The Hebrew University of Jerusalem

Syllabus

PHYSICAL CHEMISTRY B - 69301

Last update 22-10-2024

HU Credits: 6

Degree/Cycle: 1st degree (Bachelor)

Responsible Department: Chemistry

Academic year: 0

Semester: 1st Semester

Teaching Languages: Hebrew

Campus: E. Safra

Course/Module Coordinator: Prof. Liraz Chai

Coordinator Email: daniel.harries@mail.huji.ac.il

Coordinator Office Hours: open door policy - office hours by appointment by e-mail.

Teaching Staff:

Prof. Liraz Chai,
Mr. Gil Olgenblum,
Mr. Yehonathan Levy

Course/Module description:

*This is a first course dedicated to the field of thermodynamics.
The course reviews the basic terms (energy, heat, work, enthalpy, entropy, free energy, hear capacity, etc.) and the fundamental laws (I,II,III) of thermodynamics, providing insights into the fundamental forces that drive chemical reactions.*

Course/Module aims:

See Learning Outcomes.

Learning outcomes - On successful completion of this module, students should be able to:

1. Understand the energetics that drive chemical reactions and physical changes in macroscopic systems

2. Quantitatively analyze processes and reactions in thermodynamic terms.

3. Understand the relationship between macroscopic properties and the molecules that make up matter.

4. Be able to give exact definitions for basic thermodynamic properties, e.g.: the laws of thermodynamics, energy, heat, work, enthalpy, entropy, temperature, pressure, equilibrium constant, etc.

5. Solve questions with different levels of complexity, reviewed in the course.

Attendance requirements(%):

80

Teaching arrangement and method of instruction: Lecture and Exercise. Exercise-solving workshops.

Course/Module Content:

Types of thermodynamical systems, thermodynamical variables, constraints. Equilibrium. State functions and exact differentials.

The ideal gas equation of state. real gases and critical behavior. van der Waals *equation. The virial theorem and intermolecular forces.*

The first law of Thermodynamics: (internal) energy, heat and work. Calculations of work. Maximum work and reversible processes. Enthalpy. Thermochemistry. Heat capacity.

The second law of Thermodynamics: Number of states and entropy. Law of increasing entropy. Removal of internal constraints and thermal and mechanical equilibria. Statistical definitions of temperature and pressure. Heat engines. Entropy changes.

Free energies. Maxwell relations. Free energy by Gibbs and Helmholtz. Thermodynamic potentials. Spontaneity of processes and maximum work. The third law.

Phase transitions. The chemical potential, its physical meaning and dependence on temperature and pressure. Phase equilibrium. Clausius–Clapeyron relation. Phase diagrams and Gibbs' phase rule.

Chemical equilibrium: equilibrium in gas and ideal solutions. Equilibrium constant - dependence on temperature (van't Hoff equation).

Mixtures. Partial molar properties, Gibbs–Duhem equation. Ideal and non-ideal mixtures. Mixing entropy.

Ideal and non-ideal mixtures. Henry's and Raoult's laws. Colligative properties: boiling point, freezing point, osmotic pressure.

Required Reading:

The topics are covered in many basic physical chemistry books, such as those by: Castellan, Levine, Atkins, Moore, Silbey and Alberty
Specific references for these books will be given in the course.

Additional Reading Material:

K.A. Dill (Molecular Driving Forces)
Callen (Thermodynamics and Thermostatistics)
Reif (Fundamentals of Statistical and Thermal Physics)

Grading Scheme:

Written / Oral / Practical Exam 80 %
Mid-terms exams 20 %

Additional information:

1. A requirement to taking the final exam is at least 10 submitted exercises with a passing grade.

2. Participation in at least 10 workshops is recommended.

3. One midterm exams will be conducted and it will count for up to 15% of the final grade as long as they improve it (i.e., "magen").

4. Up to 5 bonus points will be awarded for in-class assignments.