Newton's Laws;

1. **First law**: If an object experiences no net force, then its velocity is constant: the object is either at rest (if its velocity is zero), or it moves in a straight line with constant speed (if its velocity is nonzero).[2][3][4]
2. **Second law**: The acceleration **a** of a body is parallel and directly proportional to the net force **F** acting on the body, is in the direction of the net force, and is inversely proportional to the mass *m* of the body, i.e., $\mathbf{F} = m\mathbf{a}$.
3. **Third law**: When a first body exerts a force $\mathbf{F}_1$ on a second body, the second body simultaneously exerts a force $\mathbf{F}_2 = -\mathbf{F}_1$ on the first body. This means that $\mathbf{F}_1$ and $\mathbf{F}_2$ are equal in magnitude and opposite in direction.

Weight: w=mg

Gravity pulls all objects down. The force that gravity pulls down is called "weight". Remember that weight is different than mass. Mass is measured in Kilograms (Kg) and measures how much matter an object has. Weight is how hard gravity pulls an object down (weight is a force). Weight depends on gravity and mass; if an object has more mass, then it weighs more. If you are in the middle of space with no gravity, you still have mass, but since there is no gravity (g) you don't weigh anything (you're weightless).

"w" is weight (measured in Newtons "N")

"m" is mass (measured in Kg)

"g" is gravity (9.8 m/s^2)

EXAMPLE 1:

A 42.0 Kg boy would weight how much on Earth?

W=mg=(42.0kg) *(9.8 m/s^2)=**412N***

Example 2:

A 12N stapler has how much mass?

$$m = \frac{w}{g} = \frac{12N}{9.8} = 1.2N$$

<u>F=ma</u>

"F" is the force applied to an object (measured in Newtons "N")

"m" is the mass of the object (measured in Kilograms "kg")

"a" is the acceleration of the object (measured in m/s^2)

It takes a force to cause an object to accelerate. The more force you apply to an object, the more it accelerates. It doesn't take any force for an object to stay at the same speed (newton's first law). If an object is traveling at a constant velocity or is not moving, then the net force acting on it is zero (more on net forces below). If an object is accelerating, you can calculate the acceleration of an object by knowing the force applied to the object and the mass of the object.

<u>Example **1**</u>

A 2.0kg box is accelerating at 4.0m/s^2. What is the force applied to the object?

F=ma=(2.0kg)(at 4.0m/s^2)=**<u>8.0N</u>**

<u>Example 2</u>

A 5.0kg box is being pushed with 20N of force. As it is being pushed, it is moving at a constant velocity.

a)what is the acceleration of the box? ***Zero!! (if an object isn't changing its velocity, then it's not accelerating)***

b) what is the net force on the box? ***Zero!! (if the acceleration of an object is zero, then the "net force" acting on it is zero. Remember, it's the "net force" on an object that causes the acceleration of an object)***

c) why is the box not accelerating when a force is being applied? ***There must be friction or some other force that is opposing the motion of the object. Since the boy is pushing 20N, there must be some force pushing in the opposite direction with 20N so the force pushed is canceled (most likely friction does this)***

d) If the 20N force was the only force (no friction) then what would the acceleration be?
A=f/m=20N/5.0kg=<u>4.0m/s^2</u> If you push 20N on a 5.0kg object is will accelerate at 4.0m/s^2. (that's only if there is no other force, in real life there always is)

Unbalanced forces (Net forces).

Unbalanced forces mean that there is more force in one direction that the other. Net force and unbalanced force mean the same thing.

Net Force = the sum of the forces = +50N + (-30N) = +20N

This object will definitely accelerate. The net force is certainly not zero. If the box above had a mass of 40kg, what would the acceleration be?

$$a = \frac{F}{m} = \frac{20N}{40kg} = 0.5m/s^2$$

Friction

There are two types of Friction, static and Kinetic.

Static Friction	Kinetic Friction
Friction when an object is not moving	Friction when an object is moving
Static friction always acts against the direction force you're trying to move the object (ex. You try to move an object to the right, friction forces to the left)	Kinetic friction always acts against the direction of the object's motion (ex. An object is moving right so, friction forces to the left)
Coefficient of static friction symbol = μ_s	Coefficient of Kinetic Friction symbol = μ_k

The equation to know how much friction is pushing:

$$F_f = F_N \mu$$

F_f is the frictional force. This is the amount of force that friction pushed against the motion of the object.

F_N is the Normal Force. This is the force that the ground pushes up on an object so that gravity won't accelerate it down.

μ is the coefficient of friction. This is a constant and depends on the materials that are rubbing together (remember, some objects have more friction that others) See the list of static and kinetic friction coefficients below.

Coefficients of Friction		
Materials	Static Friction	Kinetic Friction
Steel on steel	0.74	0.57
Aluminum on steel	0.61	0.47
Wood on brick	0.60	0.45
Copper on steel	0.53	0.36
Rubber on concrete	1.0	0.80
Wood on wood	0.25 – 0.50	0.20
Glass on glass	0.94	0.40
Waxed wood on wet snow	0.14	0.10
Waxed wood on dry snow	--	0.040
Metal on metal (lubricated)	0.15	0.060
Ice on ice	0.10	0.030
Teflon on teflon	0.040	0.040
Synovial Joints in humans	0.010	0.0030

See Friction example Notes