51 lb (23 kg)—the **weight on Mars**, due to lower gravity, **of a person weighing 137 lb (62 kg) on Earth.**

Law of Falling Bodies

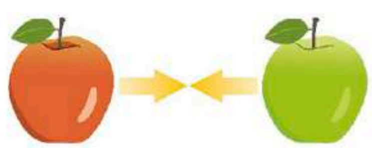
Gravity pulls more strongly on heavier objects—but heavier objects need more force to make them speed up than lighter ones. Galileo was the first person to realize, in 1590, that any two objects dropped together should speed up at the same rate and hit the ground together. We are used to lighter objects falling more slowly—because air resistance slows them more.

In the near-frictionless environment of the moon, a heavy hammer and a light feather fall at the same rate.

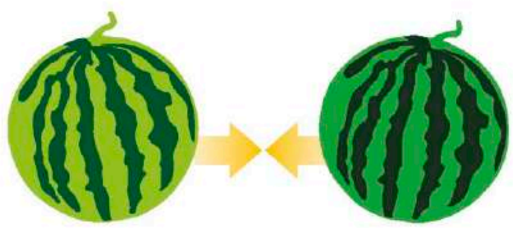
Falling in a vacuum
In 1971, astronaut Dave Scott proved Galileo right when he dropped a feather and a hammer on the moon.

Law of Universal Gravitation

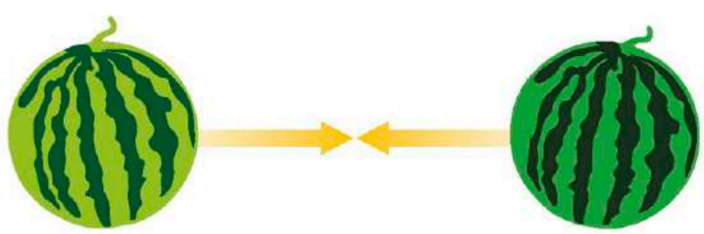
In 1687, English scientist Isaac Newton came up with his Law of Universal Gravitation. It states that any two objects attract each other with a force that depends on the masses of the objects and the distance between them.



Equal and opposite
The gravitational force between two objects pulls equally on both of them—whatever their relative mass—but in opposite directions.



Double the mass
If one object's mass is doubled, the gravitational force doubles. If the mass of both objects is doubled (as here), the force is four times as strong.



Double the distance
If the distance between two objects is doubled, the gravitational force is quartered.

Gravity and orbits

Newton used his understanding of gravity (see left) and motion to work out how planets, including Earth, remain in their orbits around the sun. He realized that without gravity Earth would travel in a straight line through space. The force of gravity pulls Earth toward the sun, keeping it in its orbit. Earth is constantly falling toward the sun, but never gets any closer. If Earth slowed down or stopped moving, it would fall into the sun!

Elliptical orbit
Earth's orbit around the sun is in fact elliptical (an oval), not circular.

Speed of travel
If Earth was not speeding through space, gravity would pull it into the sun.

Earth
Based on the strength of its gravitational force, the mass of Earth is estimated to be 6.5 sextillion tons!

The force of gravity 62 miles (100 km) above Earth is
3 percent less
than at sea level on Earth.

32.2 ft/s^2—the rate at which a falling object accelerates toward Earth.

