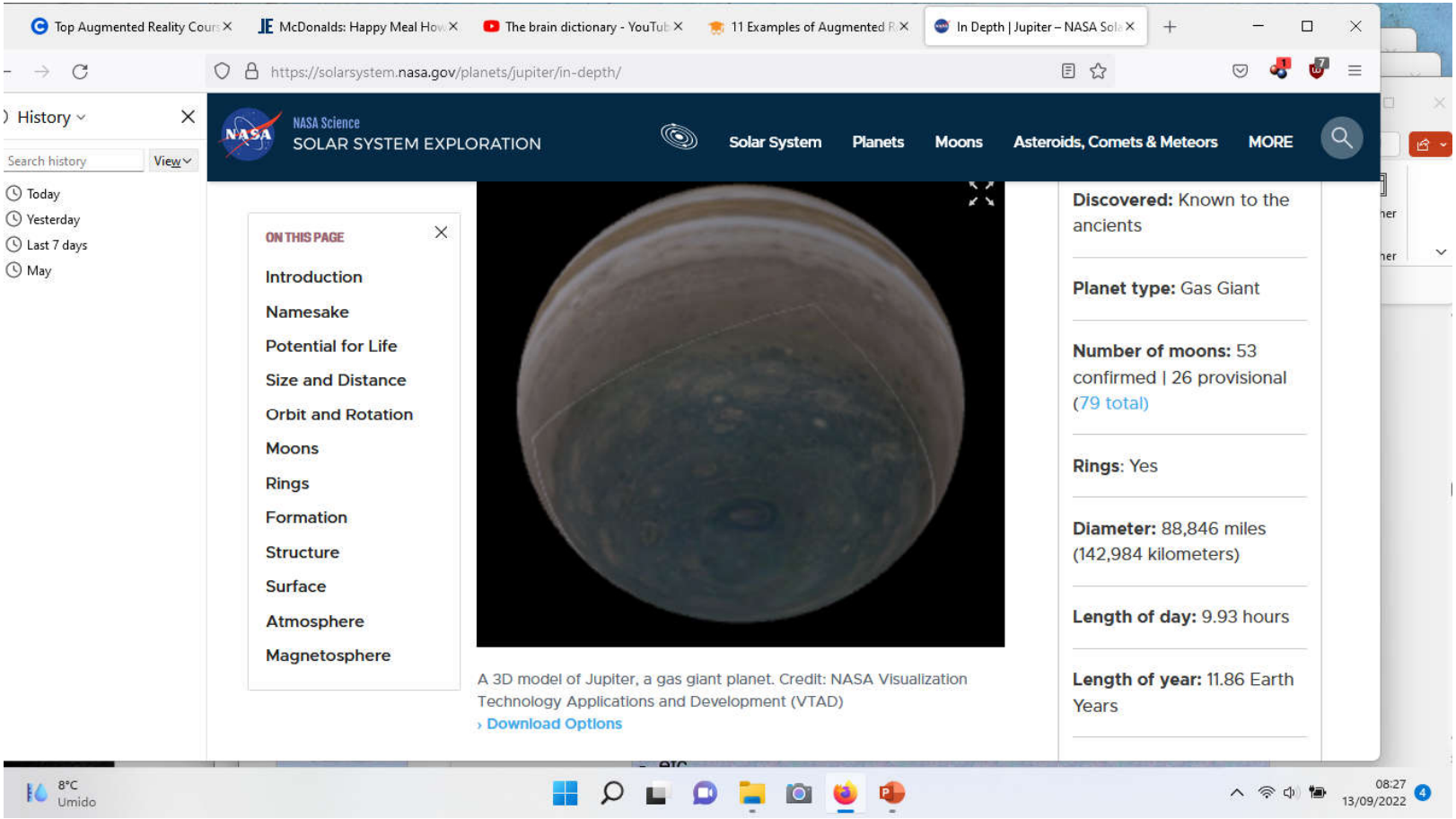
Insegnare STEAM con la realtà aumentata

Grzegorz Karwasz

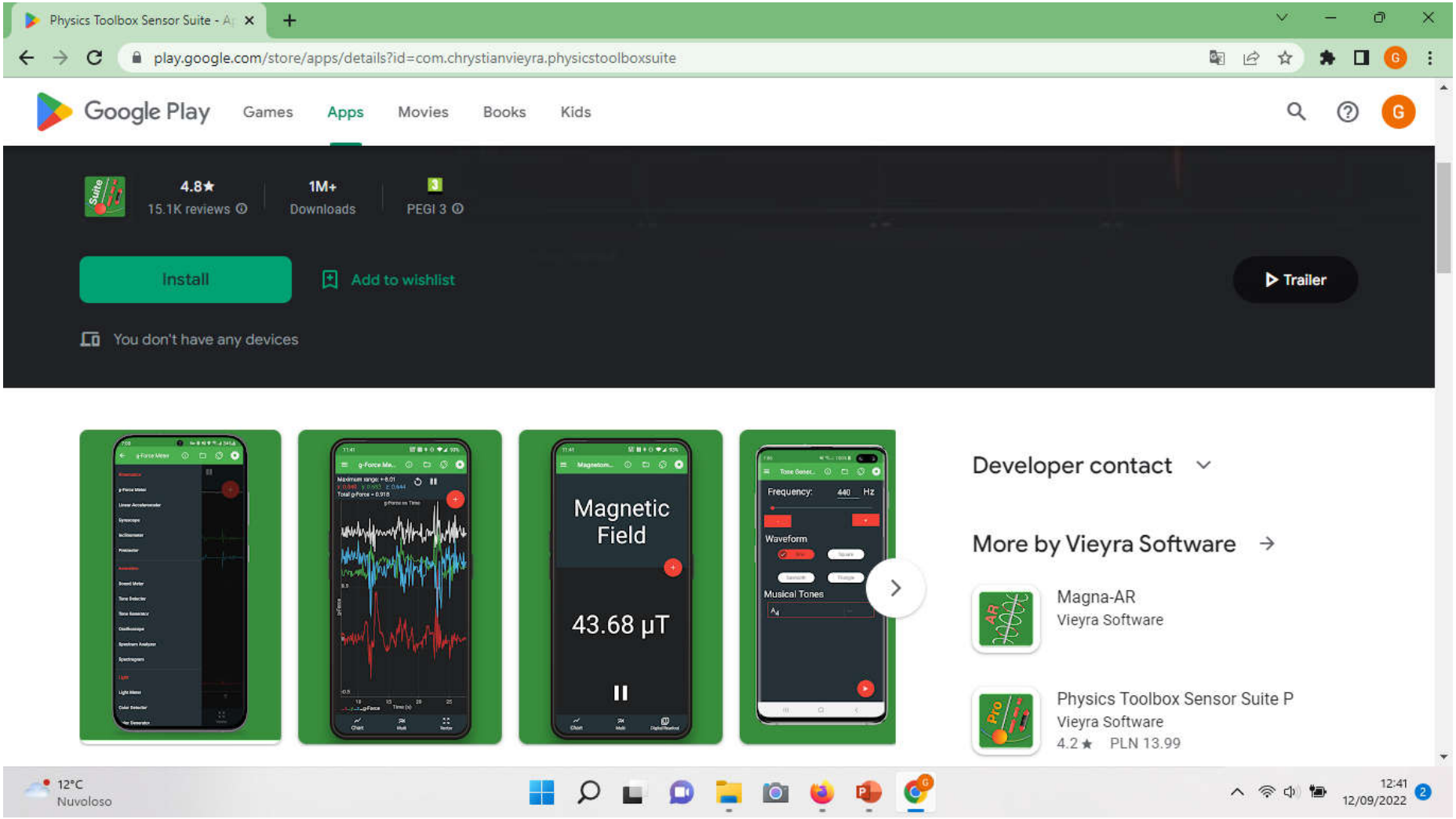
Lezione 8: Computer-guided experiments

Internet interattivo

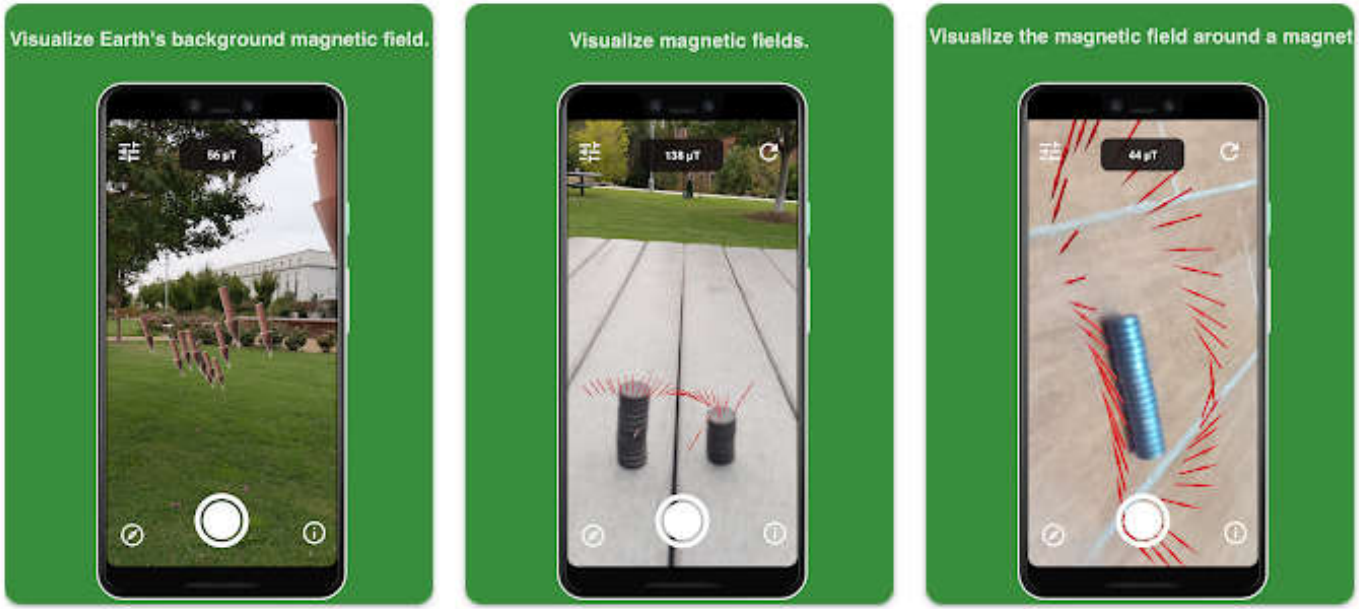


https://solarsystem.nasa.gov/planets/jupiter/in-depth/

Partiamo dalla fine, cioè da Android



Campo magnetico terrestre



Una vera applicazione con Realtà Aumentata: la mappa del campo magnetico inserito nella vista panoramica

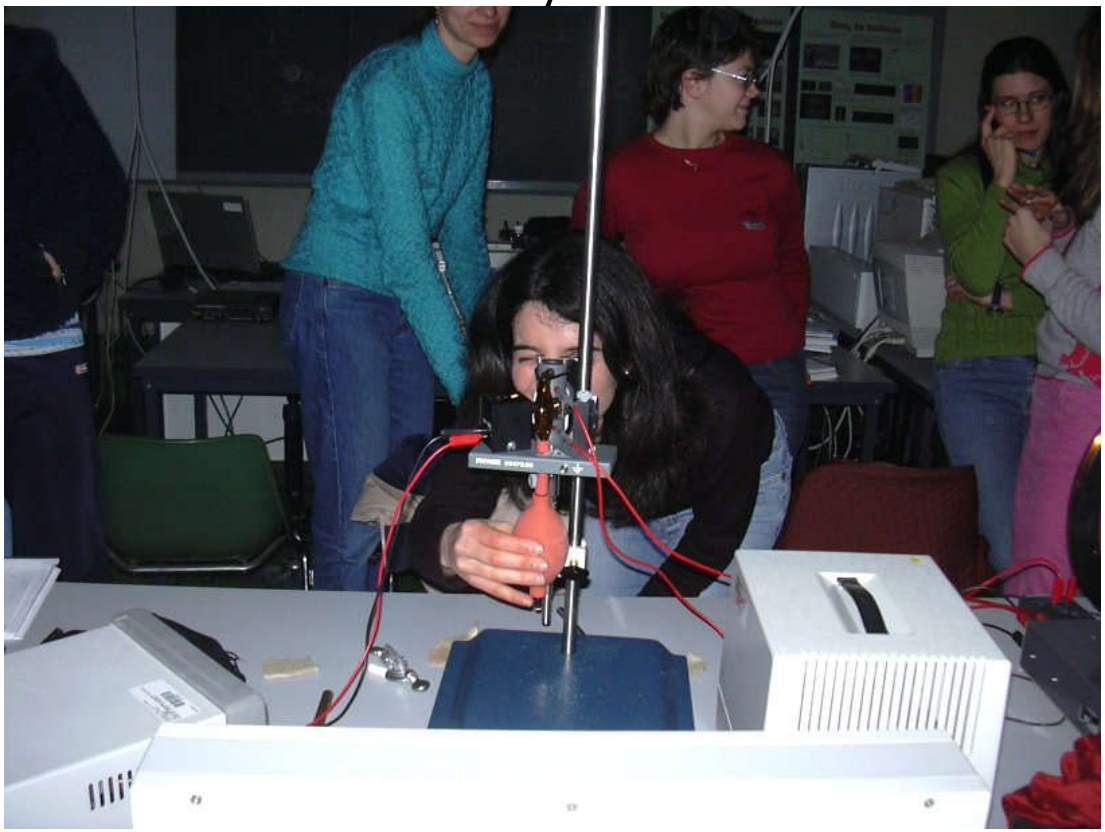
About this app →

