Low-cost Science

SCIENCE ON STAGE 2017 DEBRECEN
THE EUROPEAN NETWORK FOR SCIENCE TEACHERS

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Sound around us

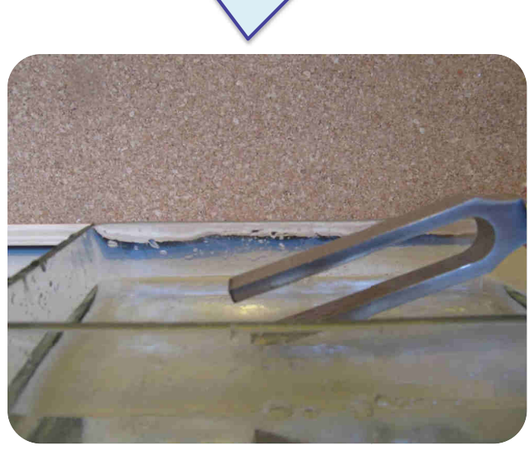
The project involves several experiments aimed at the concept of sound using mostly simple materials.

The experiments are focused on:
- how to make sound visible,
- how sound is made,
- what the frequency and amplitude of sound depends on,
- how fast sound travels.

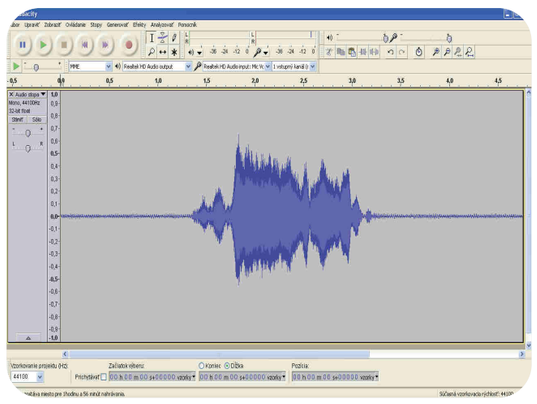
The experiments are designed for independent students´ investigation when students explore sound properties or make their own instrument producing sound (straw) or even music (plastic pipe or bicycle spoke).

Students can be involved in research and design projects connected with sound and music and the project outputs can even result in musical performance using own home-made musical instruments to present at school events.

source of sound = vibrating object



the waveform of sound can be displayed

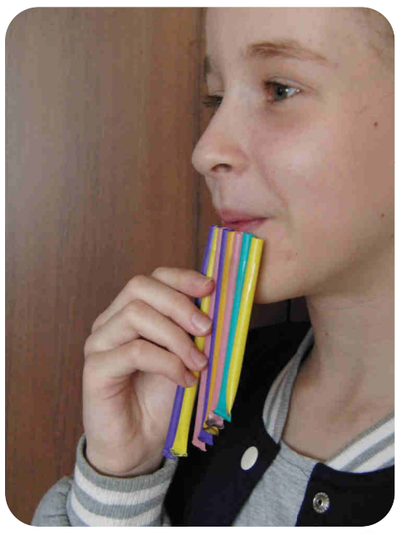


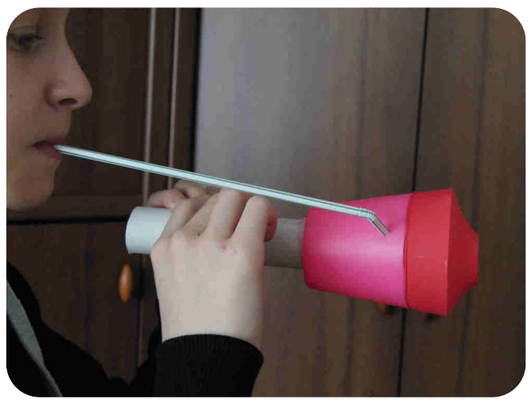
sound travels through the air

Simple musical instruments

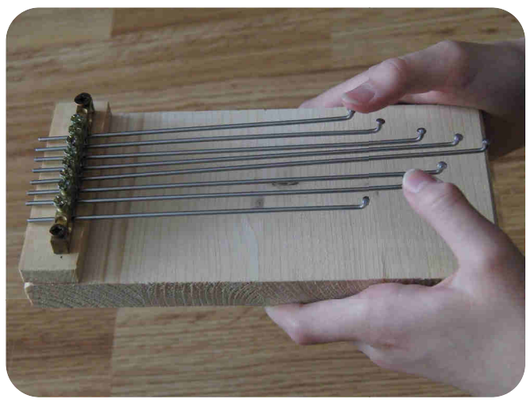
$$f = \frac{v}{\lambda}$$

f [Hz]





A [m]



λ [m]

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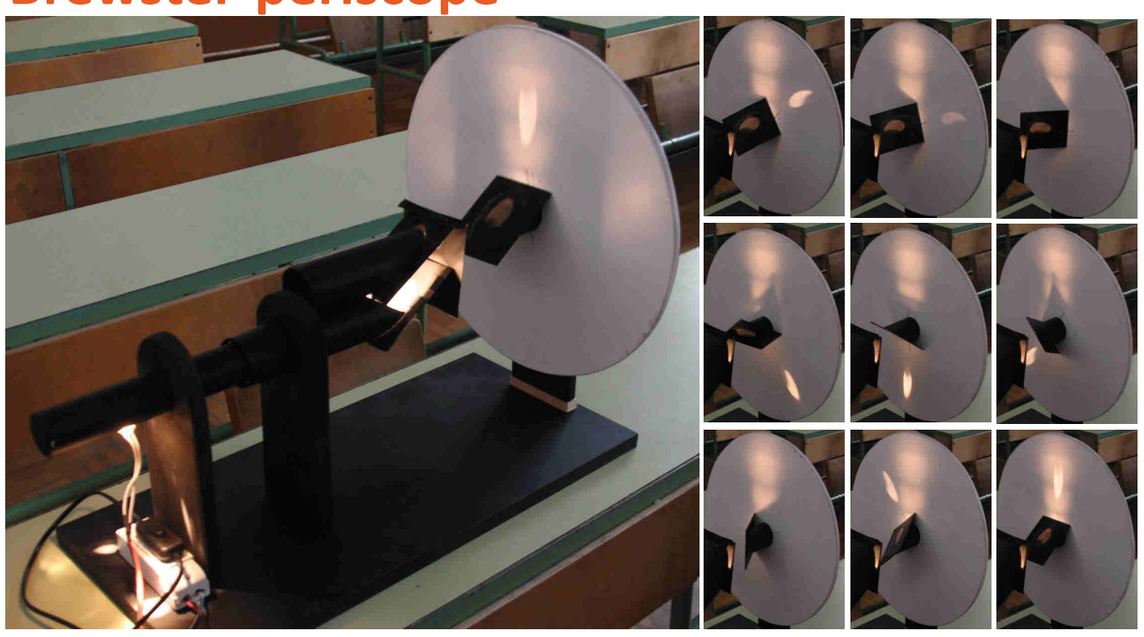
Venczel Borbély PhD | Ferences Gimnázium | Szentendre | Hungary

