CH-110 Advanced General Chemistry I

Prof. A. Steinauer

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French

- This part of the class will be taught **in English.**
- We will do our best to support you during this transition:

  Recordings with French subtitles

  Lecture transcripts in French

  You can ask questions in French in class (I'll do my best!) and on the forum.

  Five of our six teaching assistants speak French (see separate slide).
- For my part of the exam (atomic structure), the questions will be in English and in French. You can write your answers in English or French.

CH-110 Advanced General Chemistry (Fall 2025)

- Lectures:

  Tuesday, 16:15-18:00, BCH 2201

  Friday, 11:15-12:00, ELA1

- Exercises:

  Friday, 13:15-14:00, AAC231

Course organization and exam

- Part I: 9 weeks (A. Steinauer, atomic structure)
- Part II: 5 weeks (J. Waser, organic chemistry, in French)

- Two 3-hour written exams during the winter exam session 2025/26:

  Steinauer/Waser (3 hours)

  Fierz (3 hours)

- No material other than that provided is permitted during the examination.
- You will be provided with a periodic table and a list of formulas (see Moodle for last year's versions)

Changes compared to last year

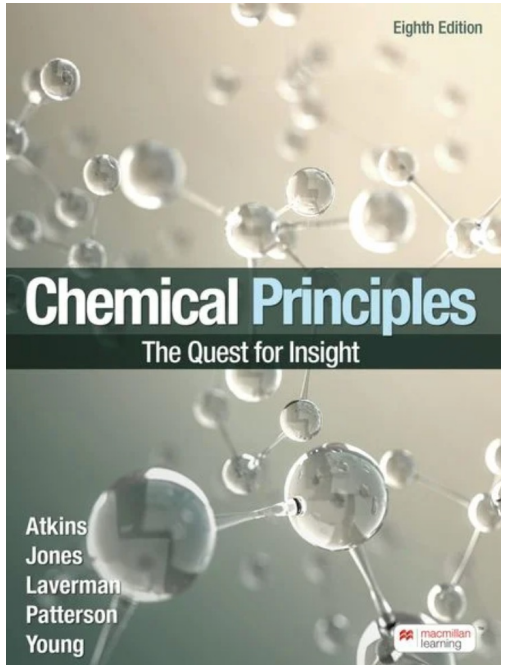
Student feedback	Change this year
Too many slides	Will try to condense material, do the important parts on the blackboard
Not clear what students are expected to know at exam	Clearer communication: the exercises provided in class and in the book are the most important practice opportunity!
Exercises were not aligned with lecture material	I will double-check each week if there are exercises that you cannot solve because we didn't cover the material in class.
Not enough practice exams	There is one now. The best practice opportunity are the exercises in the book.

Lecture content and exercises

- Syllabus online
- Textbook: Chemical Principles – The Quest for Insight by Atkins, Jones et al.
- Available at the EPFL bookstore
- Exercises:

  Weekly. Not graded.

  Form study groups!



Moodle

- https://moodle.epfl.ch/course/view.php?id=15739
- Slides, exercises, recordings will be uploaded weekly
- Forum to ask questions:
- https://edstem.org/eu/courses/2603/discussion
- Announcements

Teaching assistants

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Yannick Calvino Alonso	Fr, En, Spanish, German	yannick.calvinoalonso@epfl.ch
Tuna Karasu	Fr, En, Turkish	tuna.karasu@epfl.ch


Georges


Paula


Ollie


Diogo


Yannick


Tuna

Clicker questions

- http://responseware.eu
- Session ID: _____

What's your native language?

A. French
B. English
C. German
D. Italian
E. Other

What You Can Expect from Me

- **Dedication:** Preparing these lectures takes significant time, and I am committed to delivering quality content that helps you succeed.
- **Openness to feedback:** I am receptive to constructive feedback. You will have the opportunity to provide feedback through Moodle.
- **Answering questions:** I encourage you to attempt finding the answer yourself first. If needed, both the TAs and I are available to help guide you in the right direction.
- **Investment in your success:** I genuinely want you to do well and will support you in your academic journey!

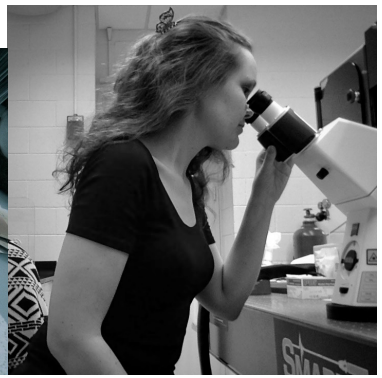
What I Expect from You:

- **A respectful and productive classroom environment:** Please engage with the material and avoid distractions. If you need to discuss something with your peers during class, keep your conversation quiet so as not to disturb others. If the matter is urgent and can't wait, feel free to step outside and continue your discussion over coffee. I don’t mind.
- **Curiosity and openness to learning:** Challenge yourself to ask, "Is this a question I could answer on my own with a bit of effort?”
- **Responsibility for learning**: You are responsible for your own learning. This means attending class and independently solving exercises, keeping up with the reading, and taking ownership of your progress.

