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

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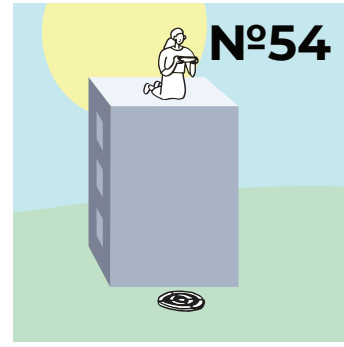
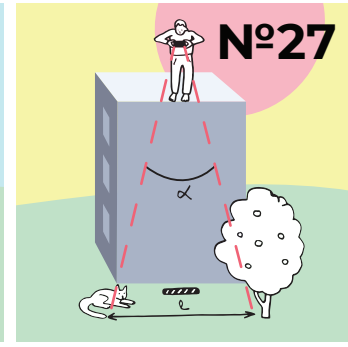
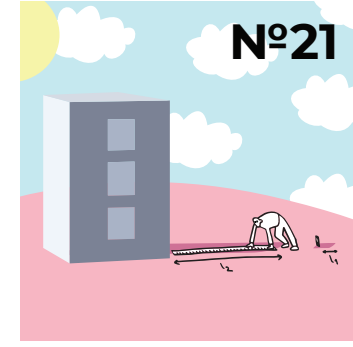
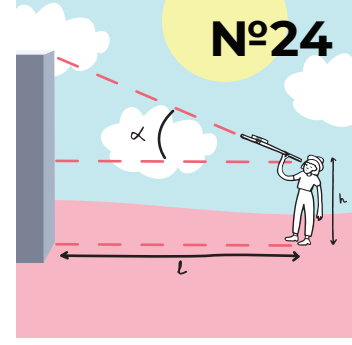


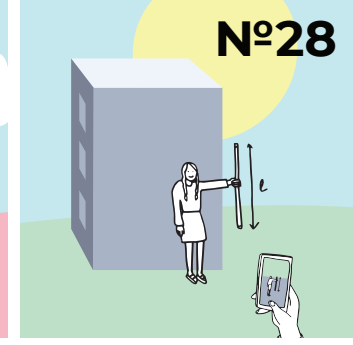


MATH challenge

Your smartphone and a little bit of geometry is all you need to measure the height of a building.



