university of groningen / faculty of science and engineering

Physics Project Practical for first year's students

The course formally known as Physics Laboratory 2

Robert Klein-Douwel 2014 - 2018
Aleksandra Biegun 2019 - …

Place in curriculum

University of Groningen: both **Physics** and **Applied Physics**

- **Year 1**
- **Physics Lab 1**: preprogrammed, short experiments, error analysis
- **Physics Lab 2**: physics project practical

- **Year 1, 2**
- **Electricity & Magnetism, Waves & Optics, Electronics & Signal Processing**: specific experiments

- **Year 2,3**
- **Physics Lab 3 & 4**: more elaborate experiments (fixed topics), report, article

Characteristics

- Carry out full research project with 4 students
- This implies
- Research question
- Hypothesis: derived from research question, predictions?
- Formulate objective: conditions to test hypothesis
- Experiment to test hypothesis
- Draw conclusions
- Make report, presentations and poster

- Necessary:
- Team work
- Organizational skills

Structure

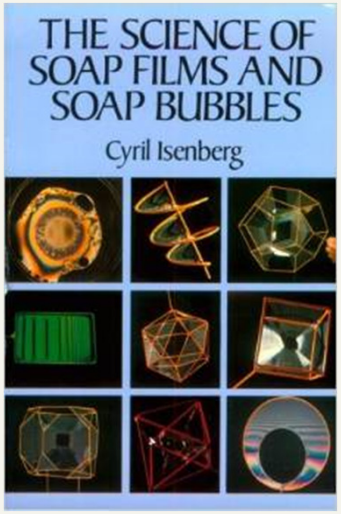
- Week 1 Introductory lecture
- Week 1 Tutorial (brainstorming, quartet formation)
- Week 1 Information Literacy workshop (library)
- Week 2 Presentations preliminary work plan
  feedback, improvement
- Week 3 Presentations improved work plan
- Week 4 – 8 Perform experiment, write report, prepare poster
- Week 9 Final presentations (Applied) Physics
- after exams Poster presentations at PAM symposium

Information literacy

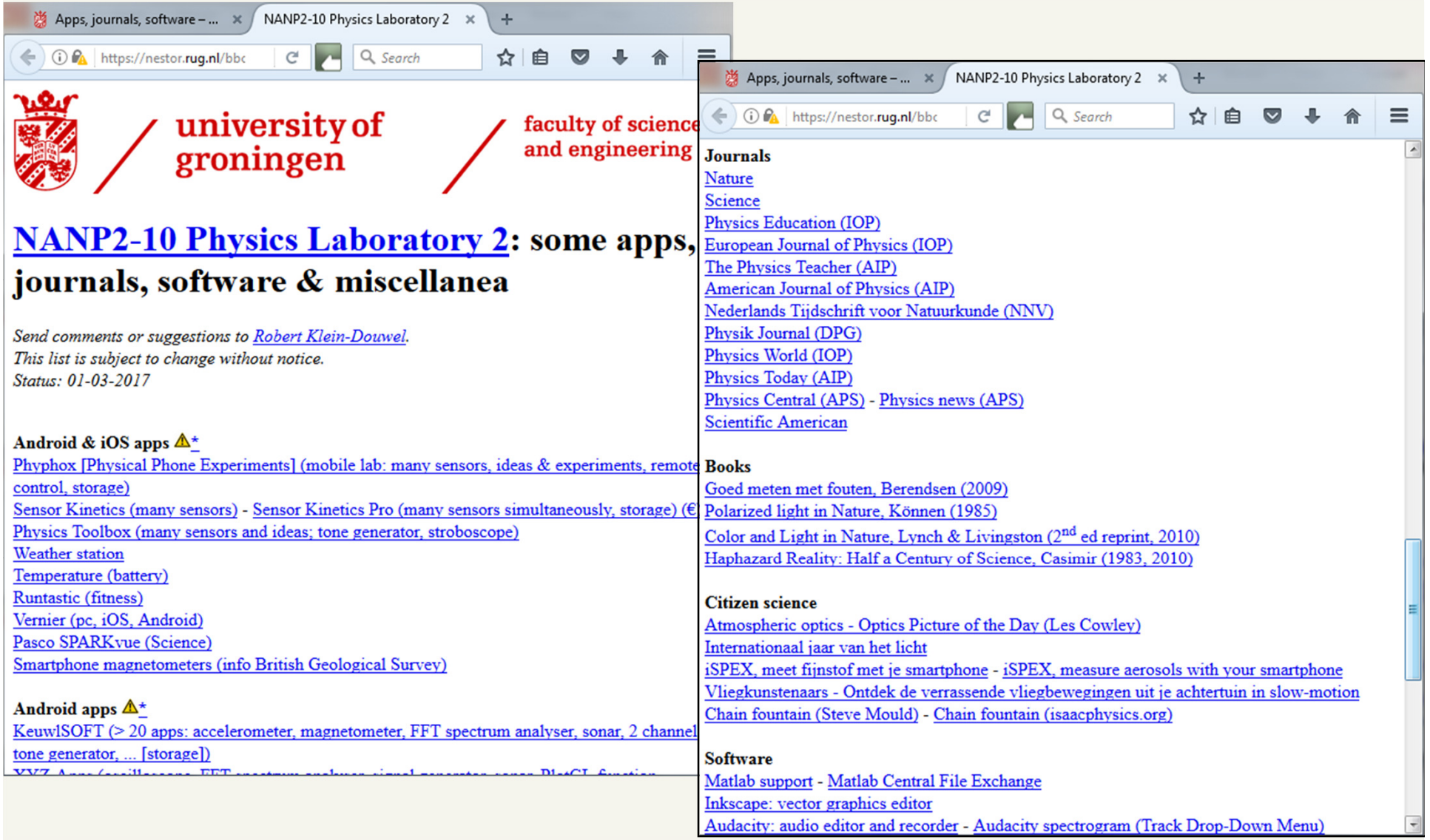
- Workshop by librarians
- How to find the scientific information/article you want
- Assignment: find article for your project
- Online test: completion required for passing course