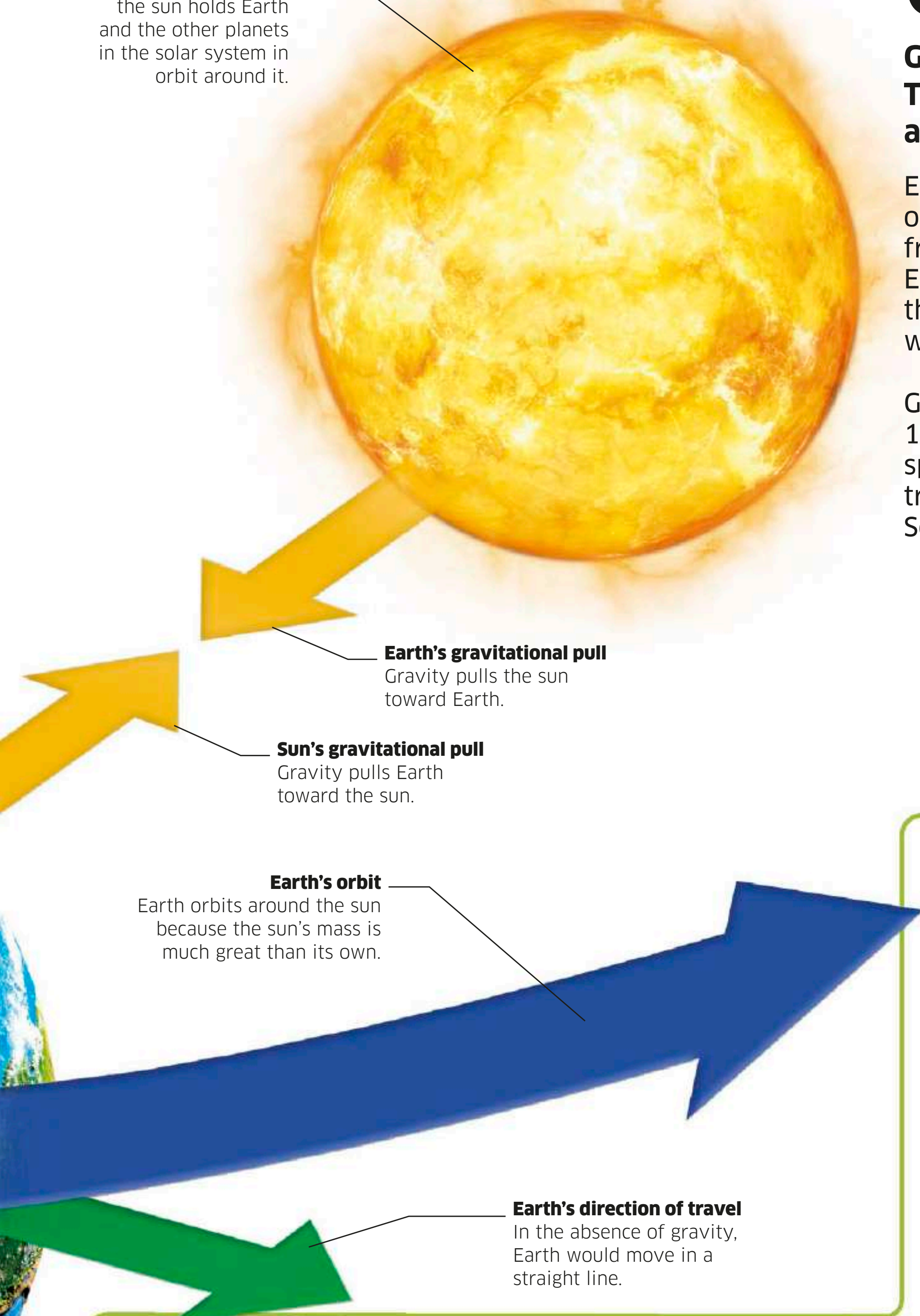
Gravity is the weakest of the four fundamental forces: strong nuclear, electromagnetic, weak nuclear, and gravitational.

Gravity

Gravity is a force of attraction between two objects. The more mass the objects have and the closer they are to each other, the greater the force of attraction.

