Department of Physics

Stockholm University

Syllabus

for course at first level

Atomic and Molecular Physics
Atom- och Molekylfysik

7.5 Higher Education Credits
7.5 ECTS credits

Course code:	FK5023
Valid from:	Summer 2022
Date of approval:	2016-02-29
Changed:	2022-02-22
Department	Department of Physics
Main field:	Physics
Specialisation:	G2F - First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Decision

Prerequisites and special admittance requirements

For access to the course knowledge and skills equivalent to the following courses is required:
• Mathematics for Natural Sciences I, 15 hp (MM2002)
• Mathematics for Natural Sciences II, 15 hp (MM4001)
• Mathematics II - Analysis, part A, 7.5 hp (MM5010)
• Mathematics II - Analysis, part B, 7.5 hp (MM5011)
• Classical Physics, 30 hp (FK3014)
• Quantum Mechanics, 7.5 hp (FK5020)
• Programming, numerical methods and statistics for physicists, 15 hp (FK4026) or both of the courses Physics with digital tools, 7.5 hp (FK4025) och Probability theory and statistics for teachers, 7.5 hp (MT1011)
• Electromagnetism and waves, 7.5 hp (FK5019)

Course structure

Examination code	Name	Higher Education Credits
HELA	Atomic and molecular physics	7.5

Course content

One- and multi-electron atoms are studied quantum mechanically, where the effects due to spin, the fine-structure, and the hyperfine structure are also taken into consideration. Time-independent perturbation theory is discussed in detail, and used to describe both the fine-structure and Zeeman effects in atoms. The physical basis for the binding in diatomic molecules and simple polyatomic molecules is discussed. The fundamental approximations which underpin the theoretical descriptions of molecules are studied. The variational principle is used to calculate atomic and molecular wavefunctions. The interaction of atoms and molecules with electromagnetic radiation is studied and the selection rules governing these interactions discussed.

Learning outcomes

After completing the course the student will be expected to be able to:
• explain and use the central concepts, theoretical descriptions, and fundamental approximations of atoms and molecules.
• treat the quantum mechanical formalism for identical particles and apply these to the structure of atoms.

• master techniques such as time-independent perturbation theory and the variational principle and apply them to both atoms and molecules.
• use the "aufbau-principle" and concepts such as atomic and molecular orbitals to obtain insight into the physical properties of the system.
• explain how the interaction between the particles allows a molecule to be formed
• explain the relationship between atomic and molecular properties.
• describe, carry out, and evaluate the various spectroscopic methods used to study atoms and molecules, and justify the choice of method to examine a specific property
• exemplify the importance of atomic and molecular physics for society and the environment.

Education

The education consists of lectures and laboratory work.
Participation in laboratory work and any associated integrated instruction is compulsory. In the event of special circumstances, the examiner may, after consultation with the teacher concerned, grant a student exemption from the obligation to participate in certain compulsory instruction.

The course will be given in English if requested by any student enrolled.

Forms of examination

a. The course is examined as follows: knowledge assessment takes the form of written exam and oral presentation of the laboratory work.

If the instruction is in English, the examination may also be conducted in English.

b. Grades will be set according to a seven-point scale related to the learning objectives of the course:
A = Excellent
B= Very good
C = Good
D = Satisfactory
E = Adequate
Fx = Fail, some additional work required
F = Fail, much additional work required

c. The grading criteria will be distributed at the beginning of the course.

d. In order to pass the course, a minimum grade of E is required.

e. Students who receive a failing grade on a regular examination are allowed to retake the examination as long as the course is still provided. The number of examination opportunities is not limited. Other mandatory course elements are equated with examinations. A student who has received a passing grade on an examination may not retake the examination to attain a higher grade. A student who has failed the same examination twice is entitled to have another examiner appointed, unless there are special reasons to the contrary. Such requests should be made to the department board.

The course includes at least two examination opportunities per year when the course is given. At least one examination opportunity will be offered during a year when the course is not given.

f. Students awarded the grade Fx are given the opportunity to improve their grade to E. The examiner decides the supplementary assignments to be performed and the pass mark criteria. The supplementary assignments will take place before the next examination session.

Interim

Students may request that the examination be conducted in accordance with this course plan even after it has ceased to be valid. However, this may not take place more than three times over a two year period after course instruction has ended. Requests must be made to the departmental board. The provision also applies in the case of revisions to the course plan (and the revisions of the course literature).

Limitations

The course may not be included as a part of a degree together with the courses Quantum Mechanics II, 7.5 credits (FK5012), Atomic Physics, 7.5 credits (FK7002) and Molecular Physics, 7.5 credits (FK7012) or equivalent.

Misc

The course is included in the Bachelor programme in Physics and the education for teachers. It can also be

studied as a separate course.

Required reading

The course literature is decided by the department board and published on the Department of Physics's website at least two months before the start of the course.