Name: _____

Period: _____

Newton's Laws of Motion and Force

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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 work.

Newton's Laws of Motion

Law One: 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

An object will keep moving or stay at rest unless a net force acts on it.

Law Two: F = ma

The acceleration of an object is proportional to the force acting on it and inversely proportional to its mass.

OR

More force causes more acceleration; more mass causes less acceleration.

Law Three: Equal and Opposite Forces

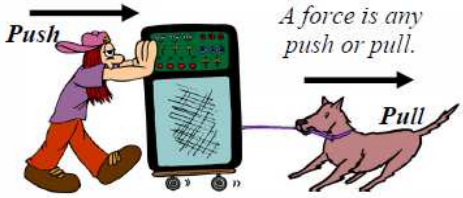
Whenever one object exerts a force on another object, the second exert an equal and opposite force on the first.

OR

For every action there is an equal and opposite reaction.

Forces

A ***force*** is any action that can change or cause motion. Forces are measured **in Newtons (N).**

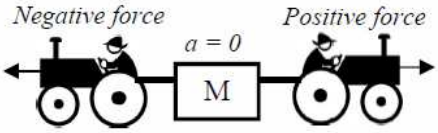


It doesn't matter which side the force is on: the object still experiences a force to the right.

Forces are Vectors

Forces are vectors: direction matters. Forces can add together or cancel each other out.

Forces acting in the same direction add together.



Opposing forces can cancel each other.

Net Force

The net force (F_{net}) is the result of all of the forces acting on an object. There can be many forces, but the object will act as if there is only one force: the net force.

Net Force — Sum of all Forces

$$F_{net} = \Sigma F$$

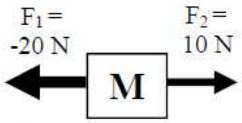
$$\Sigma F = F_1 + F_2 + \ldots$$

Add up all of the individual forces

Forces to the right are positive.

Forces to the left are negative.

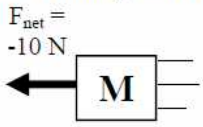
Finding F_{net}



$F_{net} = \Sigma F = F_1 + F_2$

$\Sigma F = -20 + 10 = -10$ N

Resulting Motion



The object accelerates left since F_{net} is left.

Inertia

Inertia is the property of an object that resists change of motion. A moving object has inertia: it wants to keep moving. A stopped object also has inertia: it wants to stay at rest. A net force is required to overcome inertia.

More mass = more inertia!

Something that is harder to move has more inertia!

Bowling ball: more mass, more inertia: hard to move and hard to stop.

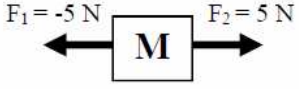
Golf ball: less mass, less inertia: easy to move and easy to stop.

Inertia is <u>not</u> affected by velocity. A fast object has the same inertia as a slow object: same mass = same inertia!

Balanced or Unbalanced

Forces are balanced if they are equal in magnitude (amount) and opposite in direction. Forces are unbalanced if one of them is stronger. Only unbalanced forces change an object's motion.

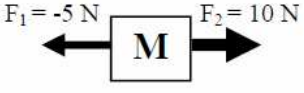
Balanced Forces



If the forces are balanced the object will remain at rest ($v = 0$m/s) or moving at constant speed in a straight line ($\Delta v = 0$m/s; $a = 0$m/s^2) .

If $F_{net} = 0$N, the object could be moving with constant speed.

Unbalanced Forces



If the forces are unbalanced the object **must** change velocity (change speed or direction) in the direction of the net force ($\Delta v \neq 0$m/s; $a \neq 0$m/s^2) .

If there is a net force ($F_{net} \neq 0$N), the object must accelerate.

1. F_{net}	A. The object is not changing velocity; the object is not accelerating.
2. ΣF	B. The net force.
3. $\Delta v = 0$	C. Force 1 is stronger than force 2.
4. $a \neq 0$	D. Add up all of the forces.
5. $F_1 > F_2$	E. The object is accelerating.

1. Inertia	A. Any action that can cause motion.
2. Mass	B. When the positive forces are equal to the negative forces.
3. Net force	C. The amount of matter in an object
4. Force	D. Total of all of the forces on an object.
5. Balanced	E. Ability of an object to resist change of motion.

Which has more inertia?

A train or a car?
A ping pong ball or a baseball?
A fast bowling ball or a slow bowling ball?
A 20 kg mass or a 10 kg mass?
A rock on the earth or a rock in space?

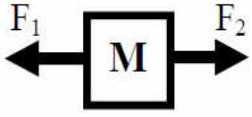
Balanced or Unbalanced Forces?

___ An person sitting on a chair?
___ 20 N left and 30 N right?
___ An object at constant speed?
___ An accelerating plane?
___ An object at rest?

____ If $\Delta v = 0$?
____ If $a \neq 0$?
____ If $a = 0$?
____ If $\Delta v \neq 0$?
____ A stopping car?

Draw arrows and label any forces you can think of for the following picture:

If $F_1 > F_2$, "a" is which way?
If $F_1 = F_2$, "a" is which way?
If $F_1 < F_2$, "a" is which way?



If the forces are balanced, what is the net force?

If the forces are unbalanced, can it be at rest?

If $F_1 = F_2$ does it have to be at rest?

How can $v = 0$ if $F_2 > F_1$?

If $F_2 > F_1$ does it have to be moving to the right?

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

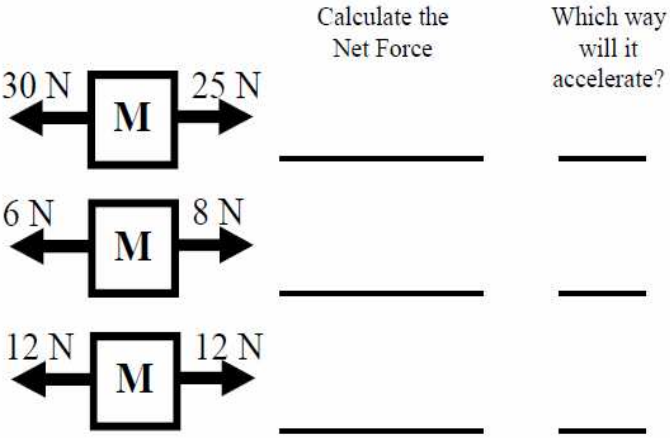
____ When you put a book on a table gravity pulls down on the book and the table pushes up on the book.

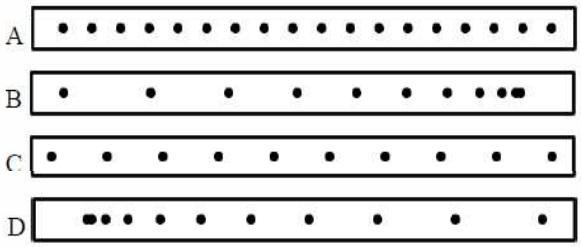
____ A person is pushed forward into their seatbelt when a car stops.

____ 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.

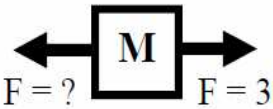




____ Which have $F_{net} = 0$.
____ Which have balanced forces?
____ Which have unbalanced forces?
____ Which have a positive net force?
____ Which have a negative net force?

For each tape timer, if there is a net force, draw its direction.

$F_{net} = 15$ N



F = ?
F = 30 N

What is the magnitude of the force pulling to the left?

Two forces (4N and 3N) pull to the left, while a 12 N force pulls to the right. Find the net force.

Why does it take a force to change an object's motion?