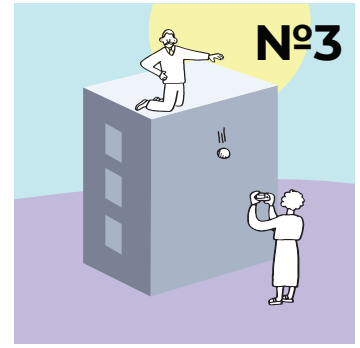
This project was imagined by Frédéric Bouquet (Paris-Saclay University) and Giovanni Organtini (Sapienza Università di Roma, Italy).

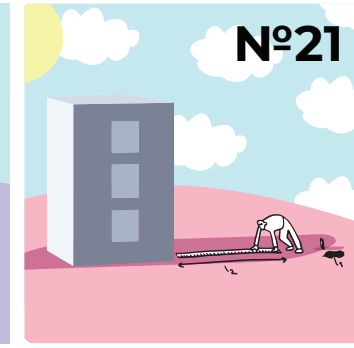
Physics: Frédéric Bouquet, Giovanni Organtini, Julien Bobroff

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.

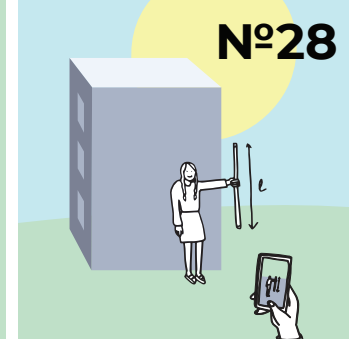


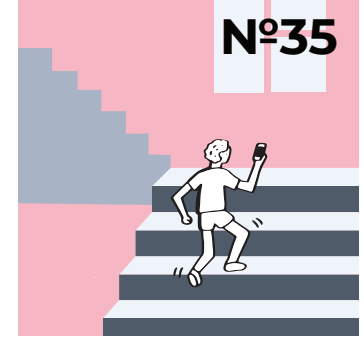


Challenge

EASY & EFFICIENT

5 simple and fast experiments to measure the height of a building using a smartphone.

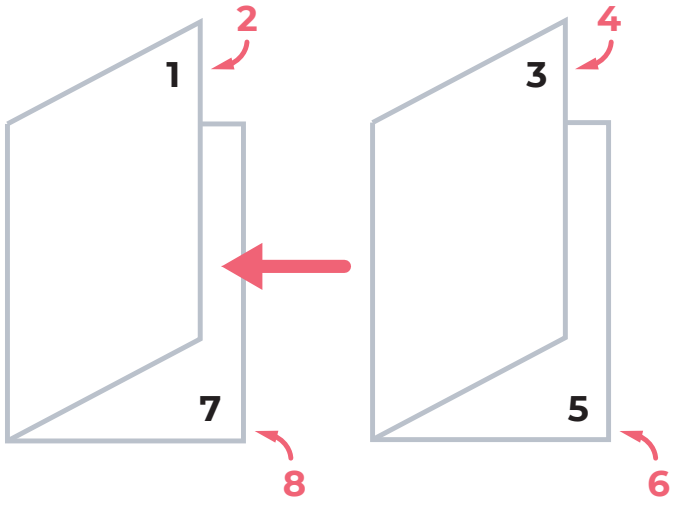




Discover The Smartphone Physics Challenge at VULGARISATION.FR

«Physics Reimagined» team (Paris-Saclay University)

To assemble the booklet:



Print on two A4 sheets using both sides (select short-edge binding), then assemble the booklet by folding the sheets in two.

To do measurements with your smartphone:

Install Phyphox app on your phone. This app is developed by Aachen University, it's free and open-source, translated in English and available for Android and iOS. Phyphox allows to conduct measurements using your smartphone built-in sensors.