Brainstorming - Topics

- Personal interest
- Earlier courses: *Mechanics & Relativity, Electricity & Magnetism, Introduction to Energy & Environment*
- Internet, youtube, … (reliability?)
- Suggestions from lecture, manual or assistant
- (not so often from scientific articles)



Resources



Apps, journals, software – ... | NANP2-10 Physics Laboratory 2

https://nestor.rug.nl/bbc

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NANP2-10 Physics Laboratory 2: some apps, journals, software & miscellanea

Send comments or suggestions to Robert Klein-Douwel.
This list is subject to change without notice.
Status: 01-03-2017

Android & iOS apps ⚠*

Phyphox [Physical Phone Experiments] (mobile lab: many sensors, ideas & experiments, remote control, storage)
Sensor Kinetics (many sensors) - Sensor Kinetics Pro (many sensors simultaneously, storage) (€
Physics Toolbox (many sensors and ideas; tone generator, stroboscope)
Weather station
Temperature (battery)
Runtastic (fitness)
Vernier (pc, iOS, Android)
Pasco SPARKvue (Science)
Smartphone magnetometers (info British Geological Survey)

Android apps ⚠*

KeuwlSOFT (> 20 apps: accelerometer, magnetometer, FFT spectrum analyser, sonar, 2 channel tone generator, ... [storage])

Apps, journals, software – ... | NANP2-10 Physics Laboratory 2

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Journals

Nature
Science
Physics Education (IOP)
European Journal of Physics (IOP)
The Physics Teacher (AIP)
American Journal of Physics (AIP)
Nederlands Tijdschrift voor Natuurkunde (NNV)
Physik Journal (DPG)
Physics World (IOP)
Physics Today (AIP)
Physics Central (APS) - Physics news (APS)
Scientific American

Books

Goed meten met fouten, Berendsen (2009)
Polarized light in Nature, Können (1985)
Color and Light in Nature, Lynch & Livingston (2nd ed reprint, 2010)
Haphazard Reality: Half a Century of Science, Casimir (1983, 2010)