This app combines the data collected by the internal magnetometer with the three-dimensional mapping of ARCore to plot magnetic fields in real space superimposed upon the camera view.

Useful for students and teachers in science, technology, engineering, and math (STEM) education and academic or industrial researchers, this app helps users to visualize magnetic fields based upon real sources—not prepared computational models—without the use of external sensors....

Laboratorio di fisica via computer (Uni Udine)

Computer guided experiments
↔ experiments in Modern Physics



Studia nauczycielskie – Uniwersytet w Udine

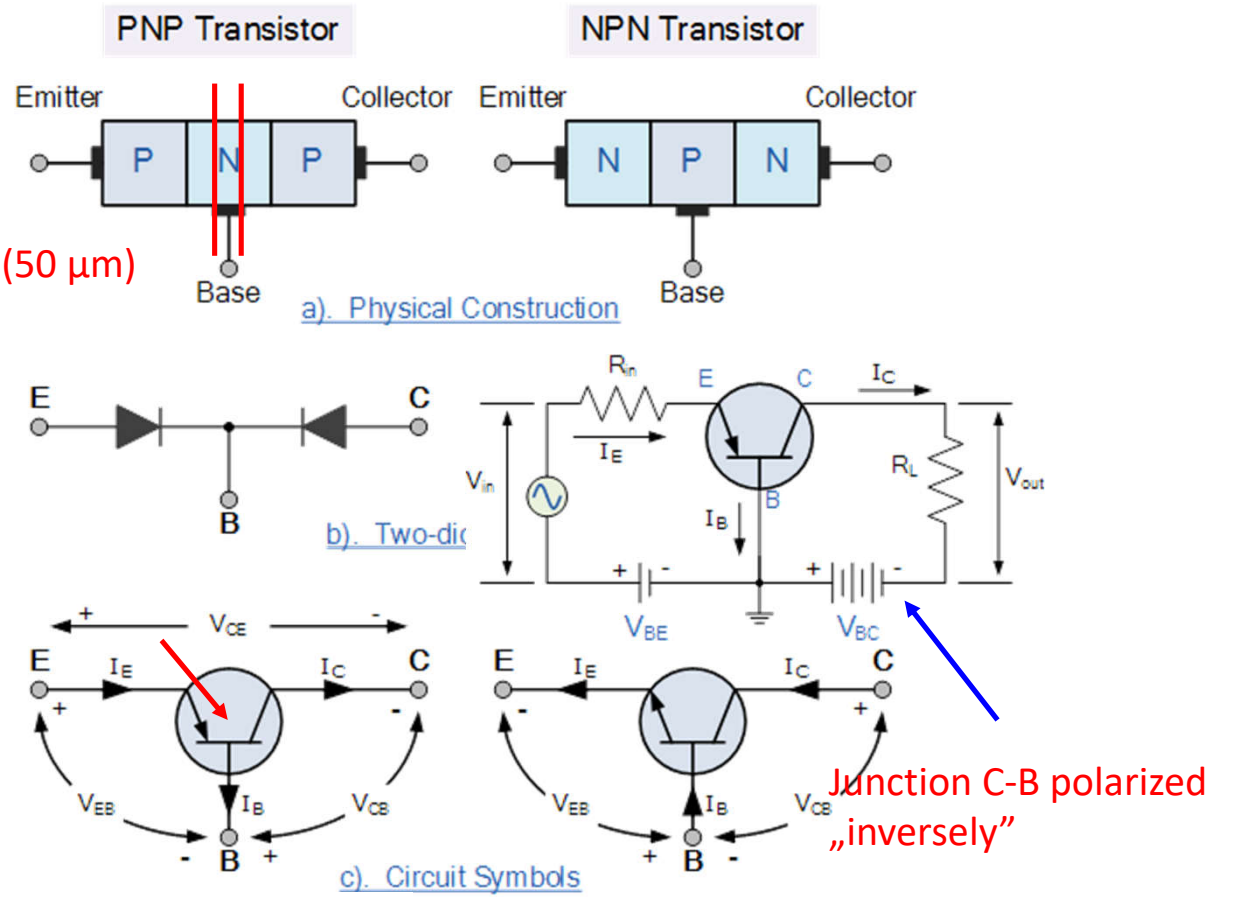
Computer - guided experiments

Four aspects:

- computer – chosen measurements standard and software
- physical – sensor or reader, for ex. of position, using reflection of ultrasounds,
- electronic – signal from the reader, for ex. piezo-electric, crystal is amplified and converted to a sequence of bits sent to the computer,
- didactical – ability to choose these experiments, which can be done more efficiently (precisely, time saving, more clear) and which assure better (cognitive) transmission of observation

At all levels errors are possible: this is modern didactics

Transient-resistor



Base thin (50 µm)

Junction C-B polarized „inversely"

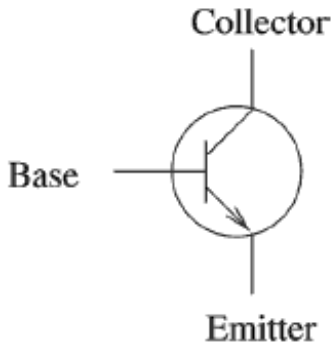
Injection of carriers into Base:
in E-C circuit the current starts to flow

https://www.electronics-tutorials.ws/transistor/tran_1.html

„transistor” (1947) = transient resistor

Logic Chips

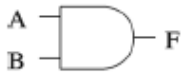
- Basic building block:
  - » Transistor
- Three connection points
  - * Base
  - * Emitter
  - * Collector
- Transistor can operate
  - * Linear mode
    - » Used in amplifiers
  - * Switching mode
    - » Used to implement digital circuits



Mathematical (Boole's) logic

Basic Concepts

- Simple gates
  - AND
  - OR
  - NOT
- Functionality can be expressed by a truth table
  - A truth table lists output for each possible input combination
- Other methods
  - Logic expressions
  - Logic diagrams



AND gate

A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

OR gate

A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

NOT gate

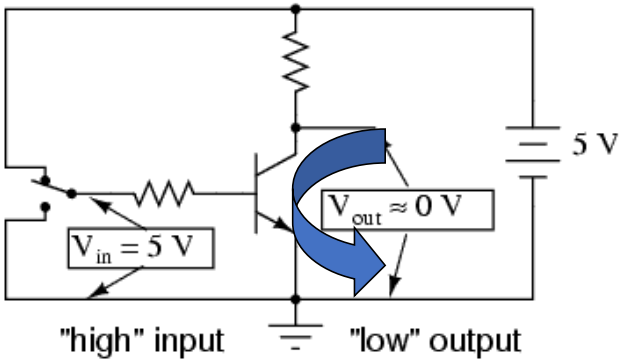
A	F
0	1
1	0

Logic symbol

Truth table

Transistor in digital circuits

Transistor in saturation

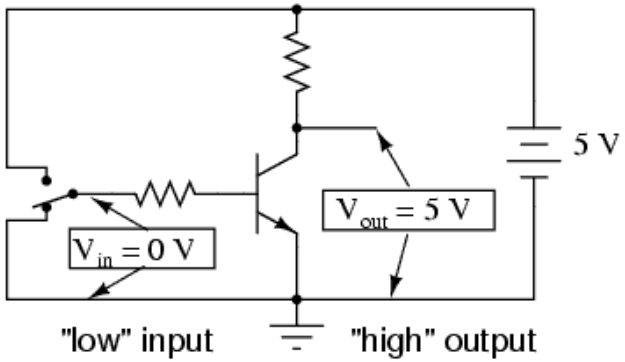


0 V = "low" logic level (0)

5 V = "high" logic level (1)

$R_{tranz}=0$

Transistor in cutoff



0 V = "low" logic level (0)

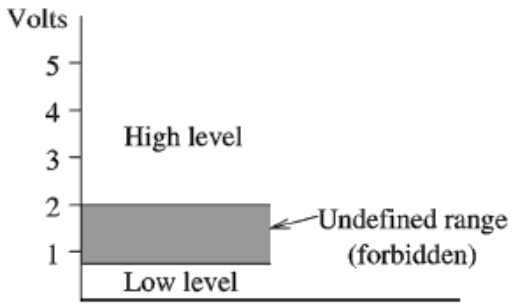
5 V = "high" logic level (1)

$R_{tranz}=\infty$

states „0” & „1”

Logic Chips (cont'd)

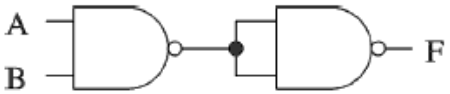
- Low voltage level: < 0.4V
- High voltage level: > 2.4V
- Positive logic:
  - Low voltage represents 0
  - High voltage represents 1
- Negative logic:
  - High voltage represents 0
  - Low voltage represents 1
- Propagation delay
  - Delay from input to output
  - Typical value: 5-10 ns



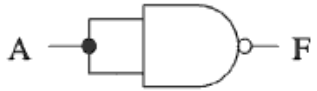
Universal gate, i.e. „NAND” = no-and

Basic Concepts (cont'd)

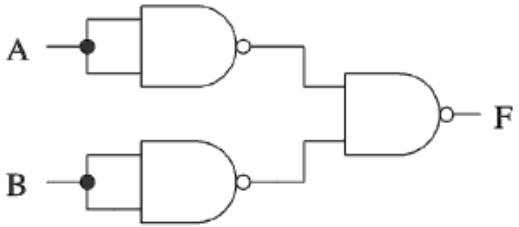
- Proving NAND gate is universal



AND gate



NOT gate

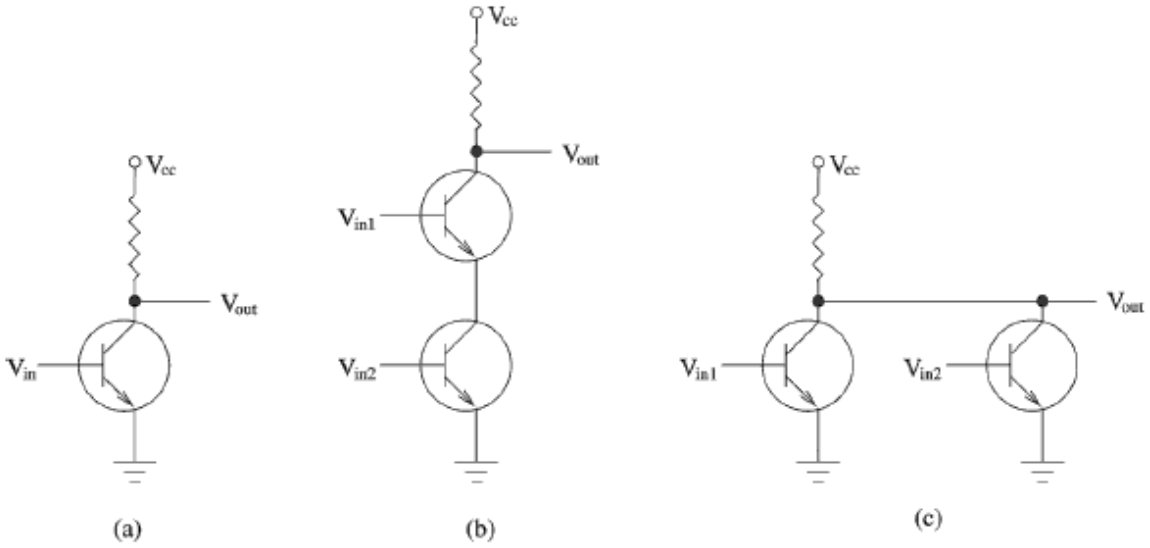


OR gate

http://www.scs.carleton.ca/~sivarama/org_book/org_book_web/slides/chap_1_versions/ch2_1.pdf

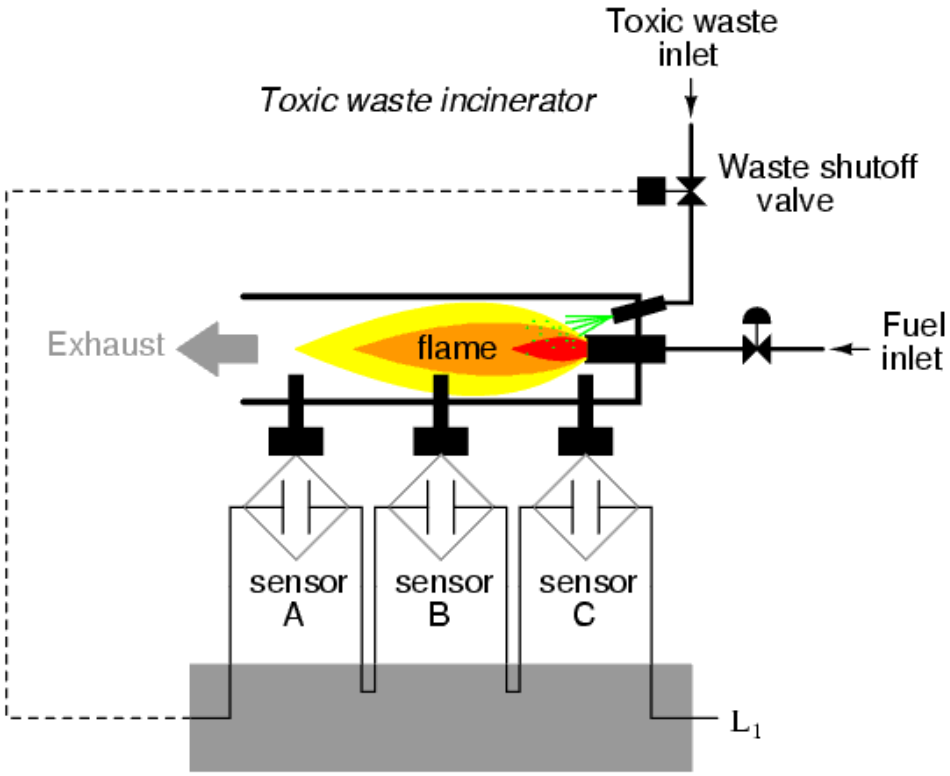
NAND & other gates

Logic Chips (cont'd)



NOT NAND NOR

1° goal: burning sensor (min. two signals OK!)

