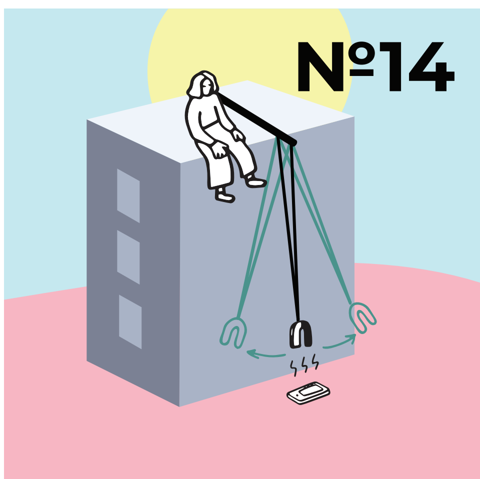
Challenge

PHYSICS IN ACTION

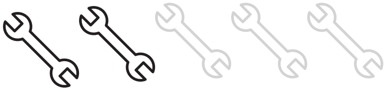
Use five different principles of physics to measure the height of a building using a smartphone.



Discover The Smartphone Physics Challenge at VULGARISATION.FR

«Physics Reimagined» team (Paris-Saclay University)

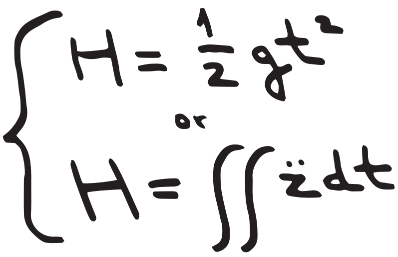
Precision: high



Difficulty: low

№1. Free Fall of the Smartpone

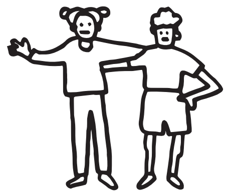
Formula



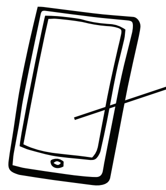
$$\begin{cases} H = \frac{1}{2} g t^2 \\ \text{or} \\ H = \iint \ddot{z}\, dt \end{cases}$$