Citizen science

Atmospheric optics - Optics Picture of the Day (Les Cowley)
Internationaal jaar van het licht
iSPEX, meet fijnstof met je smartphone - iSPEX, measure aerosols with your smartphone
Vliegkunstenaars - Ontdek de verrassende vliegbewegingen uit je achtertuin in slow-motion
Chain fountain (Steve Mould) - Chain fountain (isaacphysics.org)

Software

Matlab support - Matlab Central File Exchange
Inkscape: vector graphics editor
Audacity: audio editor and recorder - Audacity spectrogram (Track Drop-Down Menu)

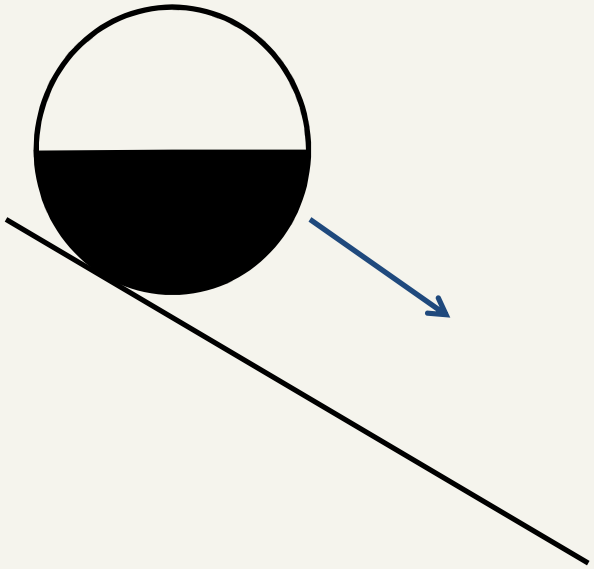
Presentations

- Each student at least once
- First presentation no mark: good speakers wait for next one
- Reality check by staff and assistants:
- - Practicality, profundity, enough physics, not just hobbying/DIY
- - Reliability of sources
- - Do not vary $5 \times 4 \times 3$ parameters, be selective
- Also feedback on presentation skills

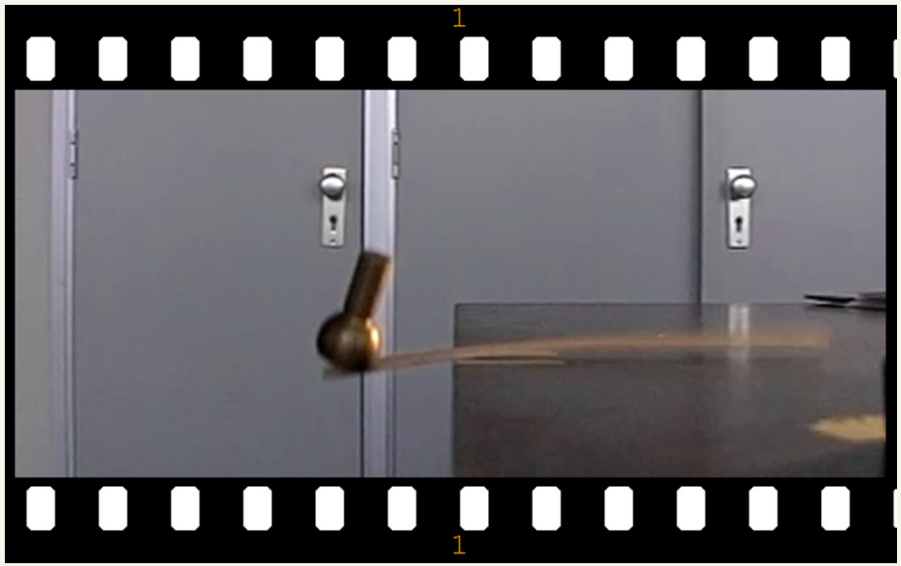
- Good example: *we explain effect, we think this will happen, so investigate these conditions to confirm/reject hypothesis*
- Not so good example: *we investigate 3D model of snapping shrimp* (way to complex, what do you learn?)

