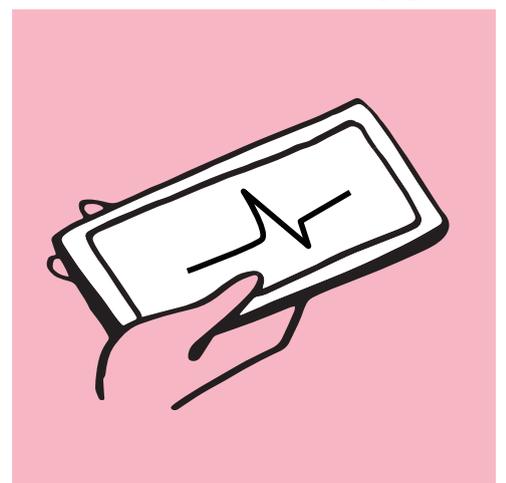
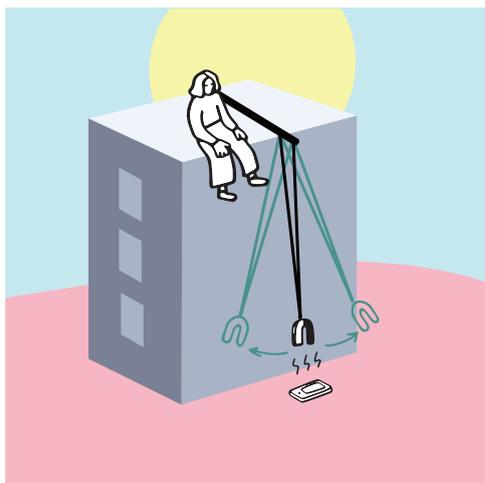
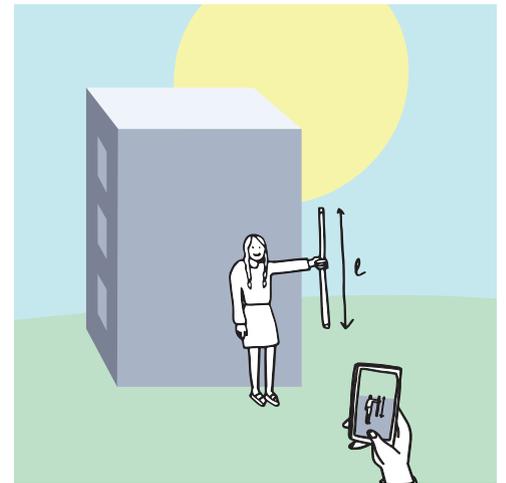


