2.12: The Mathematical Finish- Newton

The next major leap was that of Sir Isaac Newton, an English physicist and mathematician. Newton is credited with developing the **Laws of Motion, Law of Universal Gravitation**, building the first **Reflecting Telescope** (still called the Newtonian Reflector), and developing a **Theory of Color**.

The Theory of Color was based on Newton's observations that a prism breaks sunlight into component colors. Newton also shares credit for the development of Calculus with Gottfried Leibniz, as well as developed other ideas in physics, including an empirical law of cooling, studies the speed of sound, and the idea of a Newtonian fluid.

Newton's First Law of Motion

An object remains at rest or in motion at a constant velocity unless acted upon by an outside force. A force is any influence that can change the speed or direction of motion of an object.

Newton's Second Law of Motion

The relationship between acceleration of an object, force placed on the object, and the object's mass.

Newton's Second Law of Motion is stated as:

F = ma

Where:

- **F** is force
- **m** is the mass
- **a** is acceleration

Units in the Metric System:

- Mass is kilograms, **kg**
- Acceleration is meters per second squared; **m/s ^{2}**
- **f = kg-m/s ^{2}** = Newton **(N)**

An object's weight is the force with which the object is attracted by a body's gravitational pull.

F = ma w = mg

Where:

- **w** is the object's weight
- **m** is the mass
- **g** is acceleration due to gravity, 9. 8 m/s ^{2} (metric system) or 32 ft/s ^{2} (English system)

Newton's Third Law of Motion

When one object exerts a force on a second object, the second object exerts an equal force in the opposite direction on the first object. This is sometimes called the **Action–Reaction Law**. Examples include a rocket "blasting off" (action is force of the combustion/flame, reaction is the rocket moving in the opposite direction of the flame) and a book pushing against a table (a force); the table pushes back (opposite and equal force).

Centripetal Force, Fc

Inward force on an object moving that object in a curved path. Understanding Circular Motion is important due to planets orbiting stars, moons orbiting planets, or a satellite orbiting Earth.

The relationship is stated as:

$$Fc = \frac{mv^2}{r}$$

Where:

- **Fc** is the centripetal force
- **m** is the object's mass
- **v** is the object's velocity
- **r** is the radius of the circular path

Newton's Law of Universal Gravitation

Every object in the Universe attracts every other object with a force proportional to both of their masses and inversely proportional to the square of the distance between them.

The relationship is stated as:

$$F = \frac{Gm1m2}{R^2}$$

Where:

- **F** is the Gravitational force
- **G** is the Gravitational Constant; 6. 67 x 10-11 N-m ^{2} /kg ^{2}
- **m1** is the first object's mass
- **m2** is the second object's mass
- **R** is the distance between the two objects

This is often called an **Inverse Square Relationship**, where the greater the distance between the two objects, the smaller the force between these two objects – squared. If the first distance was 1 meter and the second distance was two meters, the variation in the force would be ¼ at the second distance.

Consider this…

"Do not worry about your difficulties in mathematics; I can assure you that mine are still greater. "

Albert Einstein (1879-1955)