Definition of Chemistry

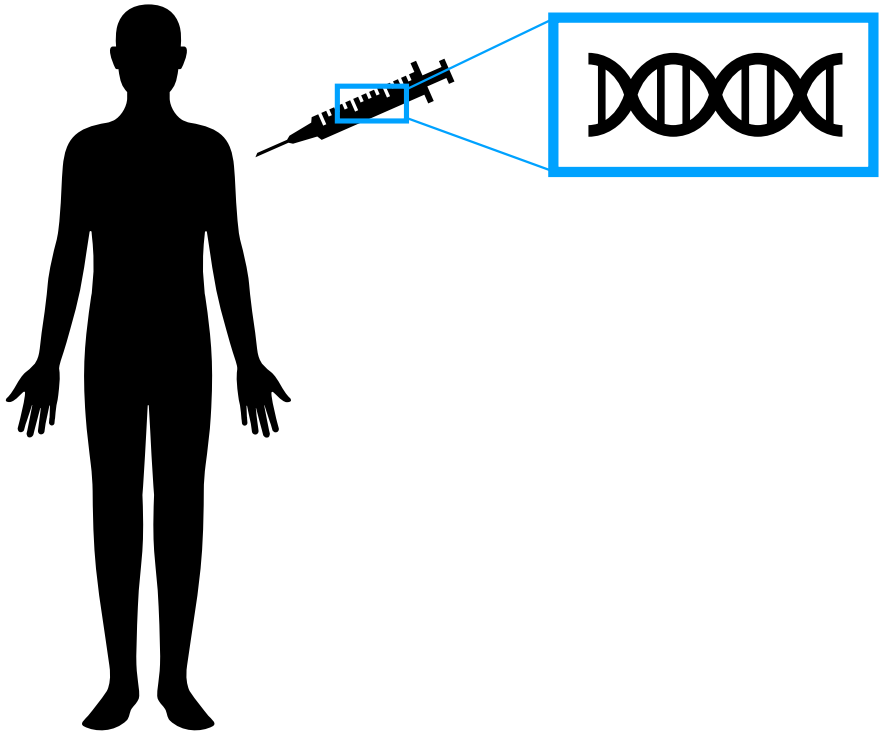
- Chemistry is the science of matter and the changes it can undergo.

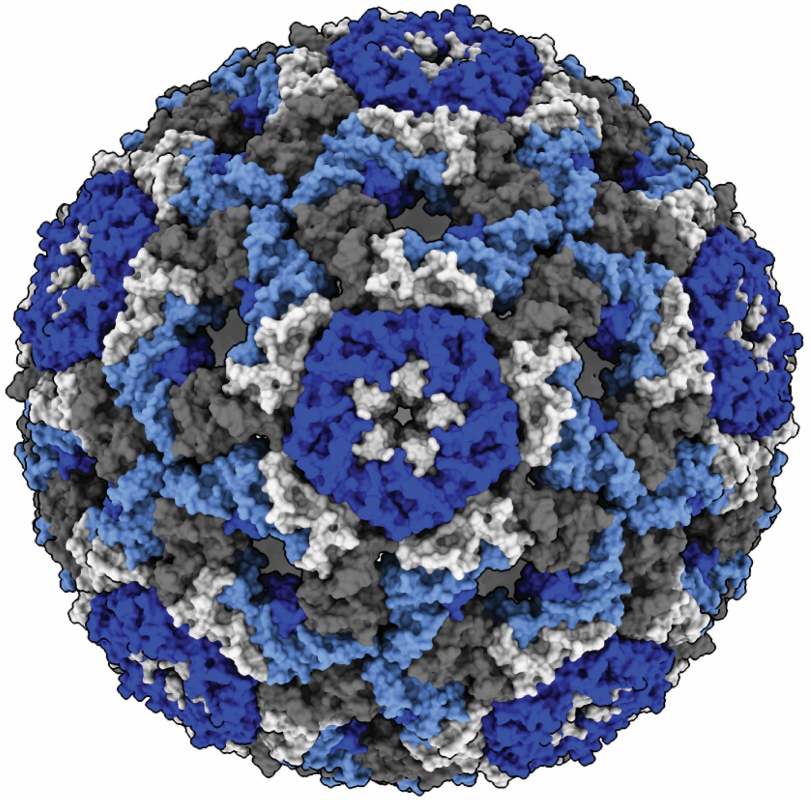
Why I studied chemistry



Why did you choose to study chemistry?

What can you do with this course?





Overview of this course

FOCUS 1: ATOMS

Topic 1A: Investigating Atoms

Topic 1B: Quantum Theory

Topic 1C: Wavefunctions and Energy Levels

Topic 1D: The Hydrogen Atom

Topic 1E: Many-Electron Atoms

Topic 1F: Periodicity

Chapters from "Chemical Principles – The Quest for Insight" Atkins, Jones, et al.

