Newton's Laws of Motion Summary

(I) First Law of Motion [*Law of Inertia*]

An object at rest will remain at rest and an object in motion will remain in motion, with constant velocity, unless acted upon by an external, non-zero force.

* Constant velocity means the motion is in a straight line!
  (*since the velocity is constant, there is no change in magnitude or direction*)
* An object at rest has a constant velocity of 0.

** The **1st Law** explains the motion of everyday objects under the influence of a **zero** force.

(II) Second Law of Motion [$F = ma$]

The acceleration of an object is directly proportional to the net force acting on the object and indirectly proportional to the mass of the object

$$\vec{F} = m\vec{a} \qquad \textit{Units of } \boldsymbol{F} : \textit{Newtons (N)} \qquad \left\{1N = 1\ \frac{kg\ m}{s^2}\right\}$$

** The net force ***always*** determines the magnitude and direction of the motion of an object.

** **Force** (*a push or pull*) is a vector.

** The **NET FORCE** is always the ***vector sum*** of all the forces acting on an object!

$\mathbf{F_{net} = F_1 + F_2 + F_3 + \ldots}$

** The **2nd Law** explains the motion of everyday objects under the influence of a **non-zero** force.

(III) Third Law of Motion [*Force Pairs*]

When 2 objects interact, the force exerted by the 1st object on the 2nd is equal in magnitude, but opposite in direction to the force exerted by the 2nd object on the 1st .

$$\mathbf{F_{1\ on\ 2} = -\ F_{2\ on\ 1}}$$

$\longrightarrow$ $\mathbf{F_{1\ on\ 2} + F_{2\ on\ 1} = 0}$ *for a closed system.*

5 Things Newton's 3rd Law Tells Us:

1) Forces always occur in pairs
2) Force pairs always occur at interaction or contact points
3) Each force in a force pair has the same magnitude
4) Each force in a force pair points in the opposite direction
5) *** Each force in a force pair acts on a **different** system ***

** The **3rd Law** explains the **source of the forces** *that cause* the motion of everyday objects.