

3. A **center of mass frame of reference** has coordinate axes whose origin is at the center of mass of the system.
- The j th particle in the system has mass m_j and velocity \vec{v}_j . What is its velocity in the center of mass frame of reference?
 - What is the momentum of the j th particle in the center of mass frame of reference?
 - What is the total momentum of all N particles in the center of mass frame of reference?
4. A 45.0-kg woman stands up in a 60.0-kg canoe that is 5.00 m long. She walks from a point 1.00 m from one end to a point 1.00 m from the other end. Neglect drag from the water on the canoe.
- How far does the canoe move during this process?
 - Relative to solid ground, how far does the woman move during this process?