Momentum & Collisions

1. A 1500 kg car rear-ends a 2000 kg at a stop sign. Immediately after the collision, the two cars have a speed of 13 m/s. (They then skid to a stop, but that is not part of this problem.) How fast was the 1500 kg car moving just before the collision?

2. Maya and Miguel are on the bumper cars and have a head-on collision. Maya (total mass 300 kg) is traveling to the right at 5 m/s. Miguel (250 kg) is traveling to the left at 3 m/s. After the collision, Maya is only traveling at 1 m/s, but still to the right. What is the final velocity of Miguel?

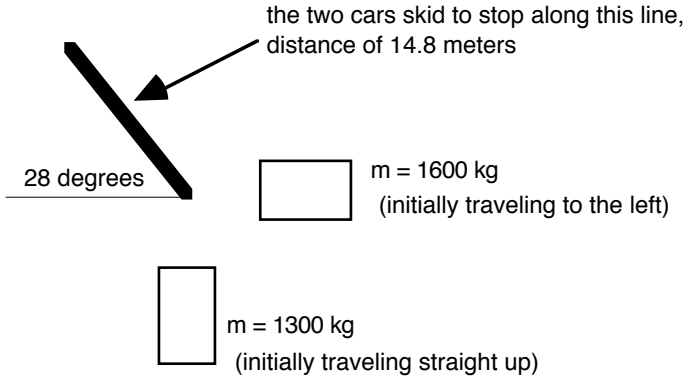
3. A stream of 40 gram bullets, fired horizontally with a speed of 1000 meters per second, strikes a 10 kg wooden block that is free to move on a horizontal frictionless tabletop. What is the speed of the block after it has absorbed 15 bullets?

4. A 0.5 kg ball is traveling with a speed of 7 m/s when it collides with a 0.4 kg ball traveling in the opposite direction with a speed of 3 m/s. After the collision, the first ball (0.5 kg) is traveling with a speed of 1 m/s, in the same direction that it was before.
   a. What is the speed and direction of the second ball after the collision?

   b. Which ball experienced the greater change in momentum? change in velocity? impulse?

   c. If the collision lasted for 0.25 seconds, what was the force on the second ball?

5. Two cars approach a 90° intersection. Neither driver is paying attention to what they are doing, and they collide. After the collision, the cars stick together, and skid to a stop in 14.8 meters at an angle as shown. The two cars have masses of 1300 kg and 1600 kg, as shown. You happen to know that the coefficient of friction between the tires and the road was $\mu = 0.3$. How fast were the drivers going just prior to the collision?



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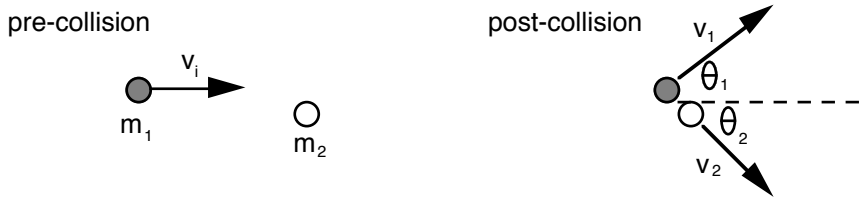
6. A ball of mass 0.25 kg has a one-dimensional elastic collision with a ball of mass 0.35 kg. After the collision the smaller ball has a velocity of 6.5 m/s and the larger ball has a velocity of 9 m/s. What was the velocity of each ball before the collision?

The 7 to 9 all use the same diagram (but the numbers are different for each problem.)



7. A ball of mass 0.2 kg is traveling horizontally with a speed of 3.5 m/s. It collides with a ball of 0.4 kg, initially at rest. After the collision, the first ball is traveling with a velocity of 3 m/s at an angle of 30° above the original direction of motion. What is the velocity of the other ball?

8. m_1 = 0.25 kg and m_2 = 0.15 kg. The speeds after the collision are v_1 = 4 m/s and v_2 = 6 m/s. If θ_1 = 30°.
   a. Was the collision elastic? *(Hint: Find the initial speed first.)*

   b. What was the impulse on m_1?

9. Both masses are 0.25 kg. The initial speed of m_1 was 5 m/s and the collision was elastic. If θ_2 = 30°, how fast were the masses going after the collision?

Answers: 1. a) 30.3 m/s 2) 1.8 m/s 3) 56.6 m/s 4. a) 4.5 m/s b) same, 0.4 kg, same
*c) (-) 12 N 5) 1600 kg: 15 m/s; 1300 kg: 9.9 m/s 6) 9.5 & 6.9 m/s 7) 0.45**i** – 0.75**j** m/s*
*8. a) 6.5 m/s; not elastic b) –0.76**i** + 0.5**j** Ns 9) v_1=2.5 m/s; v_2=4.3 m/s*