FOCUS 2: BONDS BETWEEN ATOMS

Topic 2A: Ionic Bonding

Topic 2B: Covalent Bonding

Topic 2C: Beyond the Octet Rule

Topic 2D: The Properties of Bonds

Topic 2E: The VSEPR Model

Topic 2F: Valence-Bond Theory

Topic 2G: Molecular Orbital Theory

FOCUS 3: STATES OF MATTER

Topic 3D: Intermolecular Forces

Topic 3F: Liquids

Topic 3G: Solids

Early chemists

- Prepared glass, jewels, coins, ceramics, and, inevitably, weapons:

  Art, agriculture, & warfare

- Alchemy & mysticism:

  The Philosopher's stone: a material that will turn cheap metals into gold and silver

The Alchemist
Ink on paper attributed to Philip Galle after Pieter Bruegel the Elder (*c.* 1558)

Chemistry shapes the modern world

- **Steel**: industrial revolution
- **Chemical industry**: fertilizers, communication, transportation, enhanced materials:

  Polymers → *fabrics*

  Ultrapure silicon → *computer chips*

  Glass → *optical fibers*

  Renewable fuels

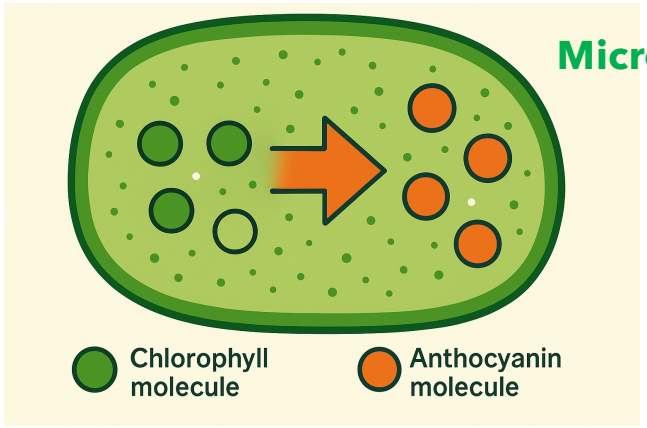
  Tough & light alloys for ***air travel***
- **Medicine** → higher life expectancy because of chemistry, genetic engineering
- **Climate change**

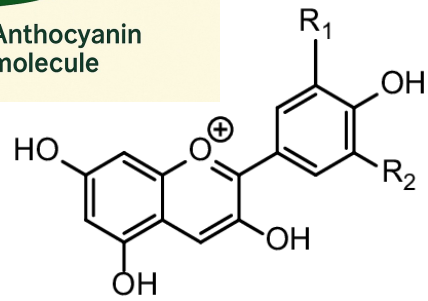
Image source: ChatGPT

Chemistry is a science at three levels

- **Macroscopic**: Matter and transformations (a leaf turns orange).
- **Microscopic**: (Re)arrangement of atoms (molecular changes that make the leave turn orange).
- **Symbolic**: Chemical symbols and mathematical equations.

A chemist thinks at the microscopic level, conducts experiments at the macroscopic level, and represents both symbolically.





Symbolic

How science is done: The scientific method

- **Meticulously careful** and **highly creative**

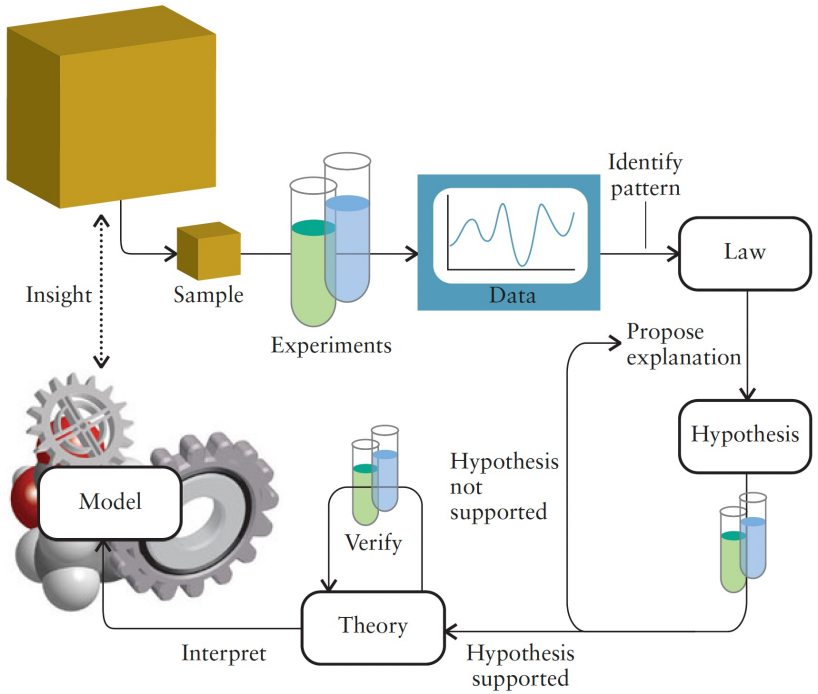


Figure 4

- **Law**: succinct summary of a wide range of observations
- **Hypothesis**: possible explanation of the law
- **Theory**: formal explanation of the law
- **Model**: a simplified version of the object of study that scientists can use to make predictions

