

Newton's First Law

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Newton's First Law

- ▶ **Newton's words:**¹ Every body perseveres in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by forces impressed.
- ▶ **Poetic version:** A body in motion stays in motion. A body at rest stays at rest.
- ▶ **Modern version:** In the absence of forces, an object maintains the same velocity.
- ▶ **Wikipedia version:** A body remains at rest, or in motion at a constant speed in a straight line, except insofar as it is acted upon by a force.

¹Translated from Latin to English by I. Bernard Cohen, Anne Whitman, and Julia Budenz.

You don't need a force to be moving.

- ▶ If you start from rest, you will need a force to get moving.
- ▶ Once you are moving, you don't need a force to stay moving.

Velocity is relative.

How fast is Einstein's statue moving?



Relative to Earth's surface	0 m/s
Relative to Earth's center	361 m/s
Relative to the Sun	29,400–30,100 m/s
Relative to galaxy center	210,000–270,000 m/s

- ▶ It is conventional to measure velocity with respect to Earth's surface, but that's just a convention.

Thought experiment

1. Imagine you and a friend somewhere in the solar system, pretty far from Earth or any other planet.
2. You've brought your space ship, your space suits, and you each have a little jet pack you can put on your back to play space games outside the space ship.
3. You're bored in space, so you put on your jet packs and go outside the space ship.
4. When you fire the jets on your jet pack, you accelerate. When you turn off the jets, you move at constant velocity.
5. When your jets are off, how can you tell whether you're at rest or moving at constant velocity?

There is no such thing as absolute rest.

- ▶ We can be at rest with respect to the surface of the Earth.
- ▶ Rest from one point of view is motion from another.
- ▶ Newton's First Law: the natural state of motion (in the absence of forces) is to be at rest *or* to be moving with constant velocity.
- ▶ Constant velocity to one observer is rest to another observer.

The fate of the tissue box

1. In my family car, we have a box of tissues that sits on the flat spot between the two front seats.
2. If the driver slams on the brakes, perhaps because the car in front of us is quickly slowing down, the tissue box goes flying forward.
3. The tissue box is obeying Newton's first law. There is no force that propels the tissue box forward. The tissue box is simply doing the best it can to move in a straight line at constant velocity.
4. The car is slowing down, but the tissue box doesn't want to.
5. Next time you slam on the brakes, and some object in your car goes flying forward, shout "Newton's First Law"!