Precision: intermediate

Difficulty: minimum

№39. Acoustic Stopwatch

Formula

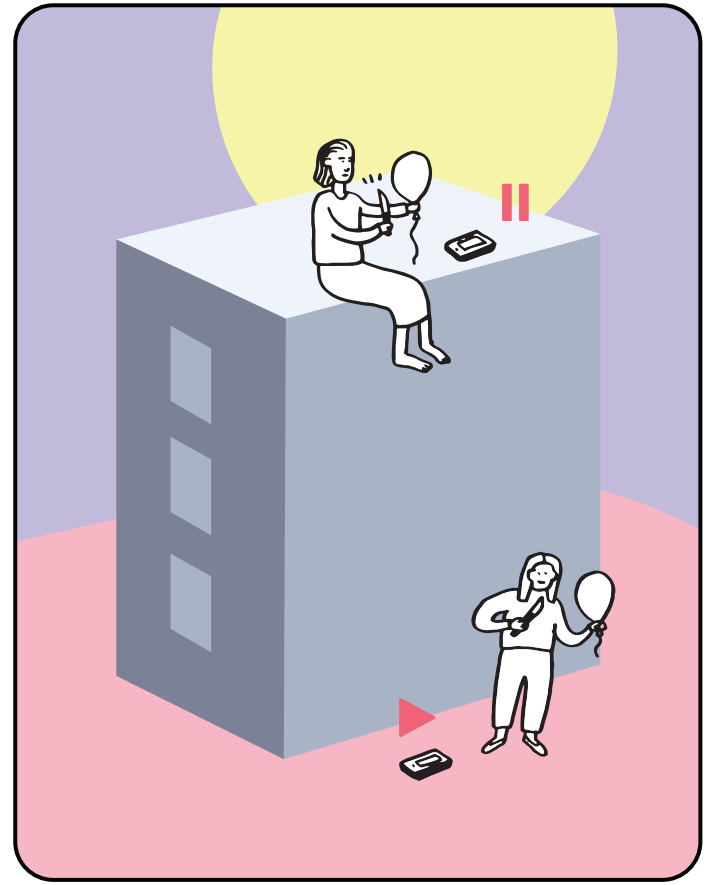
$$H = v\,\frac{\delta t}{2}$$

Material

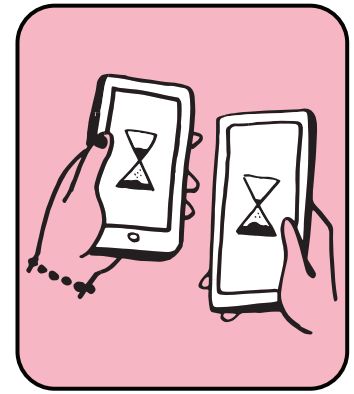
2 balloons

Sensor: **microphone**

2 smartphones



Install an acoustic stopwatch application on both smartphones (Phyphox for example). Launch the application, a smartphone at the bottom of the building, one at the top. Trigger the timers by popping a balloon at the bottom, then stop the timers by popping a balloon at the top.



v = speed of sound, δt = difference between the two chronometers

Precision: maximum

Difficulty: minimum

№35. Number of Steps

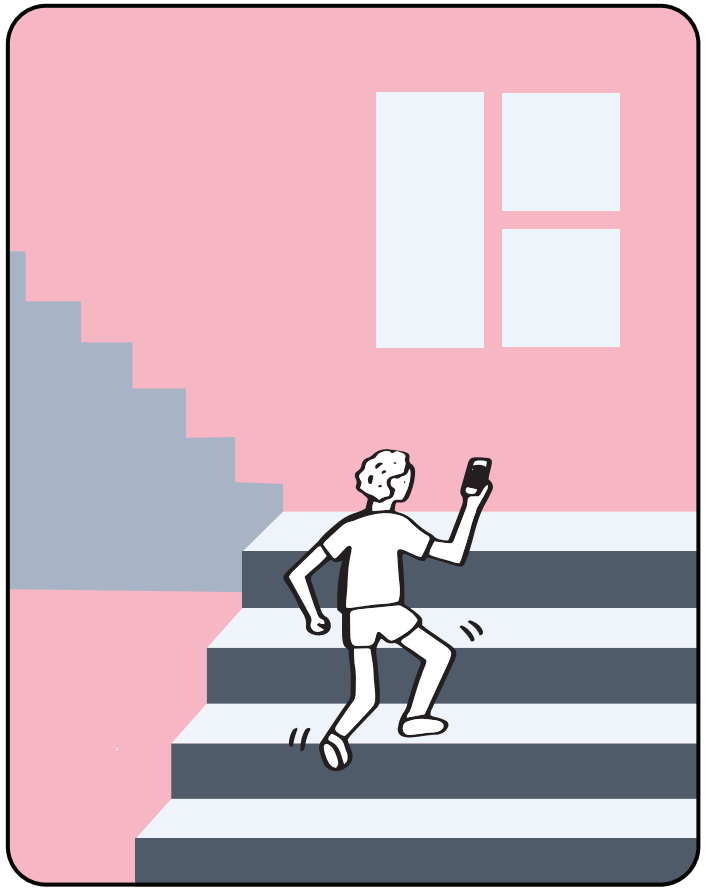
Formula

$$H = Nh$$

Material

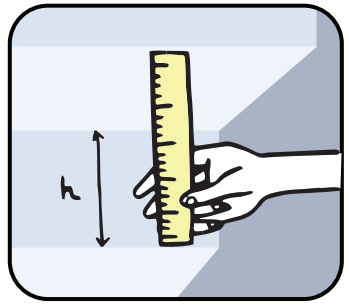
Sensor: **accelerometer**

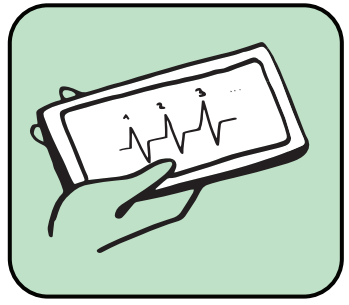
1 smartphone



Using the accelerometer, count the number of stair steps to the top of the building.