The hidden secrets of the visible light

The wave property of the light

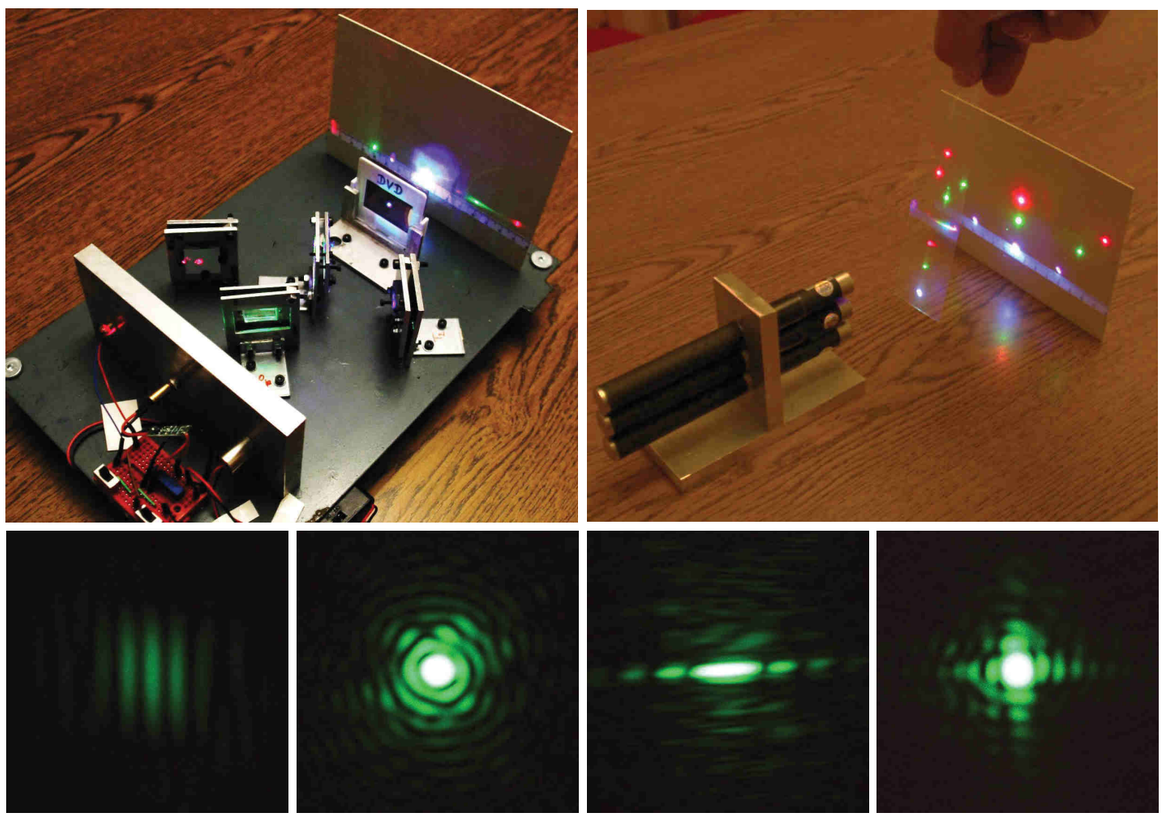
A significant part of the information about our environment is obtained by the help of visible light. However, the wave-characteristic of light remains hidden for us. The project presents experiments which proves the wave-characteristic of light with the help of simple tools available for everyone. Different physical phenomena like light interference, diffraction and polarization are shown in their respective ways by using mobile phones, cheap electronic devices and other means of everyday use available almost for free. These can sufficiently contribute to motivating students in their studies of science.

Brewster-periscope

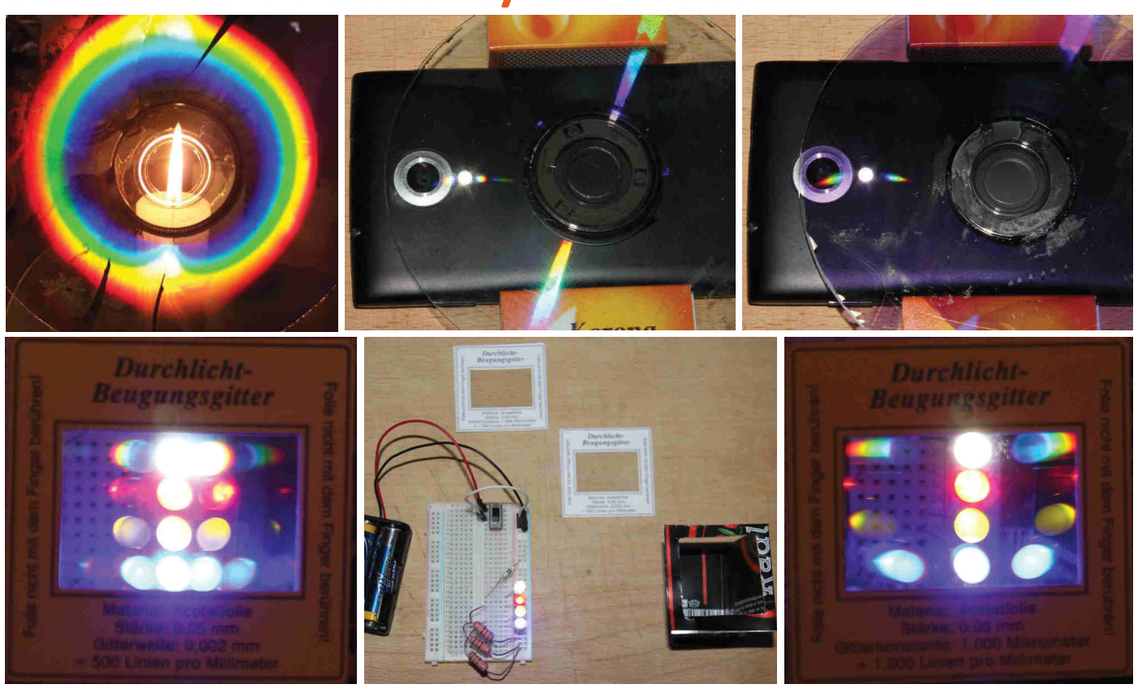


Polarization at home/classroom

RGB diffraction demonstrator



Diffraction at home/classroom



100% Great!

