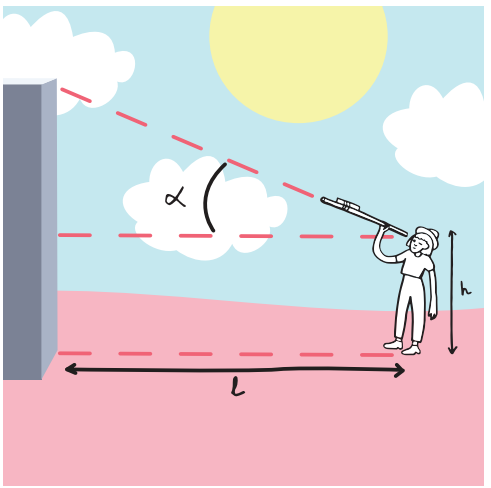
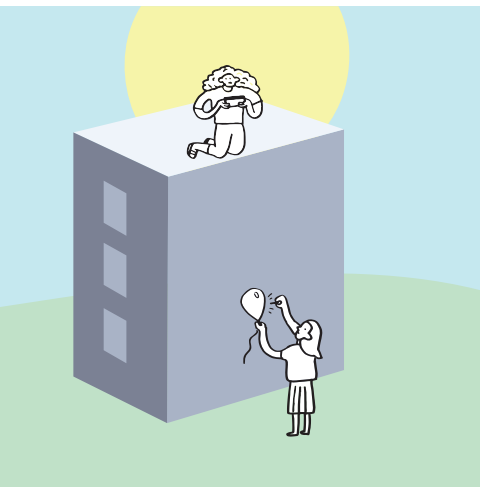
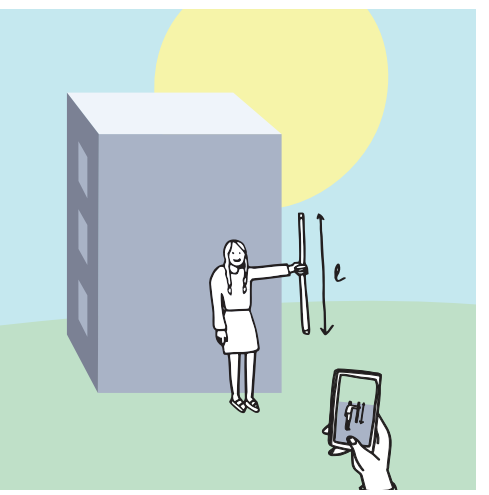


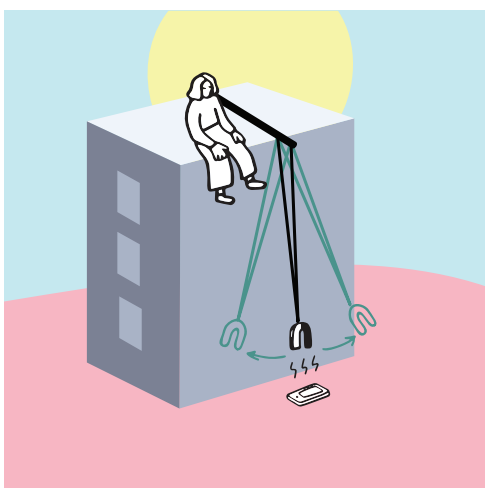


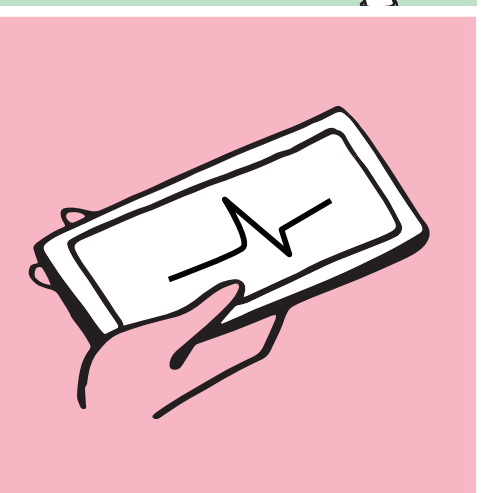
Theme:

OPTICS

All the methods using optics principles and smartphones to determine the height of a building.