Material

1 sheet

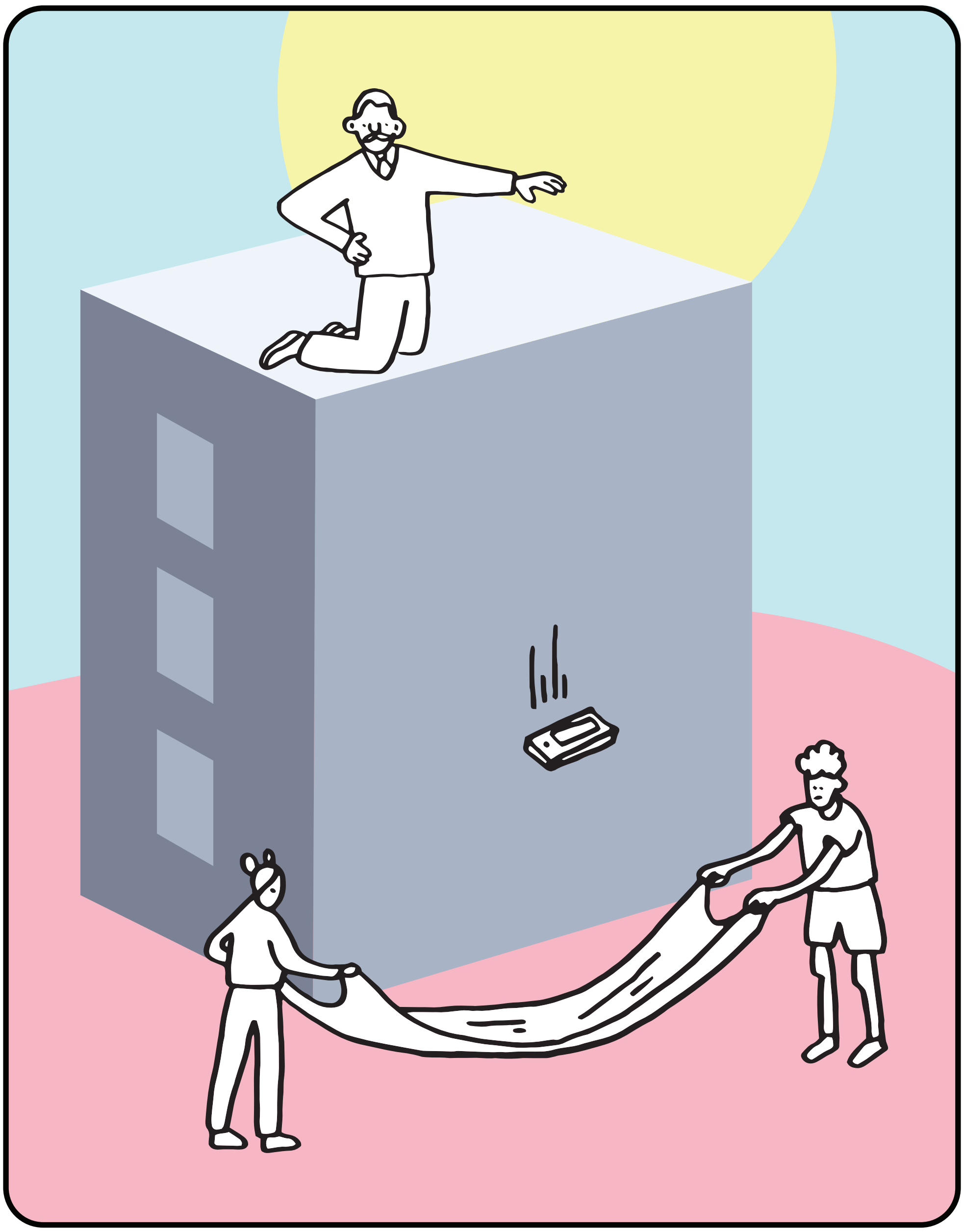


two friends

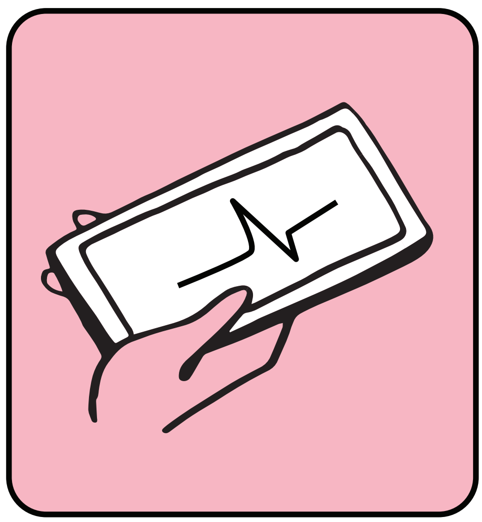


Sensor: **accelerometer**

1 smartphone



Drop your smartphone from the top of the building, your friends receiving it down in a sheet, like firefighters. The recording of the accelerometer data makes it possible to determine the time of fall, and if needed the value of the acceleration can be used to take air drag into account.



t = fall time of the smartphone,
$\ddot{z}$ = smartphone's acceleration,
$g = 9.8\ ms^{-2}$

