

## Center of Gravity & Circular Motion Summary

**Center of Gravity** - point where ALL of an object's mass (or weight) *appears* to be located. Sometimes called center of mass. The center of gravity does NOT necessarily need to reside within an object (remember the boomerang!).

### Locating the Center of Gravity:

Uniform objects - at the midpoint, the geometrical center. Examples include: a baseball, a meter stick.

Non-uniform objects - at the point of balance, i.e., NO rotation. Examples include: baseball bats, brooms.

Special Objects - The center of gravity may be where NO actual material exists. Examples include a pot, a chair, a boomerang.

**Toppling** - an object will topple only if its center of gravity extends over its support base. Examples include: tilting a chair, bending over with your legs and feet against a wall.

### Stability -

**Equilibrium** - when an object is balanced so that its CG is lowered.

**Stable Equilibrium** - when an object is balanced so that its CG is raised.

**Neutral Equilibrium** - when any motion will neither raise or lower the object's CG.

Examples include -  
1. *icebergs* - CG is below water line. Result - they won't tip.  
2. Space Needle in Seattle.

### Miscellaneous Examples of CG:

carrying a heavy load - outstretch your arm to balance.

wrestler standing wide apart with knees bent

chair with only 3 legs: Will it topple?

### TYPES of Motion:

1. **Linear** - automobiles, baseball, football

2. **Circular** - a) rotation, b) revolution

**Rotation** - circular motion around an internal axis. Examples include: CD player, earth rotating every 24 h.

**Revolution** - circular motion about an external axis.

Examples include: earth revolving around the sun every 365.25 days, roller coaster moving through a loop. **QUESTION:** Which part of a record passes the stylus faster, one near the inside or outside of the record?

### 2 TYPES of Speed:

1. **Linear Speed** - a point on the outside moves a greater distance in 1 complete revolution than a point on the inside.

Linear speed is greater on the outside!!

2. **Rotational Speed** - the number of rotations OR revolutions per unit time.

Rotational speed is EQUAL for ALL parts!! Units: *RPMs* - rotations or revolutions per minute.

**QUESTION:** What enables an object to move in circular motion??

**Centripetal Force** - (center-seeking) any force that causes a body to move in a circular path

Examples -

1. Driving a car around a corner quickly.

What happens to the unbelted driver? (Think Newton's 1st Law!)

2. Spinning an object. What happens when you release it?

3. A centrifuge - washing machine, blood-plasma unit.

**Spinning an object on a rope** - The force acting on the object is a centripetal force, an inward-directed force by the string. By N3L, the object pulls outward on the string. So, there is an outward-acting force, but on the string, NOT on the object!!!!

**Centrifugal Force** - (center-fleeing) a radially - outward acting force, and it is ONLY useful in a *rotating (non-inertial) reference* frame.

The inward push feels like an outward pull to the occupants in a rotating system, as if a big mass were out there causing gravity. In a rotating system, *THERE IS NO BIG MASS* that causes this pull.

Examples include:

1. **Magnetic force** is caused when one magnet is in the presence of another magnet!

2. **Electric force** on a charged particle is caused by the presence of another charged particle!

In a system at rest (not rotating), the centrifugal force effect is attributed **NOT** to any real force, but to **INERTIA!!!** therefore, it is often called a *fictitious force*.