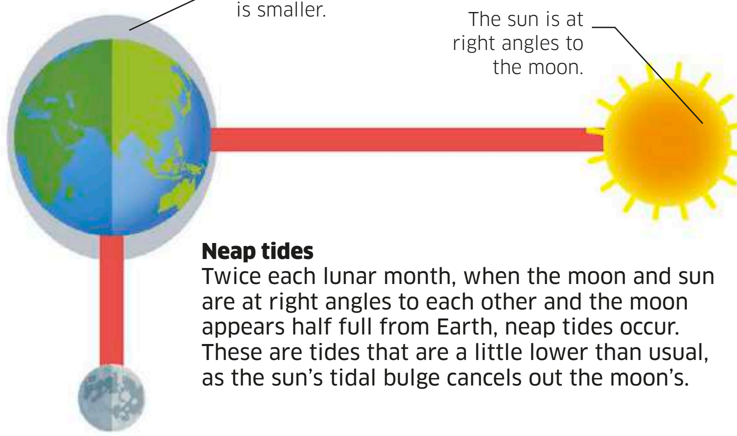
Earth's gravity is the gravitational force felt most strongly on the planet: it is what keeps us on the ground and keeps us from floating off into space. In fact, we pull on Earth as much as Earth pulls on us. Gravity also keeps the planets in orbit around the sun, and the moon around Earth. Without it, each planet would travel in a straight line off into space.

The best way scientists can explain gravity is with the General Theory of Relativity, formulated by Albert Einstein in 1915. According to this theory, gravity is actually caused by space being distorted around objects with mass. As objects travel through the distorted space, they change direction. So, according to Einstein, gravity is not a force at all!

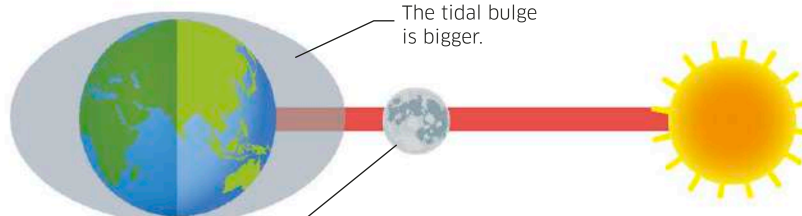


Tides

The gravitational pull of the moon and the sun cause the oceans to bulge outward. The moon's pull on the oceans is strongest because it is closest to Earth, and it is the main cause of the tides. However, at certain times of each lunar month, the sun's gravity also plays a role, increasing or decreasing the height of the tides.



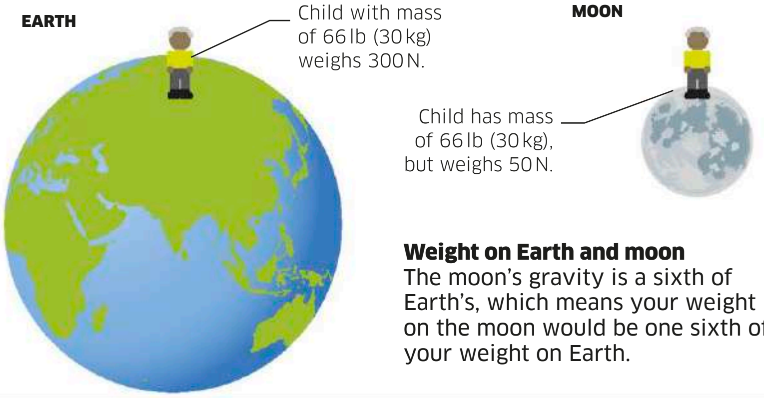
Neap tides
Twice each lunar month, when the moon and sun are at right angles to each other and the moon appears half full from Earth, neap tides occur. These are tides that are a little lower than usual, as the sun's tidal bulge cancels out the moon's.



Spring tides
Twice each lunar month, when the moon appears full and new and Earth, the moon, and the sun are aligned, spring tides occur. These are unusually high tides.

Mass and weight

Mass is the amount of matter an object contains, which stays the same wherever it is. It is measured in kilograms (kg). Weight is a force caused by gravity. The more mass an object has and the stronger the gravity, the greater its weight. Weight is measured in newtons (N).



Weight on Earth and moon
The moon's gravity is a sixth of Earth's, which means your weight on the moon would be one sixth of your weight on Earth.