Precision: maximum

Difficulty: intermediate

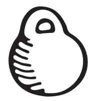
№10. Giant Pendulum Timed

Formula

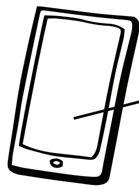
$$H = g\left(\frac{T}{2\pi}\right)^2$$

Material

1 long rope

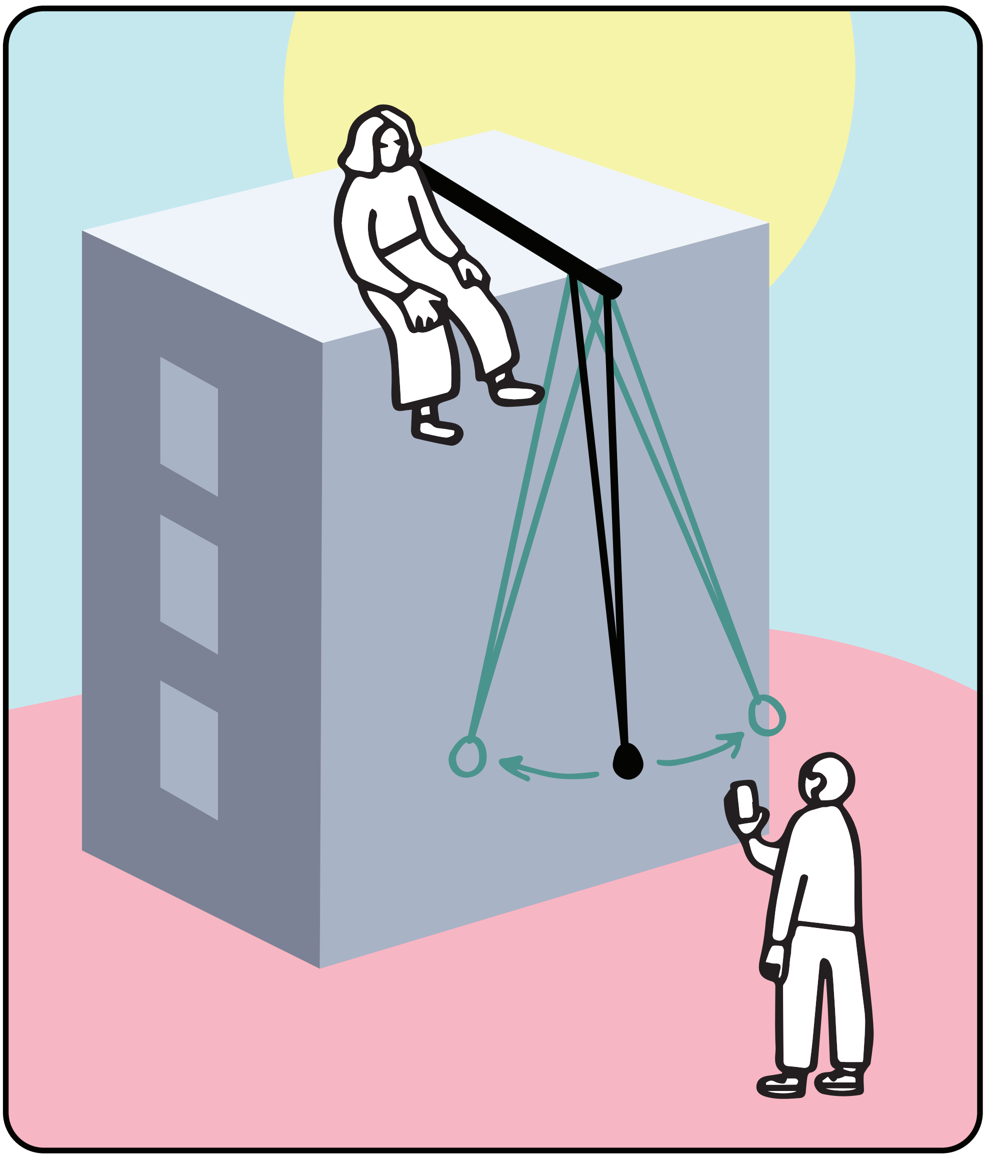


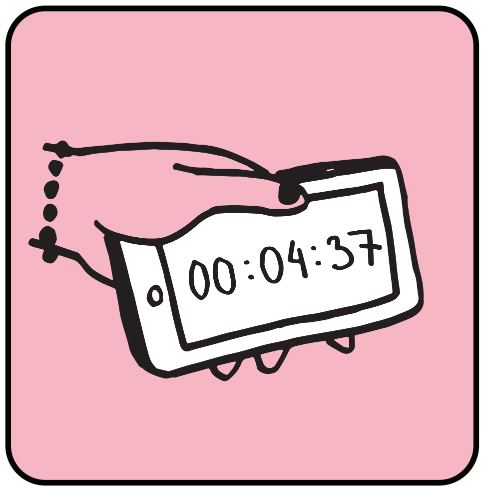
1 mass



Sensor: **stopwatch**

1 smartphone





Make a giant pendulum the size of the building. Use the smartphone timer to determine the period.

T = pendulum period,
$g = 9.8\ ms^{-2}$

The pendulum must not rotate in all directions, it must only swing.