N = number of steps,
h = height of a step





Precision: high

Difficulty: minimum

№3. Free Fall Filmed

Formula

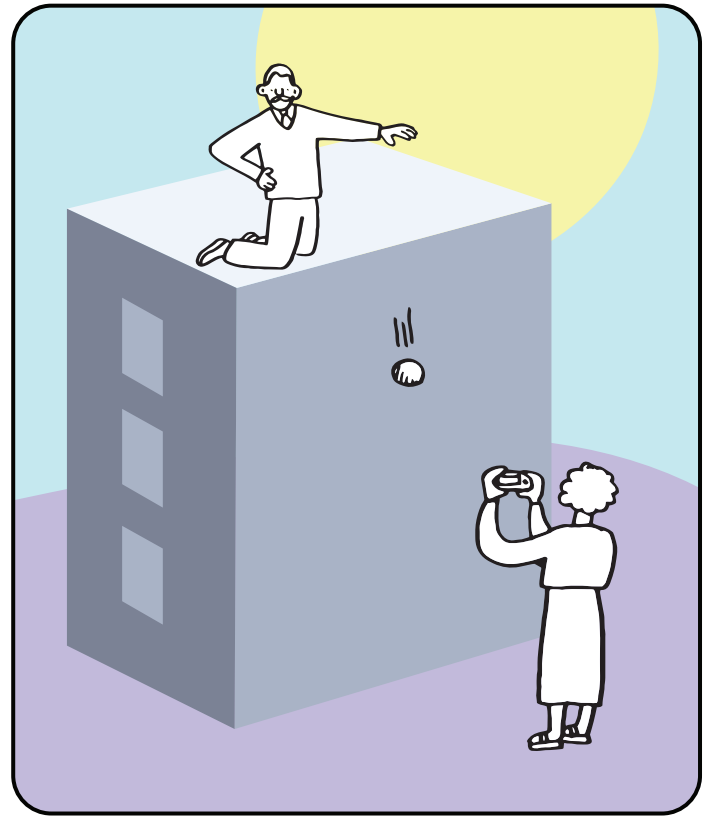
$$H = \frac{1}{2} g t^2$$

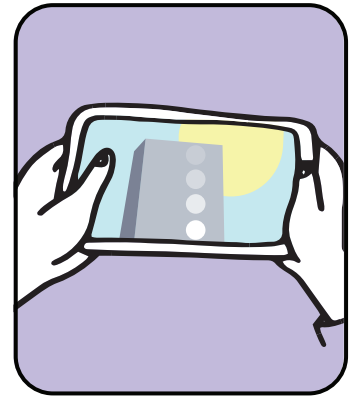
Material

1 ball

Sensor: **camera**

1 smartphone





Drop the ball from the top of the building. Film the fall and determine its duration.

t = fall time of the ball,
$g = 9.8\ ms^{-2}$

The formula does not consider air drag.

