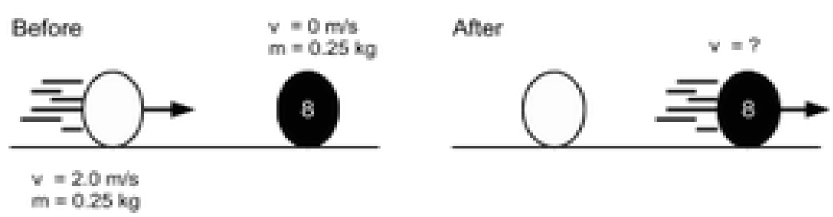
Momentum: Practice Worksheet - Solutions

Part B: Momentum Practice

3. A 5.0 kg ball is launched with a speed of 2.0 m/s. Find the momentum of the ball.
   p = mv
   p = (5.0 kg)*(2.0 m/s)
   p = 10. kg*m/s
4. A 500 kg car is driving with a speed of 4 m/s. Find the momentum of the car.
   p = mv
   p = (500 kg)*(4 m/s)
   p = 2000 kg*m/s
5. Two students are running in a cross country race. One has a mass of 60 kg, while the other has a mass of 70 kg. If they are both running with a speed of 7 m/s, which has more momentum? Why?
   The student with more mass has more momentum. If the speeds are the same, then more mass means more momentum.
6. Which has more momentum, a car with a mass of 5000 kg moving at a speed 10 m/s or a boat with a mass of 2000 kg moving at a speed of 40 m/s?
   Car: p = mv = (5000 kg)*(10 m/s)   p = 50 000 kg*m/s
   Boat: p = mv = (2000 kg)*(40 m/s)   p = 80 000 kg*m/s
   The boat has more momentum
7. How fast would a 0.40 kg football have to be thrown to have a momentum of 8.0 kg*m/s?
   p = mv --> v = p/m
   v = (8 kg*m/s) / (0.40 kg)
   v = 20 m/s
8. A pitcher claims he can throw a baseball with as much momentum as a 0.001kg bullet moving with a speed of 1500 m/s. If a baseball has a mass of 0.15kg, how fast must he throw the ball?
   Bullet: p = mv = (0.001 kg)*(1500 m/s)   p = 1.5 kg*m/s
   p = mv --> v = p/m
   Baseball: v = (1.5 kg*m/s) / (0.15 kg)
   v = 10 m/s

Part C: Conservation of Momentum

9. Someone throws a heavy ball to you when you are standing on roller skates. You catch it and roll backwards. How does your speed compare to the speed of the ball, and why?
   You would have less speed because you have more mass and the total momentum must remain constant.
10. A prospector finds himself holding his bag of gold and standing in the middle of a large pond of frictionless ice. How can he get to the side before he freezes?
    He could throw the bag of gold. While at rest, the momentum is zero. So if he throws the bag, he must move in the opposite direction so that the total momentum will remain constant (equal to zero).
11. What is the velocity of the "8" ball after the elastic collision below?



    The pool balls have the same mass. Because the cue ball stops, that mean the 8 ball moves forward with the original speed of the cue ball. So the speed is v = 2.0 m/s after the collision.
12. A 110 kg football player runs at 8.0 m/s and plows into an 80. kg referee standing on the field causing the referee to fly forward at 5.0 m/s.
    a. What is the momentum of the football player before the collision?
       p = mv
       p = (110 kg)*(8 m/s)
       p = 880 kg*m/s
    b. What is the momentum of the referee before the collision?
       p = mv
       p = (80 kg)*(0 m/s)

p = 0 kg*m/s

c. What is the total momentum before the collision? (hint: add the two above together)

p(total) = p (football player)+p(referee)

p(total) = 880 kg*m/s + 0 kg*m/s

p(total) = 880 kg*m/s

d. What is the momentum of the referee after the collision?

p = mv

p = (80 kg)*(5 m/s)

p = 400 kg*m/s

e. What must the momentum of the football player be after the collision?

p = p(total) – p (referee) because the total momentum has to stay the same

p = 880 kg*m/s – 400 kg*m/s

p = 480 kg*m/s

f. Find the football player's speed after the collision.

p = mv --> v = p/m

v = (480 kg*m/s)/(110 kg)

v = 4.4 m/s

13. An 80.0-kg fisherman jumps from a dock into a 100.0-kg rowboat which is not moving. If the velocity of the fisherman is 4.00 m/s when he jumps into the boat, what is the final velocity of the fisherman and the boat?

This is an elastic collision, so we use the elastic collision equation. $(m_1v_1+m_2v_2)_{before} = (m_1+m_2)v_{after}$

Solve for v(after): $(m_1v_1+m_2v_2)_{before} / (m_1+m_2) = v_{after}$

v(after) = (80.0 kg * 4.00 m/s + 0 kg*m/s) / (80.0 kg + 100.0 kg)

v (after) = 320 kg*m/s / 180 kg

v (after) = 1.78 m/s

14. A train car, which has a mass of 2000 kg, is rolling along with a speed of 20 m/s. It strikes a stationary car, which also has a mass of 2000 kg, and they stick together. What is their combined speed after the collision?

Same steps as #11

v(after): $(m_1v_1+m_2v_2)_{before} / (m_1+m_2) = v_{after}$

v(after) = (2000 kg * 20.00 m/s + 0 kg*m/s) / (2000 kg + 2000 kg)

v (after) = 40000 kg*m/s / 4000 kg

v (after) = 10 m/s

15. A 1200 kg car is stopped at a traffic light. A 3000 kg truck moving at 8.0 m/s hits the car from behind. If bumpers lock, how fast will the two vehicles move?

Same steps as #11 and #12

v(after): $(m_1v_1+m_2v_2)_{before} / (m_1+m_2) = v_{after}$

v(after) = (3000 kg * 8.0 m/s + 0 kg*m/s) / (3000 kg + 1200 kg)

v (after) = 24000 kg*m/s / 4200 kg

v (after) = 6 m/s