Branches of chemistry

- **Organic Chemistry:** Carbon compounds, hydrocarbons, biomolecules
- **Inorganic Chemistry:** Metals, minerals, non-organic compounds
- **Physical Chemistry:** Thermodynamics, kinetics, quantum & computational chemistry
- **Analytical Chemistry:** Composition, techniques, instrumentation
- **Biochemistry/Chemical Biology/Biological Chemistry:** Enzymes, proteins, nucleic acids, metabolism, biomedical applications
- **Environmental Chemistry:** Pollution, green chemistry, ecosystems

Which subfield of chemistry are you (currently) most interested in?

A. Organic chemistry
B. Inorganic chemistry
C. Physical chemistry
D. Analytical chemistry
E. Biochemistry/chemical biology
F. Environmental chemistry
G. Other

Fundamentals

Please review Fundamentals A yourself (slides on Moodle):

A: Matter and Energy

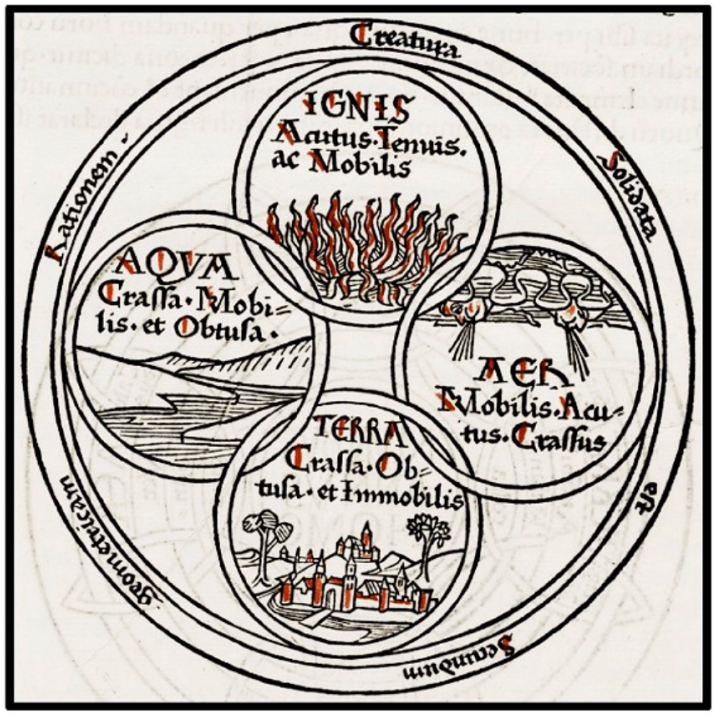
B: Elements and Atoms

Science: how are things organized? A quest for simplicity

Ancient Greek:

four elements: water, earth, fire, air

Today: +100 elements



De responsione et de astrorum ordinatione
Yale Beinecke Rare Book and Manuscript Library (*1472*)

Atoms

Individual atoms by scanning tunneling microscopy

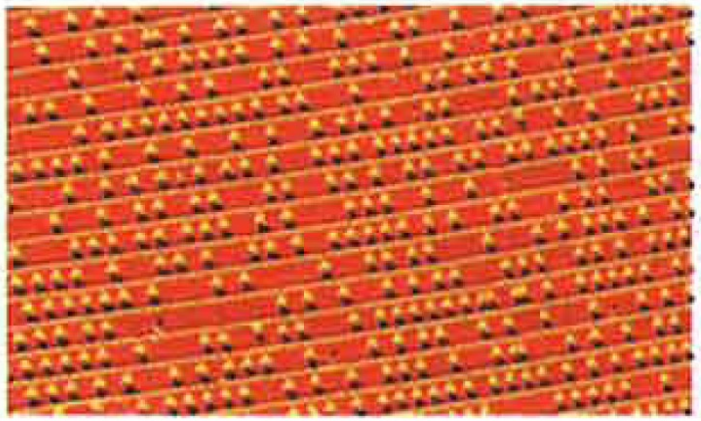


Figure B.3

Atomic hypothesis (Dalton)