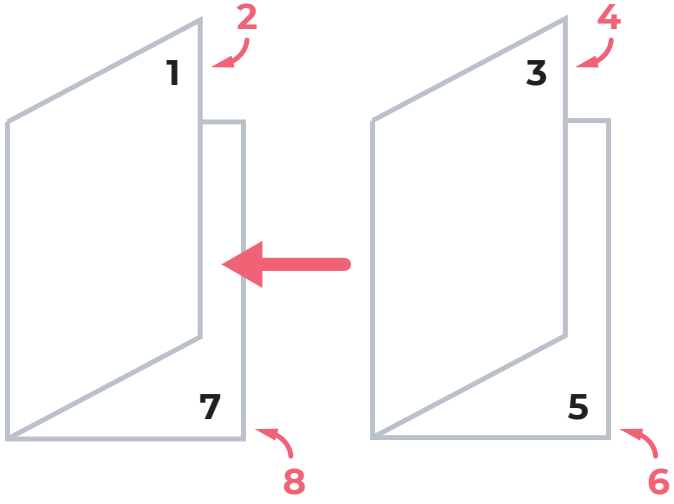




Discover The Smartphone Physics Challenge at VULGARISATION.FR

«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: high

Difficulty: low

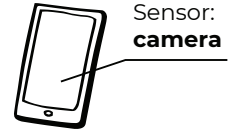
№54. Number of Pixels

Formula

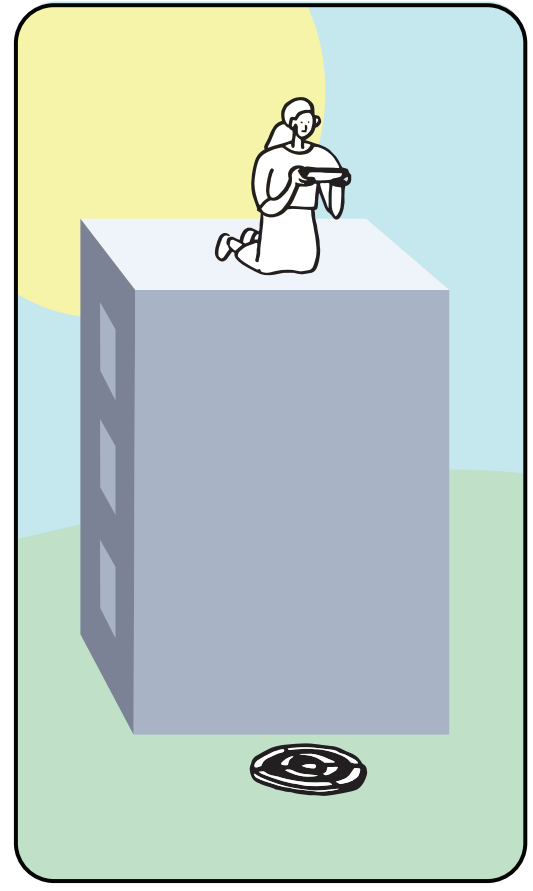
$$H \propto \frac{1}{\sqrt{N}}$$

Material

1 target



1 smartphone



Install the target at the bottom of the building, and take a picture from the top of the building. The number of pixels representing the target in the picture varies in $1 / R^2$, and must be calibrated before.

N = number of pixels

Precision: maximum

Difficulty: minimum

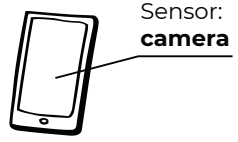
№28. Picture with Scale

Formula

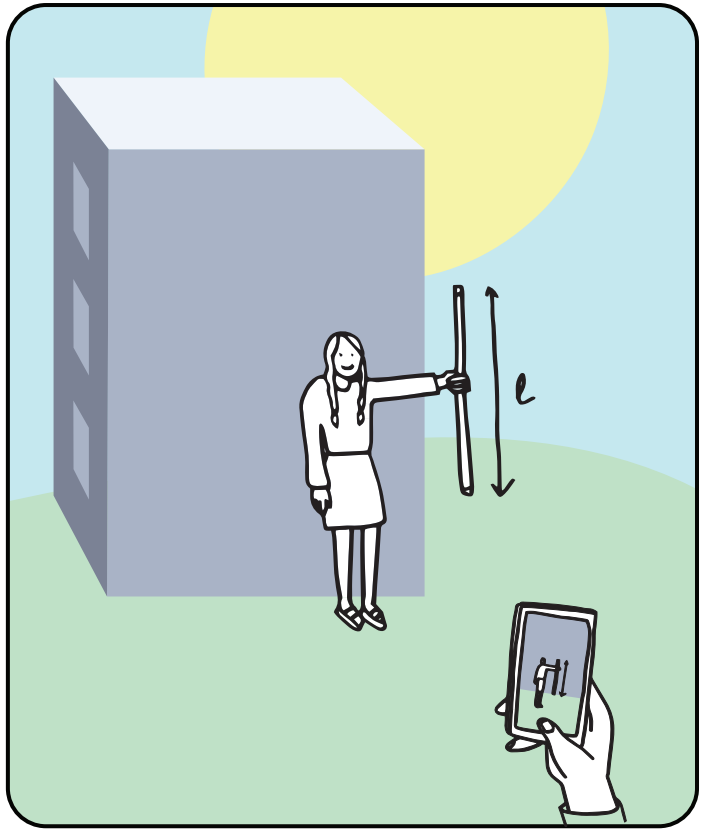
$$H = \frac{d_2}{d_1} l$$

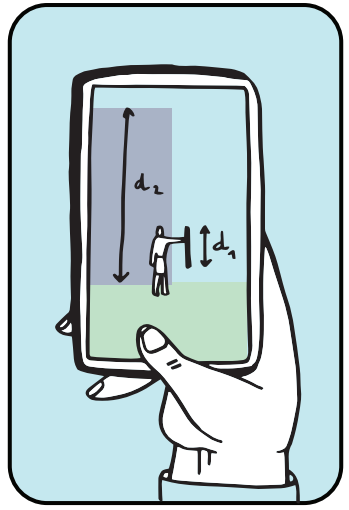
Material

1 bar of known size



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!

