

A Debian-based system to teach science, right in your pocket
Un sistema basado en Debian para enseñar ciencias, al alcance de tu mano

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Why do we teach science ?

Oh no! not the lazy answer: *"because we are science teachers?"*

My students knew me as teacher of physics and chemistry. They should definitely prefer famous authors to learn science.



Figure 1: Here is an example: a (double) rainbow

They all studied the rainbow

Aristotle, Seneca the Younger, Alhazen, Averroes, Avicenna, ... all of them built efficient theoretical frameworks. Most recently : proportionality of incidence and refraction (Kepler); proportionality of sines of those angles (Snell & Descartes); light as waves (Huygens, Fresnel, Airy); waves interacting with spheres (Mie).



Science facts can be experimented

During my course, students were given an opportunity to measure themselves refraction angles, and all of them could compare theoretical predictions of Kepler, versus predictions of Snell and Descartes.

There was a difference, and they did *touch* it.

The wisest of them could even conclude that Kepler was not contradicted by Snell or Descartes. Every theory has an application domain, that can be extended with more experimental facts and new approaches.

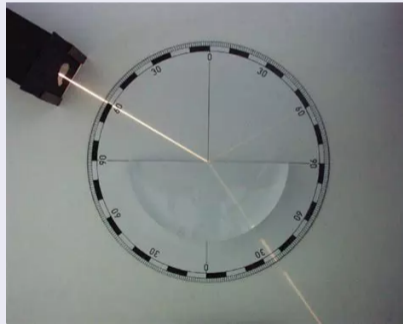


Figure 2: Experimenting with light refraction

Let us share the fun of experiments with students

Exactly as encouraging young girls and boys to publish *their* newspaper can vaccinate them against feeding fake news, encouraging them to have fun with experiments is the right way to teach science.

Scientists should never use « black boxes »

*Open science refers to the process of making the content and process of producing evidence and claims transparent and accessible to others. Transparency is a scientific ideal, and adding 'open' should therefore be redundant.*¹

As far as possible, we must use free-libre software, and free-libre hardware.

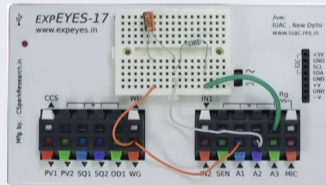


Figure 3: Eyes17 is free hard- & software

¹Munafò, M., Nosek, B., Bishop, D. et al. A manifesto for reproducible science. Nat Hum Behav 1, 0021 (2017).
<https://doi.org/10.1038/s41562-016-0021>

Once upon a time...

In year 2001, Klaus Knopper authored a live CD-ROM, named **KNOPPIX**.

The first educational live CD-ROM was FREEDUC-CD, built as a derivative of KNOPPIX in year 2002. Seven versions were published at **Sourceforge**, until year 2007.

Today's FREEDUC-USB

Nowadays, less computers come with an optical drive, and USB sticks have superseded DVD-ROMs. **FREEDUC-USB** can be used to boot computers with Debian GNU-Linux, and a selection of software packages to be used in scientific education, in high schools.



Figure 4: Freeduc is a project initiated by association OFSET

Use cases for FREEDUC-USB

I worked as a teacher in Lycée Jean Bart (Dunkirk, France), whose budget is driven by regional authorities – as for public French high schools.

Despite governmental recommendation to use FOSS whenever it is possible, for decades, French schools are equipped with computers running Windows. However, with the permission of the person maintaining our computers, I could always let them boot from a Freeduc USB stick.

Nomadic environment

Freeduc-USB sticks are organized to bear a live system, and a “persistence” partition on the same drive. One can boot it on a computer at school, and begin working. All customizations, all saved files remain in the “persistence”. When one boots again the same drive at home, the environment is identical, and the work can be continued as if one was using the same machine.

Self-copying feature (no leaks!)