The nuclear model

The nuclear model

Figure B.4

Mass spectrometry

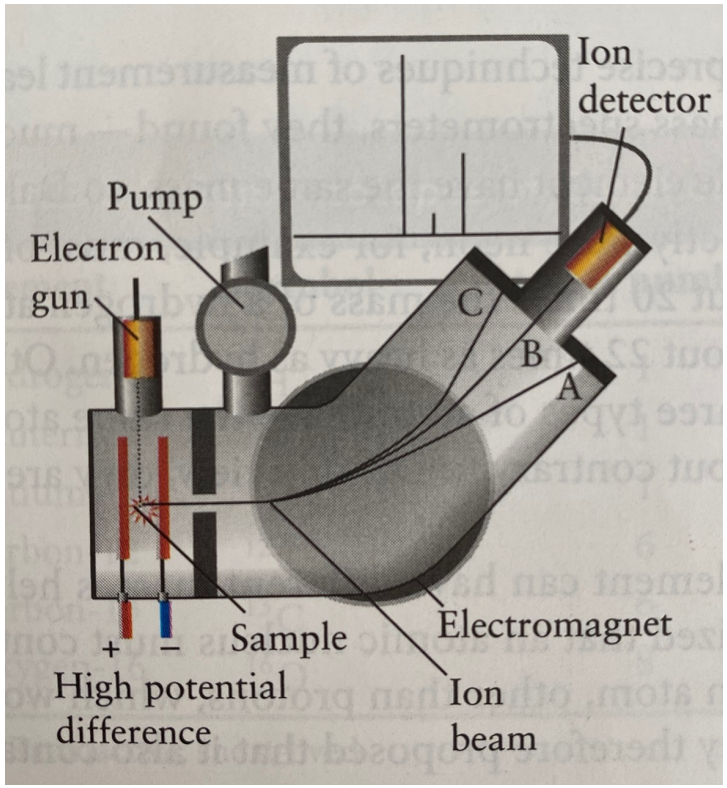


Figure B.5

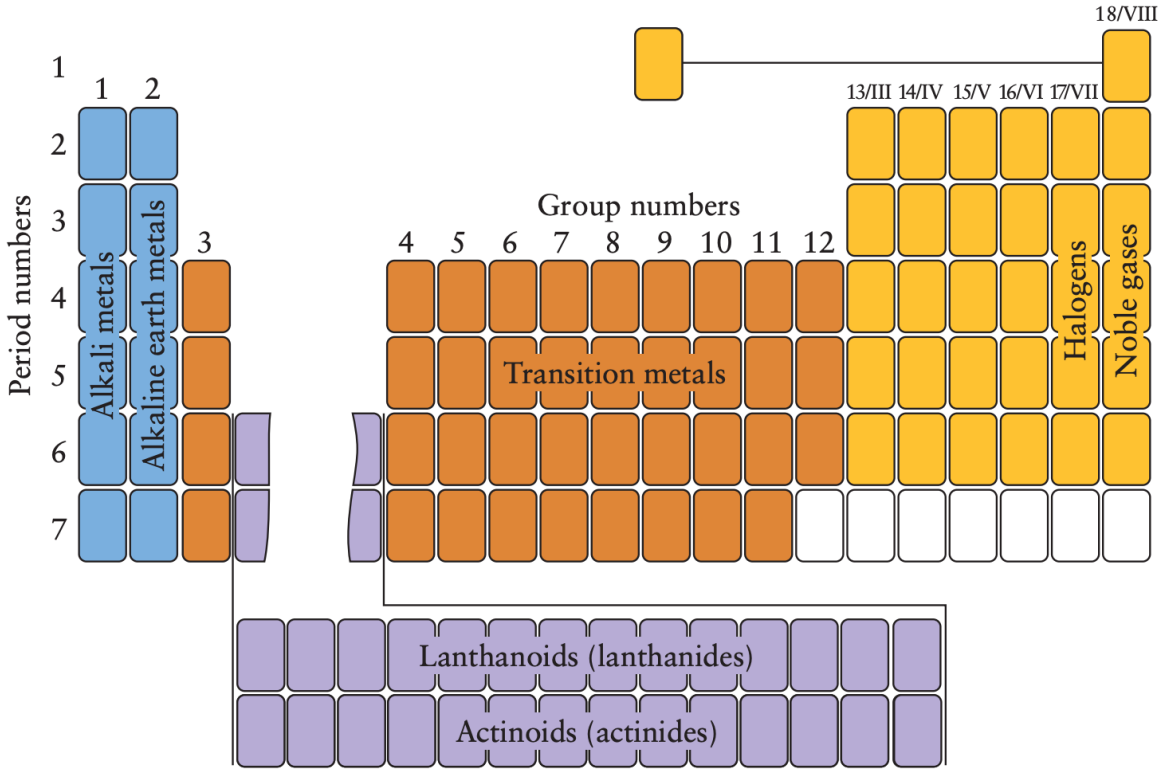
Isotopes

Isotopes and mass number

Isotopes and mass number