By doing experiments using simple, everyday tools, students can feel science has come very close to them, because they can physically take things in their hands, they can do the experiments themselves and they can draw conclusions.

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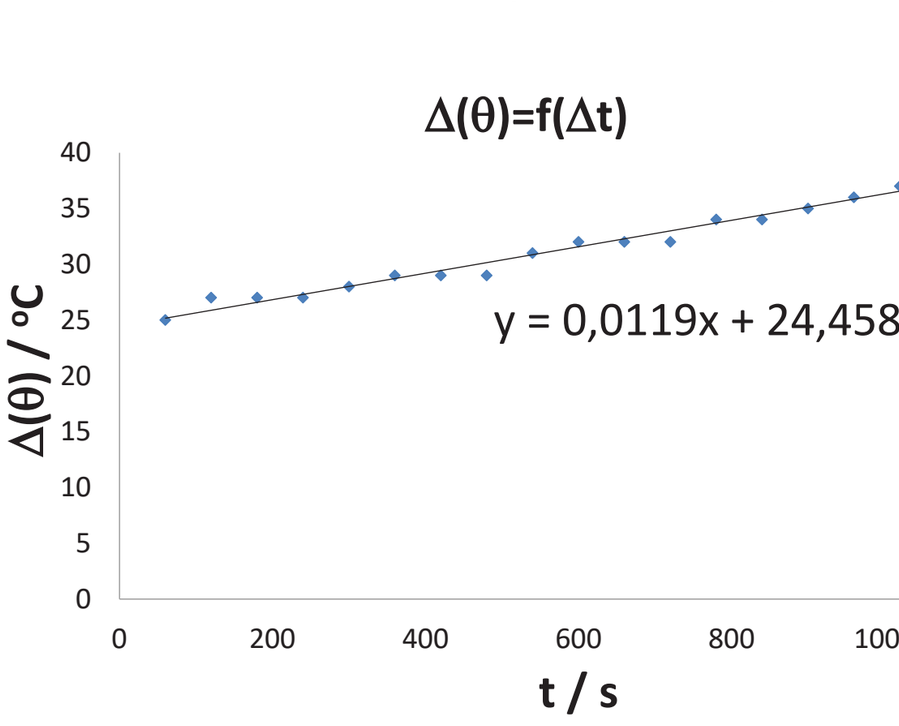
Wilson Simões | Escola Secundária Dr Joaquim Gomes Ferreira Alves | Valadares | Portugal

The Sun inspires us…

Energy Transfers

Our project is about the 4R's application:
To **R**educe, **R**ecycle, **R**euse and **R**ecover, at the building of solar ovens and solar collectors, aiming **to improved sustainability**.

Our project involves the construction and study of different types of solar ovens and a solar collector, which allows the study of the energy transfer phenomenon – heat and radiation; the bodies emissivity; kinds of materials; optical phenomena; yield in heating processes; thermal conductivity and many other things!

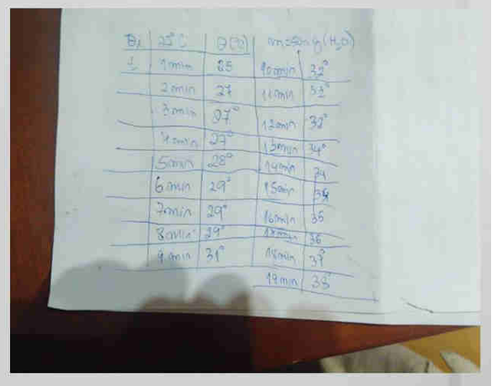


parabolic solar oven yield

(r = 0,4 m; A=0,50 m²)

$$P_{U_{(Exp)}} = 0{,}0119 \times 0{,}5 \times 4{,}18 \times 10^3 \Leftrightarrow$$

$$\Leftrightarrow P_{U_{(Exp)}} = 25\ \text{W}$$



$I = 342\ \text{W m}^{-2}$ (April, Porto)

$$P_{Tot} = 342 \times 0{,}5 \Leftrightarrow$$

$$\Leftrightarrow P_{Tot} = 171\ \text{W}$$

$$\eta = \frac{25}{171} \times 100 \approx 15\%$$

We think that classrooms should reflect the world because learning is dynamic and it is transversal and because we are curious as well.

We wish a classroom that goes beyond the walls where students can "feed" their curiosity. There they can reflect on "why questions". They can apply knowledge and develop skills related to Science.

