Physics 20

Unit B: Forces and gravitation

Gravitational field and weight

The same student, two readings

- A 55.0 kg student weighs 540 N on Earth, where the field strength is 9.81 N/kg downward.
- On the Moon the same mass weighs 89.1 N because the field strength there is 1.62 N/kg.

Force per kilogram at a place

- A gravitational field states the force per kilogram at a place.
- Symbol g is the field strength, G is the gravity constant, M is the source mass, and r is the distance from the centre.
- Weight is the gravitational force F_g. It equals mass m times field strength g, so g also equals F_g divided by m.

Key terms

gravitational field

A gravitational field describes the gravitational force per kilogram at a place. (g)

weight

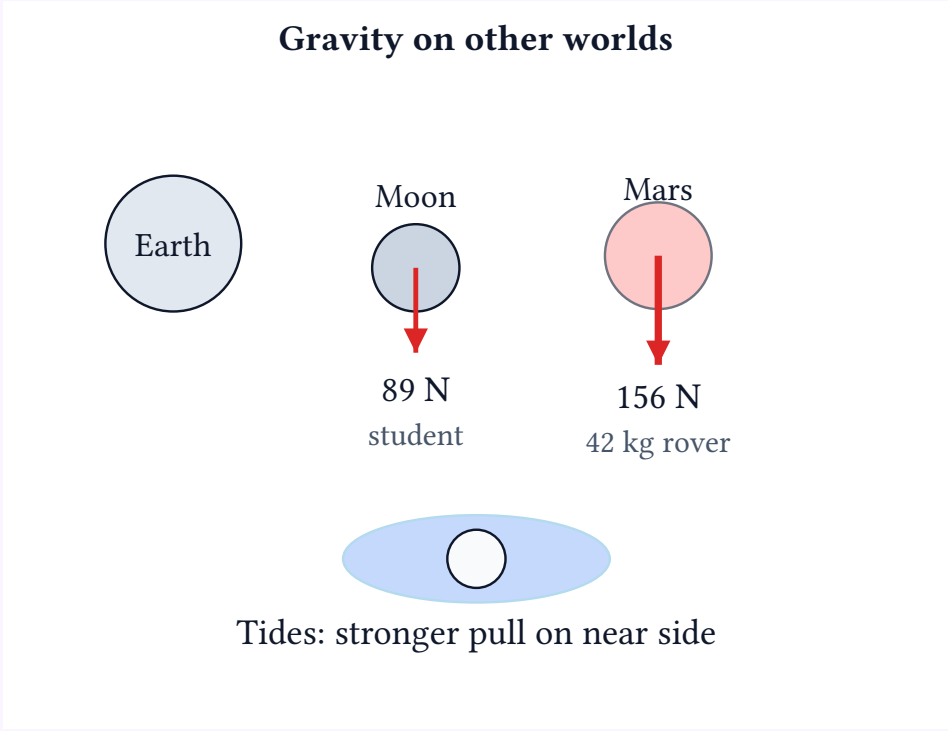
Weight is the gravitational force on an object, equal to mass times the local field strength. ($F_g = m\ g$)

field strength

Field strength is the force per kilogram at a place, g = G M / r squared and also $g = F_g / m$. ($g = G\ M / r^2$)

Gravity on other worlds

- Weight on the Moon for this student is 89.1 N, and on Mars a 42.0 kg rover weighs 156 N.
- Tides come from a difference in Earth's pull across the ocean.
- A globular cluster is a tight ball of stars held by their mutual pulls.
- On Mars the rover weighs less, so the motor force for the same acceleration up the ramp is smaller.

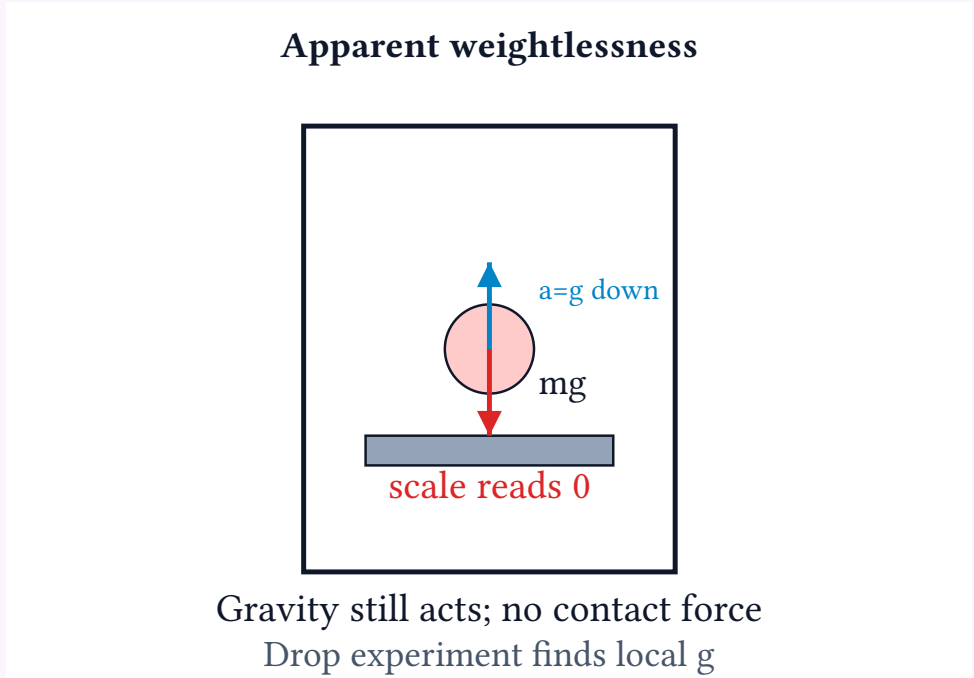


The rover’s ramp force

- The rover mass is 42.0 kg and the ramp is 15 degrees above the horizontal.
- The chosen acceleration up the ramp is 0.500 m/s squared.
- The motor force is 128 N on Earth and 61.4 N on Mars.

Apparent weight

- In apparent weightlessness, gravity still acts.
- The scale reads zero because the person and the scale accelerate together.
- A drop timed in this room can give a local g a little different from 9.81 N/kg.



Gravity still acts; no contact force

Drop experiment finds local g

A 0.800 m drop

- A mass falls 0.800 m from rest in 0.404 s.
- Compute the local field strength from 2 d over t squared.
- Compare your result with 9.81 N/kg, the value these problems use near Earth’s surface.

Weight and a uniform g

- A 70.0 kg geologist stands on Mars, where g is 3.71 N/kg.
- Find the weight on Mars and the weight on Earth.
- Near Earth's surface in these problems, use g = 9.81 N/kg straight down.