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Isaac Newton's 3 Laws of Motion

Sir Isaac Newton (1642-1727) was an English physicist and mathematician. Before the age of 30 he formulated the laws of motion and invented calculus. Much of our modern science is based on Newton's

Newton's Laws of Motion

Law One – Law of Inertia
An object at rest will stay at rest unless acted on by an unbalance force.
An object in motion will stay in motion unless acted upon by an unbalanced force.

OR

Things keep moving or stay at rest, unless a net force acts upon them.

Law Two – F = ma
The acceleration of an object is proportional to the force acting on it and inversely proportional to its mass.

OR

Force causes acceleration, while mass resists acceleration

Law Three – Law of Equal and Opposite Forces.
Whenever one object exerts a force on another object, the second exert an equal and opposite force on the first.

OR

For every action there is an equal and opposite reaction.

Inertia

Inertia is the property of an object that resists change of motion.

Moving objects have inertia: they want to keep moving; stopped objects have inertia: they want to stay at rest.

More mass = more inertia!

Something that is harder to push has more inertia!

More mass, more inertia

Less mass, less inertia

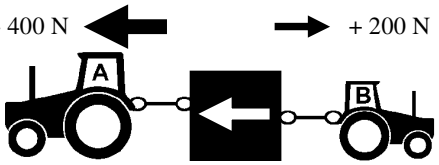
Force

A ***force*** is any action that can change or cause motion.
A force is any push or pull.
We use Newtons (N) to measure force.

Net Force

Net force is the sum of all the forces and has direction. (Be sure to make right positive and left negative.)

An object will move in the direction of the net (or unbalanced) force.



Net Force = + 200 N – 400 N = – 200 N (left)

Newton's Second Law

Force (in Newtons) → **F = ma** ← Mass (in kg)

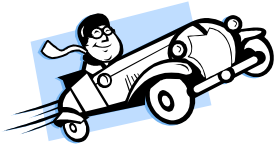
Acceleration (in m/sec^2)

Force equals mass times acceleration.

F = ma tells us:

For the same acceleration, **more mass requires more force**.

For the same mass, **more acceleration requires more force**.



Newton's 2nd Law tells us that when you accelerate (stomp on the gas) or decelerate quickly (brake fast) you use more force and wear out engine parts and brakes faster.

Ex. How big a force does it take to give a 50 kg object an acceleration of 40 m/s^2.

Variables:
40 m/s^2 = a
50 kg = m
F = ?

Equation:
F = ma

Solve:
F = ma
F = 50(40)
F = 50 x 40
F = 2000N

Ex. If a 50 N force pulls on a 10 kg object, how much acceleration will occur?

Variables:
50 N = F
10 kg = m
a = ?

Equation:
F = ma

Solve:
F = ma
50 = 10a
$\frac{50}{10} = \frac{10a}{10}$
a = 5m/s^2

Ex. A force of 49 N causes a 7 m/s^2 acceleration. Find the mass of the object it was pulling.

Variables:
49 N = F
7 m/s^2 = a
m = ?

Equation:
F = ma

Solve:
F = ma
49 = m7
$\frac{49}{7} = \frac{m7}{7}$
m = 7 kg

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1. F = _____	125 kilograms
2. m = _____	23 kgm/s
3. a = _____	3 m/s^2
4. v = _____	29 meters/sec
5. D = _____	228 meters
6. p = _____	6 newtons

1. Inertia	A. An action that can causes motion.
2. Mass	B. Force pulling all object toward each other.
3. Gravity	C. The amount of matter in an object
4. Net force	D. Total of all of the forces on an object.
5. Force	E. Ability of an object to resist change of motion.

Number these from least (1) to most (5) inertia.

A baseball	A small car	A truck	A feather	A large train

Number these from least (1) to most (5) momentum.

Fast car	Parked truck	Slow car	Fast baseball	Fast feather

Which of Newton's Three Laws Applies?
Law 1, 2, or 3?

___ When you put a book on a table the table pushes on the book.

___ A person is pushed forward into their seatbelt when a car stops.

___ A larger car takes more force to move.

___ A person leans on a wall and the wall pushes back.

___ A brick sits on a table until you push on it.

Understanding Net Force

Which way will it accelerate?

_____

_____

_____

A sled is being pulled to the left by 5 dogs, each dog pulling with 6 Newtons of force. Find the net force.

_____

If a person pulls on a cart to the right with a force of 10 N and a second person pulls to the left with a force of 3 N, what is the net force (+ direction) on the cart?

_____

A 2 N and 6 N force pull on an object to the right and a 4 N force pulls to the left a 0.5 kg object. What is the net force on the object?

A 20 kg bike accelerates at 10 m/s^2. With what force was the person pedaling?

_____

If a person is pushing a cart with a force of 40 Newtons and it accelerates at 0.5 m/s^2, what is the mass of the cart?

_____

What is the acceleration of a 3 kg rock that is thrown with a force of 18 N?