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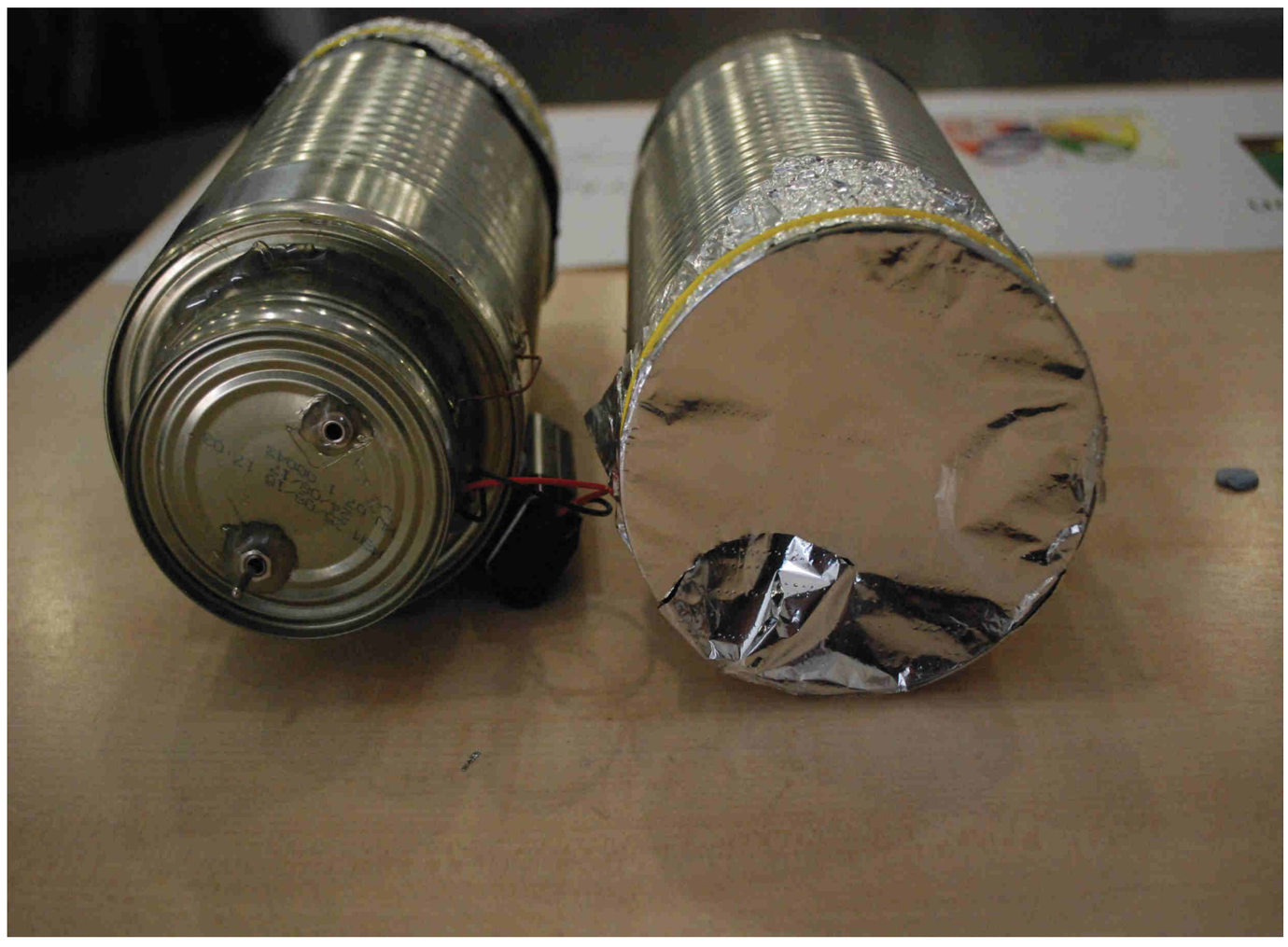
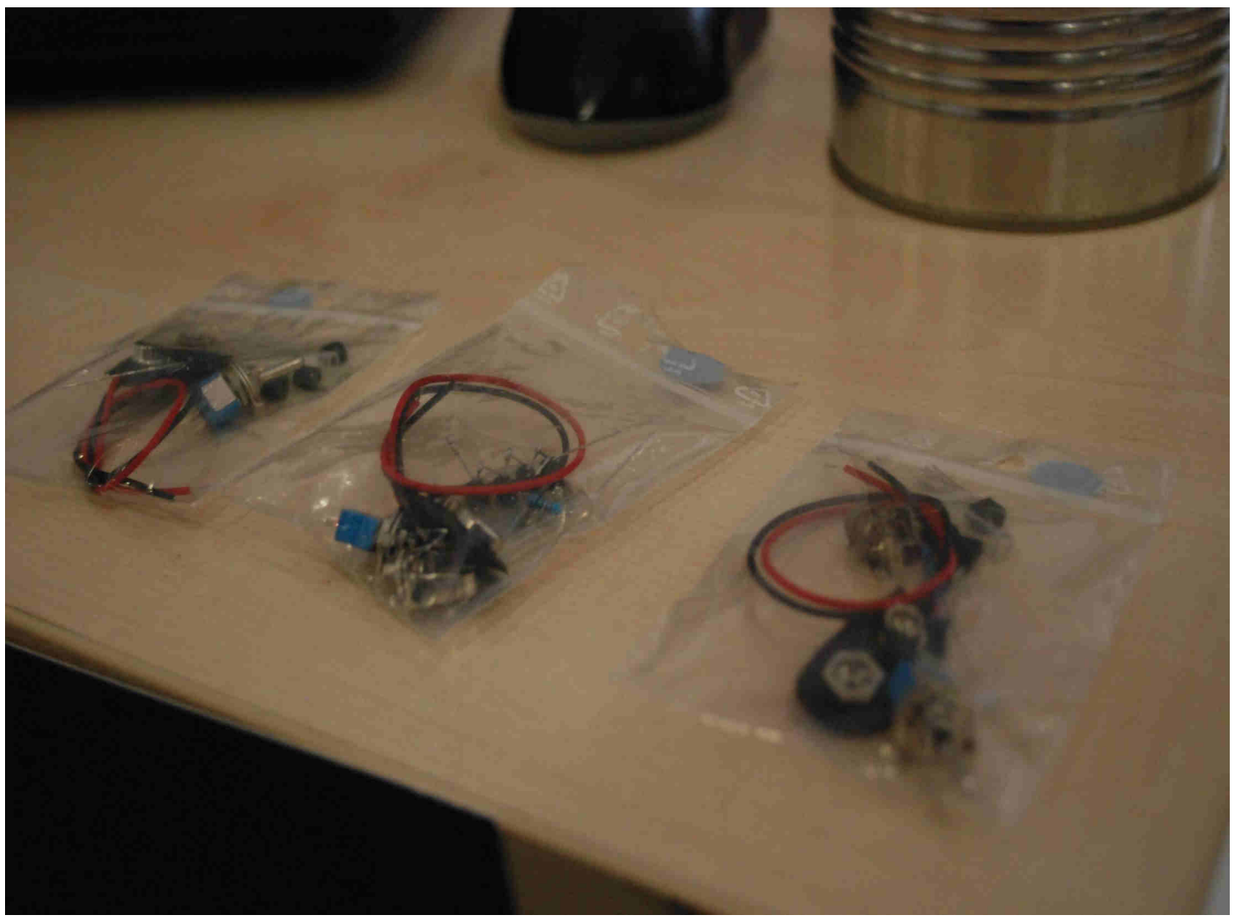
Zsolt Zsigó, Ervin Hábel| Vocational Training Centre in Nyíregyháza Bánki Donát Polytechnical High School and Dormitory| Nyíregyháza | Hungary

Tin can Radon detector

Radon detection on a budget!