Precision: high

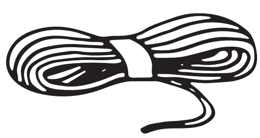
Difficulty: intermediate

№14. Giant Pendulum & Magnet

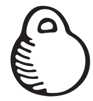
Formula

$$H = g\left(\frac{T}{2\pi}\right)^2$$

Material

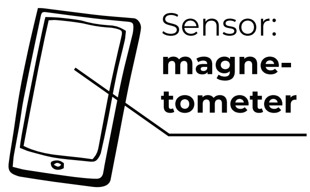


1 long rope

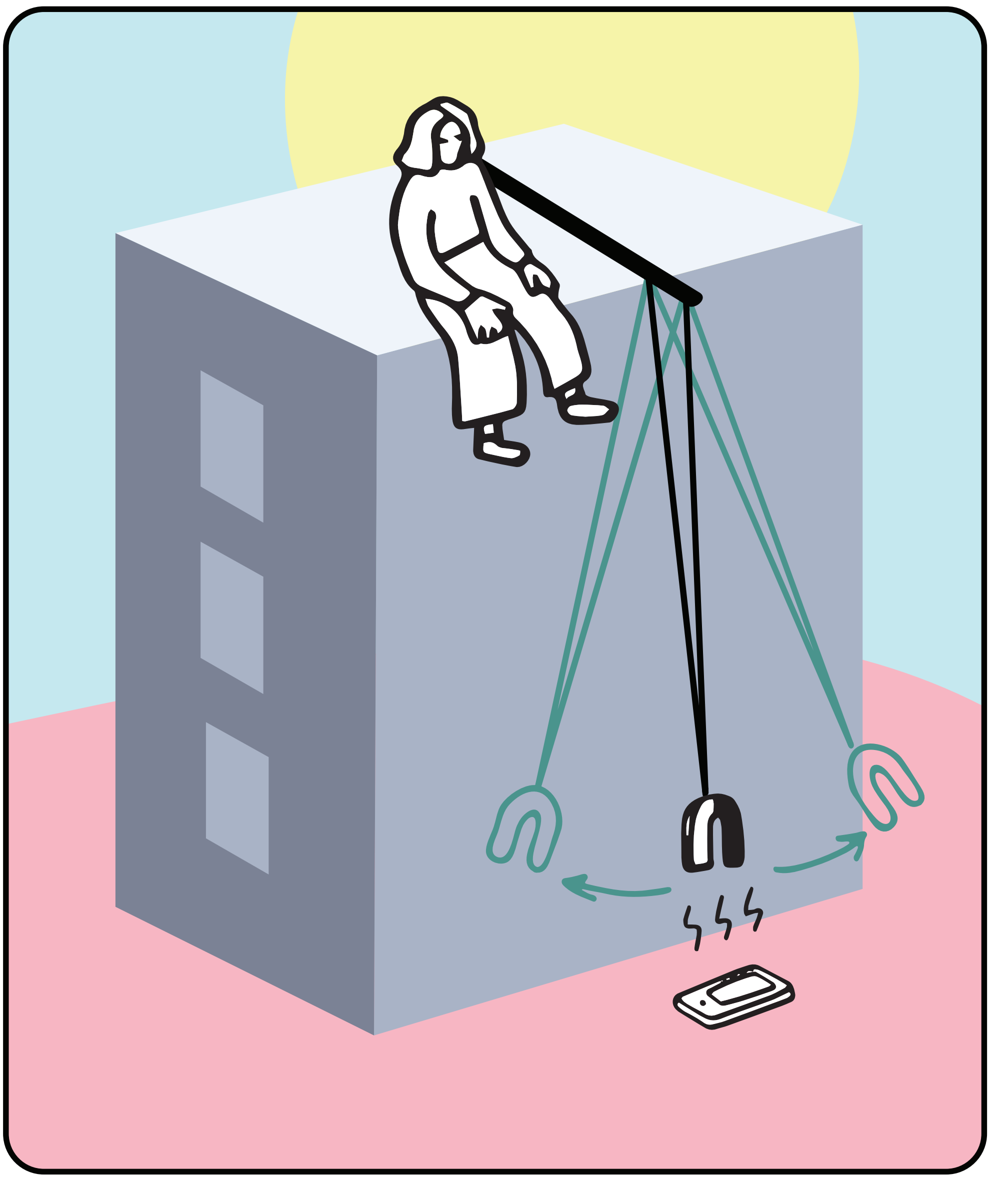


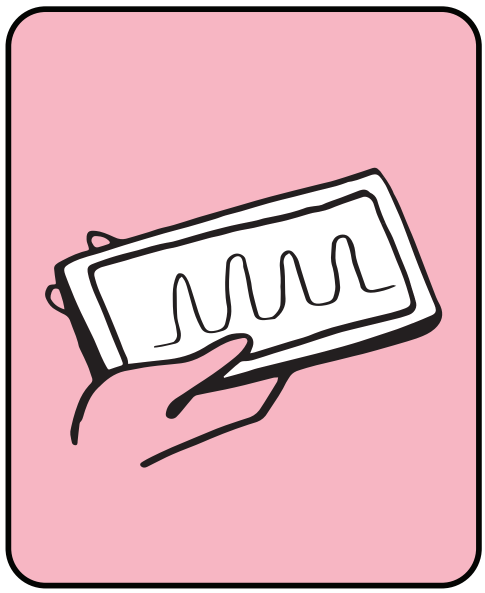
1 mass

1 magnet



1 smartphone





Make a giant pendulum the size of the building. Attach a magnet to the pendulum. Position the smartphone vertically to detect the passage of the magnet.

T = pendulum period,
g = 9.8 ms^{-2}

The Earth's magnetic field can be used in place of the magnet; the smartphone must then be fixed on the pendulum.

