Rigid Body

A rigid body is a solid object with little to no deformation and can be disregarded. The distance between any two points on a rigid body remains constant, regardless of the external forces or moments acting on it. A rigid body is commonly conceived of as a continuous distribution of mass. In practice, deformation or bending is considered negligible in the case of bodies such as wheels and steel rods, and we treat them as rigid.

Rigid Body Definition

"A rigid body is an idealised solid body in which deformation is ignored. In other words, no matter what external forces act on a rigid body, the distance between two points remains constant over time."

There is no such thing as a fully rigid body, and objects can only be assumed to be rigid if they are not traveling faster than the speed of light. A rigid body is typically considered a collection of point masses in quantum physics. Molecules, for example, are frequently regarded as rigid bodies. There could be two kinds of rigid body motion.

- Translational Motion
- Rotational Motion

Translational Motion

The motion of the body when all points of a moving body move in the same direction equally. When an object undergoes translatory motion, we can see that its orientation does not change. Another name for translatory motion is translational motion. When an object travels in such a way that all its particles move parallel, it is said to be in perfect translatory motion.

In a bowling alley, for example, when a ball is thrown toward the pins, you can see that it is not just traveling forward and undergoing translational motion but also spinning. This is referred to as a circular motion. We can claim that a stiff body's motion is not pivoted or fixed. Translatory motion can be characterized based on the movement of the item.

- Rectilinear motion
- Curvilinear motion

Rotational Motion

Rotational motion is the movement of an item in a fixed orbit around a circular route. The dynamics of rotating motion are identical to those of linear or translational motion. Many of the equations for spinning object mechanics are comparable to linear motion equations. In rotational motion, only rigid bodies are taken into account. A rigid body is a mass-holding object with a rigid shape. A few examples of rotation about a fixed point include the rotation of a ceiling fan, the hour and minute arms of a clock, and the opening and closing of a door.

Rigid Body Examples

When an external force applies to a body, and the distance between two places on the body remains constant, the body is referred to as a Rigid Body. A Rigid Body is defined as a body that does not change shape under the effect of forces. However, some forces will be acting on the body that will cause it to alter its shape. A bridge, for example, will not change shape with the weight of a single person, but it may change shape with the weight of a truck, even if the change is minor. Following are the Few Examples of the rigid body.

- Ball bearing made of hardened steel
- The flutter of an aircraft wing
- A metal rod

Linear and Angular Position

A rigid body's position is the position of all the particles that make it up. To simplify the description of this posture, we take advantage of the body's rigidity, which means that all its particles keep the same relative distance. If the body is rigid, it is sufficient to describe the positions of at least three non-collinear particles. This allows you to reconstruct the position of all the other particles if you know their time-invariant position relative to the three selected particles. However, a different, but mathematically equivalent strategy is frequently used. The entire body's posture is indicated by the linear position or position of the body, especially the position of one of the body's particles specifically chosen as a reference point, together with the body's angular position.

A vector with its tail at an arbitrary reference point in space and its tip at an arbitrary point of interest on the rigid body, often coinciding with its center of mass or centroid, can indicate the linear position. The origin of a fixed coordinate system might be defined by this reference point. A rigid body's orientation can be quantitatively described using a set of three Euler angles, a quaternion, or a direction cosine matrix. All these methods define the orientation of a basis set (or coordinate system) that has a fixed orientation relative to the body relative to another basis set from which the rigid body's motion is observed.

Linear and Angular Velocity

A rigid body's linear velocity is a vector quantity equal to the temporal rate of change of its linear location. As a result, it is the speed of a fixed spot on the body. All points on a rigid body move with the same velocity during purely translational motion (motion without rotation). When motion involves rotation, however, the instantaneous velocity of any two places on the body will not be the same. Only if two points on a rotating body are parallel to the instantaneous axis of rotation will they have the same instantaneous velocity.

The angular velocity of a rigid body is a vector number that defines the angular speed at which its orientation changes and the instantaneous axis along which it rotates (the presence of this instantaneous axis is ensured by Euler's rotation theorem). At all times, all points on a rigid body have the same angular velocity. Except for those on the instantaneous axis of rotation, all points on the body change location during purely rotational motion.