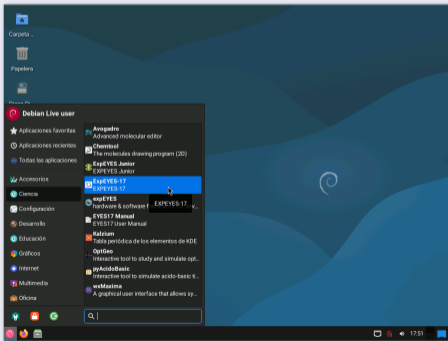
Freeduc-USB comes with the program **live-clone**: it allows one to copy the live system to another drive, without copying any personal data: the “persistence” partition is initialized as empty on the target drive.

A version for Debconf26, with locale es_AR

A recipe for the live system

- learn to use the fabulous package **live-build**
- give it a try with no custom constructs: you get a live GNU-Linux system in minutes.
- declare a list of packages and *tasks* to install, provide customization stuff. Launching **live-build** builds the target in less than one hour.

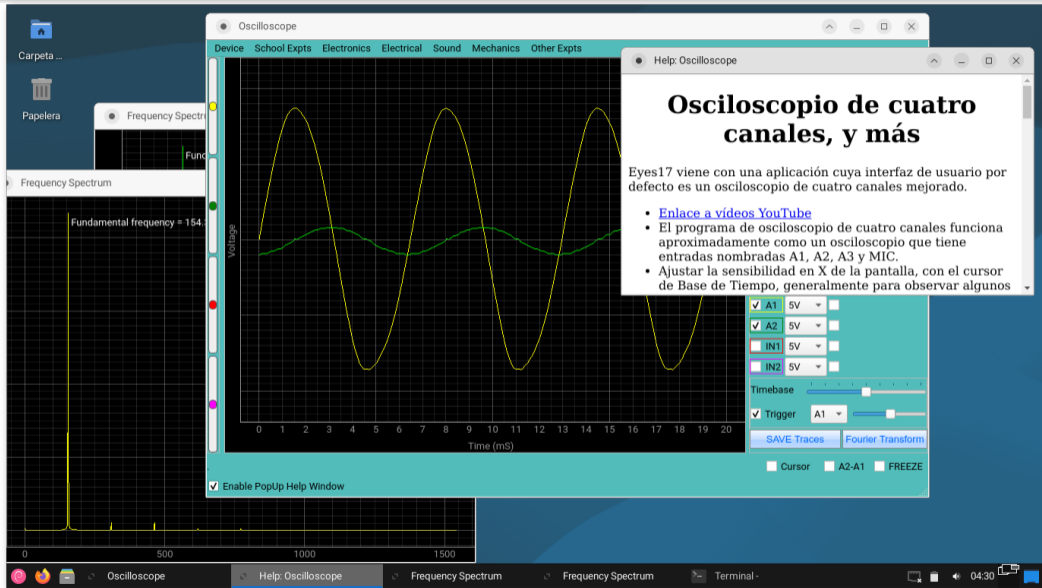
Screenshots #1



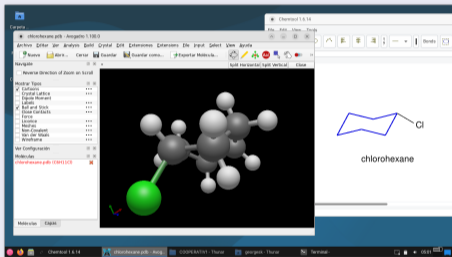
The sub-menu “Science” is open: featured applications are:

- **Avogadro**: an editor for molecular representation
- **Chemtool**: draw 2D representations of molecules
- **Expeyes, Expeyes Junior, Expeyes-17**: drive a powerful physical measurement system
- **Kalzium**: collection of chemical data, organized by the Periodic Table of Elements
- **Optgeo**: study and simulate geometrical optics
- **pyAcidoBasic**: study and simulate acido-basic titrations
- **wxMaxima**: a powerful environment for symbolic calculus

