Billy and Sally are wearing ice skates standing on the ice at rest facing each other. They get into a terrible argument and Sally shoves Billy. Sally has a mass of 65 kg and Billy has a mass of 80 kg.

1) What is the acceleration of the center of mass before the push, during the push, and after the push? Explain why.

2) What is the velocity of the center of mass before the push, during the push, and after the push? Explain why.

3) If, after the after the push, Sally's velocity is 2 m/s, what is Billy's velocity?

4) Some time after the push, Billy is -10m from where the push occurred. Where is Sally at that time? **Do NOT use kinematics.**

A 4.0 kg puck is sliding along a frictionless surface when it explodes into two parts, one moving 30 m/s due north and the other at 5.0 m/s 30° north of east. What was the original velocity (x and y components) of the puck?

a) Solve this problem by conserving the **velocity of the center of mass**.

b) Solve this problem again by conserving **momentum**.

Billy and Sally are once again standing on the ice wearing ice skates (standing on a frictionless surface) initially at rest. They are holding the opposite ends of a rope that is stretched out between them. Placed exactly halfway between them is a delicious steaming hot apple pie and they both want it. They pull on the rope and begin moving towards the pie (and each other). Sally has a mass of 65kg and Billy has a mass of 80kg.

Who gets to the pie first? How far away from the pie is the loser when the winner gets there?

HINT: Question: How does the *position* of the center of mass change as they move?
Answer: It doesn't.

An object with a mass of $5m_p$, initially at rest on a frictionless surface, explodes breaking into three pieces. One of the pieces with a mass of m_p travels in the x direction at 30.0 m/s. Another piece with a mass of $2m_p$ travels in the y direction at 20.0 m/s.

a) What is the magnitude and direction of the velocity of the last piece?
b) How much kinetic energy was released in the explosion?

A spring loaded ball is dropped from 10m. After falling 2m, the spring sproings and the ball splits into two pieces, one with a mass m the other with a mass 2m. The spring acts only in the horizontal direction.

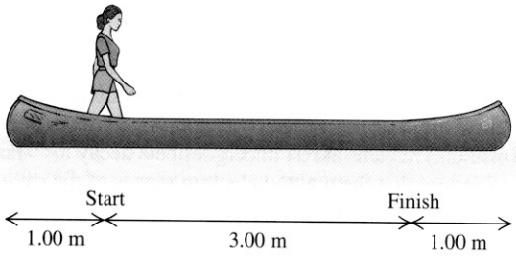
a) What is the velocity (both x and y components) of the **center of mass** as the pieces hit the ground?

b) How long does it take the center of mass to get to the ground?

c) If the x component of the velocity of the lighter half is 4 m/s after the spring sproings, how far apart are the two halves when they hit the ground? (assume that the spring sproings VERY quickly)

A 20.0 kg projectile is fired at an angle of 60.0 degrees above the horizontal with a speed of 80.0 m/s. At the highest point of its trajectory, it explodes into two fragments with equal mass. The force of the explosion acts purely in the horizontal direction. One chunk falls vertically to the ground. Where does the second chunk land? How much energy was released in the explosion?

A 45 kg woman stands up in a 60 kg canoe of length 5.0 m. She walks from a point 1 m from one end to a point one meter from the other end. Ignoring resistance due to the water, how far does the canoe move?



HINT: Consider the canoe as a point mass at it's center of mass.
Question: How does the *position* of the center of mass change as they move?
Answer: It doesn't.