# Momentum 5

1. Find the location of the center of mass for the following three and four particle systems in one dimension (imagine the masses along a number line).

      a. mass 1: 4 kg at x = 0 m
         mass 2: 4 kg at x = 5 m
         mass 3: 4 kg at x = 10 m

      b. mass 1: 8 kg at x = 0 m
         mass 2: 6 kg at x = 5 m
         mass 3: 4 kg at x = 10 m

      c. mass 1: 4 kg at x = 0 m
         mass 2: 4 kg at x = 2 m
         mass 3: 4 kg at x = 10 m

2. a. Find the center of mass of a system consisting of 4 masses each at the corners of a square with each side measuring 1 m. mass 1 = 3 kg, mass 2 = 3 kg, mass 3 = 3 kg, and mass 4 = 3 kg.
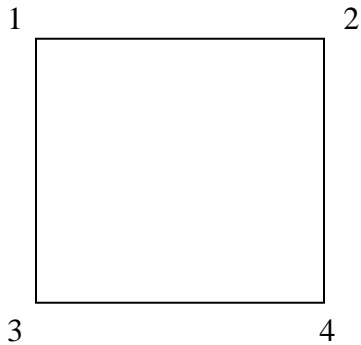
b. How would the center of mass move if masses 3 and 4 were doubled? Find the center of mass for that situation.

c. How would the center of mass move if mass 3 were removed (assume all masses are now 3 kg)? Find the center of mass for that situation.

3. Find the velocity of the center of mass for mass 1 = 5 kg moving at 15 m/s and   mass 2 = 2 kg moving at -20 m/s? What would happen to the velocity of the center of mass if these two objects were to collide?

4. a. What is the velocity of the center of mass of a system containing the following masses: a 3 kg mass traveling at 8 m/s and a 4 kg mass traveling in the opposite direction with a speed of 6 m/s?

   b. What would happen if the two objects hit and stuck together? What would the final velocity of the system of masses be?

   c. What is the momentum of each mass before they hit?

   d. What is the total momentum of the system?

5. Two ice-skaters (m_1= 60 kg, m_2=80 kg) are standing next to each other and moving with a velocity of 3 m/s. They push off of each other.
   a. What is the velocity of the center of mass before they push off of each other?

   b. What happens to the velocity of the center of mass when they push off of each other? Why?

   c. Skater 1 moves away with a velocity of 3 m/s in the opposite direction than they were traveling. What is the velocity of skater 2?

   d. What is the velocity of skater 1 with respect to the center of mass?

   d. What is the velocity of skater 2 with respect to the center of mass?

6. Two bowling balls of equal mass collide. Ball 1 is initially moving with a velocity of 10 m/s and ball 2 is initially at rest.
   a. Find the velocity of ball 2 if ball 1 moves with a velocity of -3 m/s after the collision.

   b. Find the velocity of ball 2 if ball 1 moves with a velocity of 5 m/s after the collision.

   c. Find the velocity of ball 2 if ball 1 is at rest after the collision.