Radon is a radioactive gas which may be a threat to our health. It can be found everywhere, and comes from the cracks of our planet's soil.
This DIY radon detection kit lets you inspect the rising or falling level of the radioactive gas. The detector amplifies an unbelievably small ion current flowing trough the air in the tin can when high energy particles fly into it. We use transistors to amplify the signal, and a multimeter measures a voltage drop between the pins of a resistor.





To help the DIY process, we made some kits, pre assembled amplifiers with the resistors. This action provides an easier approach if you want to build the detector. Also these kit elements are cheap and easy to get, even from scrap parts.(e.g.: old transistor radio)
If you choose these kits, all you need to have, is two different sized tin cans, some aluminum foil, a multimeter, and a 9V battery. Everything else will be in the kit.

Our goal is to provide the students a cheap DIY way to get closer to understanding physics, to ask questions, also have great ideas, more and more curiosity about physics and nature.

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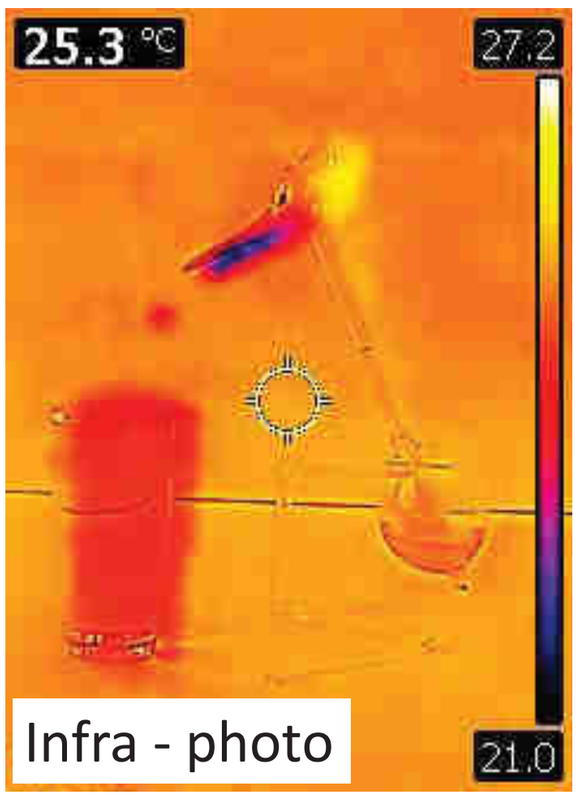
Zdeněk Polák| Alois Jirásek Grammar School | Náchod | Czech Republic

Playing with heat – turning heat into work

Simple and straightforward experiments on converting heat into mechanic work.
We show the basic principle of all heat engines which is the one based on the fact, that they can change into work only a portion of heat which spontaneously moves over from the warmer part of the machine to the cooler one. The tools are easily available and low-cost, but the physical principles of converting heat into work are very diverse.

Drinking bird as a heat engine



Heat engine

T_1 Hot source

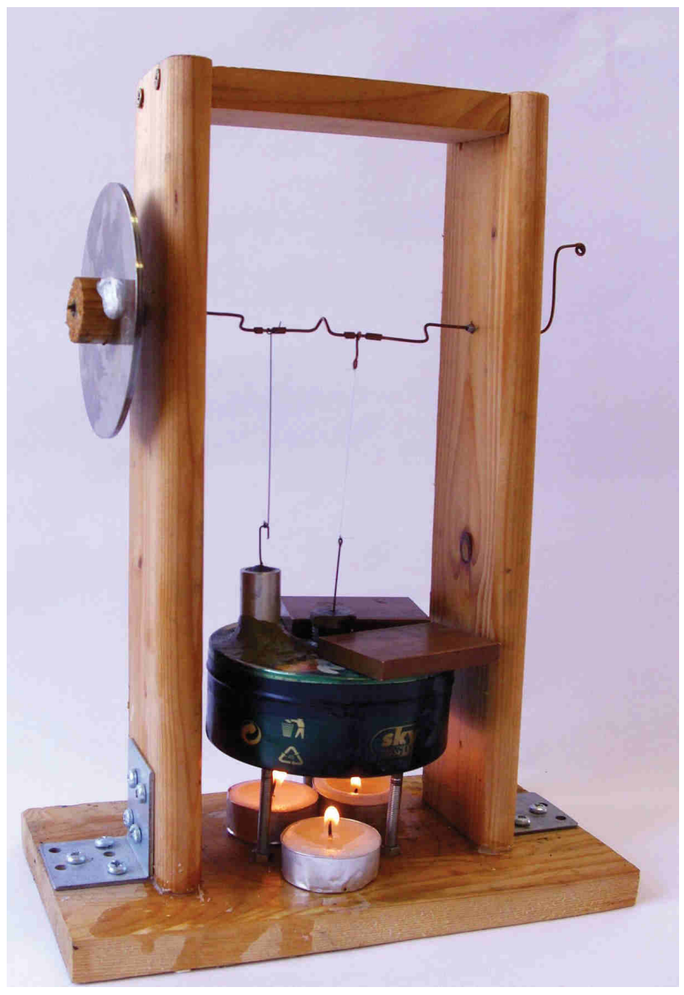
Q_1

Engine → $W=Q_1-Q_2$

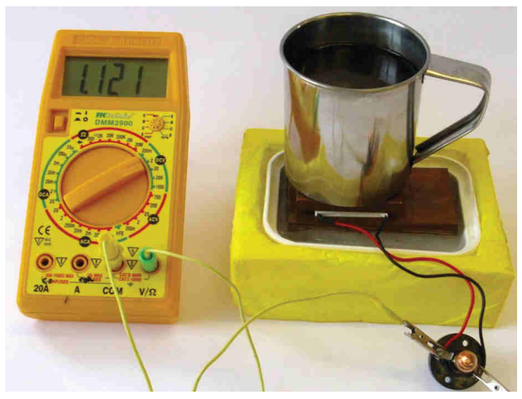
Q_2

T_2 Cold sink

Stirling engine



Thermoelectric generator



Physics is fun

There are many ways to change heat into work. The best way how to find it out is try to do it with your own hands and head.

