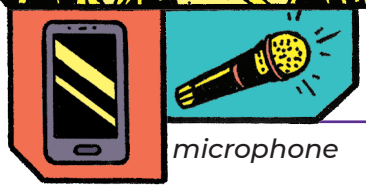
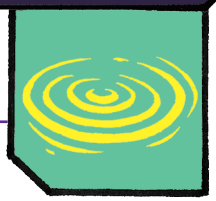


microphone

DOPPLER EFFECT



wave physics

MATERIAL

– two smartphones
– a tape measure
– a sporty student
– a non-sporty student
– optional: Bluetooth speaker

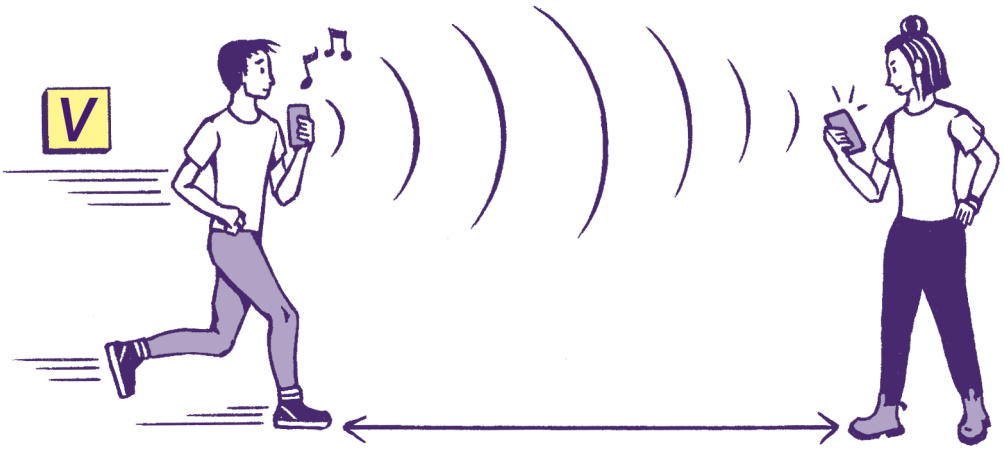
CHALLENGE

Like police radars or astronomers for galaxies, measure speed with a frequency shift.

OVER TO YOU

The sporty student runs with his smartphone (or speaker) that emits a pure high-pitched note, above 5000 Hz –so that this note is well detached from the ambient sound. The second student remains motionless, and measures the frequency with his smartphone. The Doppler effect explains that the received frequency is different from the emitted frequency, depending on whether the runner approaches or moves away, and at what speed.

Determine the speed of the runner using the Doppler effect formula, and compare this result to a more traditional measure of the run speed, by timing the time taken to cover a known distance.



DOPPLER EFFECT

The Doppler effect results in the following formula for speeds below Mach 1:

$$f = \frac{f_0}{1 \pm v/c}$$

f_0 is the emitted frequency
v is the speed at which the athlete approaches (-) or moves away (+)
c is the speed of sound (about 340 m/s)
f is the frequency detected by the second student

THE ULTIMATE CHALLENGE

Experimentally determine how the frequency changes when the non-sporty student starts to run as well.