Equilibrium

A body is in equilibrium when:

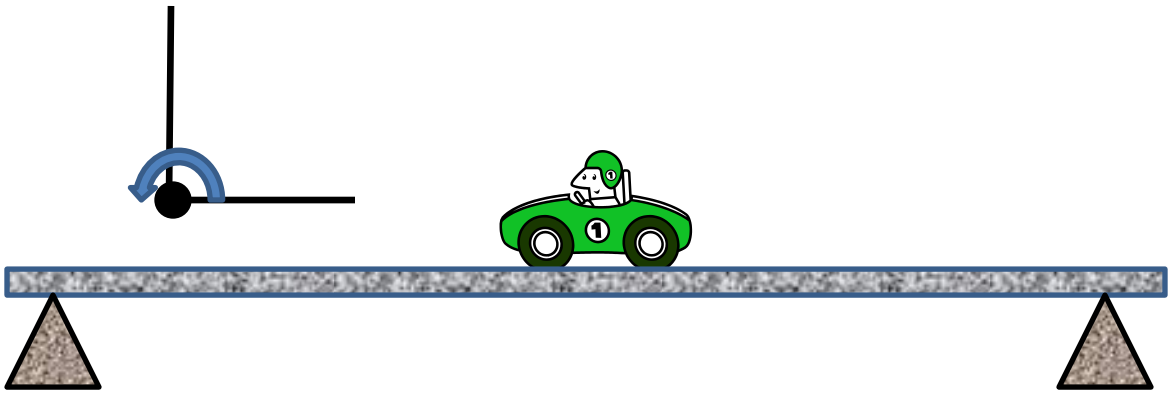
1) Sum of the external forces is Zero. - Translational Eq.

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

2) Sum of the external torques is Zero. – Rotational Eq.

$$\sum \vec{\tau} = 0$$

<u>This is equivalent to saying that acceleration of the center of mass is zero and the angular acceleration about the center of mass is zero.</u>



Important Facts:

1. These two equations are vector equations so each component produces a separate scalar equation that must hold.

For 2-D problems there are three scalar equations:

$$\sum F_x = 0 \qquad \sum F_y = 0 \qquad \sum \tau_z = 0$$

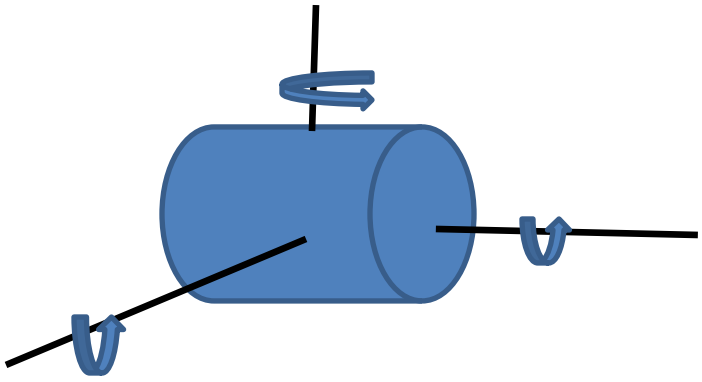
so you can solve for three unknowns.

For 3-D problem there are six scalar equations:

$$\sum F_x = 0 \qquad \sum F_y = 0 \qquad \sum F_z = 0$$

$$\sum \tau_x = 0 \qquad \sum \tau_y = 0 \qquad \sum \tau_z = 0$$

so you can solve for six unknowns!!



2. If the sum of forces is equal to zero and the torque is also equal to about a specific axis then it is zero about any parallel axis. Thus, the axis for calculating torques in static problems is arbitrary.

Statics – when equilibrium conditions are used to calculate unknown forces and torques. Statics is an important part of civil and mechanical engineering.