Precision: high

Difficulty: minimum

№21. Thales and the Shadows

Formula

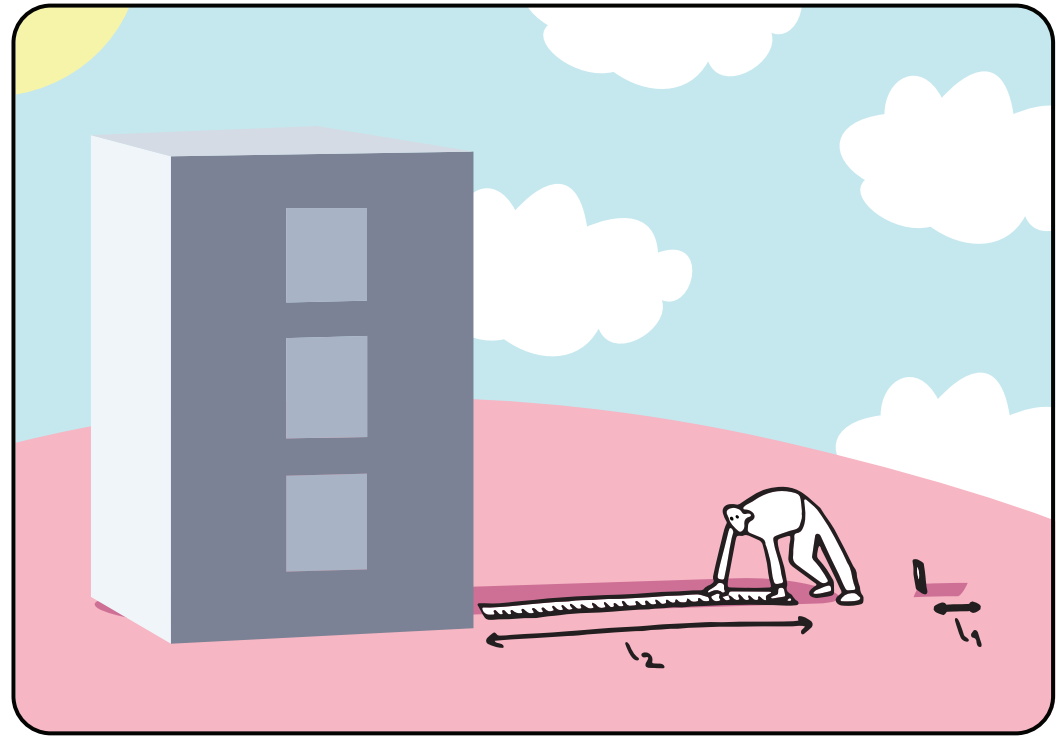
$$H = h \frac{l_2}{l_1}$$

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: low

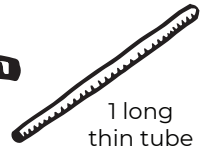
№24. Trigonometry Version 1

Formula

$$H = h + l \tan \alpha$$

Material

1 tape measure



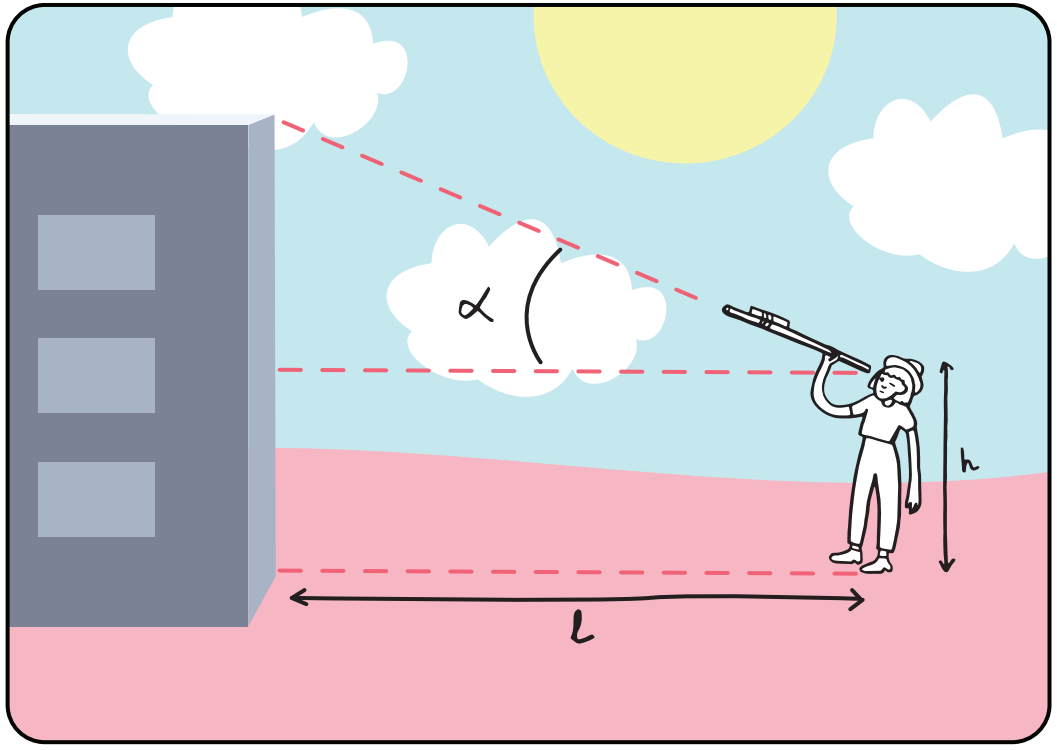
1 long thin tube

1 smartphone

Sensor: **accelerometer**

Attach the smartphone to the tube, and go at a known distance from the building. With the accelerometer, measure the inclination from the horizontal when you aim at the top of the building.

h = height of eye of the investigator, l = distance to the building, α = angle of the top of the building