Theory - Experiment

- Good experimental work, theory may be too difficult
- Relatively simple experiment, thoroughly analysed and compared to full theory



Physics Lab 2 (2017-2018)



Physics Lab 2 (2013-2014)

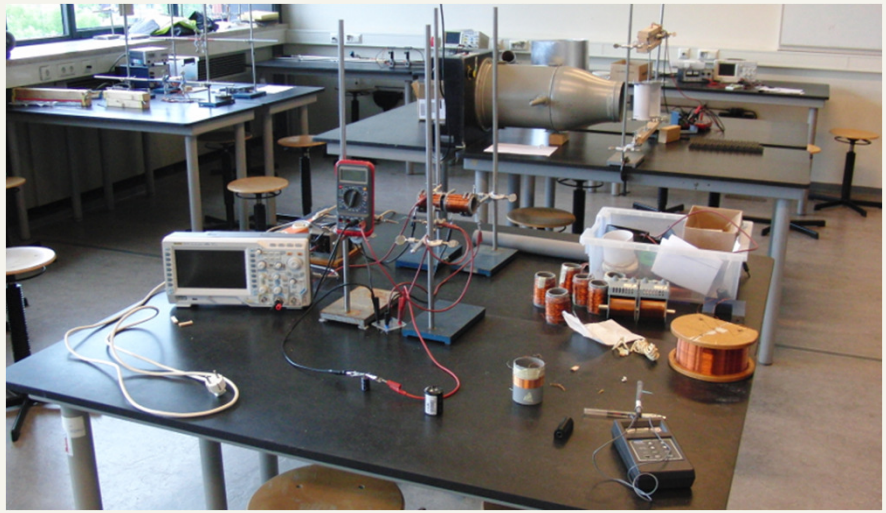
Dangers

- High voltage, high current?
- Toxic materials?
- Radioactive sources?

- Limit voltage or find alternative
- Go to chemistry or change topic
- Qualified person handles radioactive sources

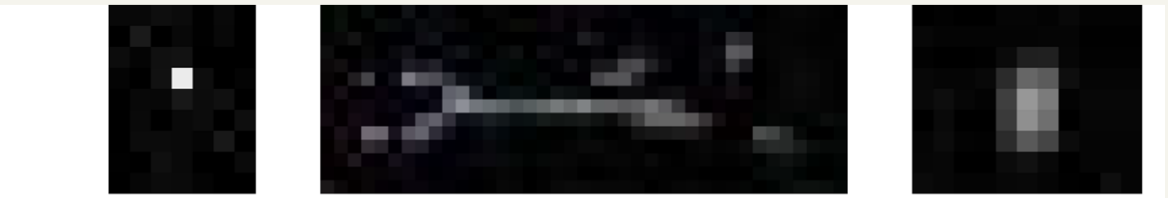
5 weeks of experiment

- Assistants watch progress: physics and group dynamics
- Assistants discuss issues with staff
- Technical support available (incl. workshop)
- Students learn limitations: time, equipment, cost
- € 20 available per student group
- Buy/borrow equipment or go to research group, lab buys equipment
- In lab or outdoors



Topics - Examples

- Kelvin water dropper
- Singing wineglass
- Magnus effect
- Leidenfrost effect
- Capacitive sensor
- Vibrating strings
- non-Newtonian fluids
- Chain fountain
- Stirling engine
- Chladni figures
- Cosmic ray detection with weather balloon
- Soap bubbles
- Superconductor YBCO
- Airplane/wing
- Dominos
- Water rockets
- Thermoelectric effects
- Bouncing ping pong ball
- Flying stick
- Sound generation by heat
- Mpemba effect



Figures 4.4. 4.5. and 4.6. left to right respectively: Examples of an incident β-particle, Compton scattering and current leakage

Physics Lab 2 (2017-2018): webcam modified for β, γ detection

Final presentations

- Complete: setup, theory, results, analysis, conclusions
- If no results: do you know and understand why?
- Audience: students of this course
- 2 best presentations invited to give talk at PAM symposium

PAM symposium

- **P**hysics, **A**stronomy, **M**athematics: similar courses
- Experience a real scientific symposium
- Every group presents poster – 4 sessions
- Staff invited
- Posters assessed by fellow students and staff (outliers rejected)
- Posters: jury prize and audience prize (bonus)

- Invited student presentations (bonus)
- Keynote lectures by Physics, Astronomy, Mathematics staff