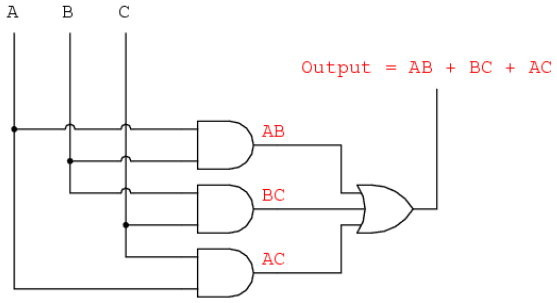


sensor inputs

A	B	C	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

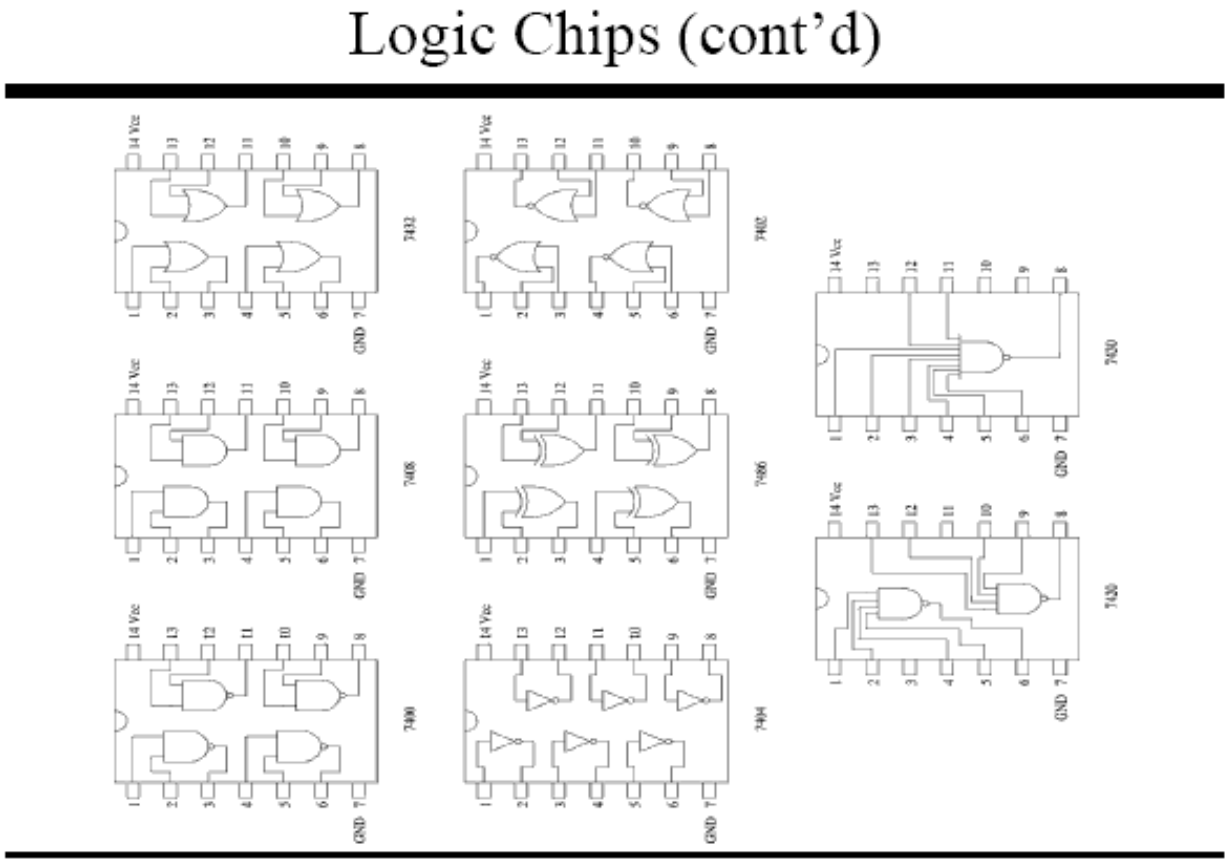
Output = 0 (close valve)

Output = 1 (open valve)



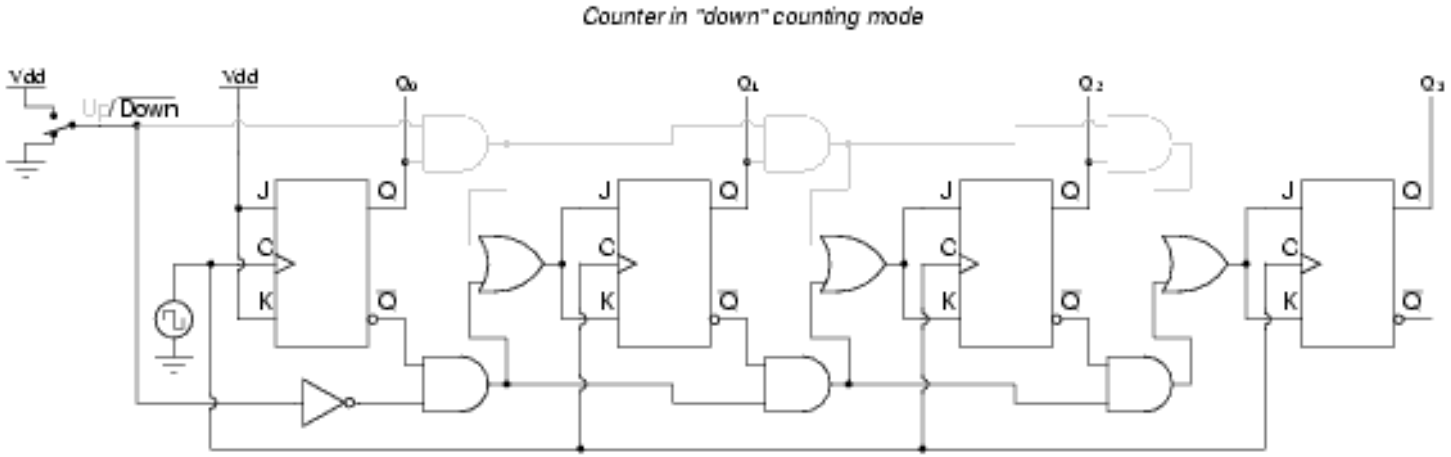
http://openbookproject.net//electricCircuits/Digital/DIGI_7.html

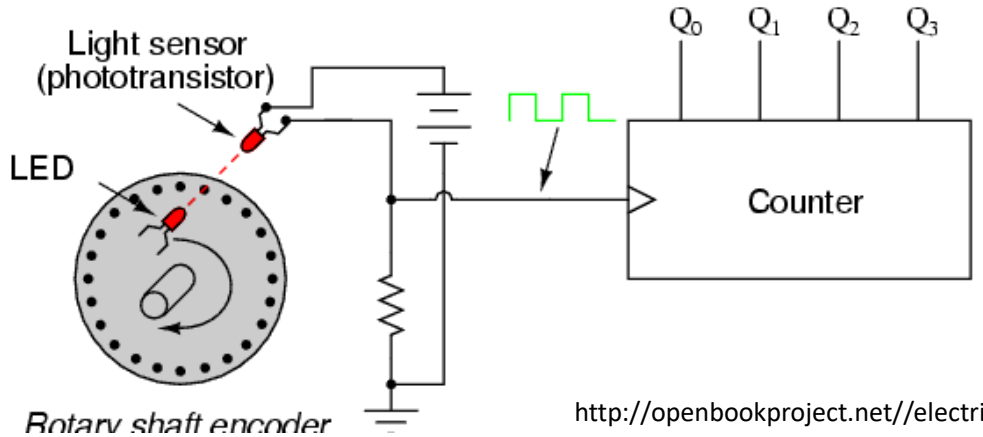
Integrated circuits = black „bugs”,



http://www.scs.carleton.ca/~sivarama/org_book/org_book_web/slides/chap_1_versions/ch2_1.pdf

