Newton’s Laws of Motion – Accelerated Motion Version

In 1667, Isaac Newton identified three laws of motion which are the basis of our study of mechanics which is often call Newtonian mechanics. “Mechanics” refers to the motion of objects larger than atoms moving at speeds much less than the speed of light far from large gravitational fields like that of stars. Describing motion without referring to forces is called “kinematics.” That is what we have done so far. Newton’s laws tell the relationship between forces and motion. Describing motion using forces is called “dynamics.”

***Newton’s First Law*** – law of inertia – **IF** there is no NET force on an object **THEN** an object at rest will remain at rest and an object that is **already** moving will continue to move in a straight line at constant speed.

*Moving at constant speed in a straight line* is the definition of constant velocity. Constant velocity occurs when the acceleration of the object is zero. We can restate the first law: **IF** the NET force on an object is zero **THEN** the acceleration of the object is zero.

**IF** the NET force on an object is zero **THEN** the object has two possible motions:

1. The object is and remains motionless.

2. The object is already moving and will continue to move in a straight line at constant speed.

For an object to start moving, the NET force on the object is not zero.

For an object to stop moving, the NET force on the object is not zero.

**IF** an object accelerates **THEN** the NET force on the object is not zero.

***Newton’s Second Law*** – law of acceleration – The acceleration of an object is directly proportional to the NET force on the object and inversely proportional to the mass of the object.

A bigger NET force on an object produces a greater acceleration.

The larger the mass of an object, the smaller is the acceleration for the same NET force.

**This law is the single most important idea in mechanics.** The statement of the law is mathematical and the equation for this law is:

 OR  OR 

*a* – the acceleration of the object in m/s2

*F* – NET force - the vector sum of all the forces on the object in newtons, N

*m* – mass of the object in kg

The acceleration of an object depends upon the combined effect of **ALL** the forces on the object.

Acceleration and NET force are vector quantities. They have direction. The direction of the acceleration is the same as the direction of the NET force. Mass is a scalar quantity.

***Newton’s Third Law*** – law of paired forces – When object A applies a force on object B, object B will apply a force on object A that is equal in magnitude and opposite in direction.

Another statement of Newton’s Third Law – law of action-reaction – For every action there is an equal but opposite reaction. We shall see what Newton meant by “action” and “reaction” later.