AP Physics – Unit 8 Worksheet 3:

1. In a railroad yard, a train is being assembled. An empty boxcar, coasting at 3.0 m/s, strikes a loaded car that is stationary, and the cars couple together. Each of the boxcars has a mass of 9000 kg when empty, and the loaded car contains 55,000 kg of lumber.
   a. Complete the momentum conservation diagram.

event:

initial		final
object/mass/velocity		object/mass/velocity
– 0 +		– 0 +

   b. Momentum conservation equation:

   c. Find the speed of the coupled boxcars.

2. An astronaut of mass 80.0 kg carries an empty oxygen tank of mass 10.0 kg. By pushing the tank away with a speed of 2.0 m/s, the astronaut recoils in the opposite direction.
   a. Complete the momentum conservation diagram.

event:

initial		final
object/mass/velocity		object/mass/velocity
– 0 +		– 0 +

   b. Momentum conservation equation:

   c. Find the speed with which the astronaut moves off into space.

3. A tennis player returns a 30.0 m/s serve straight back at 25 m/s, after making contact with the ball for 0.50 s. The ball has a mass of 0.20 kg.
   a. Use a momentum conservation diagram to show the change in momentum of the ball.

event:

initial
object/mass/velocity

—   0   +

final
object/mass/velocity

—   0   +
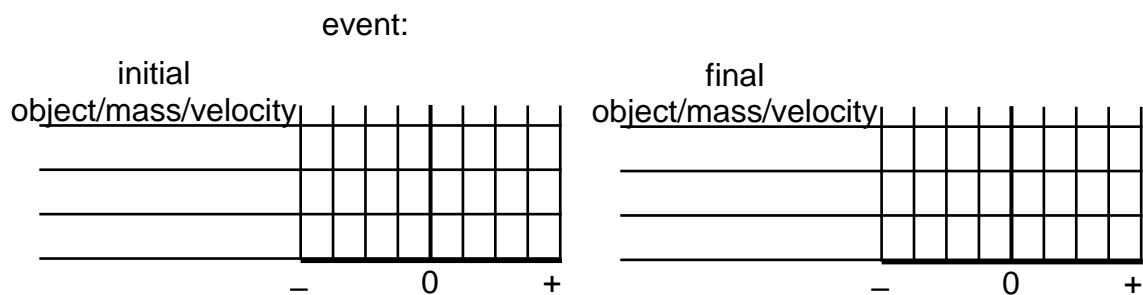
   b. Impulse-Momentum equation:

   c. How much force did the racket exert on the ball?

4. A 50.0 kg cart is moving across a frictionless floor at 2.0 m/s. A 70.0 kg boy, riding in the cart, jumps off so that he hits the floor with zero velocity.
   a. Complete the momentum conservation diagram.

event:

initial
object/mass/velocity

—   0   +

final
object/mass/velocity

—   0   +
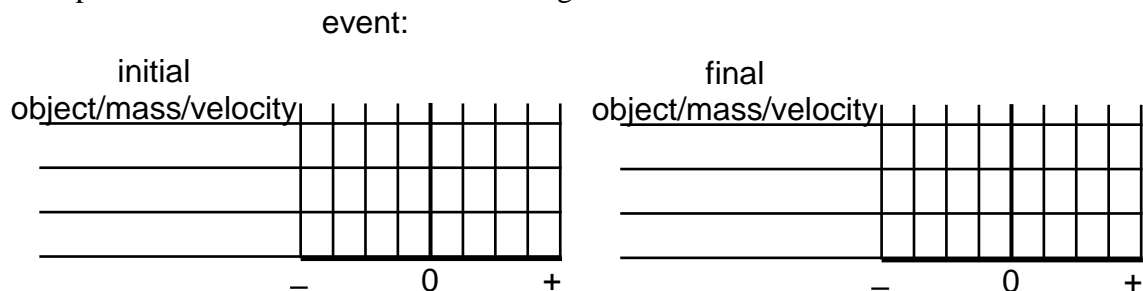
   b. Momentum conservation equation:

   c. How large an impulse did the boy give to the cart?

   d. What was the velocity of the cart after the boy jumped?

5. Two girls with masses of 50.0 kg and 70.0 kg are at rest on frictionless in-line skates. The taller girl pushes the shorter girl so that the shorter girl rolls away at a speed of 10.0 m/s.
   a. Show the effect of the push on both girls with a momentum conservation diagram.

event:

initial
object/mass/velocity

final
object/mass/velocity

_   0   +

_   0   +
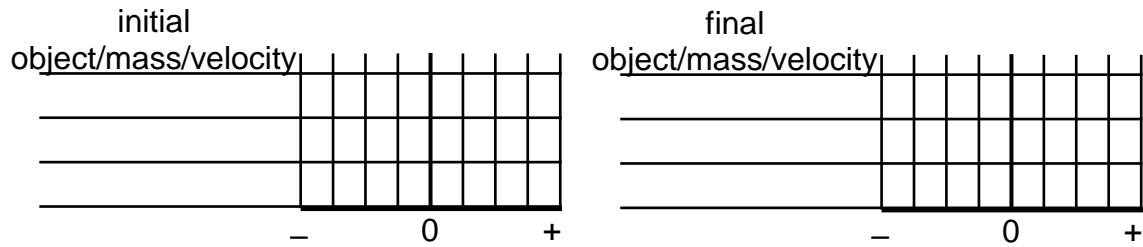
   b. Momentum conservation equation:

   c. Calculate the impulse that each girl imparts to the other.

6. A 2.0 kg melon is balanced on a circus performer's head. An archer shoots a 50.0 g arrow at the melon with a speed of 30 m/s. The arrow passes through the melon and emerges with a speed of 18 m/s.
   a. Draw a momentum conservation diagram for the stunt.

event:

initial
object/mass/velocity

final
object/mass/velocity

_   0   +

_   0   +
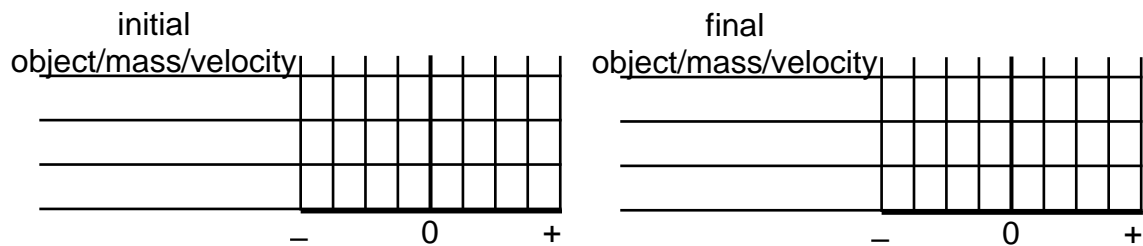
   b. Momentum conservation equation:

   c. Find the speed of the melon as it flies off the performer's head.