Discover The Smartphone Physics Challenge at VULGARISATION.FR

«Physics Reimagined» team (Paris-Saclay University)

Precision: high

Difficulty: minimum

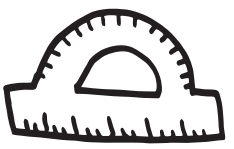
№27. Angle of View of a Picture

Formula

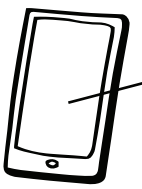
$$H = \frac{l}{2\tan(\alpha/2)}$$

Material

1 bar of known size

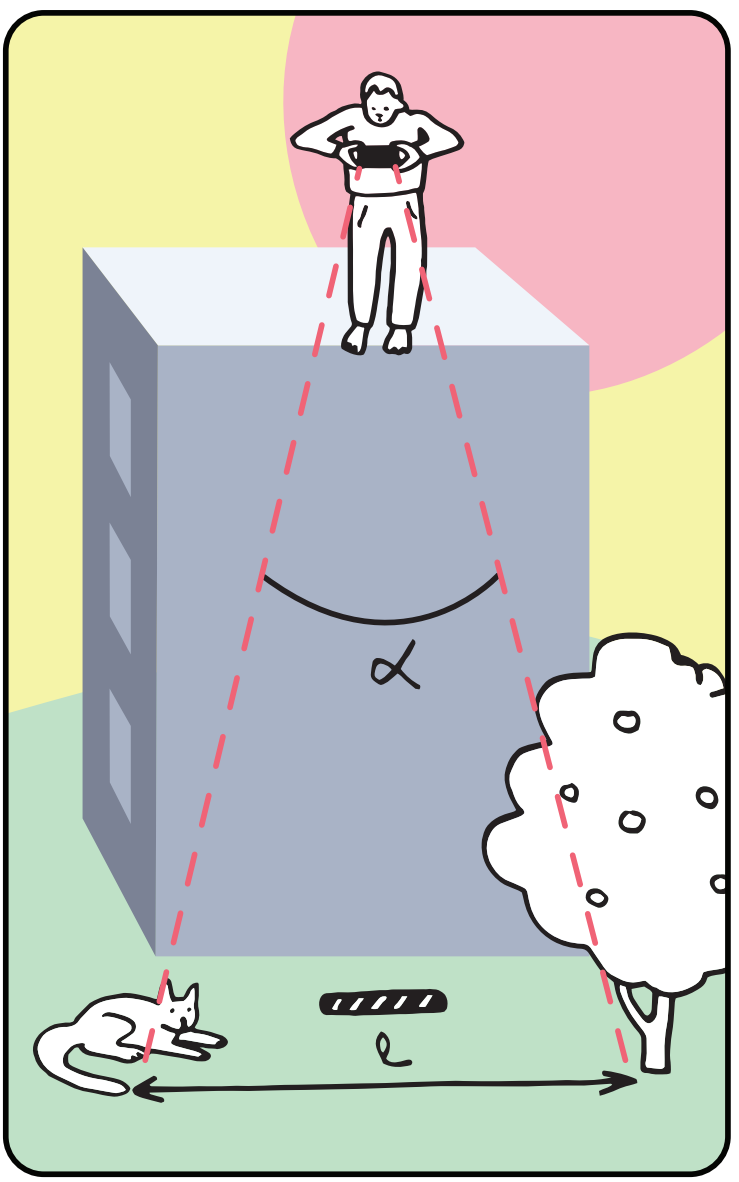


1 protractor



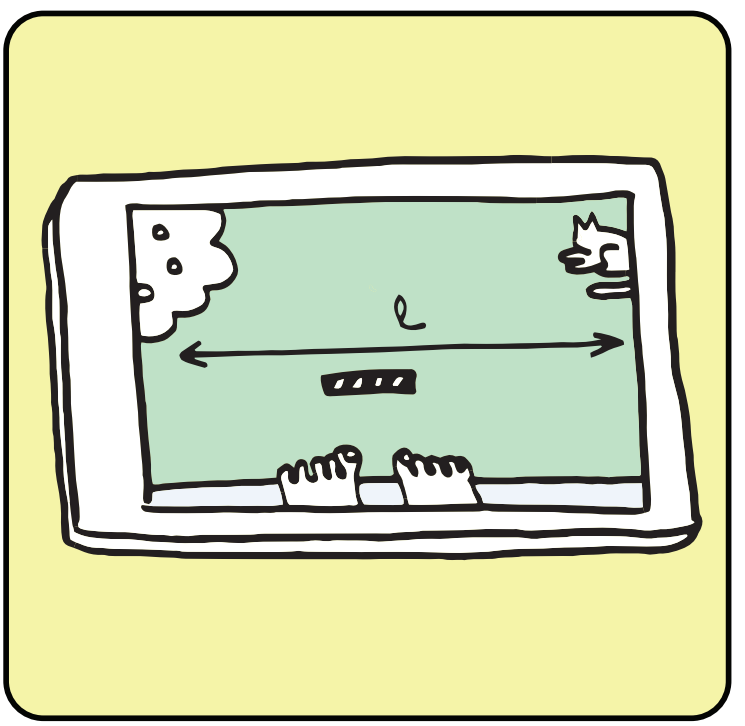
Sensor: **camera**

1 smartphone



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.

