Laws of motion

Galileo's law of inertia
Before Galileo developed the concept of Inertia, people believed that a push was necessary to keep something moving.

Galileo, first of all, said that that object moves with constant speed when no forces act on them.

This means that if an object is moving on a frictionless path and no other force is acting upon it, then the object would be moving at that constant speed forever.

But practically it is impossible for any object to attain the condition of zero unbalanced force, as forces like Force of friction, Force of air and many other forces are always acting upon the objec

Later on, Sir Isaac Newton built on Galileo's concept of Inertia to include all objects, giving formation to Newton's First Law of Motion.

Kinds of Inertia
There are three types of inertia:
1. Inertia of rest: The ability of a body to resist any change in its state of rest. i.e. body at rest.
2. Inertia of motion: The ability of a body to resist any change in its state of motion. i.e. moving body with uniform speed.
3. Inertia of rotation: The ability of a body to resist any change in its state of rotation.i.e. rotating body with uniform speed.

inertia
If the net external force is zero, a body at rest continues to remain at rest and a body in motion continues to move with a uniform velocity. This property of the body is called inertia (i.e. resistance to change).

Inertia and Mass
The inability of a body to change its state of rest or of uniform motion by itself is called inertia.

Inertia of a body depends mainly upon its mass. If we kick a football, it flies away.But if we kick a stone of the same size with equal force, it hardly moves. Instead, we may injury our foot. A force, that is just enough to cause a small carriage to pick up a large velocity, will produce a negligible change in the motion of a train. We say that the train has more inertia than the carriage

Clearly, more massive objects offer larger inertia. The inertia of an object is measured by its mass.

First law of motion

A body continues to be in its state of rest or in uniform motion in a straight line unless an external unbalanced force is applied on it.

Newton's first law in practical scenarios

Some applications of Newton's first law in real life scenarios are:

1. A suitcase kept in the train remains in rest w.r.t the train unless brakes are applied or train gains speed.
2. Passengers in the bus fall forward when brakes are applied.

Unit and formula for momentum

Momentum is a product of mass and velocity.It is denoted as p. Momentum has both direction and magnitude. It is a vector quantity. Its direction is same as that of the velocity.

$p=mv$

Unit of momentum is kgm/s or Ns

Linear Momentum

Linear momentum is defined as a product of mass of an object and its velocity. It's a vector quantity. Any change in mass or the velocity of the system causes change in linear momentum.

Second Law of Motion

The rate of change of momentum of a body is directly proportional to the force applied on it and this change in momentum takes place in the direction of the applied force.

Qualitative meaning of force

Force is a quantity which changes the velocity of a body. So, a body that is sliding stops because frictional force opposes relative motion.

Applications of second law of motion

According to Newton's second law:

$F = \frac{dP}{dt}$

If time interval for the application of force is increased then the value of applied force will decrease. Cricketers use this while catching the ball. They pull their hands backwards so that time of contact with ball increase and less jerk they would experience due to motion of ball.

Third Law of Motion

To every action, there is always equal and opposite reaction, i.e.

$\vec{F_{12}} = -\vec{F_{21}}$.

Applications of third law of motion

Newton's third law states that for every action there is an equal and opposite reaction. As you stand on the ground, your body push on the earth with a force, and the earth reacts on your body with the same force in opposite direction. This is an example of Newton's third law.