Classical Mechanics

- Describes the relationship between the motion of objects in our everyday world and the forces acting on them
- Conditions when Classical Mechanics does not apply
  - very tiny objects (< atomic sizes)
  - objects moving near the speed of light

Newton's First Law

- An object moves with a velocity that is constant in magnitude and direction, unless acted on by a nonzero net force
  - The net force is defined as the vector sum of all the external forces exerted on the object

Inertia

- Is the tendency of an object to continue in its original motion

Mass

- A measure of the resistance of an object to changes in its motion due to a force
- Scalar quantity
- SI units are kg

Newton's Second Law

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

$$\vec{\mathbf{a}} \; \alpha \; \frac{\sum \vec{\mathbf{F}}}{m} \; or \; \sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}$$

  - F and a are both vectors

Gravitational Force

- Mutual force of attraction between any two objects
- Expressed by Newton's Law of Universal Gravitation:

$$F_g = G\frac{m_1 m_2}{r^2}$$

Weight

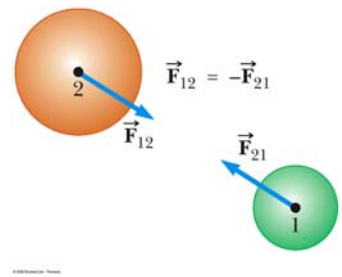
- The magnitude of the gravitational force acting on an object of mass *m* near the Earth's surface is called the weight *w* of the object
  - $w = m\,g$ is a special case of Newton's Second Law
    - g is the acceleration due to gravity
- g can also be found from the Law of Universal Gravitation

Newton's Third Law

- If object 1 and object 2 interact, the force exerted by object 1 on object 2 is equal in magnitude but opposite in direction to the force exerted by object 2 on object 1.
  - $\vec{\mathbf{F}}_{12} = -\vec{\mathbf{F}}_{21}$
  - Equivalent to saying a single isolated force cannot exist

Newton's Third Law cont.

- The action and reaction forces act on **different** objects



Free Body Diagram

- Must identify all the forces acting on the object of interest
- Choose an appropriate coordinate system

Equilibrium

- An object either at rest or moving with a constant velocity is said to be in *equilibrium*
- The net force acting on the object is zero (since the acceleration is zero)

$$\sum \vec{\mathbf{F}} = 0$$

Equilibrium cont.

- Easier to work with the equation in terms of its components:

$$\sum F_x = 0 \text{ and } \sum F_y = 0$$

- This could be extended to three dimensions

Multiple Objects – Example

- When you have more than one object, the problem-solving strategy is applied to each object
- Draw free body diagrams for each object
- Apply Newton's Laws to each object
- Solve the equations