Precision: high

Difficulty: minimum

№21. Thales and the Shadows

Formula

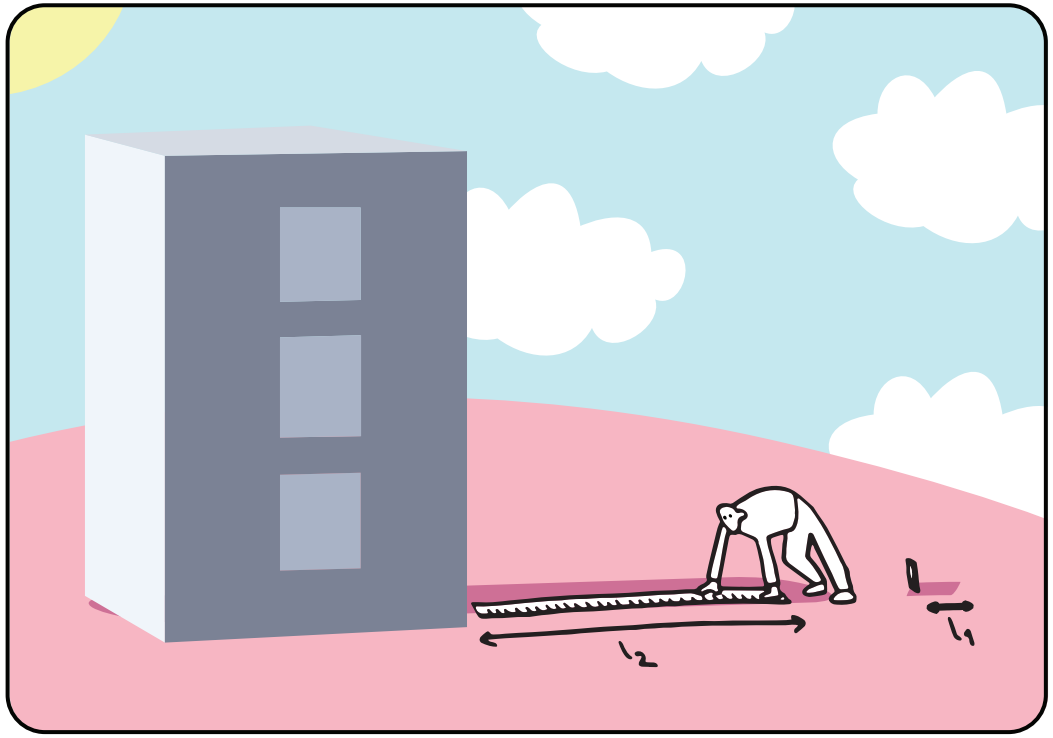
$$H = h \frac{l_2}{l_1}$$

Material

1 tape measure

1 smartphone

Measure the shadow of a smartphone and the shadow of the building. Use Thales' method to determine the height of the building from the height of the smartphone.



h = height of the smartphone l_2 = shadow of the building, l_1 = shadow of the smartphone

Precision: maximum

Difficulty: minimum

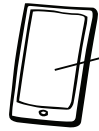
№28. Picture with Scale

Formula

$$H = \frac{d_2}{d_1} l$$

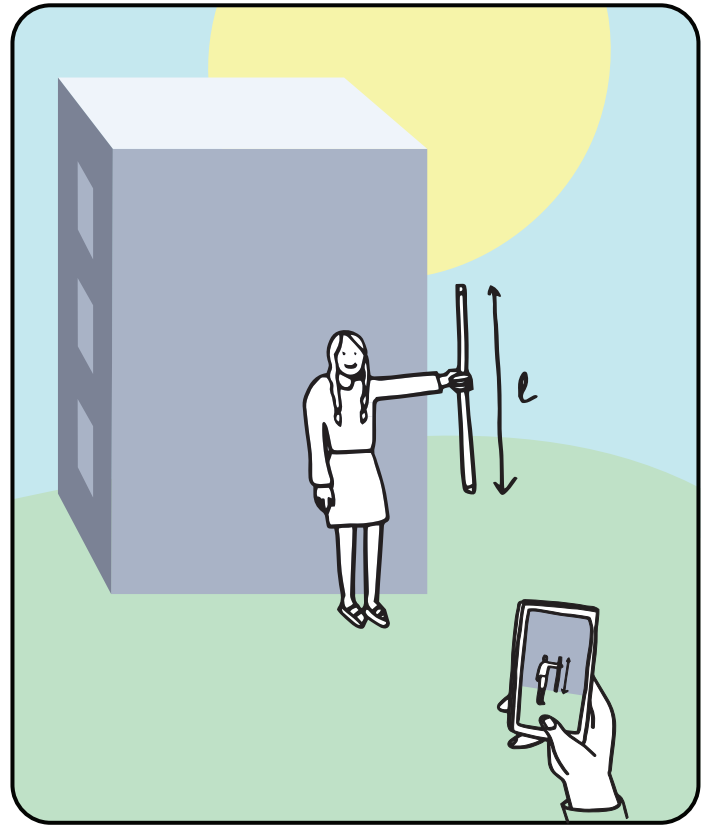
Material

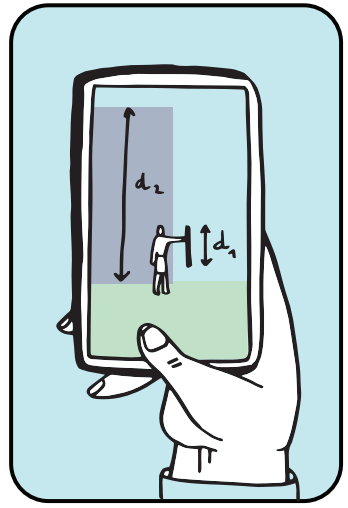
1 bar of known size



Sensor: **camera**

1 smartphone





Take a picture of the facade of the building, with the bar serving as a scale. Measure the sizes of the building and the bar on the picture.

d_2 = size of the building on the photo, d_1 = size of the bar on the photo, l = actual size of the bar

Minimize perspective distortion while taking the picture!