Position counter





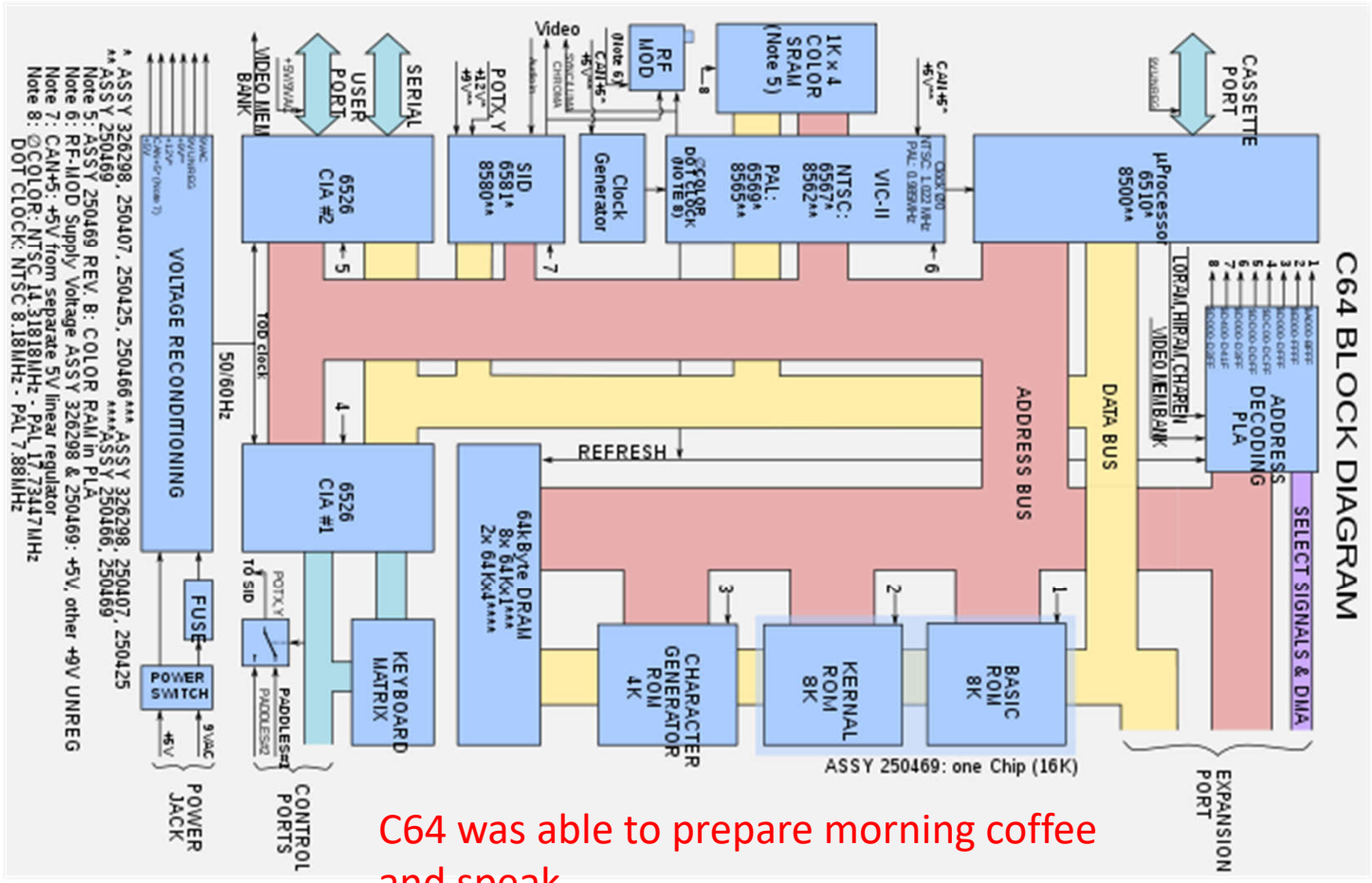
http://openbookproject.net//electricCircuits/Digital/DIGI_10.html

C64 (1984): two clocks, sound generator, AD converters (paddles) etc.

- Video: MOS Technology VIC-II 6567/8562 (NTSC), 6569/8565 (PAL)
  - 16 colors[93]
  - Text mode: 40×25 characters; 256 user-defined chars (8×8 pixels, or 4×8 in multicolor mode); or extended background color; 64 user-defined chars with 4 background colors, 4-bit color RAM defines foreground color
  - Bitmap modes: 320×200 (2 unique colors in each 8×8 pixel block),[94] 160×200 (3 unique colors + 1 common color in each 4×8 block)[95]
  - 8 hardware sprites of 24×21 pixels (12×21 in multicolor mode)
  - Smooth scrolling, raster interrupts
- Sound: MOS Technology 6581/8580 SID
  - 3-channel[93] synthesizer with programmable ADSR envelope
  - 8 octaves
  - 4 waveforms per audio channel: triangle, sawtooth, variable pulse, noise
  - Oscillator synchronization, ring modulation
  - Programmable filter: high pass, low pass, band pass, notch filter
- Input/Output: Two 6526 Complex Interface Adapters
  - 16 bit parallel I/O
  - 8 bit serial I/O
  - 24-hours (AM/PM) Time of Day clock (TOD), with programmable alarm clock[96]
  - 16 bit interval timers

https://en.wikipedia.org/wiki/Commodore_64

Commodore 64 (cont.ed)



C64 was able to prepare morning coffee and speak

VALUE OF USING ON-LINE SENSORS IN DIDACTIC LABORATORY

Social, methodological-disciplinary and practical reasons lead to the using of computer in school laboratory:

- Our everyday life is full of computerized objects and IT is important, on social level, to prepare young students to this continue evolution, with information, adequate experiences, methodologies and critical instruments to understand and use such apparatuses.

- In research laboratories computers manage data and are integral part of the investigation. So on-line experiments may allow students to understand contents and methods characterizing physics.

- On practical level, on-line experiments offer efficiency, time-saving, reliability, precision, reproducibility of data, all with quite cheap instruments. Moreover they allow an immediate and direct contact with the phenomenon, advancing a laboratory open to the personal construction of ideas and new occasion of learning, thanks to the following potentialities:

VALUE OF USING ON-LINE SENSORS IN DIDACTIC LABORATORY

POTENTIALITIES

- Extension of the possibility of

1. observation of events too much quick or slow as regards manual measures

2. measures in rather inaccessible places

3. collecting data easily, favouring in this way the comparison of diagrams and graphs, the search of characteristics and initial conditions, various considerations about the analyzed system (e.g. energetic)

VALUE OF USING ON-LINE SENSORS IN DIDACTIC LABORATORY

POTENTIALITIES

4. study of non linear processes, like the transitory in several types of phenomena, thanks to the quick data acquisition (not possible in traditional laboratory, where measures regards the variation of quantities in initial and final equilibrium states). This allows familiarity with experimental situations and theoretical closely examination based on experimental evidence

These possibilities make the experimentation in school closer to the reality and, thus, more interesting and stimulating, so that phenomena may be analyzed in their completeness and interpretative models easily understood

VALUE OF USING ON-LINE SENSORS IN DIDACTIC LABORATORY

POTENTIALITIES

- Improving of quality of measures, in reliability and sensitivity, that allows both advanced and base experiments, these last in several deeper ways, to encounter the interests of students, so that the laboratory becomes culturally stimulating.

- Time-saving (collecting quickly data on-line) and good reproducibility, that favour the conceptualization and the focusing of the attention on data, on planning and manual aspects (choose of the experiment and Its assembly), on physic problem, on the description of the characteristics of phenomena, on the comparison between different experimental situations.

- Collecting a lot of data, that limits the introduction of hypothesis and allows the use of statistic methods

VALUE OF USING ON-LINE SENSORS IN DIDACTIC LABORATORY

POTENTIALITIES

- Attention to conceptual aspects of procedure of measurement: setting and calibration of the system, chose of measure interval, sensitivity, resolution, time of data acquisition.

- Real time graphs of time depending (and not) phenomena, whose understanding (of role and meaning) may help in overcoming some cognitive problems (e.g. lacking in capability of execution and use of graphs) thanks to the following potentialities:

1. visual impact favours the analysis of the phenomenon

2. the possibility to follow, in real time, the evolution of the phenomenon and/or the characteristics of collected data stimulates the search of interpretations, common discussion, the comparison of ideas, analysis and selection of meaningful parts, the determination of questions and problems to test.

