

Collisions

**Total Momentum Before Collision is
Equal to Total Momentum After
Collision**

Solving Collisions

- 1. Determine the Momentum of Each Object before the collision ($P = mV$).
- 2. Add together all these momenta. This is the total momentum before collision.
- 3. Set the total momentum before collision equal to the total momentum after collision.
- 4. Solve for the missing velocity or mass using the total and the given masses.

Example

- A 0.5 kg object traveling at 2 m/s EAST collides with a 0.3 kg object traveling at 4 m/s WEST. After the collision the 0.3 kg object is traveling at 2 m/s EAST. What are the magnitude and direction of the velocity of the first object?
- Before: $(.5)(2) + (.3)(-4) = -0.2 \text{ kg m/s}$
- Before = After = -0.2 kg m/s
- $-0.2 = (.3)(2) + (.5)V \quad (.5)V = -.2 - .6 = -.8$
- $V = -.8/.5 = -1.6 \text{ kg m/s}$ or 1.6 kg m/s WEST

Rifle

- A 5.0 kg gun fires a 0.002 kg bullet. If the bullet exits the gun at 800 m/s EAST, calculate the recoil velocity of the rifle.
- Total Momentum Before = ZERO kg m/s
- Momentum Before = Momentum After = 0
- $0 = 5.0 V + (.002)(800)$
- $0 = 5.0 V + 1.6$ $V = -1.6/5 = -0.32 \text{ m/s}$

Group Activity

- 1. An 80 kg skater and a 60 kg skater stand at rest in the center of a skating rink. The two skaters push each other apart. The 60 kg skater moves with a velocity of 10 m/s EAST.
- What is the velocity of the 80 kg skater?

Group Activity

- 2. A projectile with a mass of 0.01 kg has a muzzle velocity of 1000 m/s when fired from a rifle weighing 5 kg . The recoil velocity of the rifle is how much?
- 3. A 0.4 kg toy cannon is at rest on a horizontal, frictionless surface. When a 0.1 kg projectile is fired horizontally from the barrel of the cannon, the cannon recoils with a speed of 2.5 m/s . What is the speed of the projectile as it leaves the barrel?

Group Activity

- 4. A 2.0 kg rifle initially at rest fires a 0.002 kg bullet. As the bullet leaves the rifle with a velocity of 500 m/s, what is the recoil velocity of the rifle?

Group Activity

- 5. Two carts resting on a frictionless surface are forced apart by a spring. One cart has a mass of 6 kg and moves to the left at a speed of 3 m/s. If the second cart has a mass of 9 kg, it will move to the right at a speed of how much?

Group Activity

- 6. A 4.0 kg mass is moving at 3.0 m/s toward the right and a 6.0 kg mass is moving at 2.0 m/s toward the left on a horizontal, frictionless table. If the two masses collide and remain stuck together after the collision, what is their final velocity? What is their final momentum?