Precision: maximum

Difficulty: minimum

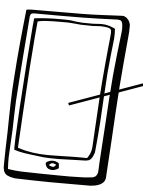
№28. Picture with Scale

Formula

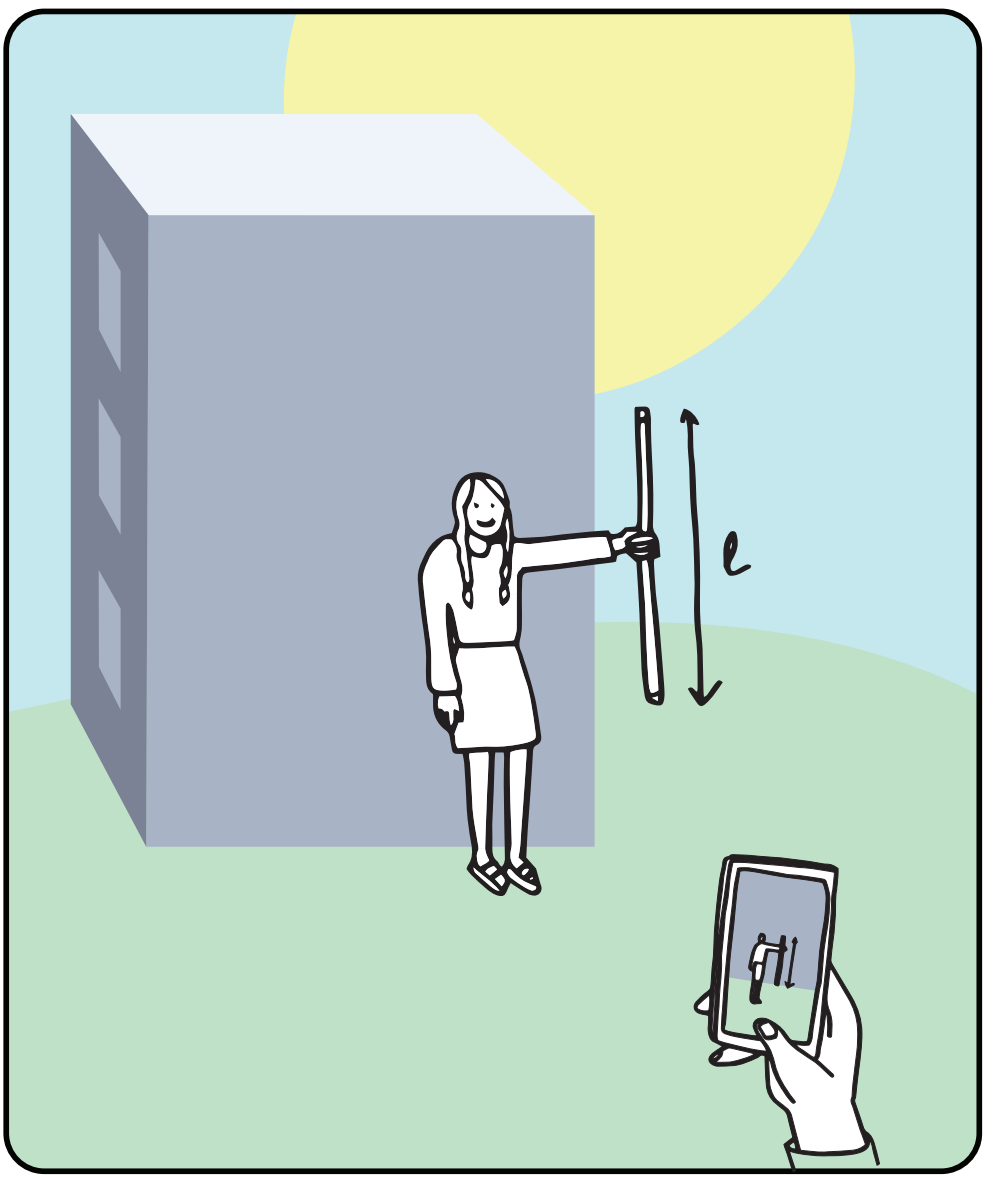
$$H = \frac{d_2}{d_1} l$$

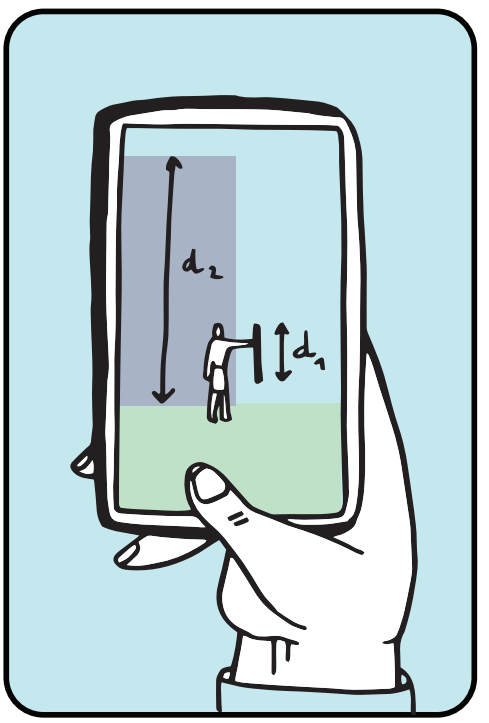
Material

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

№29. Facade Picture