The organization of the elements

The periodic table



The periodic table

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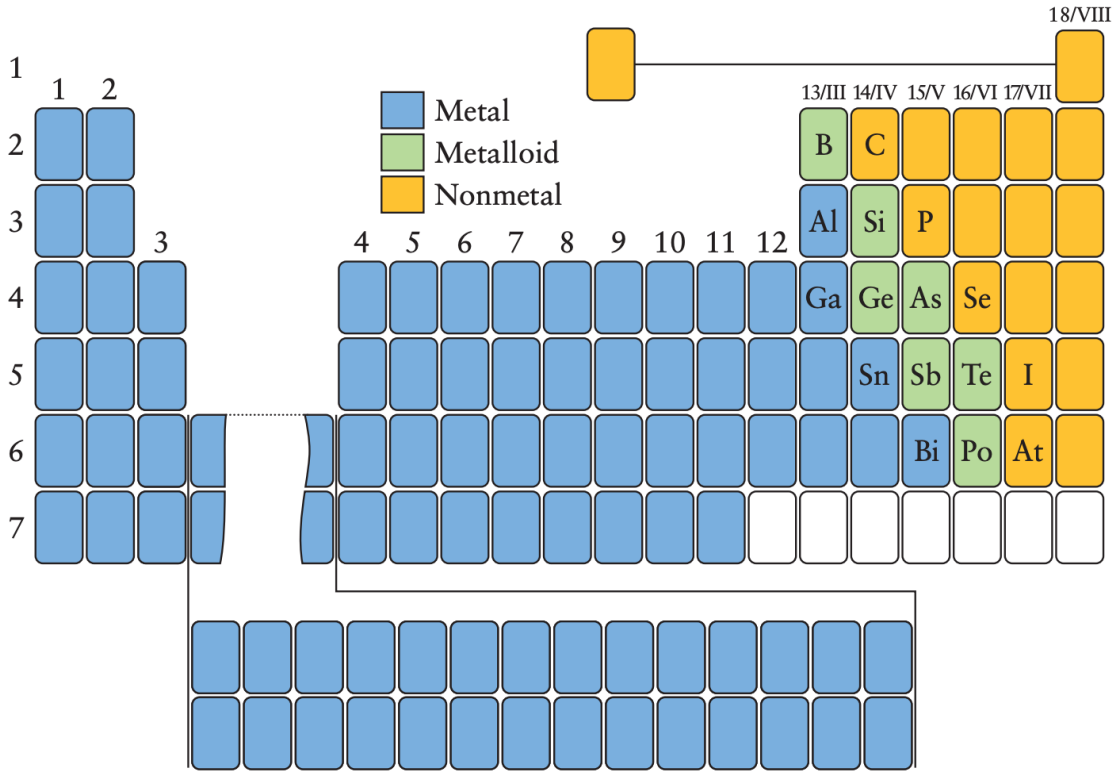
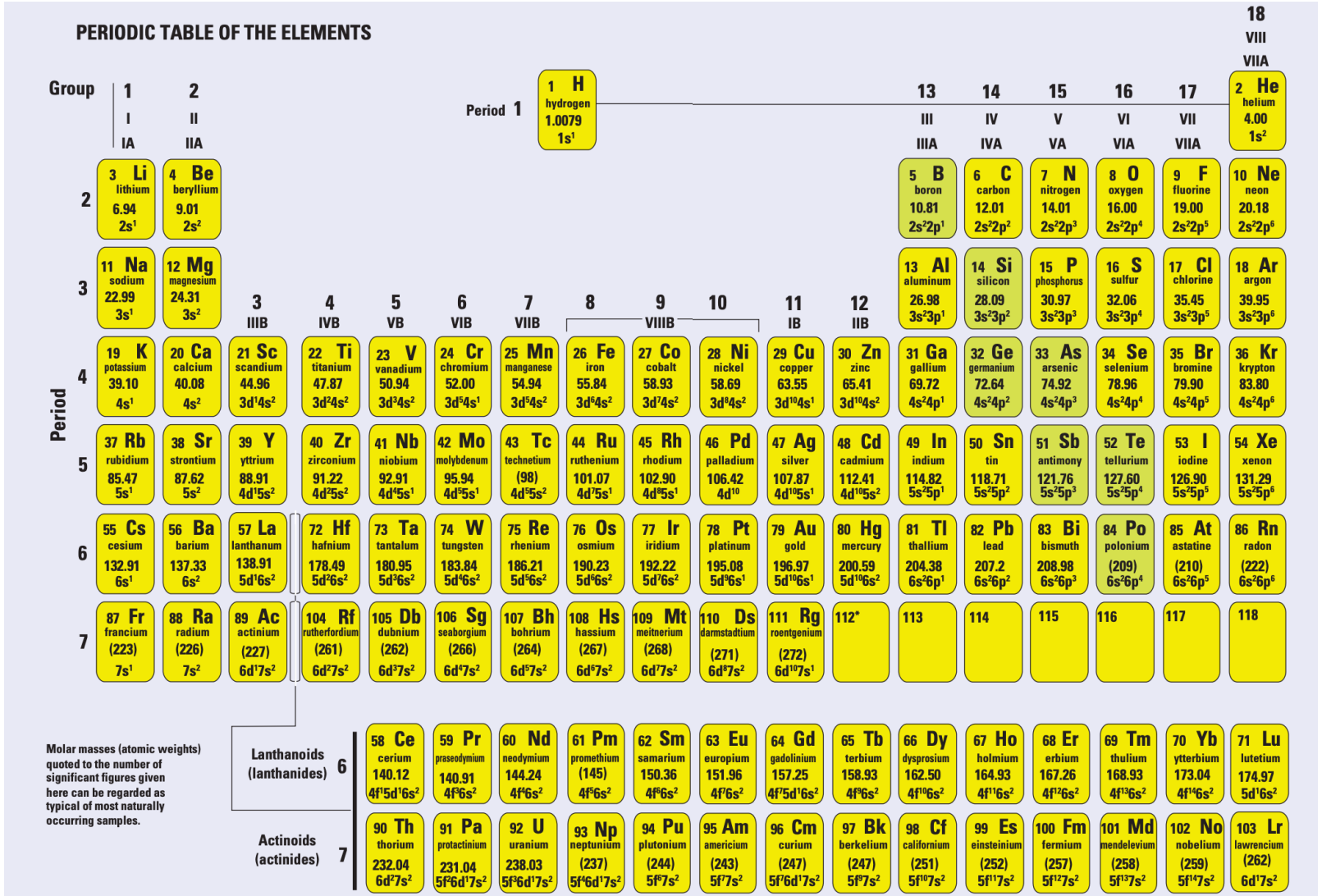


