Physics I - Introduction

We will study various
aspects of mechanics this semester:

- Kinematics & Dynamics
- Work, Energy & Conservation Laws
- Fluids: Hydrostatics & Hydrodynamics
- Oscillations, Waves & Acoustics

see **Syllabus**

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- background in engineering
    - Bachelor in Electrical Engineering and Information Technology
    - Master in Medical Systems Engineering
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Course Structure:

- **weekly lecture:**
    - presentation of the theoretical foundations of physics
    - demonstration of experiments
- **bi-weekly lecture tutorial:**
    - led by the instructor/teaching staff
    - focus on conceptual exercises
    - additional demonstrations/experiments
- **bi-weekly class tutorial:**
    - active student participation (*voting system*)
    - students present solutions to assigned physics problems
    - tutor provides guidance and problem-solving support

Class tutorial voting system

- class exercise tasks will be posted on eLearning platform approx. one week before the exercise takes place
- tasks should be solved before the exercise takes place
- prior to the exercise, you indicate, which tasks you solved (in eLearning)
- through selection/"voting", you agree that you are able to explain and present the task and your proposed solution
- the solution does not have to be completely correct, however, it must be clear that you conscientiously dealt with the task and seriously attempted to solve it (otherwise all your selections/"votes" for that exercise will be revoked)

- exercise instructor will pick the presenting student randomly from all students who selected the particular task

Exam:

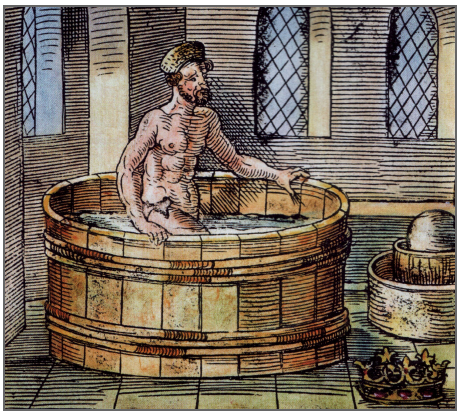
- written exam (90 min) on the contents of Physics I
- requirement for eligibility:
    - vote for at least **40%** of all class tutorial task
- allowed are: pen, ruler, pocket calculators (not graphical, not programmable), blank pieces of paper.
- no cheat sheet allowed!
- points are distributed following this scheme: 25% for level 1 task, 25% for level 2 task, 25% for level 3 tasks, 25% for multiple choice theory questions

Course resources:

- script and slides openly available as Jupyter notebooks
    - **https://github.com/hendrikmattern/pl**
    - **https://colab.research.google.com/git**
    - **FYI:** lecture/slides complement script and vice versa
- book:
    - `GIANCOLI, Douglas C. Physics for scientists and engineers with modern physics. Pearson Education, 2023.`
- **eLearning course** (enrollment required)
- **LSF** (enrollment required)
- **How to solve physics problems**

What is science?

Definition by **Cambridge Dictionary**: **Science**, *noun* /ˈsaɪ.əns/
(knowledge from) the careful study of the structure and behaviour of the physical world, especially by watching, measuring, and doing experiments, and the development of theories to describe the results of these activities



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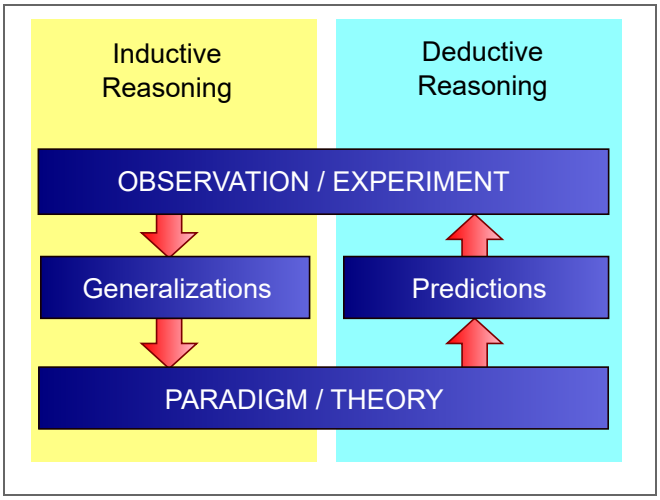
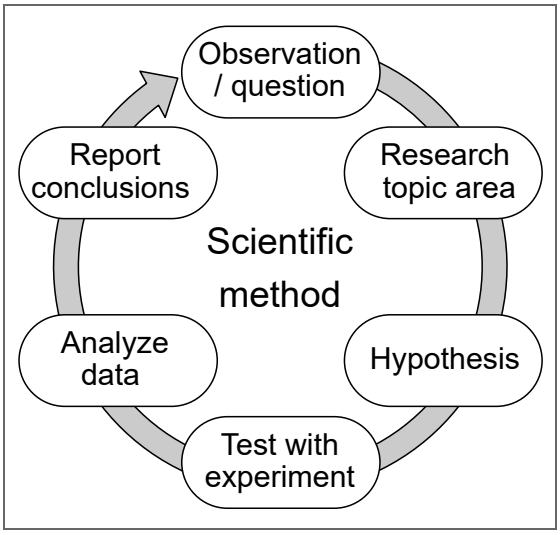
How science works