Formula

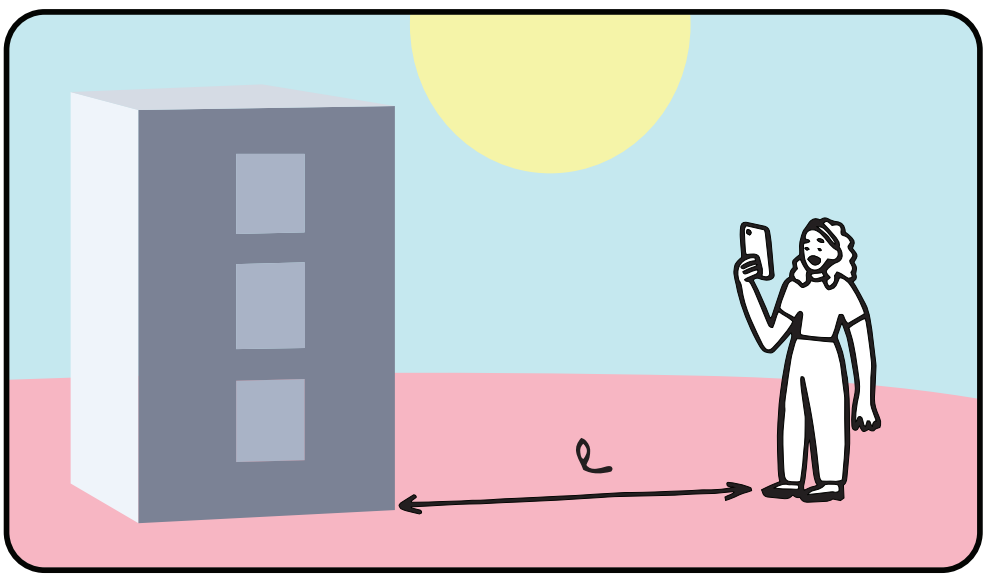
$$H = l \frac{d}{f}$$

Material

1 tape measure

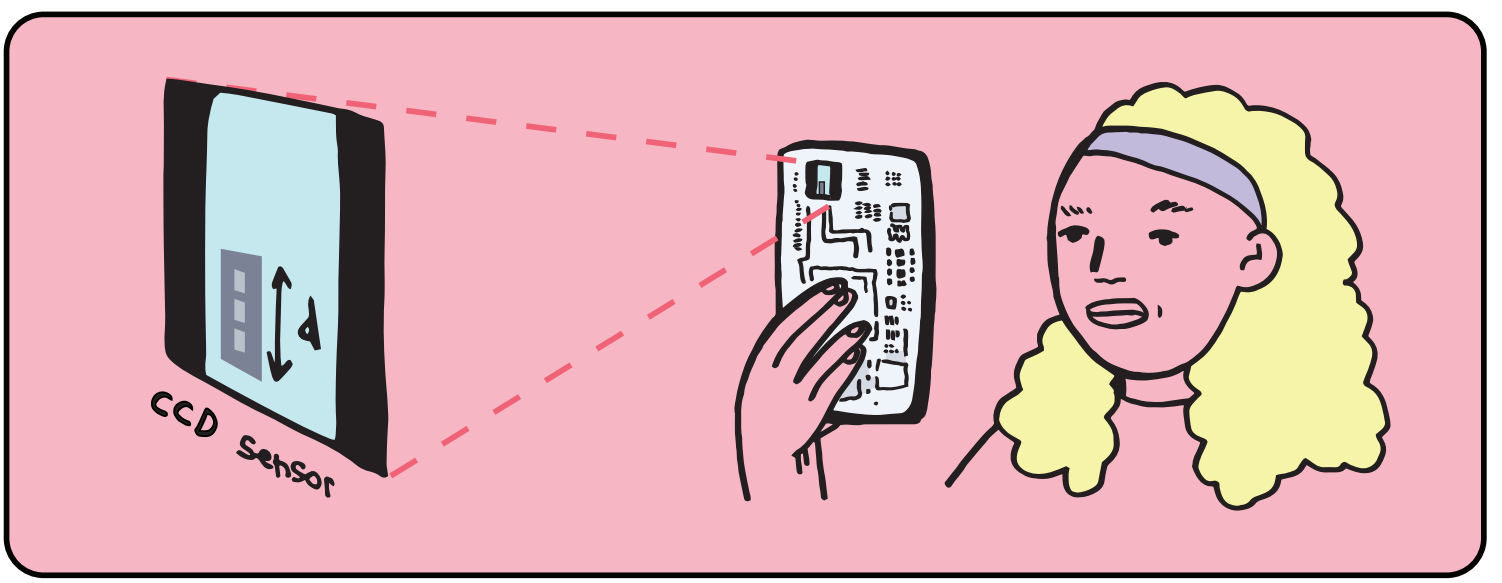
1 smartphone with known CCD sensor size and focal length

Sensor: **camera**



Take a picture of the building facade, at a known distance. Determine the actual size of the building image on the CCD sensor by looking at the fraction of the picture height occupied by the building.

l = distance to the building, d = size of the building image on the CCD sensor, f = focal length of the camera



Minimize perspective distortion while taking the picture!

