CH-242(b) **Statistical thermodynamics**

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Cursus	Sem.	Type
Chemistry and chemical engineering	BA4	Obl.
HES - CGC	E	Obl.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

This course enables the acquisition of basic concepts in statistical thermodynamics including the Boltzmann distribution law, partition functions, ensembles, calculations of thermodynamic properties, Bose-Einstein and Fermi-Dirac statistics, metals, semiconductors, p-n junctions and photovoltaics.

Content

1. The Boltzmann distribution law
Derivation, Approximation

2. Partition function
The translational, rotational, vibrational and electronic partition functions

3. Thermodynamic functions from statistical thermodynamics
U, *CV,* heat and work, Entropy, Helmholtz' and Gibbs' free energies, Chemical potential

4. Ensembles
The canonical ensemble, the canonical partition function, the equilibrium constant

5. Quantum statistics
Bose-Einstein statistics, Fermi-Dirac statistics, the grand canonical partition function

6. Applying partition functions and ensembles
Heat capacity of solids, Computational chemical methods

7. The solid state
Electronic energy levels and density of states in metals, Fermi level

8. Semiconductors
Energy levels, density of states, intrinsic semiconductors, n- and p-doping

9. p-n junctions
Equilibrium. applied bias, diode equation, photovoltaics

Keywords

Boltzmann distribution
Partition function
Ensembles
Quantum statistics
Semiconductors

p-n junction

Learning Prerequisites

Important concepts to start the course

Laws of thermodynamics
Equations for quantum energy levels of particle-in-a-box, rotation and vibtration.

Learning Outcomes

By the end of the course, the student must be able to:

- Contextualise the connection between quantum mechanics and thermodynamics
- Apply the molecular partition functions
- Derive the vibrational and translational partition function
- Derive and compute thermodynamic functions from partition functions
- Describe the different ensembles
- Apply Fermi-Dirac and Bose-Einstein statistics to solids
- Demonstrate the formation of a p-n junction
- Describe the principles of photovoltaics

Teaching methods

Lectures with hand outs. Exercises.

Assessment methods

Written exam

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

Handouts of Lecture Notes and exercises

Reference books:
Benjamin Widom, Statistical Mechanics: A Concise Introduction for Chemists, Cambridge University Press - 2002, ISBN-13: 978-0521009669
Donald A. McQuarrie, Statistical Mechanics, University Science Books - 2000, ISBN - 1-891389-15-7.

For introduction and as a reference for classical thermodynamics

Pierre Infelta & Michael Grätzel, Thermodynamique: Principles et Applications. BrownWalker Press - 2006. ISBN - 1-58112-995-5.

Ressources en bibliothèque

- Thermodynamique / Infelta

- Statistical mechanics / Widom
- Statistical mechanics / McQuarrie