Precision: high

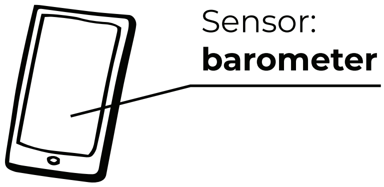
Difficulty: minimum

№36. Pressure Variation

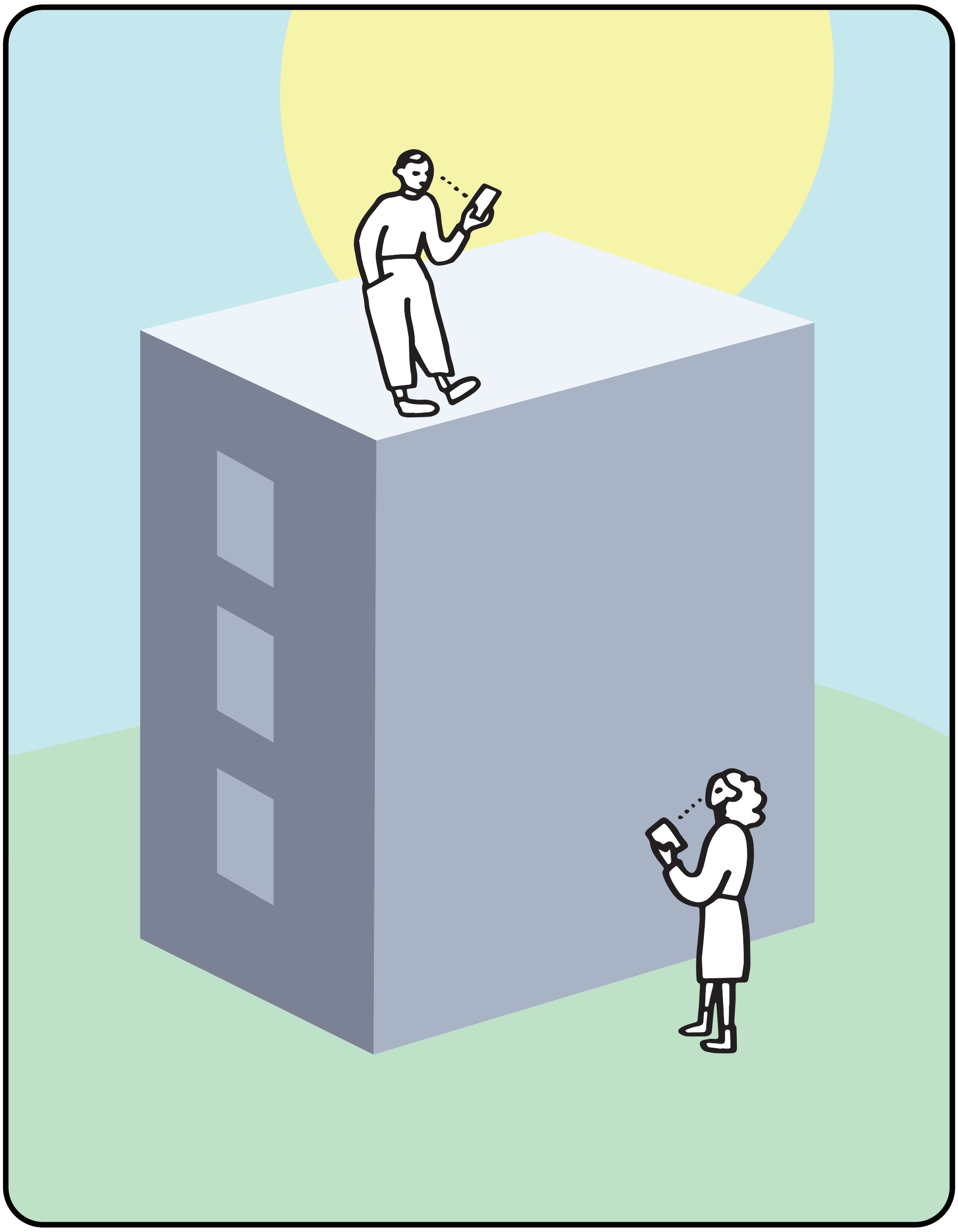
Formula

$$H = \frac{P_2 - P_1}{\rho g}$$

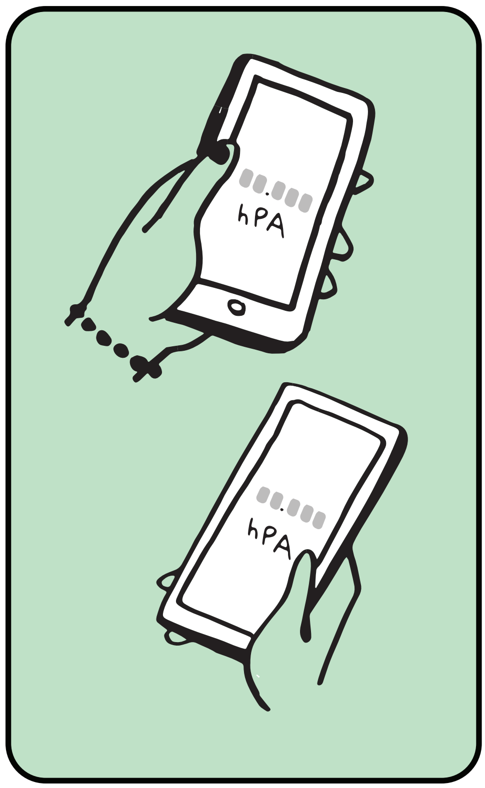
Material



1 smartphone



Measure the atmospheric pressure at the top and bottom of the building. The pressure variation depends directly on the height and density of air.



P_1 = pressure at the top,
P_2 = pressure at the bottom,
ρ = density of air, $g = 9.8\ ms^{-2}$