Precision: high

Difficulty: minimum

№30. Picture From the Top

Formula

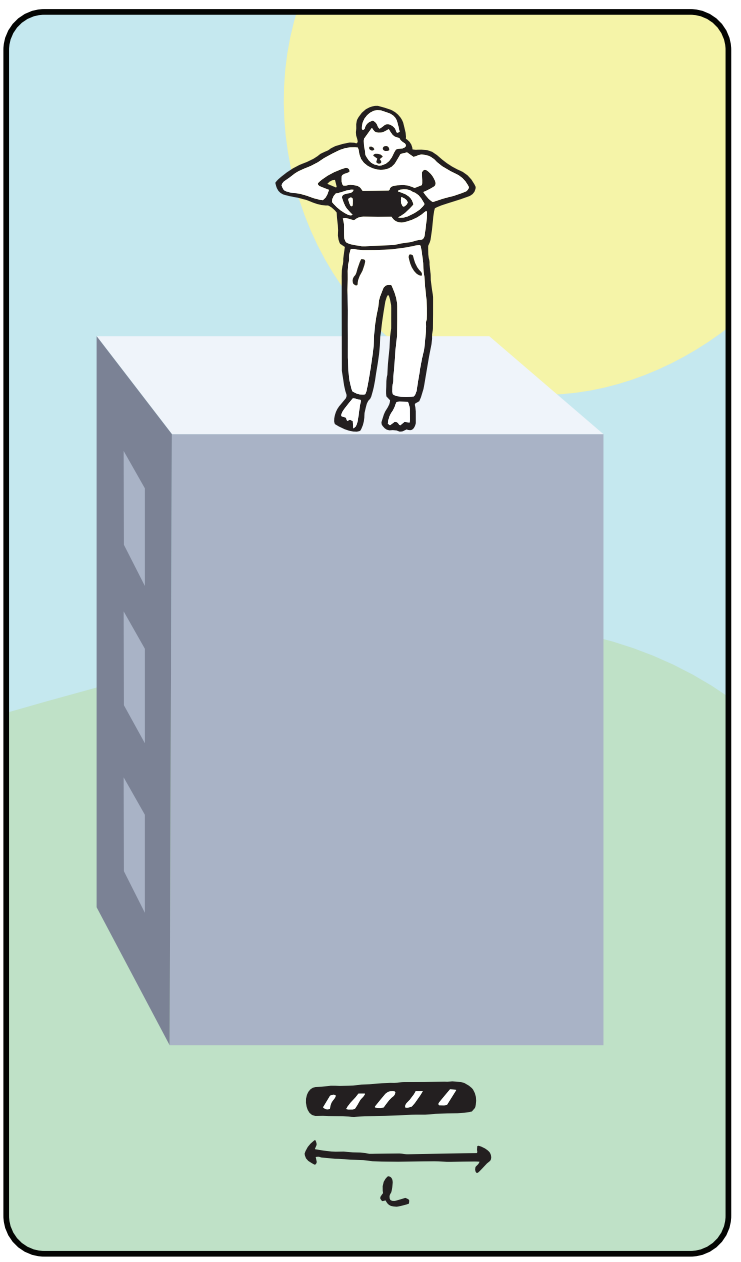
$$H = l \frac{f}{d}$$

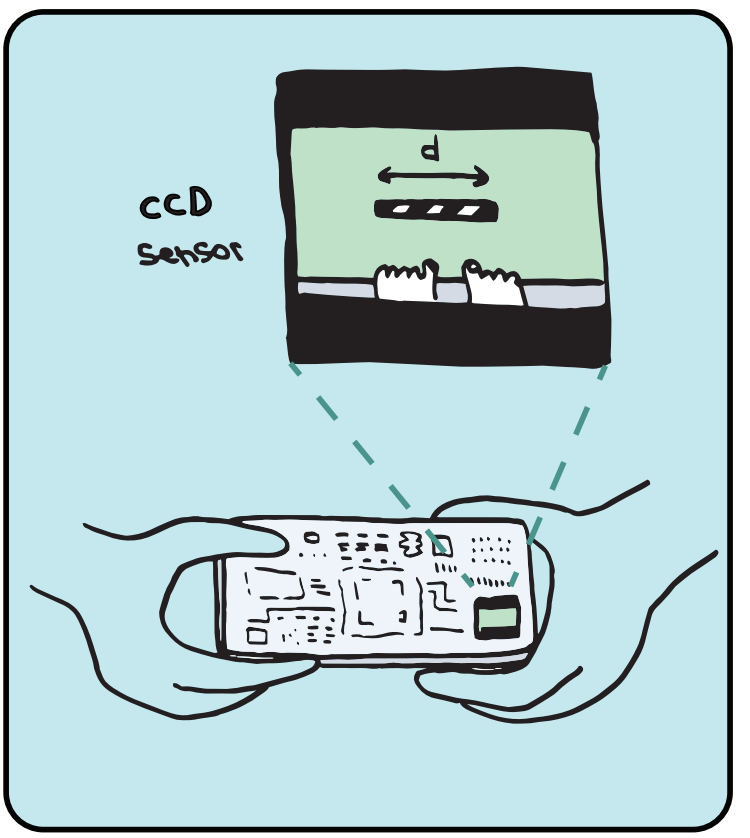
Material

1 bar of known size

1 smartphone with known CCD sensor size and focal length

Sensor: **camera**





From the top of the building, take a picture of the bar on the ground. Determine the actual size of the bar image on the CCD sensor by looking at the fraction of the picture width occupied by the bar.

l = size of the bar, f = focal length of the camera, d = size of the image of the bar on the CCD sensor