PAM symposium

Assessment criteria - 1

Presentation

Content	Format	Discussion
- physically correct - clear explanation of formulae and symbols used - brief discussion of theory - measurements - conclusions - references - is knowledgeable about experiment and presented material	**Material presented** - well structured - not too much text - clear illustrations - appealing layout **Presenter(s) (max. 2)** - intelligible story - clear pronunciation - calm attitude (body language) - proper use of allotted speaking time	- physically correct - uses relevant arguments - understands questions
0 - 3 points	0 - 4 points	0 - 3 points
Total: 0 - 10 points		

Assessment criteria - 2

Physics Laboratory 2: Assessment criteria for report

A report has the following general structure:

- Title (page) (including: names and student numbers of contributors, name of assistant)
- Abstract
- Table of contents
- Introduction
- Theory
- Experimental setup
- Results (including error analysis)
- Discussion
- Conclusions
- References
- Appendices (if necessary)

Introduction, Discussion, Conclusions	**Abstract, Theory, Experimental setup, Results, Discussion, Conclusions, Appendices**	**Format, General structure, Layout, Graphs and tables, Language**	**Table of contents, References, Appendices**
- originality, use of own words - connection between goal of experiment and theory - connection between introduction and discussion - connection between stated expectations (introduction) and results/conclusions	- completeness - clarity and accuracy - relevance - conciseness - sound conclusions, based on and justified by obtained results - proper error analysis - lengthy derivations/error analysis in appendices	- well organized - proper general structure - clear graphs with proper axis labels, units, error bars and caption - clear tables with proper headings, units and caption - correct use of language (both in physical and linguistic sense)	- completeness - correctness
0 - 2 points	0 - 4 points	0 - 3 points	0 - 1 points
Total: 0 - 10 points			

Assessment criteria - 3

Poster Grading Form

poster:

Grading the Poster	--	-	±	+	++
Is the subject of the poster clear, e.g. from the (sub-)title?					
Is an introduction given that clearly reflects the subject and/or problem?					
Are the conclusion and/or summary clearly formulated?					
Is the message clear?					
Is the poster 'stand-alone' (interesting, communicative without oral explanation)?					
If external sources are used, are references clearly given?					
Did the researchers use enough reliable sources to build their research on?					
Does the poster draw attention?					
Is the overall image of the poster attractive?					
Is the amount of text chosen well?					
Is the use of colors and fonts o.k. (contrast etc.)?					
Is the information well balanced (primary/secondary issues)					
Is the information at the correct depth (not profound, not superficial)?					
Does the poster contain the correct level of details?					

Grade for t
between 1 and 10, rounded towa

Grading the Student (oral explanation)	--	-	±	+	++
Does the explanation provide supplementary information?					
Does the researcher have sufficient knowledge about the subject?					
Is the oral explanation clear?					
Does the explanation stimulate interaction with the public?					
Does the researcher pay enough attention to the public?					
Does the researcher handle questions satisfactorily?					

Grade for the Oral Explanation:
between 1 and 10, rounded towards ½ point

Name of the student that explains the poster:	**student**
Name of the person that assigns the grade:	**reviewer**

Assessment

- Presentation preliminary work plan: 0%
- Presentation improved work plan: 10%
- Final report: 50%
- Final presentation: 20%
- Poster (“piece of paper”): 10%
- Poster presentation individual student: 10%

Students' comments

- Most students like it a lot, lots of freedom
- *"Zelf vond ik Physics Lab 2 heel ontzettend leuk en misschien wel één van de meest leerzame vakken." (aspiring assistant)*
- Students often line up to become assistant

- *"Technical support staff was the only nice person" (group ignoring strong recommendations from lecturer and assistant to adapt line of research)*

Lecturer's perspective

- Most students like it a lot
- Free topics: interesting variation
- (Astro & Math: fixed topics)
- Organization labour intensive
- Well appreciated by Visitation Committee (2014)
- Results and discussions with students rewarding

Take home message

- Students experience full research cycle from research question to experiment to reporting, presentation and symposium
- Students experience group work in quartets

- Labour intensive for lecturer, assistants and staff
- Well appreciated by (almost) everyone

Thank you for your attention