Theme: **OPTICS**

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

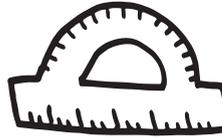
Nº27. Angle of View of a Picture

Formula

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



1 bar of known size

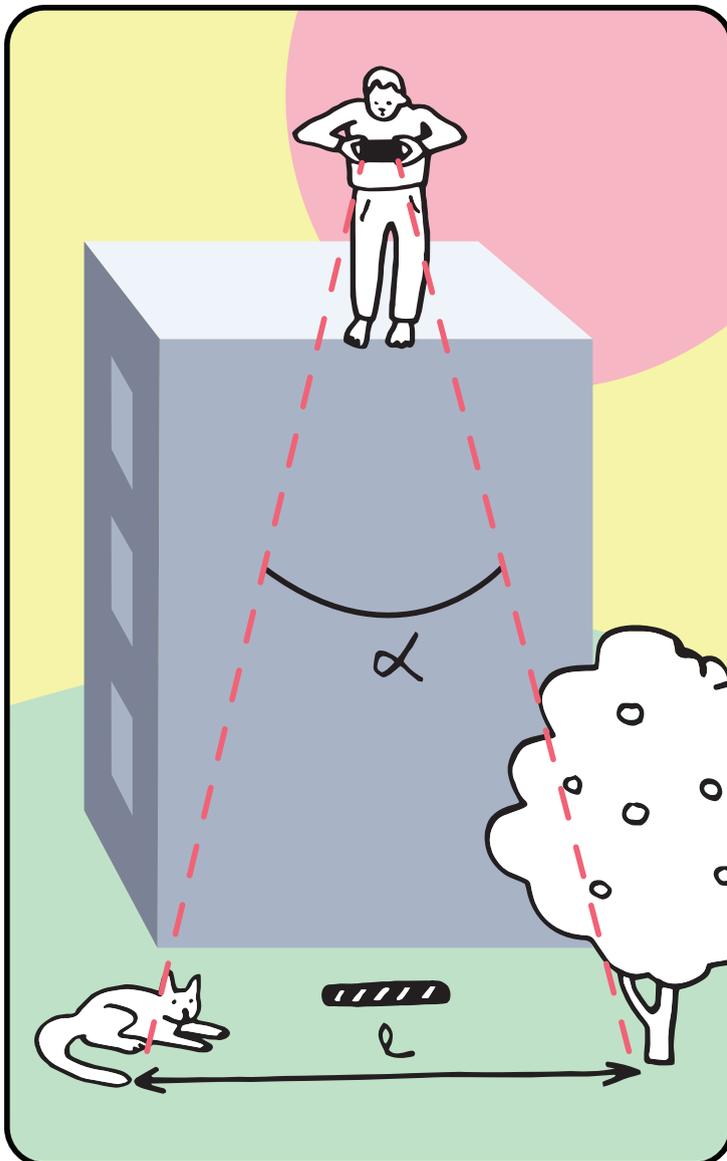


1 protractor



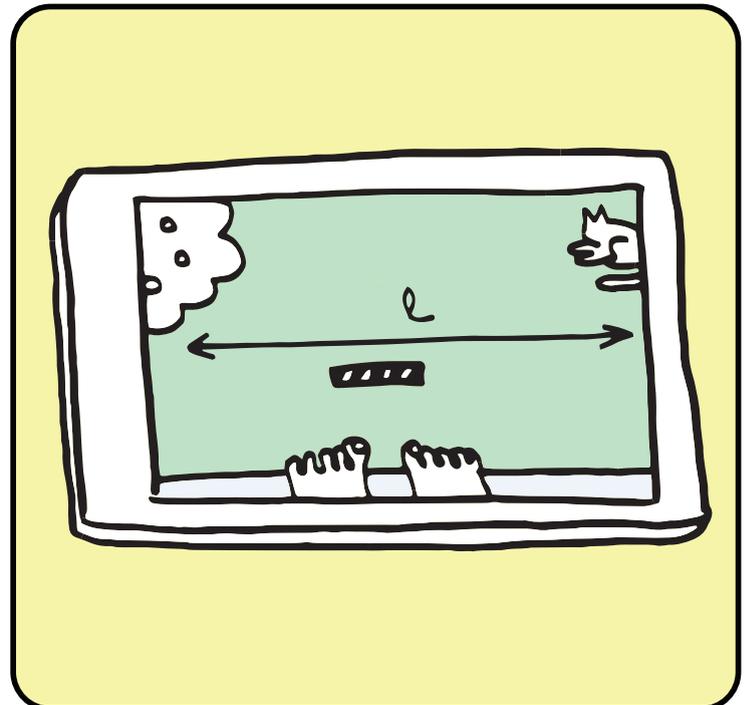
1 smartphone

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.



