

Lesson 15-Static Equilibrium

Static Equilibrium – Recall that equilibrium means that no net force is acting on an object. The object may be sitting still or it may be moving at a constant velocity. As long as no net force is acting on the object it will not accelerate so it cannot change its velocity.

We sometimes wish to make a distinction between objects at equilibrium moving at constant velocity and other objects at equilibrium but not moving at all in some convenient reference frame.

An object is in **static equilibrium** if it is not moving linearly and not rotating in the chosen inertial reference frame.

Among various objects in static equilibrium we may further refine our description of static equilibrium to include the following types:

Stable equilibrium – An object in a stable equilibrium is not likely to suddenly tip over or start rolling. A book on the floor is in a stable equilibrium. A golf ball in the cup is in a stable equilibrium.

Unstable equilibrium – An object that is precariously balanced might not be moving now, but may be likely to suddenly tip over or start moving. A coin balanced on its edge or a meter stick balanced on your finger might be in a static equilibrium for the moment, but both are prone to tipping without much notice because they are in unstable equilibriums.

(Note that for both stable and unstable equilibriums if you apply a small tipping force of your own, it changes the other forces acting on the object and usually creates a new torque. The difference between stable and unstable is that the new torque tends to resettle the object if it is in a stable equilibrium while the new torque tends to continue the tipping process if the object is in an unstable equilibrium.)

Neutrally stable equilibrium – A tipping force applied to an object in neutrally stable equilibrium will not create any new force or any new torque. Thus when the tipping force is removed the object is immediately back in static equilibrium without any settling process. A ball on a horizontal (presumably frictionless) surface is in a neutrally stable equilibrium.

Conditionally stable equilibrium – An object in a conditionally stable equilibrium can tolerate small tipping forces and still settle back into its former stable equilibrium. Tipping forces above some threshold, however, push the object into a condition of unstable equilibrium and the object will never return to its former state once this threshold is reached. A book on a table is in a stable equilibrium until you push it hard enough to push it off the table.

These definitions are not for memorizing but for helping you organize and classify the objects you observe. The conditions in which you find an object tell you something about the forces acting on it. One of our major goals is to understand how forces move objects.