VALUE OF USING ON-LINE SENSORS IN DIDACTIC LABORATORY

POTENTIALITIES

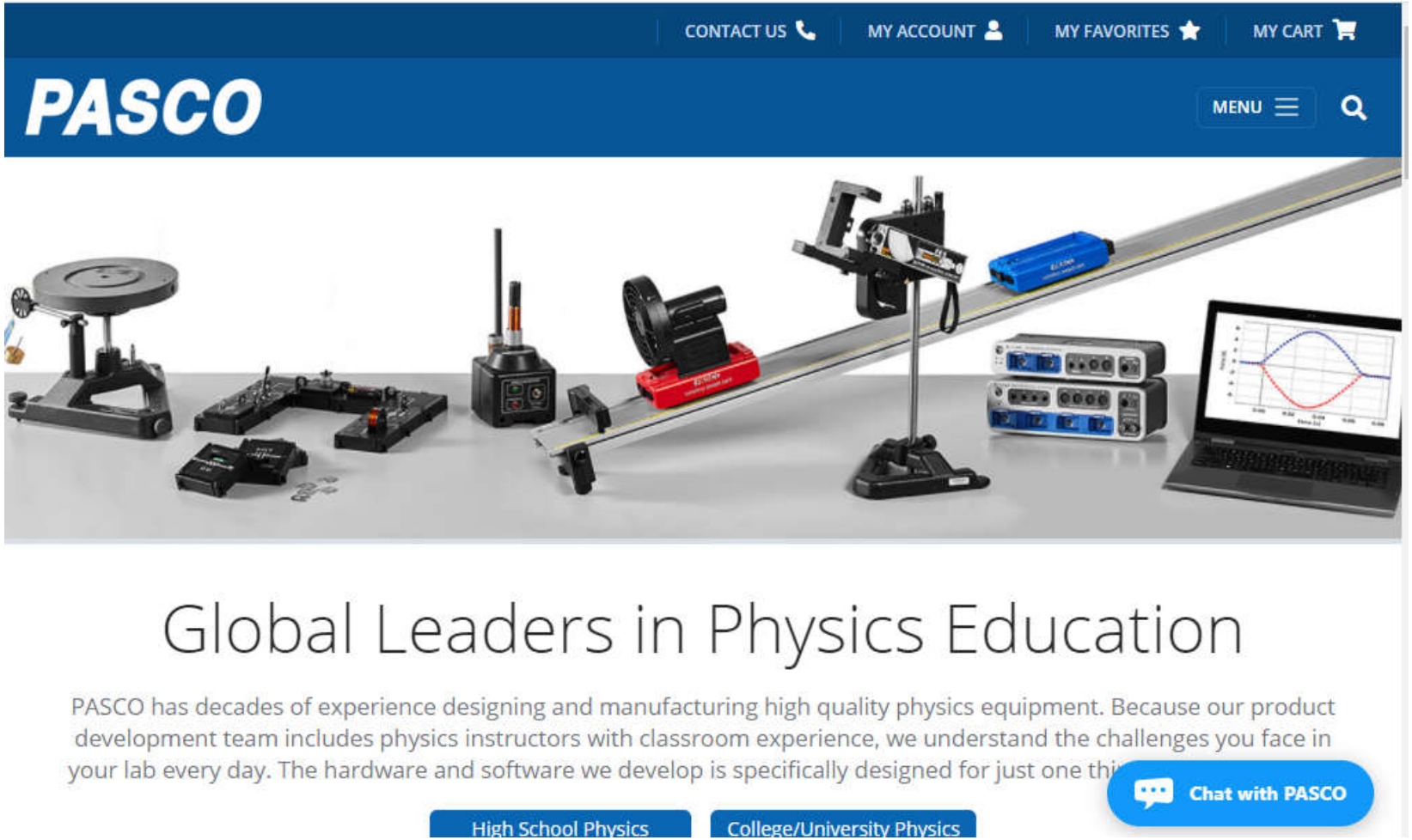
3. in explorative activities, in which student compares sensorial information with signals collected by the sensors, the graph favours the rationalization of sensations and the enucleation of interpretative hypothesis.

4. collecting several graphs for each event makes graph a familiar representative tool.

- Developing of planning capability, comparison between data collected in different times and conditions, comparison between phenomena describable through similar formal relations.

and so on…

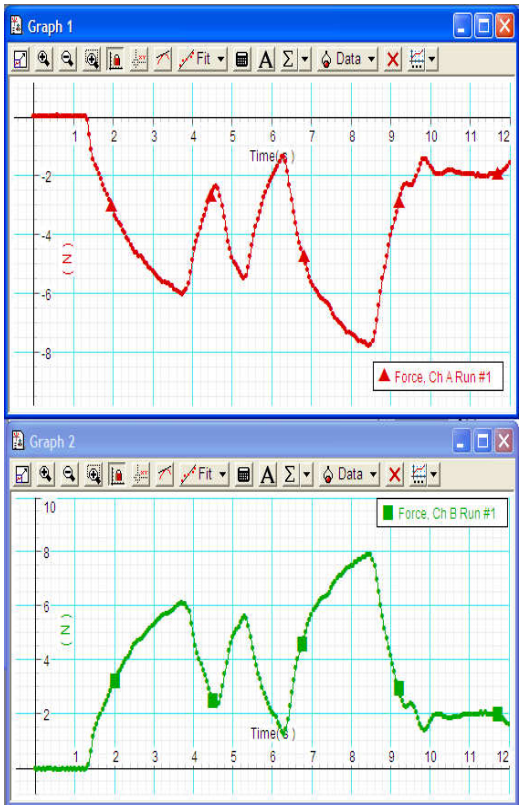
Many different standards

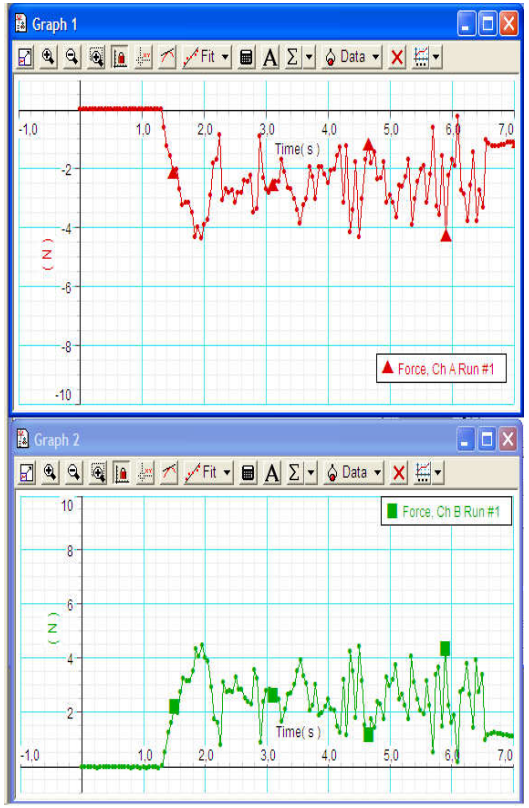


Didactical packages

From measurement to representation

3rd law of Newton





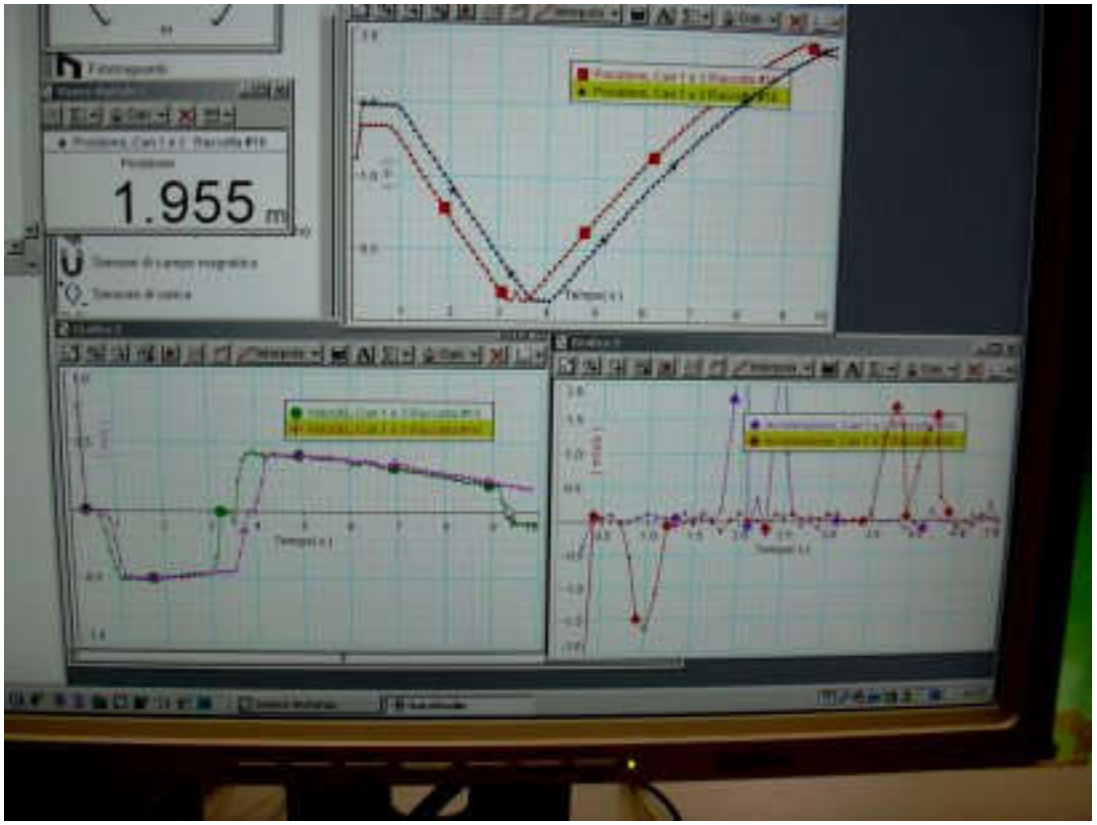
From a real experiment to its mathematical abstraction

