Warm-up:

1. Why do golfers & baseball players follow through?
2. Why do skydivers bend their knees on impact?
3. What is the best way to win the egg toss?
4. What is the purpose of car airbags?

- Momentum: inertia in motion

- Impulse: Force applied over time

- Equation: $J = F \cdot t$ J = Impulse

  Units $= N \cdot s = kg \frac{m}{s^2} \cdot s$ F = Force

  $kg \frac{m}{s}$ t = time the force is acting

- Momentum caused by Impulse
  - ↳ Impulse-Momentum theorem
- Momentum: $p = m \cdot v = F \cdot t = J$ (p = momentum, J = Impulse)

  $kg \frac{m}{s}$

Calculate Momentum in $kg \cdot \frac{m}{s}$

Ex1: A 75 kg football player travels @ 9.40 m/s

$75 kg \cdot 9.40 \frac{m}{s} = 705 \ kg \frac{m}{s}$

Ns

Ex2: A 12 lb bowling ball at 20 ft/s

1.0 kg = 2.2 lbs

1 m = 3.28 ft

$\frac{12 lb}{} \cdot \frac{1 kg}{2.2 lbs} \cdot \frac{20 ft}{s} \cdot \frac{1 m}{3.28 ft} = \boxed{33.6 \ kg \frac{m}{s}}$

Ex 3: 2.0 ton truck at 40 mph →

1 ton = 2000 lbs

1.0 kg = 2.2 lbs

1 m = 3.28 ft

1 mi = 5,280 ft

$\frac{2.0 ton}{} \cdot \frac{2000 lbs}{1 ton} \cdot \frac{1 kg}{2.2 lbs} \cdot \frac{40 mi}{1 hr} \cdot \frac{1 hr}{3600 s} \cdot \frac{5280 ft}{1 mi} \cdot \frac{1 m}{3.28 ft}$

$= 32,000 \ kg \frac{m}{s}$

Question: Can a hummingbird have more momentum than an elephant?

↳ Yes, if the elephant is stationary!

$\Delta p = m_f \cdot v_f - m_i \cdot v_i = F \cdot t = J$

Ex: You have an angry significant other and they throw a flower pot at your head. Which hurts more:

1. if the pot breaks

$\Delta p = m \cdot v_f - m \cdot v_i$

$\Delta p = m \cdot 0 - m \cdot v_i$

$\Delta p = -m \cdot v_i$

2. if it bounces off

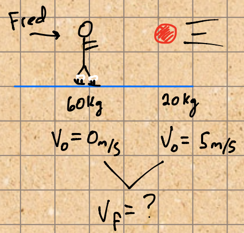
$\Delta p = m \cdot v_f - m \cdot v_i$

$\Delta p = m \cdot {-v_f} - m \cdot v_i$

$= -2mV$

• Law of Conservation of Momentum: total momentum is conserved

$p_f = p_i$ ★ isolated system



$p_i = p_f$

$p_{ball} + p_{Fred} = p_{Fred+ball}$

$20kg \cdot 5\,m/s + 60kg \cdot 0\,m/s = 80kg \cdot V_f$

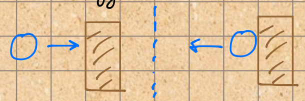
$$\frac{100\ kg\frac{m}{s}}{80kg} = \frac{80kg \cdot V_f}{80kg}$$

$$\boxed{1.25\,m/s = V_f}$$

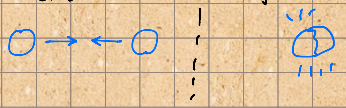
• Collisions:

↳ Elastic Collision: Collisions without deformation or generation of heat

★ Energy is retained



↳ Inelastic Collisions: objects deform and/or generate heat



Ch 8 EOC: 1,2,32

1. A force sets an object in motion. When the force is multiplied by the time of its application, we call the quantity *impulse*, which changes the *momentum* of that object. What do we call the quantity *force × distance*, and what quantity can this change? (8.1)

2. Work is required to lift a barbell. How many times more work is required to lift the barbell three times as high? (8.1)

32. Does an object with momentum always have energy? Does an object with energy always have momentum? Explain.