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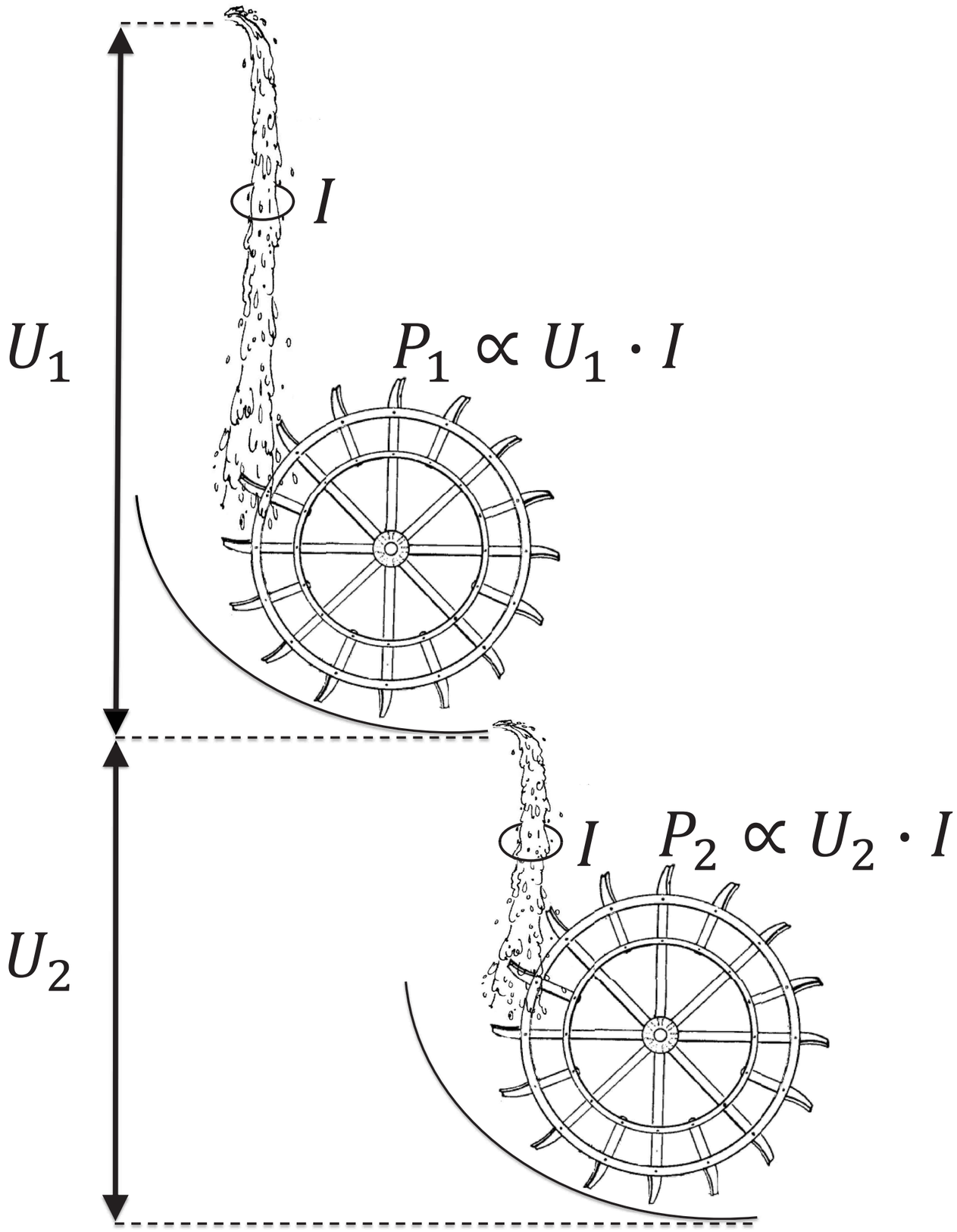
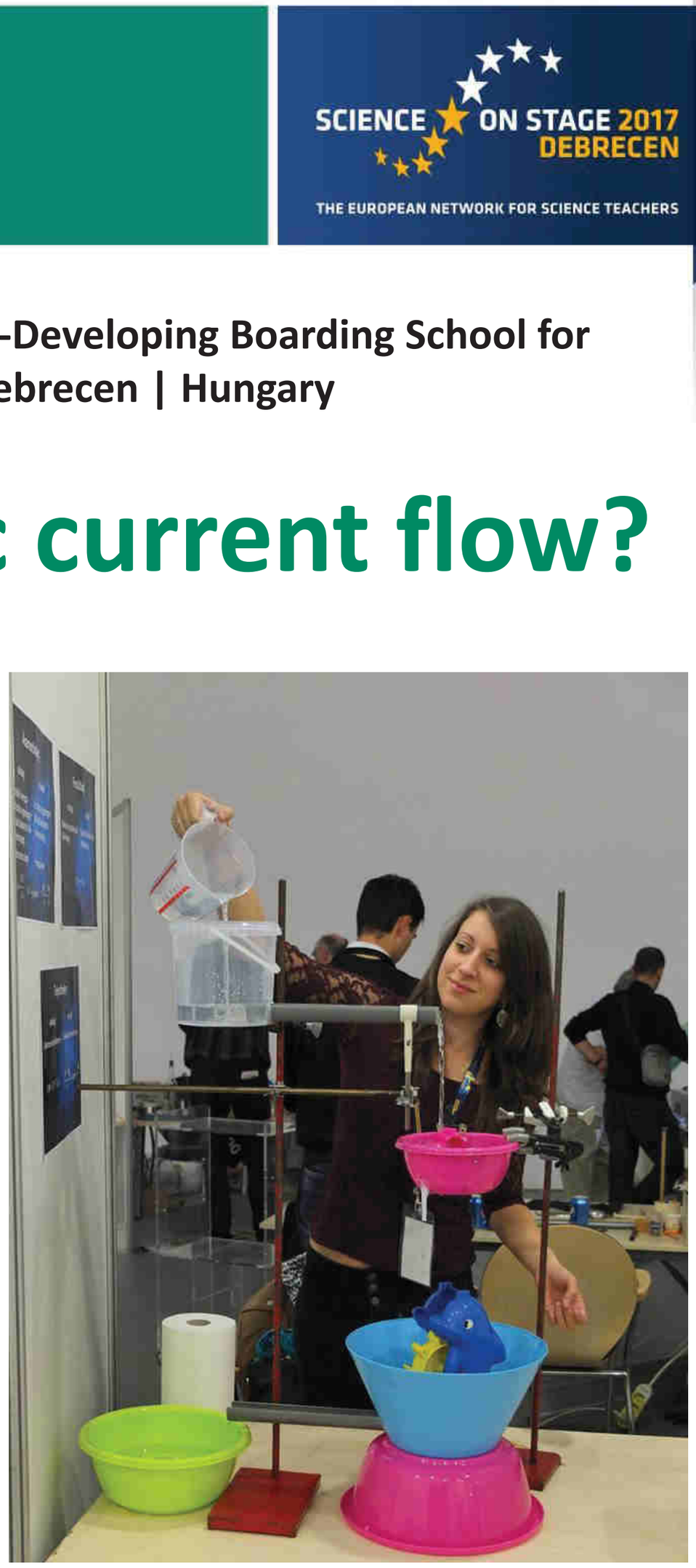
Borbála HERENDI[1], János TOMÁN[2]| [1]Deák Ferenc Talent-Developing Boarding School for Secondary School Students, [2]University of Debrecen| Debrecen | Hungary