Precision: high

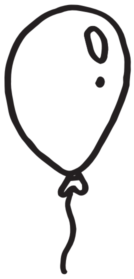
Difficulty: low

№43. Slow Motion

Formula

$$H = vt$$

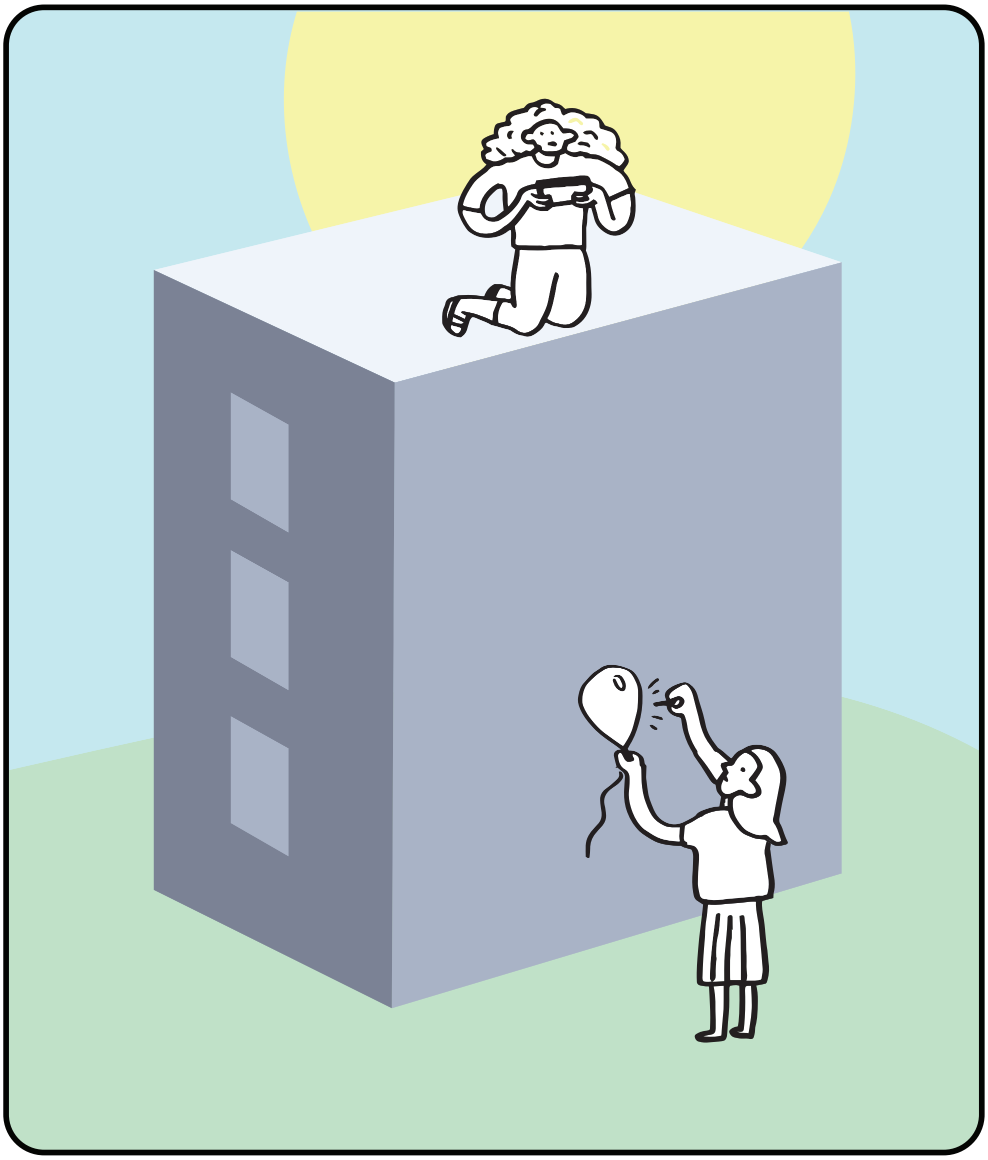
Material

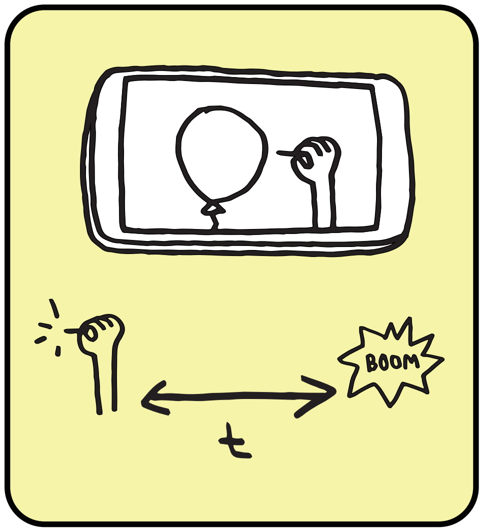


1 balloon

Sensors:
camera, microphone

1 smartphone with slow motion





From the top of the building, film in "slow motion" the bursting of a balloon at the bottom of the building. Measure the time elapsed between the image and the sound of the exploding balloon.

v = speed of sound, t = delay between pop image and pop sound

Some smartphones do not record sound in slow motion.

This project was imagined by Frédéric Bouquet (Paris-Saclay University) and Giovanni Organtini (Sapienza Università di Roma, Italy).

Physics: Frédéric Bouquet, Giovanni Organtini, Julien Bobroff

Videos, photos, gifs: Amel Kolli

Graphic design and illustrations: Anna Khazina

This project is a production of «Physics Reimagined» from Paris-Saclay University and CNRS. It benefited from the support of the IDEX Paris-Saclay and of the «Physique Autrement» Chair, held by the Paris-Sud Foundation and supported by the Air Liquide Group.