Precision: intermediate

Difficulty: low

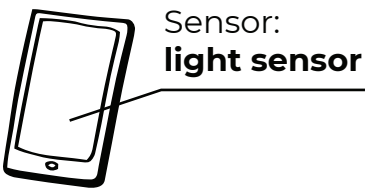
№50. Light Intensity

Formula

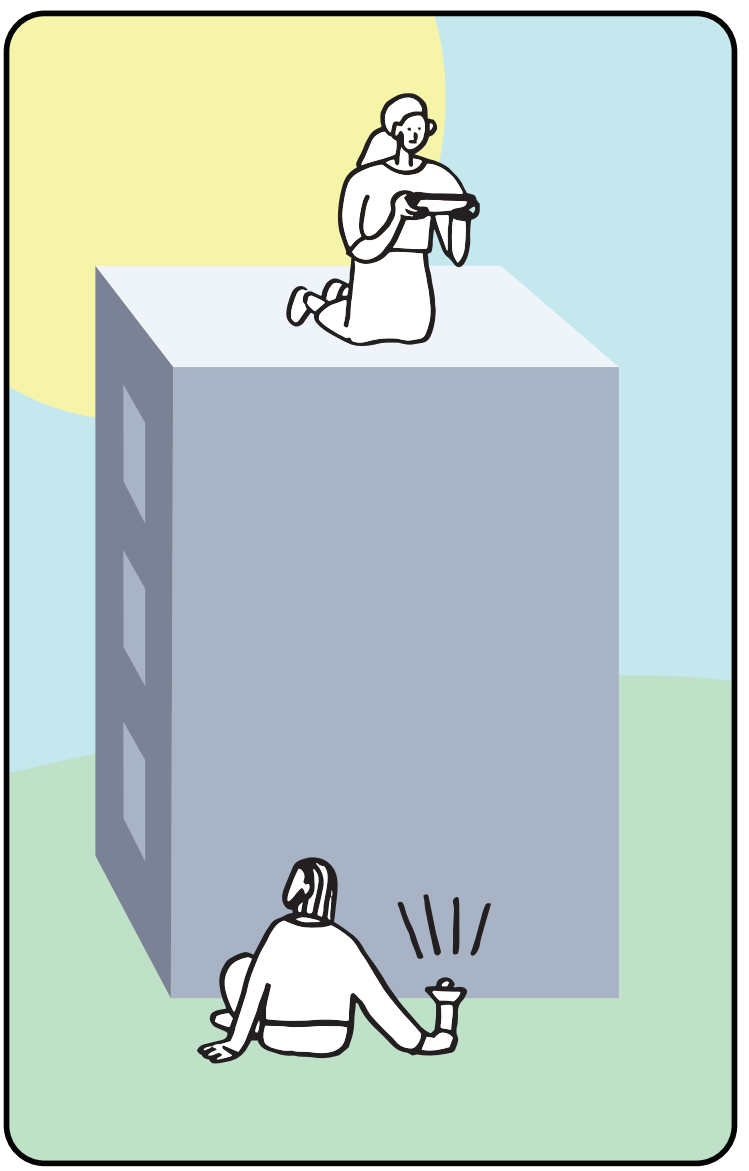
$$H \propto \frac{1}{\sqrt{I}}$$

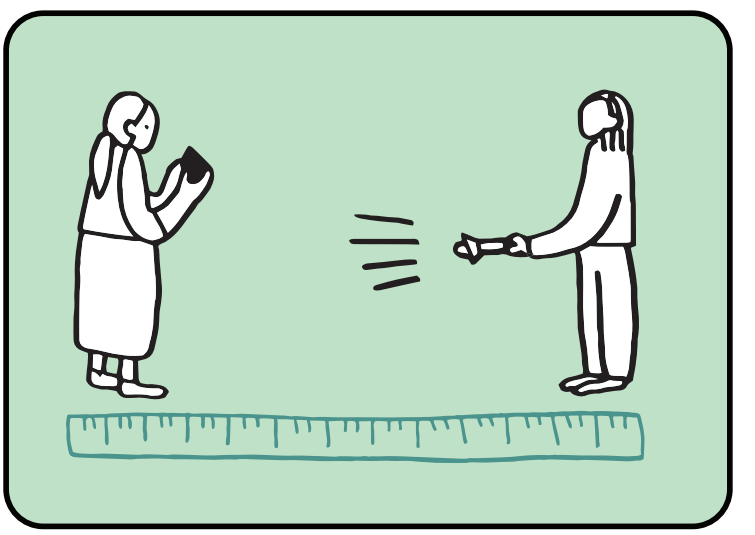
Material

1 lamp



1 smartphone





I = light intensity

Install the lamp at the bottom of the building, and measure the light intensity at the top. Turn off the light to determine the ambient light. The measured intensity varies in $1 / R^2$, and must be calibrated before.

Works best in the evening or at night.