Precision: maximum



Difficulty: minimum

Nº28. Picture with Scale

Formula

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

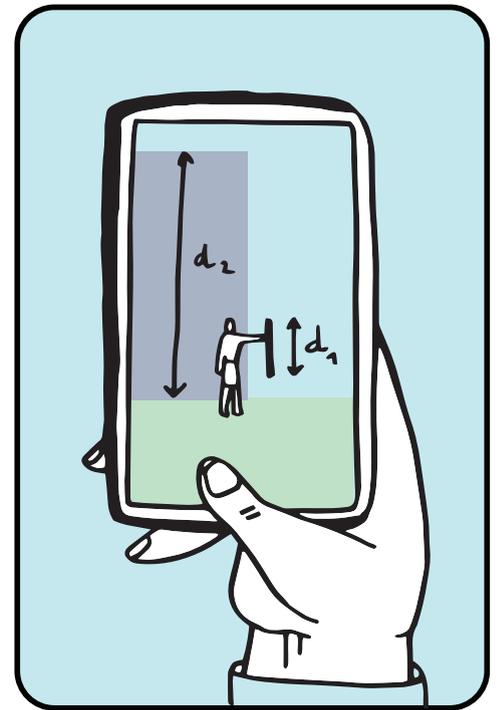
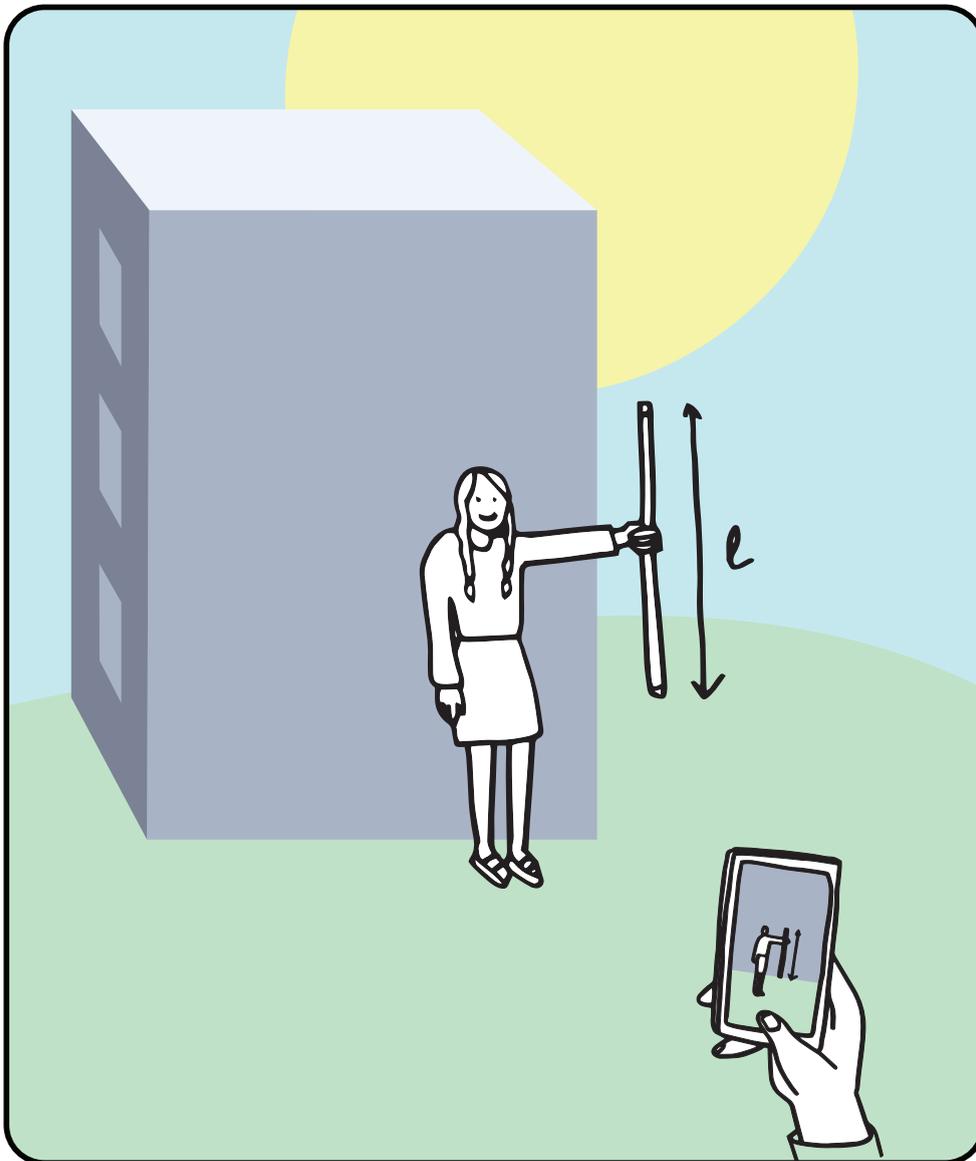


1 bar of known size



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!



