Momentum

Momentum is a vector quantity calculated by multiplying the mass of an object by its velocity.
The direction of momentum is the same as the object's velocity.

$$\boxed{\mathbf{p} = m\mathbf{v}}$$

The Law of Conservation of Momentum states that whenever two or more objects interact with one another, the total momentum of the system remains constant.
Whenever a force acts on an object for a period of time, its velocity changes in proportion to the force. This results in a change in the object's momentum.

$$\boxed{\mathbf{F}t = m(\Delta\mathbf{v}) = \Delta(m\mathbf{v})}$$

Newton's Third Law of Motion states that
"Whenever object 'A' exerts a force **F** on object 'B', object 'B' exerts a force **–F** on object 'A'"
Since the forces are equal in magnitude and opposite in direction and are exerted for the same amount of time, each object experiences the same magnitude change in momentum but in opposite directions. The net change to the system is, therefore, zero. This is true regardless of the masses of the objects. The more massive object has a smaller velocity change but the same momentum change due to its larger mass.

The change in an object's momentum is called **impulse**.

In **inelastic** collisions, the objects collide and stick together resulting in an identical velocity after the collision. Momentum is conserved but kinetic energy is not. Any loss of kinetic energy is accounted for by an increase of potential energy or a loss in the form of heat.

$$\boxed{m_1\mathbf{v}_1 + m_2\mathbf{v}_2 = (m_1 + m_2)\mathbf{v}}$$

In **elastic** collisions, the colliding objects leave the collision separately and materially unchanged. Their velocities are effected by the collision. Both momentum and kinetic energy are conserved in these collisions.

$$\boxed{\begin{array}{l} m_1\mathbf{v}_1 + m_2\mathbf{v}_2 = m_1\mathbf{V}_1 + m_2\mathbf{V}_2 \\ \frac{1}{2}m_1\mathbf{v}_1^2 + \frac{1}{2}m_2\mathbf{v}_2^2 = \frac{1}{2}m_1\mathbf{V}_1^2 + \frac{1}{2}m_2\mathbf{V}_2^2 \end{array}}$$

Most real collisions are neither completely elastic nor completely inelastic but atoms and molecules do undergo collisions that are completely one or the other.
Explosions are the reverse of an inelastic collision in that the two or more pieces are initially together as one object with one velocity and after the explosion, the travel separately with their own velocities. Momentum is still conserved in explosions.
The earth accounts for what might be considered discrepancies in momentum calculations. Its mass is so large compared to the objects interacting with it, its velocity changes very little even when it absorbs what appears to be large amounts of momentum.