to take this course.

General Education:

This course is <u>not</u> being proposed for inclusion on the regular General Education course list.

A4. Effect on Content of Existing Courses or Programs:

The proposed course will have <u>no</u> effect on the current contents of existing courses or programs in the Chemistry Department.

A5. Type of Offering:

This course will follow the traditional type of offering by the Chemistry Department.

A6. Trial Offering:

A somewhat similar course was offered for B.S. Biology Students several years ago as a special topics course. Low enrollment and lack of manpower forced the department to drop this course at that time. Since then, additional faculty have been hired and anticipated student demand for the proposed Biochemistry Program should now make this course viable.

A7. Dual-Level:

This course will not be dual-level.

A8. Other Institutions Offering this Type of Course:

The following east-coast institutions offer courses using the same text book which is proposed for this course:

1. Georgetown College, Washington D. C.
2. Towson State College, Towson, Md.
3. West Chester University of Pa., West Chester, Pa.
4. Western Maryland College, Westminster, Md.
5. Smith College, Northampton, Mass.
6. Rutgers, New Brunswick, N.J.
7. Marshall University, Huntington, W. Va.

B. <u>Interdisciplinary Implications</u>

B1. Instruction:

The proposed course will not be team taught.

B2. Additional Courses:

No additional courses will be needed.

B3. Relationship of the Course Content with the Content of Courses in Other Department:

No similar courses are offered by other departments.

B4. Continuing Education:

This proposed course would be of no interest to the School of Continuing Education.

C. Evaluation

C1. Student Evaluation:

The evaluation of student performance in this course will arise from three primary sources: homework assignments, hour examinations and a cumlative final examination. More specifically, it is anticipated that 8-10 homework exercises would be assigned during the course of the semester and that 3-4 hour examinations would be also be administered. Finally, a comprehensive final examination would be given during the normally scheduled final exam period. These three sources would then contribute the following percentages to the total score:

Source	Percentage
Homework (8-10 sets)	15% (total)
Hour Exams (3-4)	60% (total)
Final Exam	25%

C2. Variable Credits:

This course will be assigned 3 credits and will not have a variable number of credits associated with it.

D. Implementation

D1. Resources Needed:

a. Faculty - Currently, the Chemistry Department has the personnel needed to teach this course.

b. Space & Equipment - No equipment other than standard audio-visual aids which the department already possesses are neeeded. The department has sufficient class room space to teach this course.

c. Laboratory Supplies - None are needed for this lecture course.

d. Library Materials - No additional materials are needed for a course at this level.

e. Travel Funds - None are needed for this course.

D2. Frequency:

This proposed course will be offered for the first time in the third year following the implementation of the proposed B.S. Biochemistry major. It will then be offered every year thereafter in the Spring semester.

D3. No. of Sections:

Since the number of majors in this proposed Biochemistry program most likely will be small and since only a few Biology students would be interested in this course, only one section would be offered.

D4. No. of Students:

The number of students that we plan to accommodate in this course is simply limited to the size of the lecture room that the course is taught in. Most likely we will be able to accept all students (with the proper prerequisites) who sign-up for this course.