Precision: high



Difficulty: minimum

Nº29. Facade Picture

Formula

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

Material

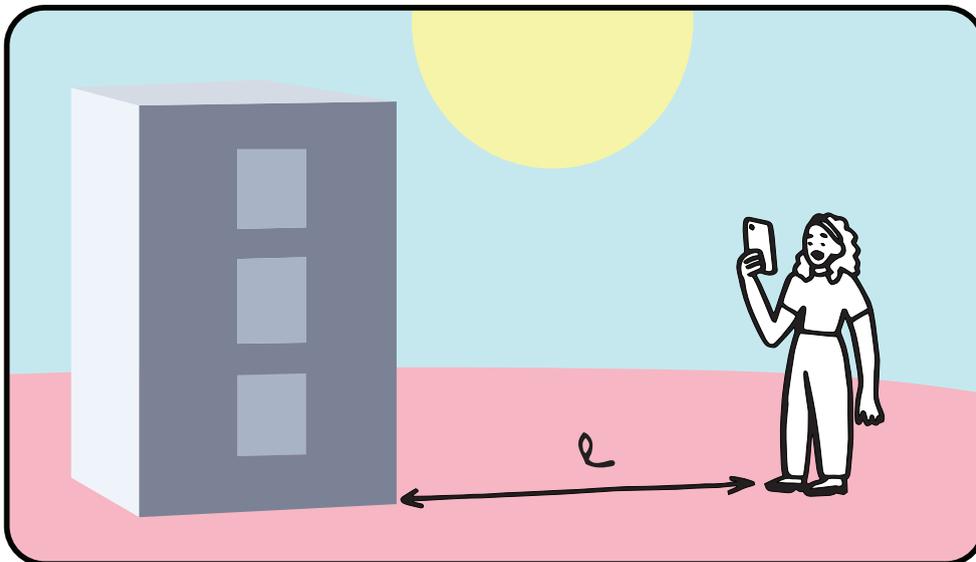


1 tape measure

1 smartphone with known CCD sensor size and focal length

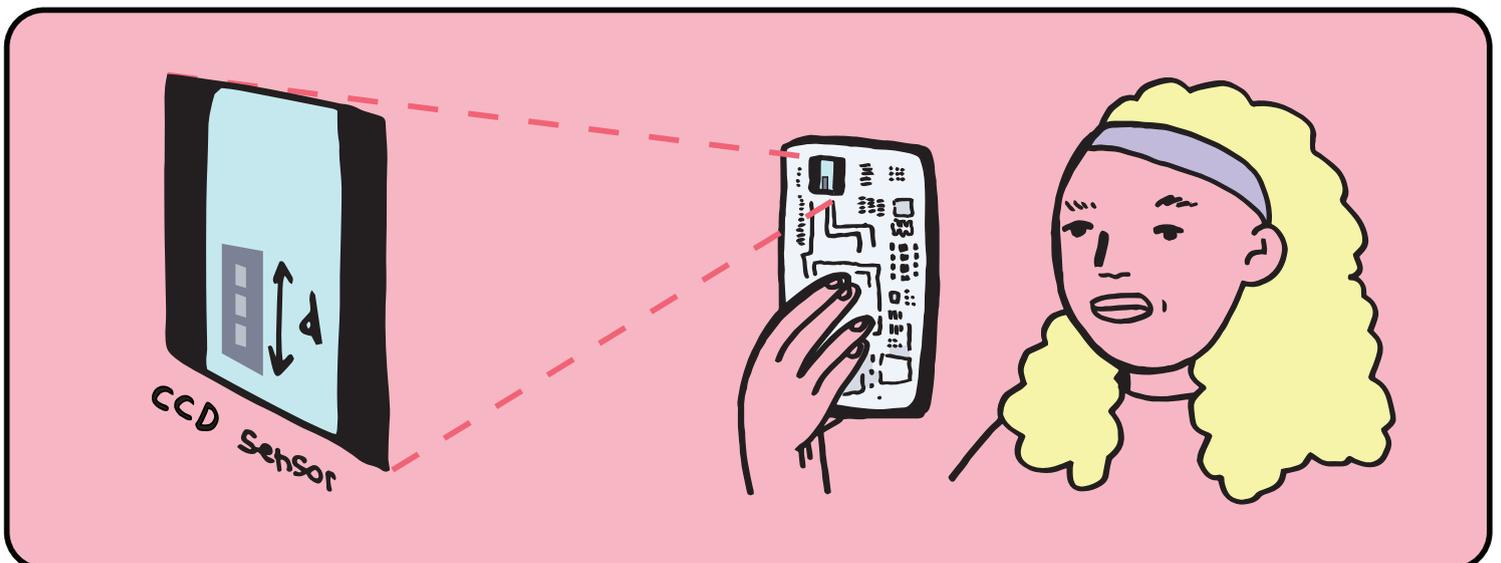