Precision: high

Difficulty: minimum

№27. Angle of View of a Picture

Formula

$$H = \frac{l}{2 \tan(\alpha/2)}$$

Material

1 bar of known size

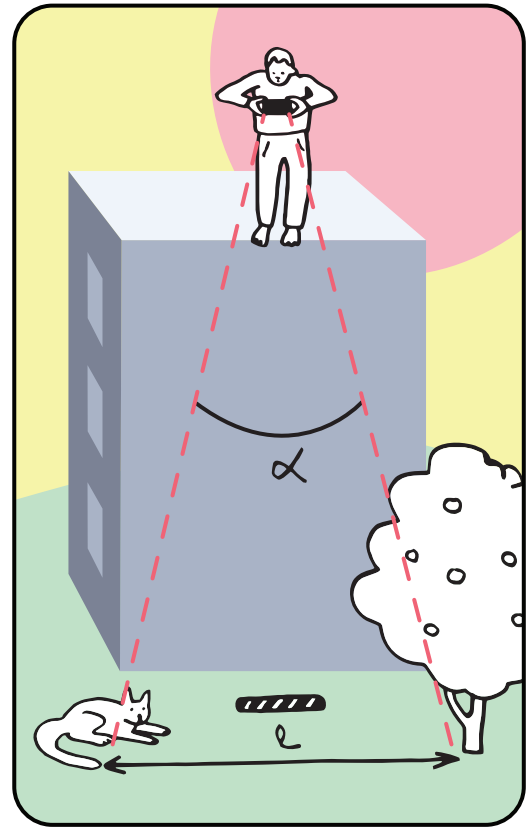
1 protractor

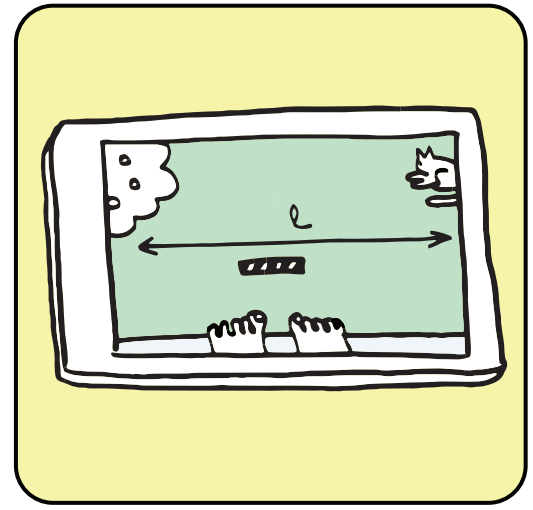
1 smartphone

Sensor: **camera**

From the top of the building, take a picture of the ground, and determine the length of the ground photographed, the bar serving as a scale. Using the protractor, determine the angle of view of your smartphone.

l = length of ground visible in the picture, α = smartphone angle of view





The angle of view can also be determined by taking a picture of the bar at a known distance.