
Newton's Laws of Motion

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1st Law

Every object continues in its state of rest or in uniform motion in a straight line, unless it is acted upon by a force --- the law of inertia

- All objects possess inertia – it is a property of matter.
- Mass is a measure of inertia. The unit of mass is the kilogram –
- Weight is a measure of the gravitational force exerted by the nearest most massive body. The unit of weight is the Newton.

Questions – Does a 2-kg iron brick have twice as much inertia as a 1-kg iron brick? Twice as much mass? Twice as much volume? Twice as much weight?

2nd Law

The acceleration of an object is directly proportional to the net force acting on the object, is in the direction of the net force, and is inversely proportional to the mass of the object

In other words $F = ma$

The 2nd law defines what a force is beyond “a push or a pull”. A force is anything that accelerates an object. Remember that this acceleration can be a change in speed and/or a change in direction.

Question: What is the weight of a 2.0 kg brick on the surface of the earth?

Mechanical Equilibrium – zero acceleration

A body that is motionless must have zero net force acting on it. This is static equilibrium. Example: a book on a table.

Any body that is moving with constant velocity (not accelerating) must have zero net force acting on it. This is dynamic equilibrium. Example: a car going at constant speed in a straight line

Friction

Friction is an “opposing motion” force which acts when surfaces tend to slide over each other. The amount of this force depends on the kinds of materials and how they are pressed together.

Example: A jumbo jet cruises at a constant velocity of 1000. km/h when the thrusting force of its engines is a constant 100,000 N. What is the acceleration of the jet? What is the force of air friction on the jet?

Free-Fall – acceleration is g

If air resistance is negligible, then the force of gravity is the only force acting on a falling object and the acceleration is g .

Questions: In a vacuum a coin and a feather fall side by side. Do they have equal masses? Are they acted upon by equal forces? Why do they fall at the same rate?

Nonfree-fall -- acceleration is less than g

Feathers and coins don't travel equally fast in air. The frictional force of the air on the object is called the *drag* and is dependent on the frontal area of the object as well as its speed. This makes the acceleration less than g .

Since drag increases with speed most objects reach a terminal speed (velocity). At this point the net force is zero with zero acceleration – dynamic equilibrium.

Question: Suppose a man and woman parachute out of a plane and have the same size chutes. The man is twice as heavy as the woman. Who gets to the ground first and why?

3rd Law

Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first. “To every action there is an equal and opposite reaction”

<i>Action</i>	<i>Reaction</i>
Book pushes on table	Table pushes on book
Man pulls on spring	Spring pulls on man
Tire pushes on road	Road pushes on tire
Earth pulls on ball	Ball pulls on earth
Gun pushes on bullet	Bullet pushes on gun (recoil)
Rocket pushes on escaping gas	Escaping gas pushes on rocket