Sensor: **camera**



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

Nº30. Picture From the Top

Formula

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

Material

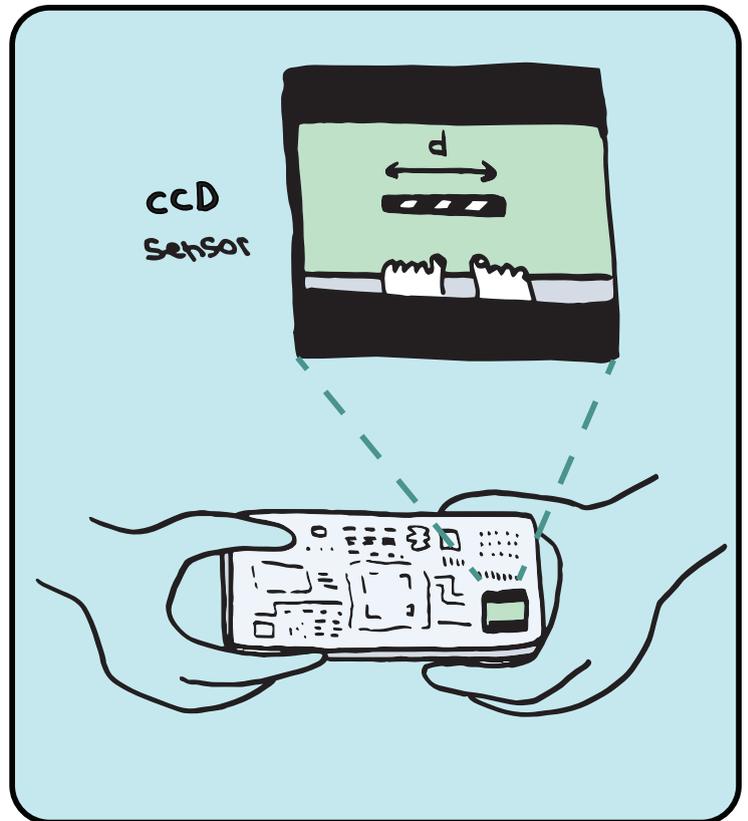
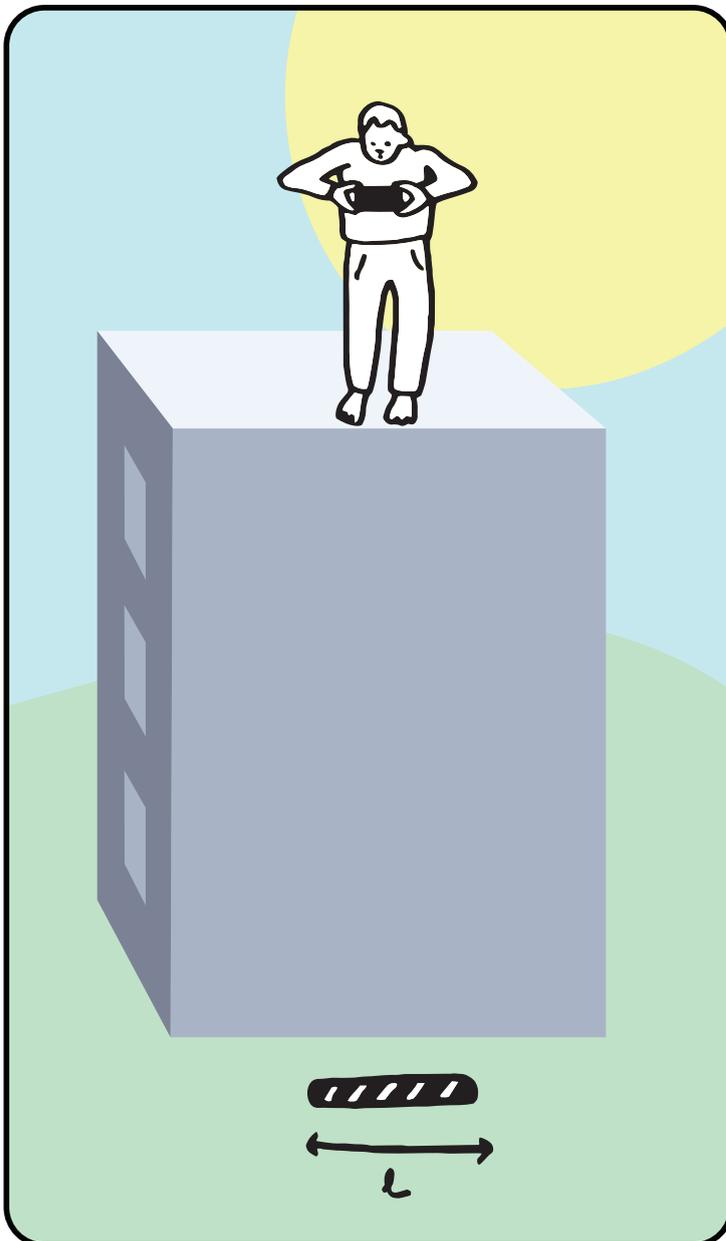