Precision: high

Difficulty: high

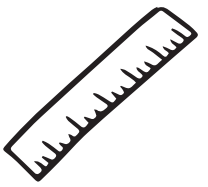
№56. LCD Screen Diffraction

Formula

$$H = \frac{lp}{\lambda}$$

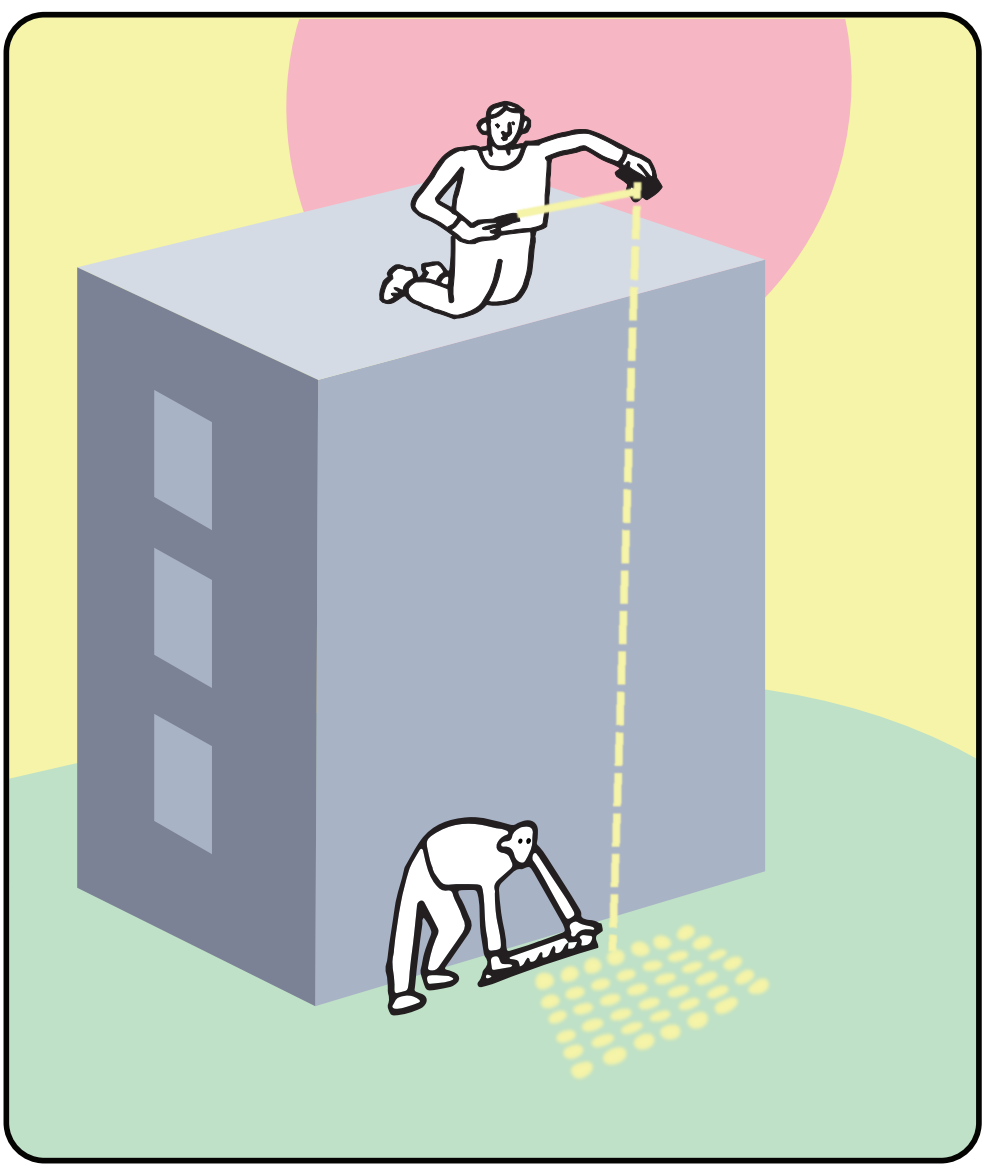
Material

1 laser



1 ruler

1 smartphone



From the top of the building, illuminate the smartphone screen with the laser and project the diffraction pattern on the ground. Measure the characteristic distance of the pattern. Determine the size of the pixels by comparing their number and the size of the screen. (Some screens diffract better than others.)

l = distance between the diffraction spots, p = size of a pixel, λ = wavelenght of the laser

Warning: handling a laser is dangerous.

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

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