Why does the electric current flow?

Many student have a hard time understanding the **abstract concepts of electricity**. For some of them it might be helpful to show **a visual and practical analogy** that helps them to remember the many interesting phenomena of this subject.

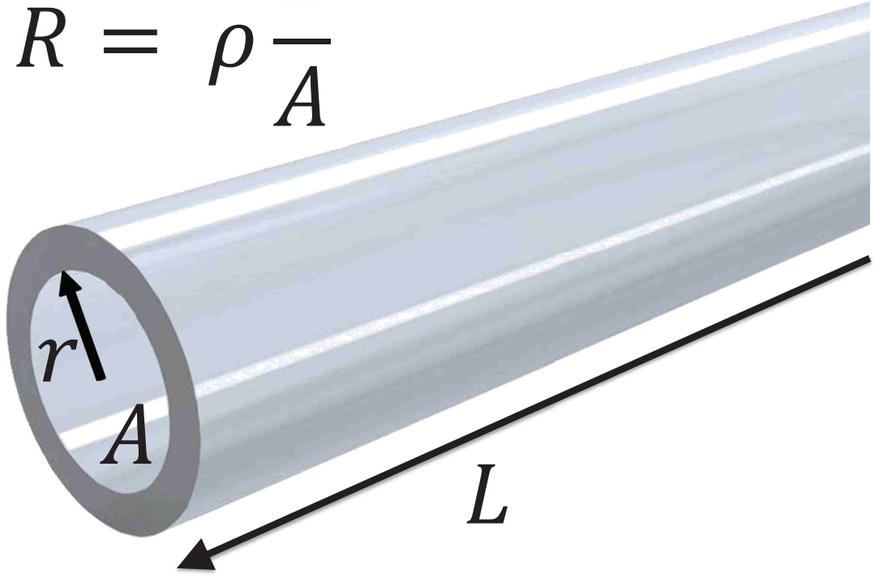
The flow of water is a surprisingly perfect analogy for the flow of electric current. The height have the role of voltage as the driving force. The flow rate (gram/s) is analogous to electric current and even the mechanical power behaves the same as electric power.





Water flowing in tubes can demonstrate all aspects of the resistance of electric wires.

$$R = \rho \frac{L}{A}$$



The ρ can be represented as obstacles in the tube, and then **the dependence on the type of material and length can be demonstrated, too**.

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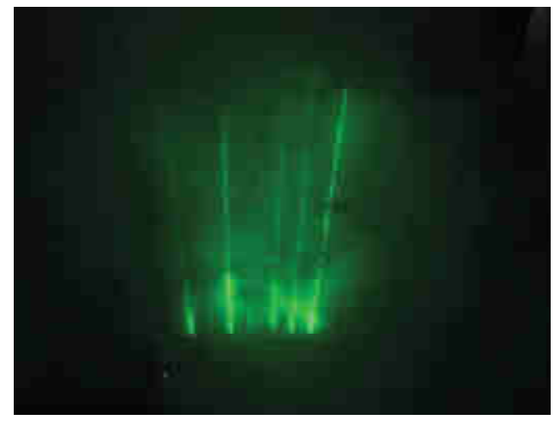
Rita Rocha | Colégio Luso-Francês High School | Porto | Portugal

Ars Lux Laser Harp

The musicality of Light

```
//int nr = (2*green-blue-red)*2+0*green/(2+max(blue,red));
int nr =          red  *  kernel[x-(String[string].Pos[y-DETECT_MIN_Y]-halfk)][0] +
                  green*  kernel[x-(String[string].Pos[y-DETECT_MIN_Y]-halfk)][1]
```



A laser harp is a musical instrument whose functioning is based on blocking laser beams with the purpose of producing a sound. *Ars Lux* is a frameless harp and employs eight 5mW power lasers, each one regulated to a different frequency, in order to create an entire musical octave. The lasers are connected to a video camera which, in turn, is connected to a Raspberry Pi board computer.

How does it work?

When we cut the laser beam, there's a small dot in our hand. The camera detects the small dot and transmits information to the board. The board, then, processes the coordinates at which the dot is in and emits a musical note through the speakers.