1 bar of known size

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



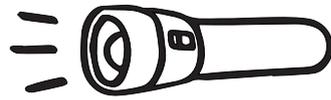
Difficulty: low

Nº50. Light Intensity

Formula

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

Material

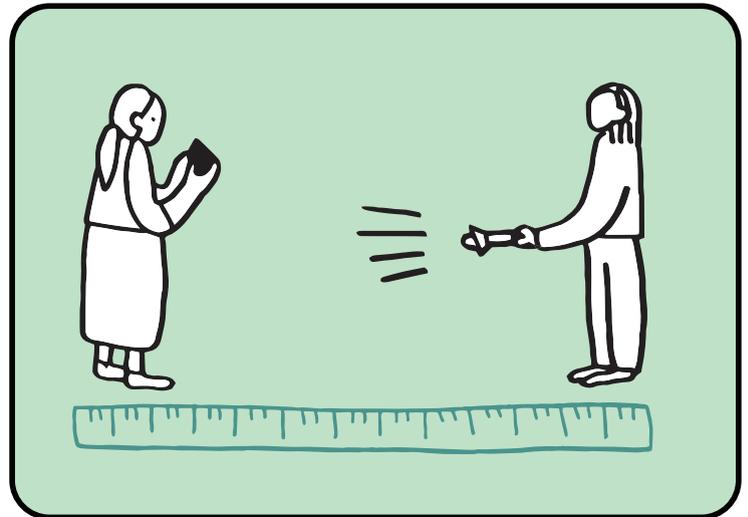
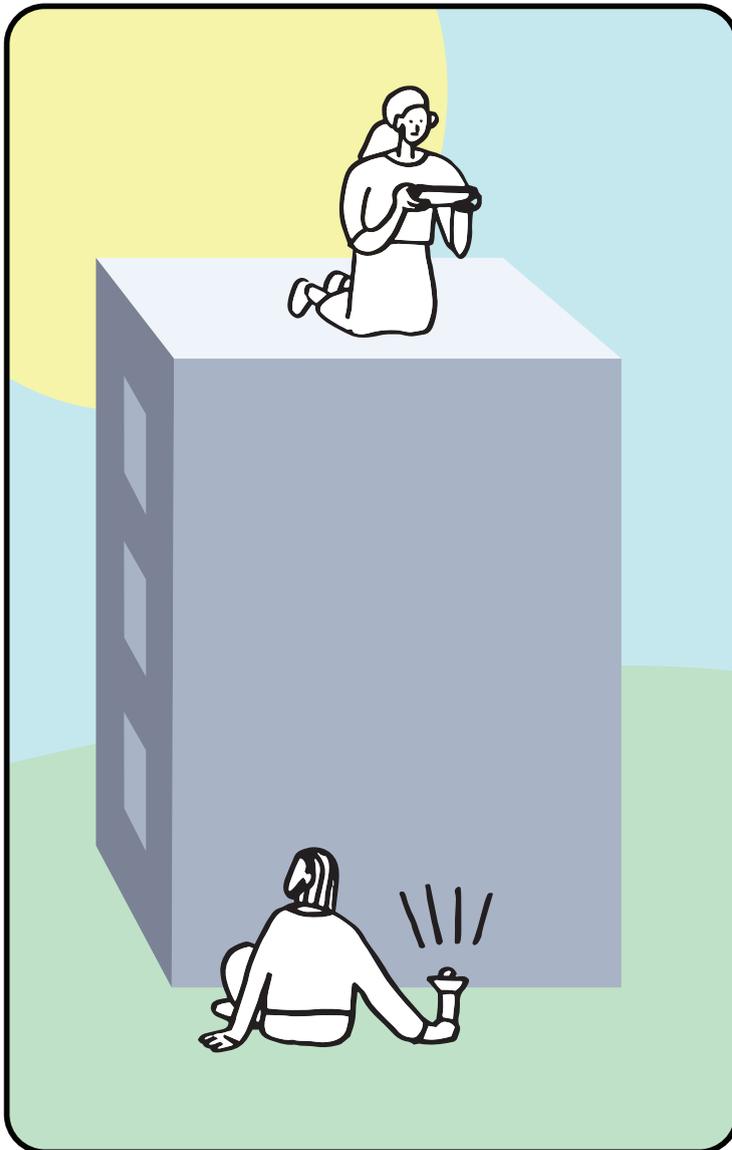


1 lamp



Sensor:
light sensor

1 smartphone



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.

