האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

# *The Hebrew University of Jerusalem*

## *Syllabus*

# *PHYSICAL CHEMISTRY A - 69163*

*Last update 08-04-2024*

*HU Credits: 4*

*Degree/Cycle: 1st degree (Bachelor)*

*Responsible Department: Chemistry*

*Academic year: 0*

*Semester: 2nd Semester*

*Teaching Languages: Hebrew*

*Campus: E. Safra*

*Course/Module Coordinator: Prof. Elad Gross*

*Coordinator Email: elad.gross@mail.huji.ac.il*

*Coordinator Office Hours: By appointment*

*Teaching Staff:*

*Prof Elad Gross,*
*Ms. Einav Scharf,*
*Mr. Yinon Deree*

*Course/Module description:*

*First course in the field of physical chemistry for chemistry students, which focuses on the fundamentals of physical chemistry. The guideline is a physical quantitative analysis of chemical reactions and phenomena.*
*The course includes quantitative treatment of gas properties and the kinetic theory of gases. In addition, it deals with chemical kinetics, i.e. the rate of chemical reactions.*
*The course covers definitions and basic concepts (reaction rate, rate law, reaction order, etc.), experimental measurements of reaction rates, reaction mechanisms, temperature-dependence, potential energy surfaces, etc. Applications in the fields of chemistry of the atmosphere, enzymatic reactions and photochemistry are also discussed.*

*Course/Module aims:*

*See Learning Outcomes.*

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

*Describe chemical phenomena in a physical approach using mathematical models.*

*Define and classify chemical reactions according to kinetic properties.*

*Know experimental methods for rate measurements and determination of reaction orders.*

*Know the fundamentals of the kinetic theory of gases and its application to the understanding of chemical processes in the gas phase.*

*Know fundamental concepts in photochemistry.*

*Attendance requirements(%):*

*None*

*Teaching arrangement and method of instruction: Lecture and Exercise*

*Course/Module Content:*

*A. Mathematical Background.*
*B. Introduction to Chemical Kinetics.*
*C. Definitions and Basic Concepts:*
*rate of reactions, rate laws, rate constants, order of reaction (partial, full, and pseudo), reaction mechanisms, elementary and complex reactions.*
*D. Measuring Reaction Rates (Chemical and Physical Methods).*
*E. Elementary Reactions of 0,1,2,3 and n order.*
*Reversible (equilibrium), sequential and parallel reactions.*
*F. Methods for Determination of Order of Reactions.*
*G. Complex Reactions and Reaction Mechanisms*
*Assumption and approximations: rate-determining step, steady state, fast equilibrium.*
*H. Examples for Mechanisms:*
*Unimolecular Reactions & Lindemann Mechanism.*
*Catalysis and enzymatic catalysis – Michaelis-Menten Mechanism.*
*Radioactive decays.*
*A taste of photochemistry – Jablonski diagram, competing reactions, quantum yield, Stern-Volmer Equation.*
*I. Dependence of Reaction Rate of Temperature*
*Activation energy and reaction profile.*
*Arrhenius equation.*
*J. The Kinetic Theory of Gases:*
*Basic concepts and assumptions.*
*Maxwell-Boltzmann speed and kinetic energy distributions.*
*Obtaining average and most probable values.*
*Collision theory, cross-sections for collision and reaction, mean free path.*
*Effusion.*
*Linking kinetic theory to reaction rates.*
*K. The Molecular Basis for Rate Constants of Reactions:*
*Collision theory vs. rate constants.*
*Potential energy surfaces (PES), reaction coordinate.*

*L. Transport Properties:*
*heat conductivity, diffusion, viscosity, diffusion-controlled reactions, mobility of ions in solution, transference numbers, ion conduction.*

*Required Reading:*

*Levine I., Physical Chemistry (5th Edition or later), McGraw-Hill, Boston, 2002. (QD 453.2 L49 2002)*

*Additional Reading Material:*

*Any book dealing with the basics of physical chemistry, e.g.:*
*1. Atkins P.W. and de-Paula J., Physical Chemistry (8th Edition or later), W.H.*

*Freeman, New York, 2002. (QD 453 A88 1994/1998/2002)*
*2.McQuarrie D.A. and Simon J.D., Physical Chemistry – a Molecular Approach, University Science Books, California, 1997*

*For advanced reading:*
*• Levine R.D., Molecular Reaction Dynamics, Cambridge University Press, New York, 2005. (QD 461 L66 2005)*

*Grading Scheme:*
*Written / Oral / Practical Exam 80 %*
*Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 20 %*

*Additional information:*
*A weekly homework exercise. Handing of at least 8 exercises. 20% of the final grade will be based upon the averaged grade of 8 exercises. Lower number of home excersies will lead to a decrease of 3 points in the final grade for each missing excerise.*

*Recordings will be released after two weeks.*