Collisions:

Two objects colliding together:

→ Bounce off each other

Elastic collision:

$$P_{1i} + P_{2i} = P_{1f} + P_{2f}$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

→ collide and stick together

Inelastic collision:

$$P_{1i} + P_{2i} = P_{1+2f}$$

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$$

→ Start together then separate

Recoil:

$$P_i = P_{1f} + P_{2f}$$

$$(m_1 + m_2) v_i = m_1 v_{1f} + m_2 v_{2f}$$

Elastic Collision Practice Problem

A car with a mass of 1000 kg is traveling at 30 m/s. The car collides with a 4000 kg truck that was stopped at a stop light. The car bounces off of the truck. After the collision, the truck moves at a velocity of 8 m/s. What is the final velocity of the car?

	car	truck
Before:	$m = 1000$ kg $V = 30$ m/s	$m = 4000$ kg $V = 0$ m/s
After:	$V = ?$	$V = 8$ m/s

$$m_1 V_1 + m_2 V_2 = m_1 V_1 + m_2 V_2$$

$$(1000 \, kg)(30 \, m/s) + (4000 \, kg)(0 \, m/s) = (1000 \, kg)(V_{1f}) + (4000 \, kg)(8 \, m/s)$$

$$30,000 + 0 = 1000 \, V_{1f} + 32,000$$
$$-32000 \qquad\qquad\qquad - 32,000$$

$$\frac{-2000}{1000} = \frac{1000 \, V_{1f}}{1000}$$

$$\boxed{-2 \, m/s = V_f}$$

Inelastic Collision Practice Problem

A car with a mass of 1000 kg is traveling at 30 m/s. The car collides with a 4000 kg truck that was stopped at a stop light. The car and truck become an entangled mass. What is the final velocity of the entangled mass after the collision?

car	truck
Before: $m = 1000$ kg	$m = 4000$ kg
$V = 30$ m/s	$V = 0$ m/s

After $V_f = ?$

$$m_1 V_1 + m_2 V_2 = (m_1 + m_2) V_f$$

$$(1000 kg)(30 m/s) + (4000 kg)(0 m/s) = (1000 kg + 4000 kg) V_f$$

$$\frac{30000}{5000} + 0 = \frac{5000}{5000} V_f$$

$$\boxed{6 m/s = V_f}$$

Recoil practice problem

A 57 kg basketball player jumps vertically upward to make a shot. At the very top of his jump, he throws the basketball with a velocity of 4.4 m/s. What is his recoil velocity after he releases the ball? The mass of the basketball is 0.62 kg.

	Basketball player	ball
Before:	$m = 57$ kg $v = 0$ m/s (at top of jump)	$m = 0.62$ kg $v = 0$ m/s (at top of jump)
After:	$v = ?$	$v = 4.4$ m/s

$$(m_1 + m_2) v_i = m_1 v_{1f} + m_2 v_{2f}$$

$$(57 \text{ kg} + 0.62 \text{ kg})(0 \text{ m/s}) = (57 \text{ kg})(v_{1f}) + (0.62 \text{ kg})(4.4 \text{ m/s})$$

$$0 = (57 \text{ kg})(v_{1f}) + 2.728$$
$$\underline{-2.728 \qquad\qquad\qquad -2.728}$$

$$\frac{-2.728}{57} = \frac{57 \text{ kg} (v_{1f})}{57}$$

$$\boxed{0.05 \text{ m/s} = v_{1f}}$$