- Science seeks order in observations and proposes testable explanations
- Absolute proof is impossible — confidence grows with experimental agreement
- Hallmark of science: interplay of imagination and disciplined testing





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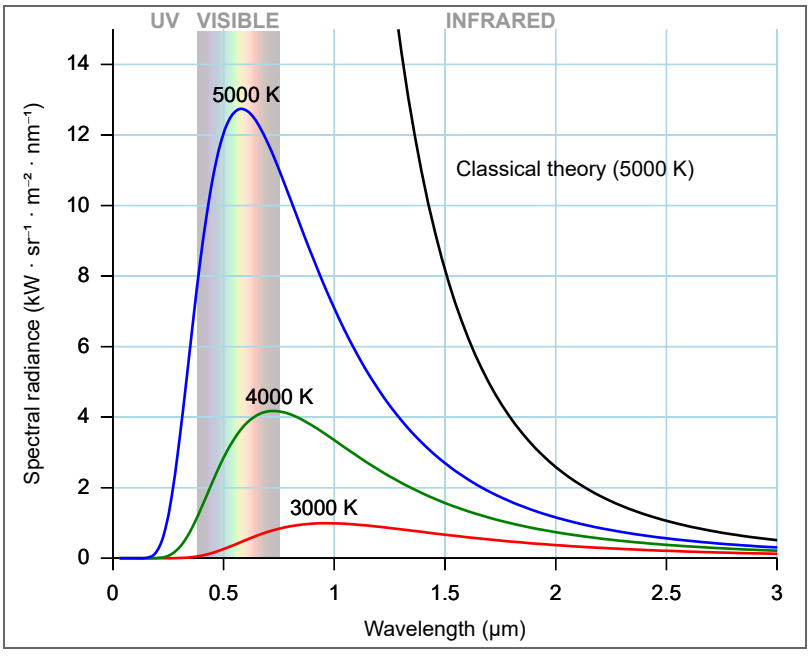
Experiments: Breaking beliefs, building Knowledge

- Careful experiments test and refine ideas, making science more than speculation
- Reproducibility ensures that results hold beyond a single observer or setup
- Surprising experiments often overturn long-held beliefs
- From ancient thought to modern labs, progress rests on experimental evidence

*from **wikipedia**, public domain*

Models, theories, and laws

- Model: simplified picture (e.g. sound as a wave)
- Theory: broader, connects many phenomena, yields quantitative predictions
- Law: concise general relationship, often an equation
- Descriptive, not prescriptive — they report what nature does
- Each has a range of validity; crucial to recognize limits



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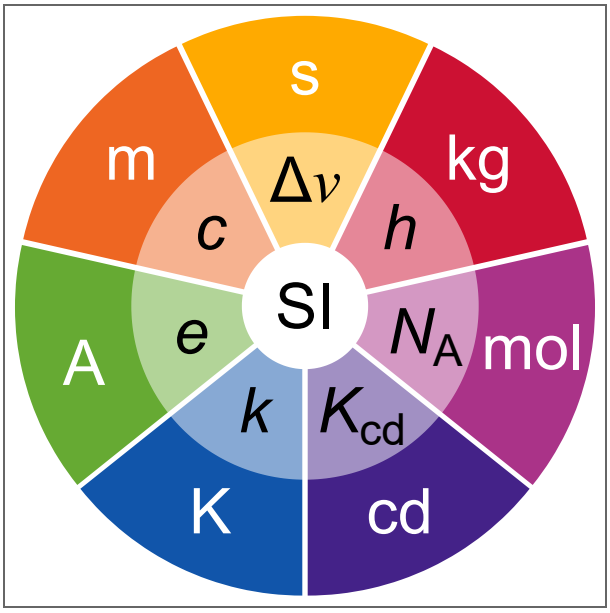
Units, standards, & motivation for the SI system

- A physical quantity = number + unit
- Standards must be stable, reproducible, widely available
- SI system (Système international d'unités):
    - Prevents confusion and reduces mistakes
    - Ensures comparability across labs and countries
    - Based on universal constants (stable, reproducible, transferable)

Gimli Glider (1983): An Air Canada Boeing 767 ran out of fuel mid-flight because ground crew ***calculated fuel in pounds***

***instead of kilograms**, leading to half the needed fuel onboard. ;from **wikipedia**, License: public domain*

SI base units and definitions



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Quantity	Unit	Symbol	Definition
Length	meter	m	Speed of light c in vacuum
Time	second	s	Cesium-133 transition frequency
Mass	kilogram	kg	Planck constant h
Electric current	ampere	A	Elementary charge e

Quantity	Unit	Symbol	Definition
Temperature	kelvin	K	Boltzmann constant $\mathrm{k_B}$
Amount of substance	mole	mol	Avogadro constant $\mathrm{N_A}$
Luminous intensity	candela	cd	Radiation at 540×10^{12} Hz