Name: ID:

General Physics I (151)
Discussion Questions #5
Momentum

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1. An astronaut is a distance L from her spaceship, and is at rest with respect to the ship, when she discovers that her tether has broken. She tosses a wrench with a speed V_w in the opposite direction of the ship to propel herself back to the ship. The astronaut has mass M_A, and the wrench has mass M_w.
    a) Draw a sketch, showing the subsequent motion of the astronaut and the wrench.

    b) What is the initial momentum (before toss) of the astronaut plus wrench system? What is the final momentum?

    c) Use conservation of momentum to solve for the speed of the astronaut V_A, relative to the ship, in terms of M_A, M_w and V_w.

    d) How long does it take her to reach the ship in terms of L, M_A, M_w and V_w?

    e) How far has the wrench traveled from its original position when the astronaut reaches the ship? Express your answer in terms of L, M_A and M_w.

2. In this problem, consider Tom and Jerry in space and throwing a ball back and forth. Initially, they are at rest with respect to each other and are separated by a distance L_0. For simplicity assume that they have the same mass, and that they both always throw the ball with the same speed V.

a) If they are in "open space" (no walls or ropes) what happens?

   i) To answer this, continue drawing a sequence of sketches below showing the motion of: Tom and the ball after his toss #1, Jerry and the ball after his catch #1, Jerry and the ball after his toss #1, Tom and the ball after his catch #1. In each sketch, it is important to indicate their relative positions and the direction of motion by arrows.

   ii) Then extrapolate, and state in one sentence what happens as they continue to play, say for ten or twenty tosses. Assume that they do not get tired!

b) Now Tom and Jerry are inside a spaceship. Let's say they are in a box shaped room, and are each strapped to opposite walls. As they toss the ball back and forth, what happens to the box? Again draw a series of diagrams and indicate the position of the box and the motion of the box with arrows.