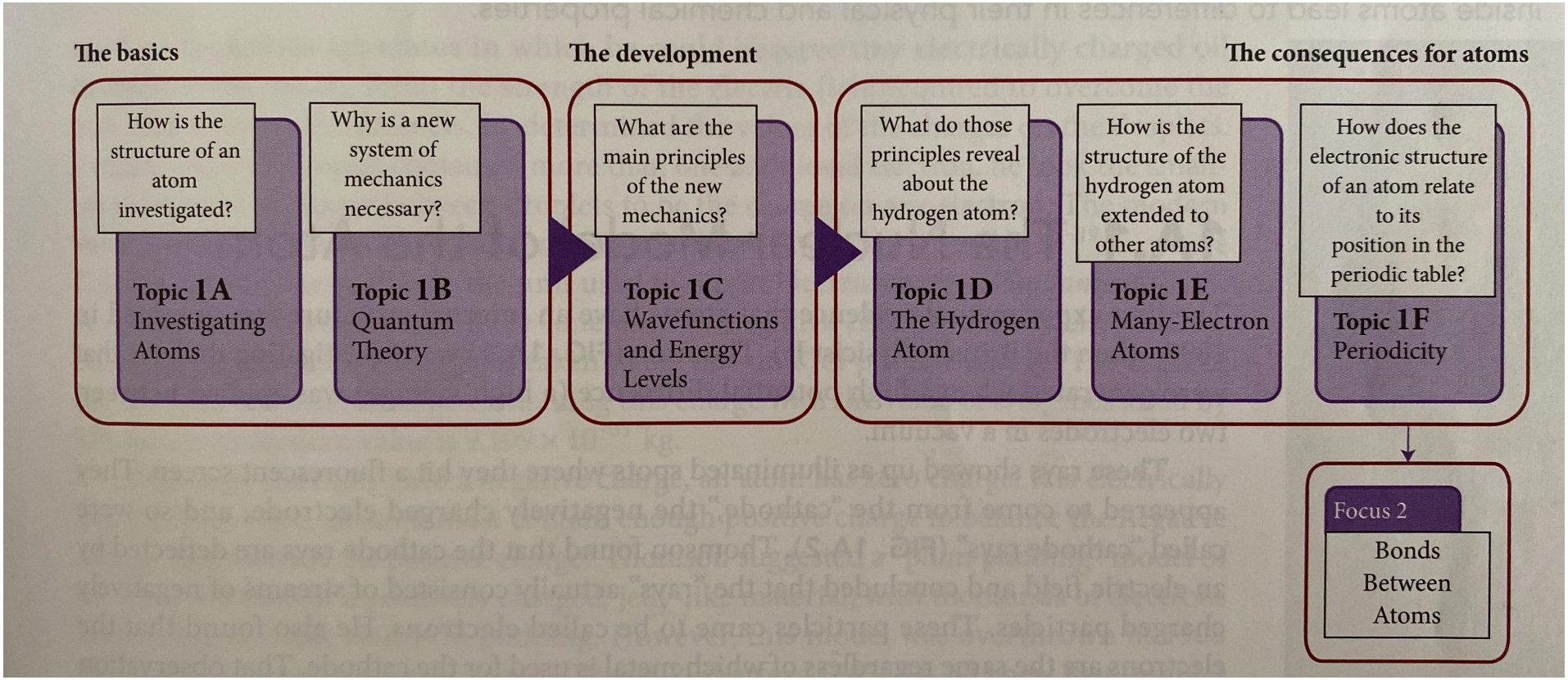

PERIODIC TABLE OF THE ELEMENTS
Group
Period
Molar masses (atomic weights) quoted to the number of significant figures given here can be regarded as typical of most naturally occurring samples.
Lanthanoids (lanthanides) 6
Actinoids (actinides) 7
*The names of the elements 112 and higher have not yet been determined; both 112 and 114 have been confirmed.

