

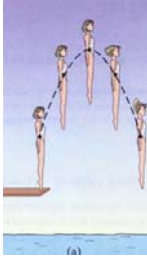

**LINEAR MOMENTUM - 4**

7.8

**CENTER OF MASS**


Translational Motion

Translational and Rotational Motion

**CENTER OF MASS**


- center of mass – the one point that moves in the same path that a particle would if subjected to the same net force.





- If you put a rock in a sock, the center of mass will be in the Rock NOT IN THE SOCK.

**CENTER OF MASS**

- The general motion of an extended body [or system of bodies] can be considered as the sum of the translational motion of the CM, plus rotational, vibrational, or other types of motion about the CM.



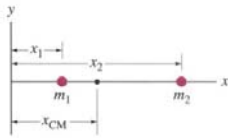
**CENTER OF MASS**

•Revisiting the diver: She follows a parabolic path whether she rotates or not.

**CENTER OF MASS**

- We consider any extended body as being made up of many tiny particles BUT we are going to cheat and focus on only 2 selected particles first.
- Next, we select an x coordinate system to make our lives easy!



**FIGURE 7-21** The center of mass of a two-particle system lies on the line joining the two masses.

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{m_1 x_1 + m_2 x_2}{M}$$

### CENTER OF MASS

- It's even easier if the masses are equal
- $$x_{cm} = \frac{m(x_1 + x_2)}{2m} = \frac{x_1 + x_2}{2}$$
- These equations can (of course) have more than two terms.
- If the particles are spread out in 2 or 3 dimensions, then we need to specify the y and z coordinates as well as the x

### CENTER OF GRAVITY

- Cm and Cg are usually the same unless it is a very large and irregularly shaped body.
- center of gravity** – the point on a body at which the force of gravity can be considered to act.
- The Cg is easier to determine experimentally than analytically.
- Suspend a body and it will swing UNLESS its CG lies on the vertical directly below the point from which it is suspended.

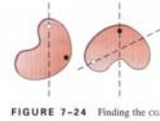


FIGURE 7-24 Finding the CG

### CENTER OF GRAVITY

- Hang the object if 2-D [flat; one plane] from 2 different pivot points and draw the 2 plumb lines, their intersection is the CG.
- 3-D objects require 3 suspension points so that their plumb lines DO NOT lie in the same plane.
- Uniform cylinders (wheels), spheres, and rectangular solids have a CG at their geometric center.

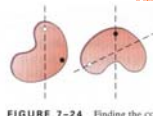


FIGURE 7-24 Finding the CG

### CENTER OF MASS FOR A SYSTEM

- Newton's 2<sup>nd</sup> Law for a system of particles
- $$M a_{cm} = F_1 + F_2 + F_3 = F_{net}$$