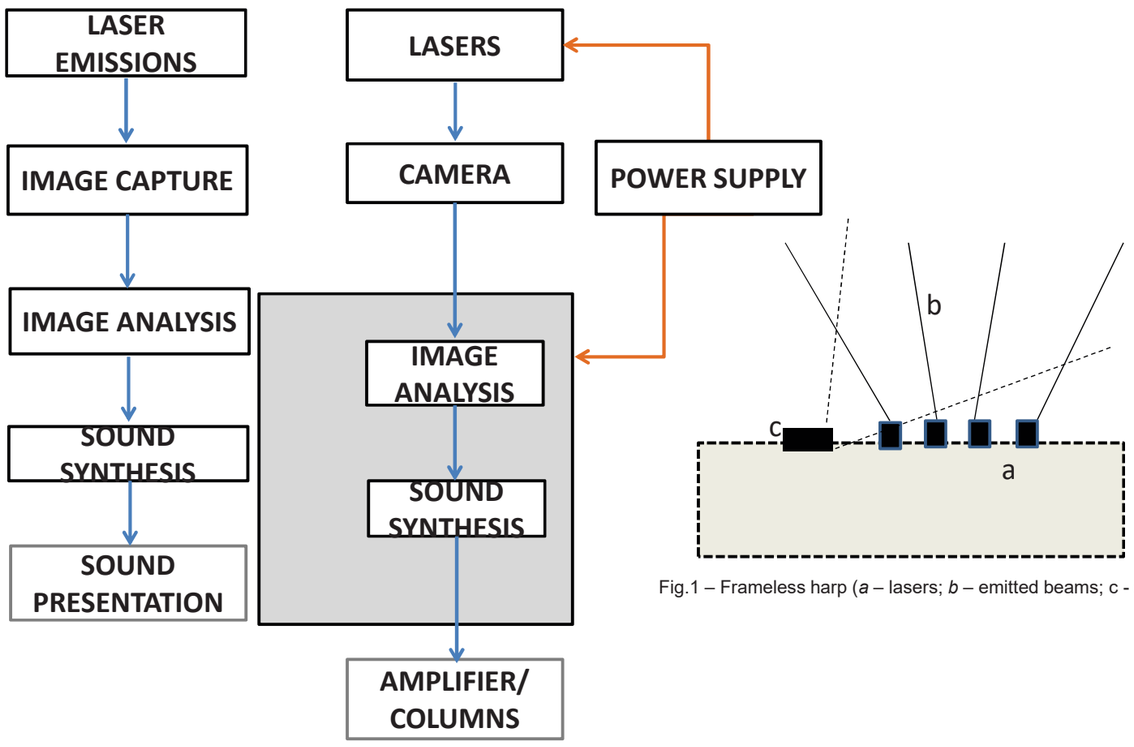
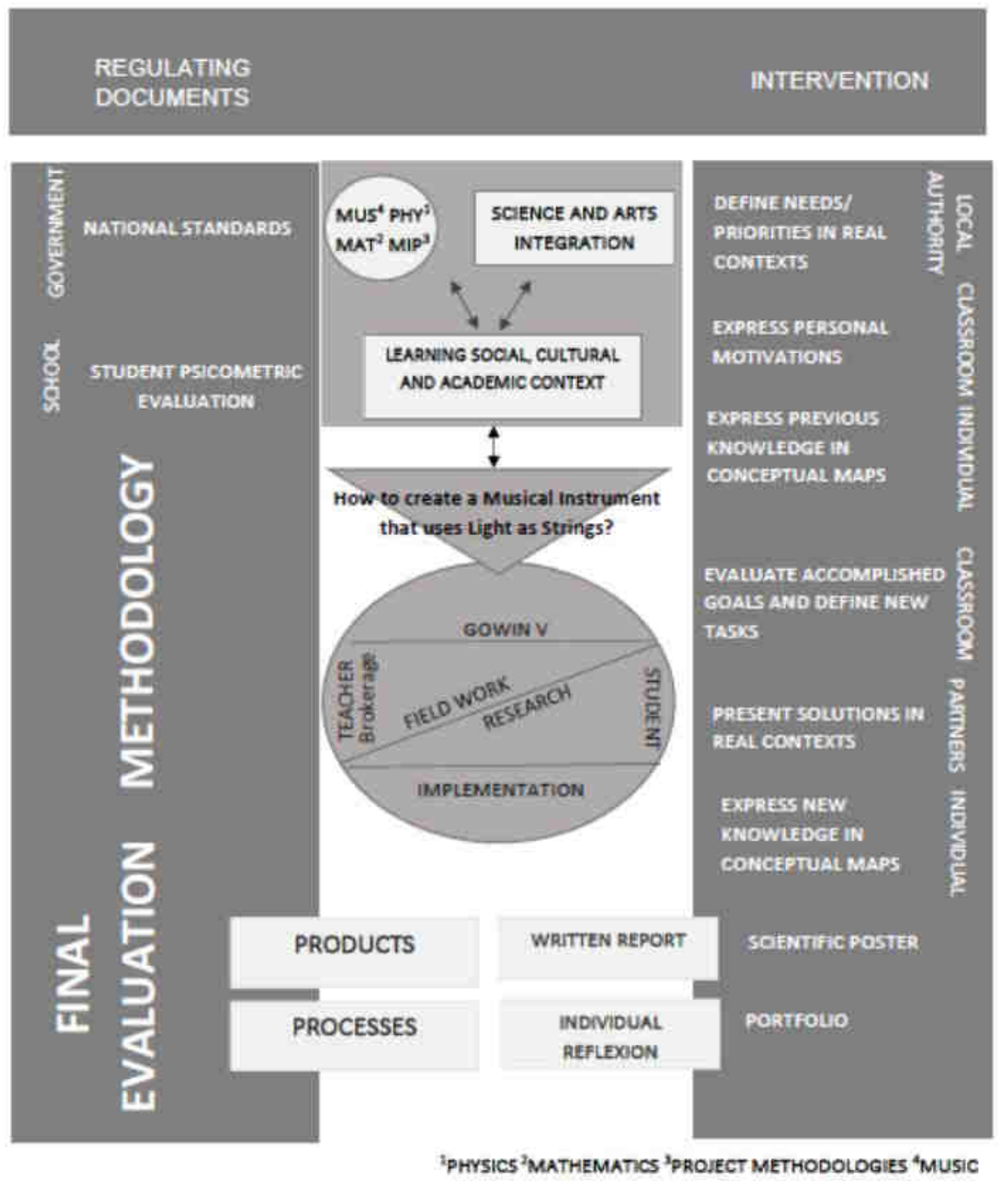


Fig.1 – Frameless harp (*a* – lasers; *b* – emitted beams; c - camera)

How to build a Laser Harp?

MIP – a Project-based Learning Experience



Honor Award.
Villadecans, Spain.

1st Prize Award.
Viana do Castelo, Portugal.

INTERNATIONAL YEAR OF LIGHT 2015

Invited Speaker.
Funchal, Madeira [PT].

Maker of Merit Award.
Lisbon, Portugal.