VIII LO Toruń, fot. J. Kosicki

From a real experiment to its mathematical abstraction

VIII LO Toruń, fot. J. Kosicki

From a real experiment to its mathematical abstraction



G. Karwasz, Univerista' di Udine

Instructions (Pasco)

Acceleration Due to Gravity

Kinematics: linear motion, acceleration, free fall, graphing	GLX setup file: **free fall**

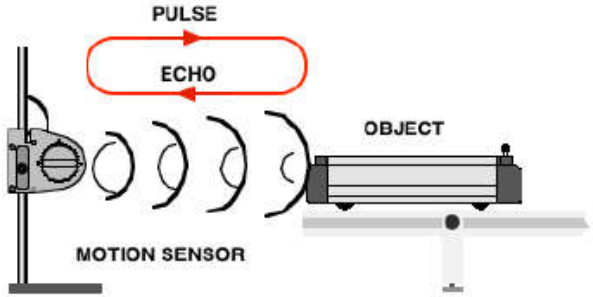
Qty	Equipment and Materials	Part Number
1	PASPORT Xplorer GLX	PS-2002
1	PASPORT Motion Sensor	PS-2103
1	Large Base and Support Rod	ME-9355
1	Rod, 45 cm	ME-8736
1	Double Rod Clamp	ME-9873
1	Tape Measure, 1.5 m	PM-8761
1	Ball, rubber	

Purpose

The purpose of this activity is to measure the acceleration due to gravity of a falling object.

About the Motion Sensor

The Motion Sensor sends out pulses of ultrasound and picks up the echoes of ultrasound that bounce back from objects in front of it.



The software program keeps track of the time when the pulses go out and the time when the echoes come back. One-half of the round trip time is the time that it took for the ultrasound to reach the object. Since ultrasound travels at the speed of sound (about 344 meters per second or about 770 miles per hour), the program figures out how far away the object is as follows:

Moti oscillatori, moti accoppiati

Implementation in lower secondary

b) c)

Figure 1 – Computers and robotics in school laboratories in Kazakhstan.

a) b) c)

figure 3 – PASCO implementation in primary school (aged 13) in A. Michelson school in Strzelno (30/01/2020)
figure 3a – Wireless motion sensor PS-3219 in use: the search for a harmonic motion.
figure 3b – A real-time read-out and graphical presentation on the screen of the harmonic motion.
figure 3c – Level of the sound (student's screaming) as an interactive involving students' emotions into teaching.
Lesson teacher is K. Fedus, photo by Zh. Akimkhanova

Real-time temperature vs time measurement with termocrono (UniUdine/ UMK)

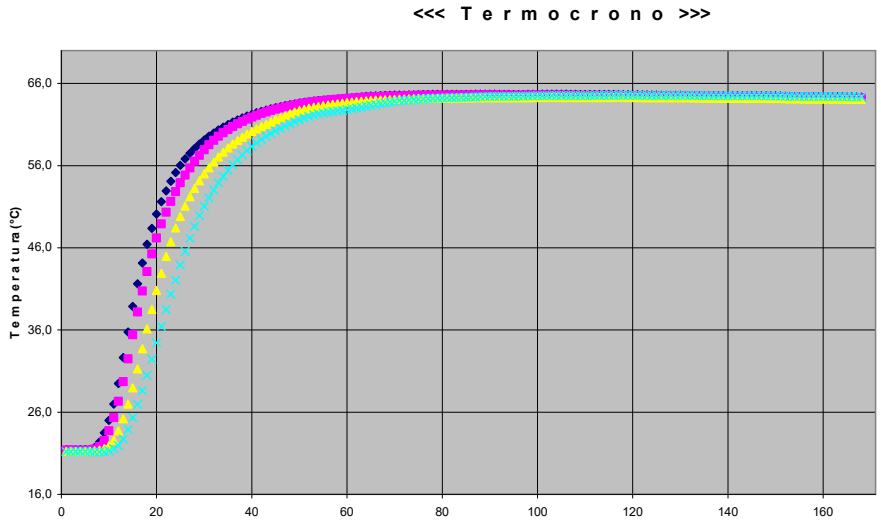
Termocrono is a system based on on-line sensors to make four contemporary real-time measures of temperature that allows to follow thermodynamic processes. The connection to the computer is via USB.
The system consists of an hardware and a software part.

Michelini, Postępy Fizyki, Nr 6 (2009)

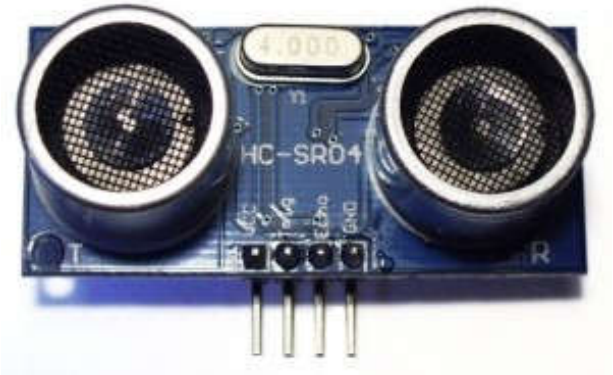
REAL-TIME TEMPERATURE VS TIME MEASUREMENT WITH TERMOCRONO

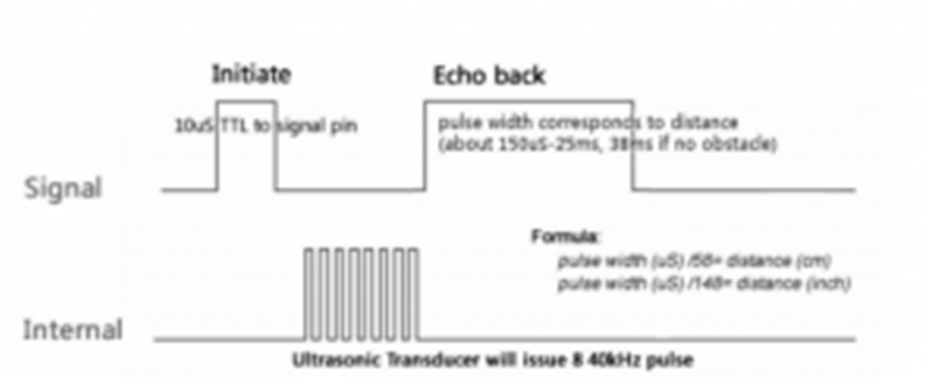
EXAMPLES OF MEASURES

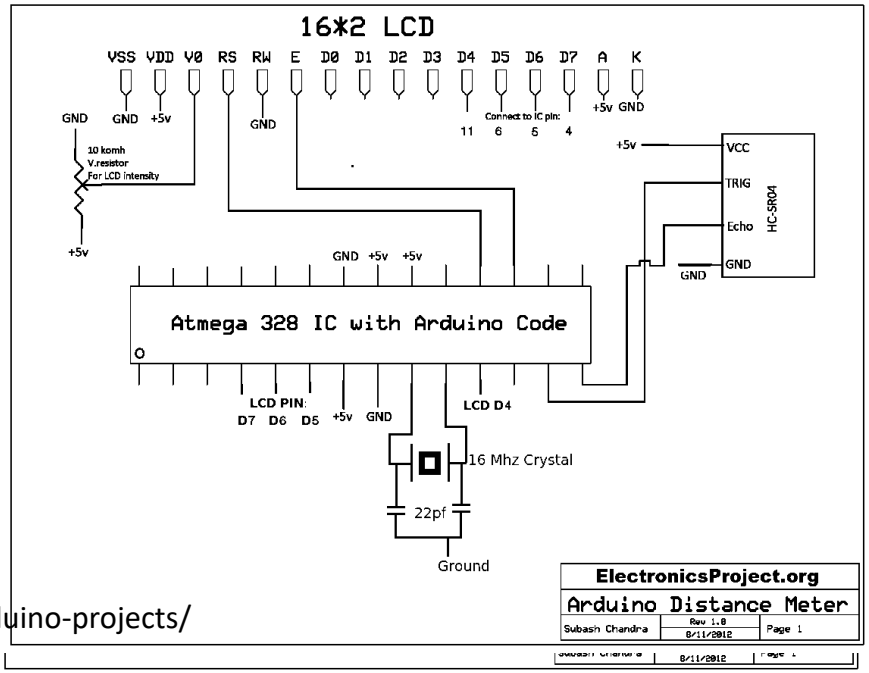
D) Fig. shows data obtained when the four sensors are covered with different masses of aluminium (0, 2, 4 and 10g) and putted in a big mass of warmer water (isothermic).
The dependence of the time to reach equilibrium on the mass of aluminium allows to understand the meaning of time of response of a system and to calculate It.
It is possible to study the exponential low to reach equilibrium.



