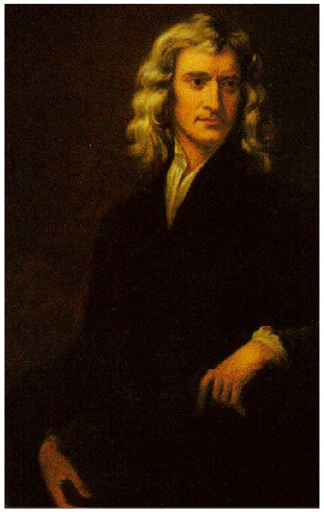
Science 10 Unit B - Physics

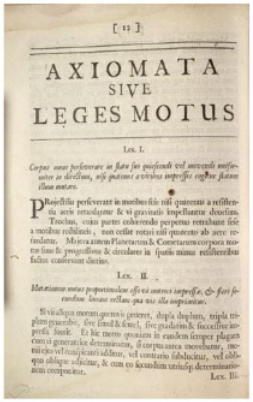
Forces and Newton's Laws

Newton's Laws of Motion



In 1687, at the age of 23, Sir Isaac Newton published perhaps the most important book in math or physics: the Principia Mathematica. The book contained (among other things) three laws that governed all motion in the universe.

And even though these ideas are over 300 years old, they still hold up as a good basis for understanding dynamics.



AXIOMATA
SIVE
LEGES MOTUS

Philosophiae Naturalis Principia Mathematica (1687).

Forces

A force is sometimes described as a push or a pull.

What are some forces you can think of?

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-
-
-
-
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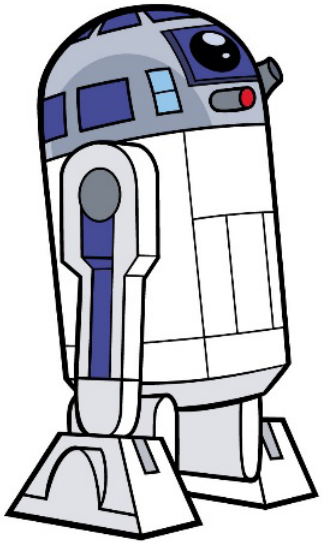
Newton's First Law:

The Law of Inertia

Newton said...

"An object continues in a state of rest or in a state of motion at a constant speed along a straight path, unless acted on by an overall force."



Gravity Switch

Now that you've heard the first law, consider this with a partner:

Suppose gravity could be turned off and on by a switch. What would happen to the following in the classroom when the switch was switched off;

- the desks
- A spitball flying through the air
- you!

And: what would happen when the gravity was switched back on?

Space Place

Suppose you are standing outside the ISS in outer space far from the effects of gravity. You apply a force to a baseball by hitting it with a bat.

- What direction will the ball travel in?
- Will the ball stop after no more forces are acting on it?
- Is it moving with a constant velocity, or constantly accelerating?

if $F_{NET} = 0$,
$v = \text{constant}$

Another way of thinking of the first law is using inertia.

Inertia - the tendency of an object at rest to want to stay at rest, and an object in motion to want to stay in motion.

inertia gedankin:

Do you notice how large objects are difficult to get moving at first...

...but once they get going, they're hard to stop?

That's inertia.

Newton's Second Law

Any overall force produces an acceleration.

Simply put:

$$\vec{F} = m\vec{a}$$

where:

$\vec{F}$ = force (kgm/s^2 or N [a newton])

$\vec{a}$ = acceleration (m/s^2)

m = kg

Applying the Second Law:

ex) _____ has a mass of 100 kg. What force is needed to accelerate _____ to 1.5 m/s^2?

ex) A spring-scale can pull with a force of 2.0 N. What is the maximum acceleration such a scale could give to a 3.5 kg object?

ex: Mr. P's mass is 88.18 kg. What is his weight?

Hint: mass is measured in kg, but weight is measured in Newtons.

Newton's Third Law

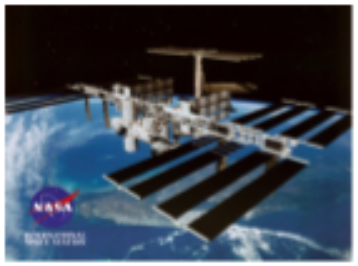
"For every force, there is an equal and opposite force."

Forces do not exist all by themselves, they occur in pairs. We can never have one force acting all by itself*.

This force is equal in magnitude and opposite in direction.

***Although we only focus on one force for simplicity.**

Repair Scare



You are in outer space fixing the International Space Station. Your tether suddenly breaks and you find yourself at rest in space.

You don't have fancy rockets or anything to get back to the station. You do, however, have a wrench.

How can you get back to the station?

ex) Darnell Nurse has a manly mass of 100 kg. Andrew Mangiapane has a puny mass of 83 kg. If Nurse hits Mangiapane with a force of 15 N, what is the acceleration of both players?

Secret Rock'em Sock'em Thing

The forces are the same, only opposite. Do two force calculations.