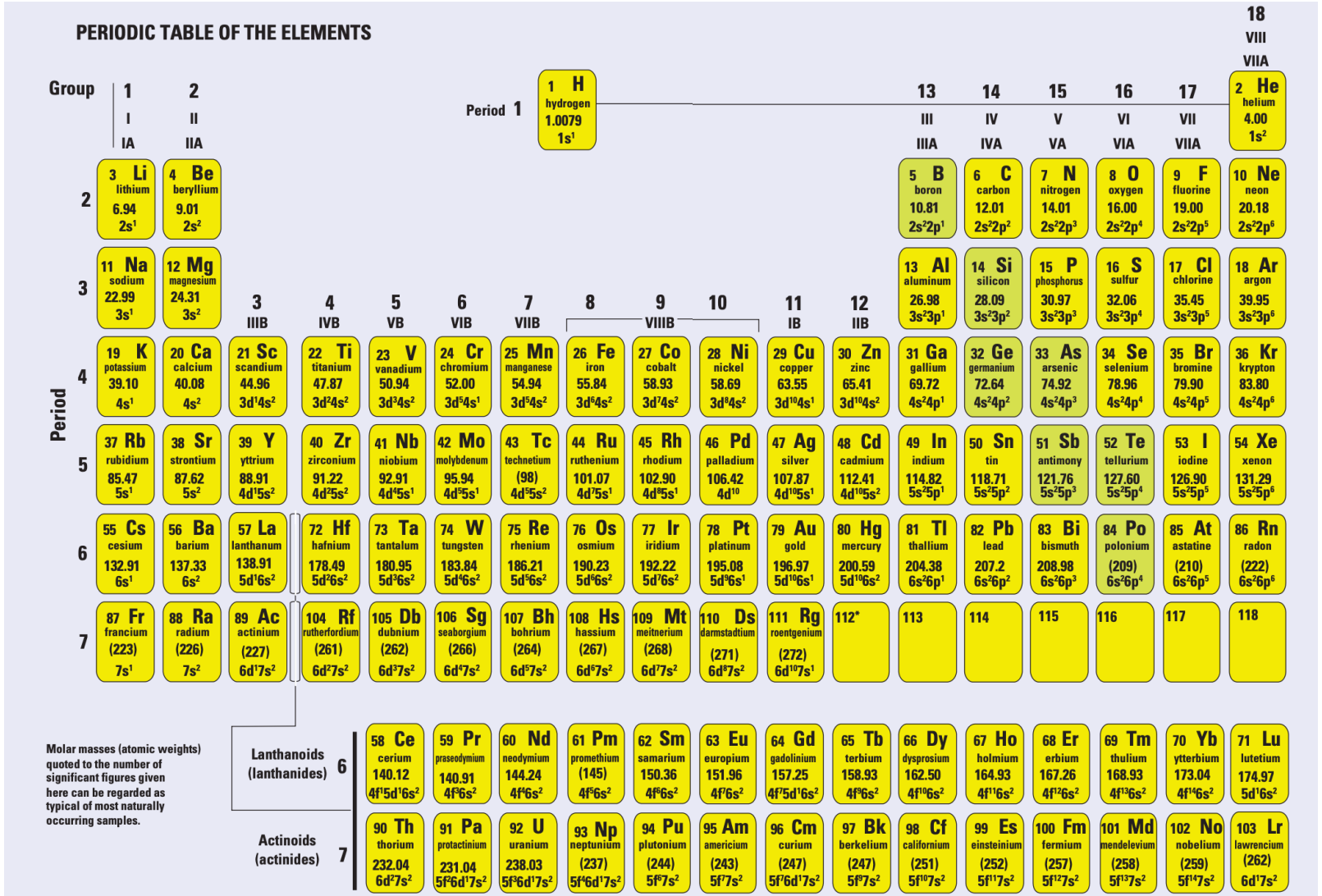
The skills you have mastered are the ability to

- ❑ Describe the structure of an atom.
- ❑ Find the number of atoms in a sample of an element of given mass.
- ❑ State the number of neutrons, protons, and electrons in a nuclide.
- ❑ Write the symbols of the elements.
- ❑ Describe the organization of the periodic table and the characteristics of elements in different regions of the table.

Summary: The periodic table is an arrangement of the elements by atomic number that reflects their family relationships; members of the same group typically show a smooth trend in properties.

Preview Chapter 1 (Focus 1: Atoms)

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