Arduino [King of Italy, 1002 DC]: distance meter



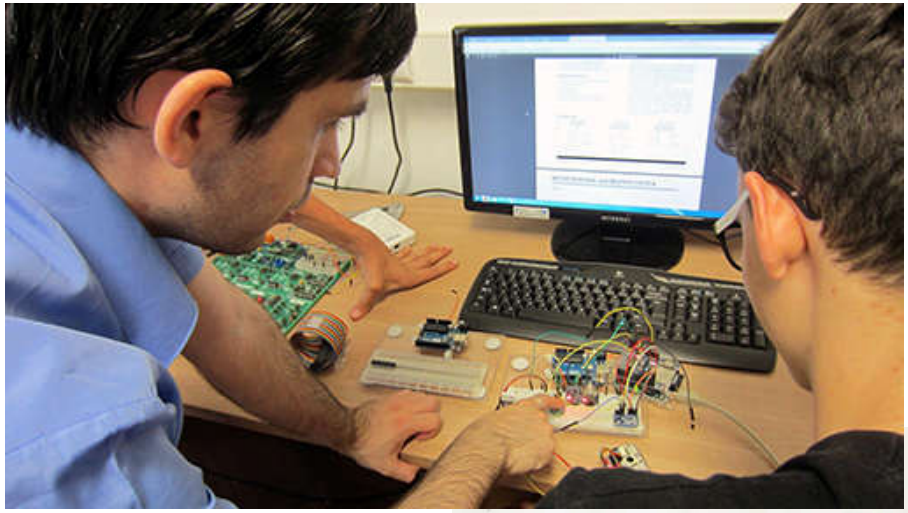




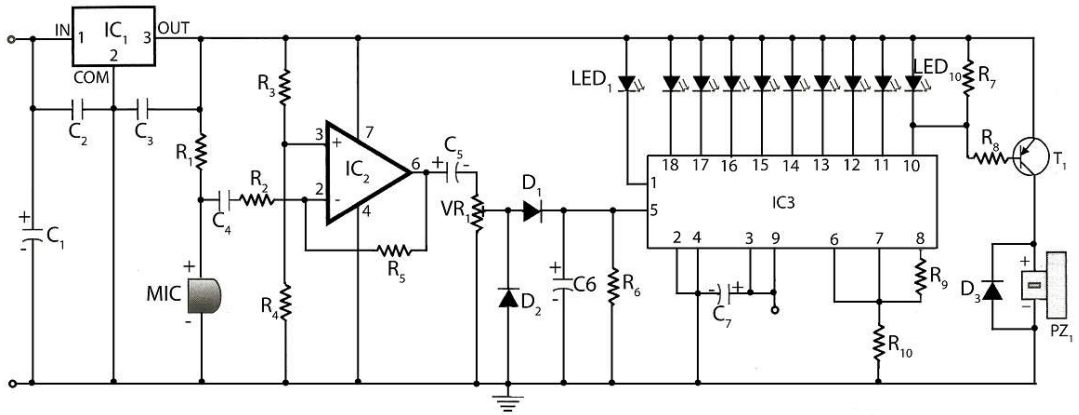
Simple, cheap, well explained

http://www.electronics-tutorial.net/electronicsvd/arduino-projects/

Arduino & Mindstorms: applications



Arduino: noise meter



https://electronicsproject.org/noise-meter/

Figure 1: Noise Meter

The future belongs to you

Figure 4a – Noise indicator - a simple construction with LED indicators, based on Arduino standards. The two girls (Zuzanna Seklecka i Maja Ostrowska) from the 1st Lyceum in Kwidzyn won the prize at the local competition. Supervisor: Joanna Poźniak.

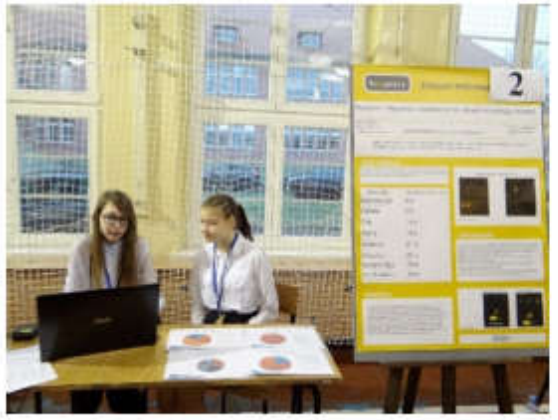
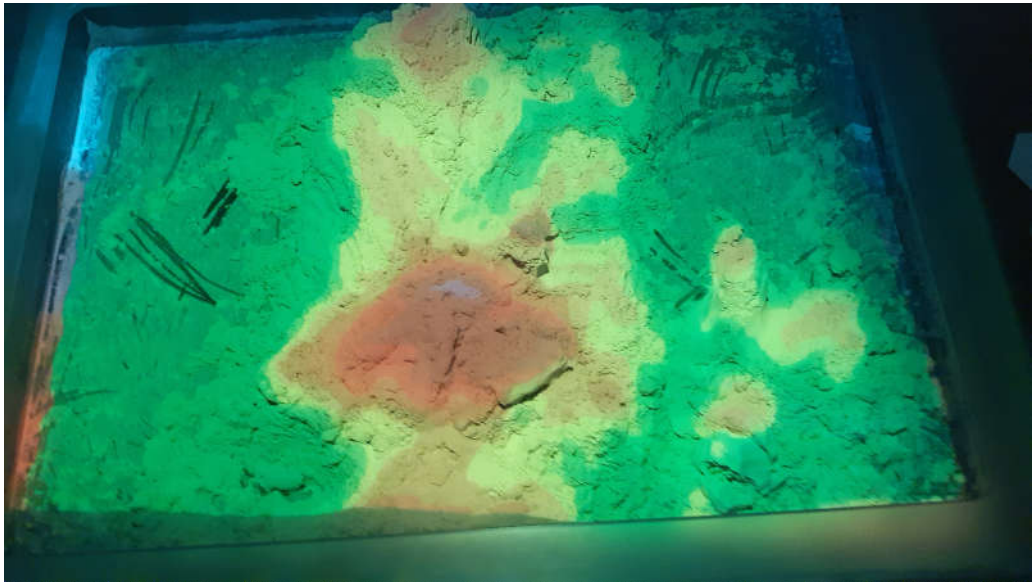
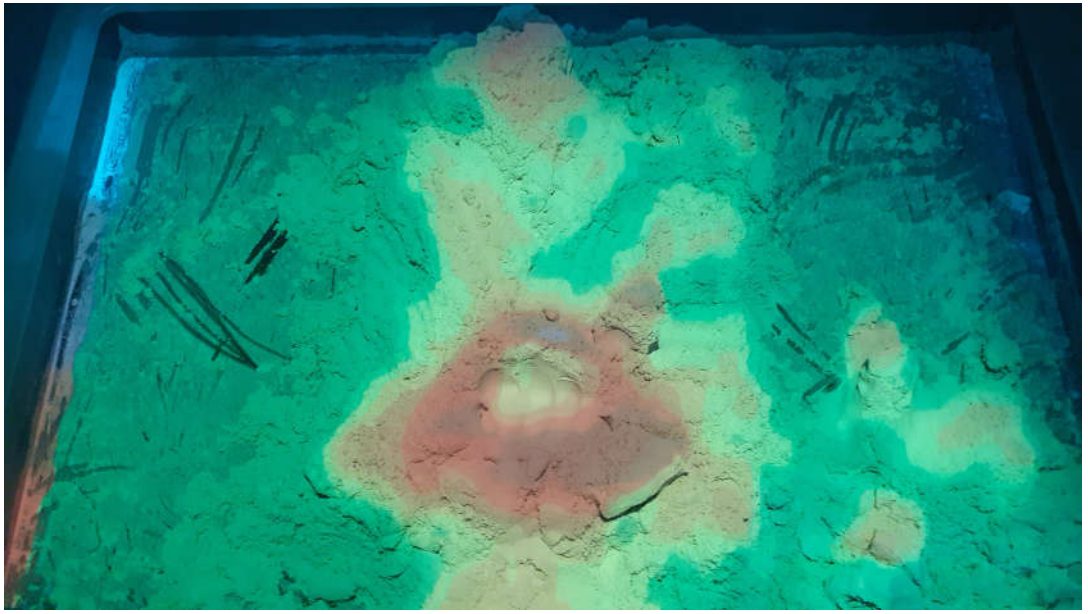


Figure 4b – A similarly simple idea – measuring the level of luminosity in different environments using a photo-camera from a cell phone. Idea and implementation Emilia Szramowska and Natalia Poźniak (Elemantery school No. 2 in Kwidzyn). Supervisor: Ewa Jurek.

Varie: isoipse (Hevelianum, Gdansk)





Il rivelatore della distanza fa scansione e manda
al proiettore un «pattern» di illuminazione

On-line experiments

- Kaiserslautern Physics