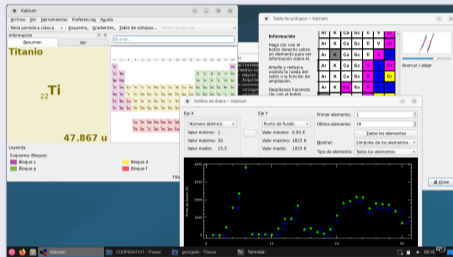
Screenshots #2: an expEyes box is connected



Molecule representation; periodic table of elements



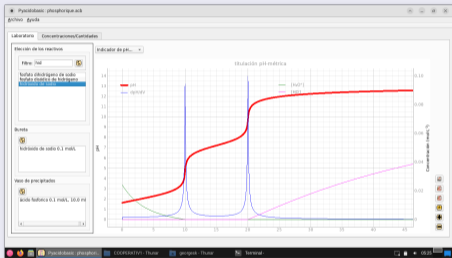
Avogadro, Chemtool



Kalzium

Simulation of acido-basic titration

Pyacidobasic



The application is named **pyacidobasic**; interactively choose a mixture for the beaker (example: phosphoric acid, 0.1 mol/L; 10 mL), and a reagent for the burette (example: sodium hydroxide, 0.1 mol/L).

A simulated titration curve appears, one can zoom it at will, and export it to reuse it in didactic documents.

In a second panel, one can see the evolution of all chemical entities plotted as a function of burette's added volume. Either *concentrations*, which build curved lines, or *quantities of matter*, which build straight lines.

Screenshots #5: geometrical optics (modeling a Newton telescope)

Espace de travail: horiz: [0, 1020], vert: [0, 609] - Simulation: telescope_newton.opt

Fichier Edition Ajouter Options Aide

Miroirs: Ecrans: Sources: Dioptries:

Divers: Afficher: Normales Angles d'incid. et de réfr. Grille Attraction Coord. Zoom: x1

X=733.3±0.5mm Y=338±0.5mm Faites passer la souris sur un des éléments colorés... Mode: déplacement d'un élém

Commentaires sur la simulation / usr/shar

Télescope de type Newton

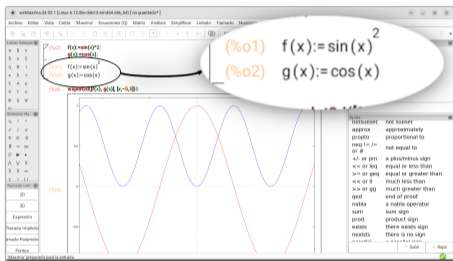
Le miroir primaire est sphérique,
Le miroir secondaire est plan est
L'oculaire a son plan focal objet t
La distance entre le foyer du mir
secondaire est égale au rayon du

On envoie un faisceau de lumière
l'axe du télescope.

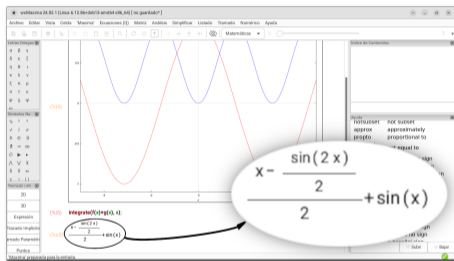
En passant en zoom x10, on vérifie que les rayons émerg
parallèles entre eux: l'oeil peut observer sans accommoder.

Fin dépl.
Dupliquer
Propriétés
Supprimer
Grouper
Grouper tout
Imprimer
Export PNG
Export JPG
Export PS
Copier

Screenshots #6: math tools for studying functions, and make symbolic calculus



WxMaxima: defining functions, plotting them



WxMaxima: primitive of a function

Let us share science as we share Free-Libre Software, with Debian!

- Lots of scientific and didactic packages, among the > 60 k packages in Debian
- `live-build` is our friend, to create easy to publish Gnu-Linux systems
- When students learn with **free-libre software** + **free-libre hardware**, they are learning freedom, too.

QUESTIONS ?

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