I = light intensity

Works best in the evening or at night.



Precision: high



Difficulty: high

Nº56. LCD Screen Diffraction

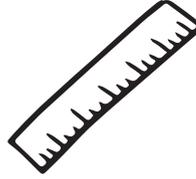
Formula

Material

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



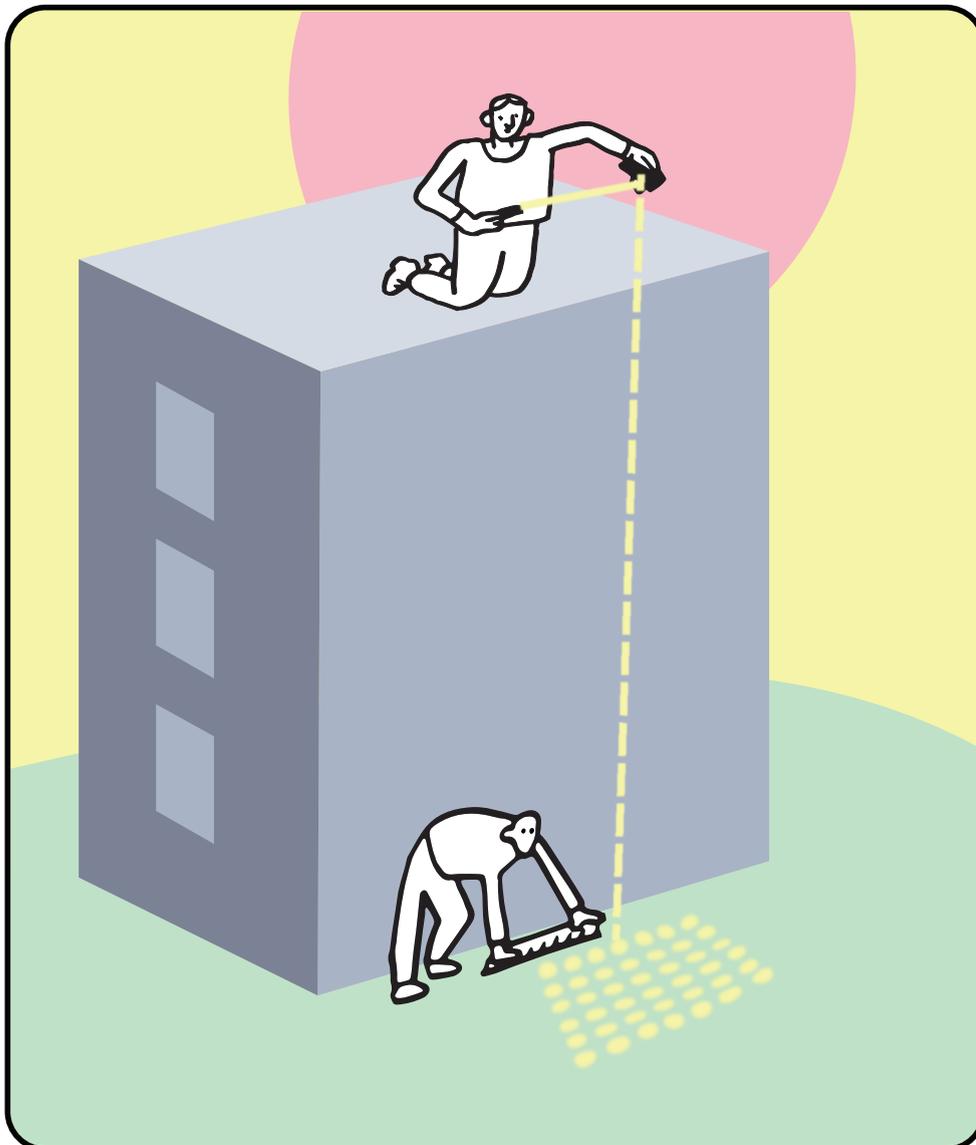
1 laser



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 = wavelength 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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