Unit 6: Momentum

Impulse

Impulse: change in momentum (Δp)

We can derive the change in momentum from Newton's 2nd Law:

$F_{net} = ma$

$F_{net} = m\frac{\Delta v}{t}$ → $F_{net} \cdot t = m\Delta v$

$$\Delta p = m\Delta v = F_{net} \cdot t$$

Ex: Luigi is sick of taking orders. He swings a 9.0 kg hammer at 16 m/s when Mario's mustache brings it to a stop in 0.25 s. What is the net force exerted on Mario's mustache?

$m\Delta v = F_{net} \cdot t$

$F_{net} = \frac{m\Delta v}{t}$

$= \frac{m(v_f - v_i)}{t}$

$= \frac{(9.0\,kg)(0 - 16\,m/s)}{0.25\,s}$

backwards → $= -580\,N$

Ex. A soccer player kicks a 0.450 kg ball at 25.0 m/s east. If the goalie stops the ball by exert 215 N of force, how long does it take the ball to stop?

$F_{net} \cdot t = m\Delta v$

$t = \frac{m\Delta v}{F_{net}} = \frac{(0.450\,kg)(0 - 25.0\,m/s)}{215\,N} = 0.0523_5 = 0.52\,s$

If the goalie stops the 6.5 kg bowling ball traveling at the same velocity in the same amount of time, how much force is required?

$F_{net} \cdot t = m\Delta v$

$F_{net} = \frac{m\Delta v}{t} = \frac{(6.5\,kg)(0 - 25.0\,m/s)}{0.0523\,s} = 3100\,N$

Example: Calculate the force required for a student to land stop after they jump off their desk bent-kneed.

m = _____ kg

height = _____ m

Stopping distance = _____ m

Estimate the force required if they land straight legged.

Example: Coaches for many sports such as baseball, tennis and golf can often be heard telling their athletes to "follow through" with their swing. How does this help a weaker player hit a ball farther than a stronger player?

$F_{net}\,t = m\Delta v$

F_{net} const. ↑ t ; $m\Delta v$ const. ↑

more time in contact the ball means greater change in velocity

Example: Using the principle of impulse, explain why an airbag can help people sustain less damage during a collision.

$F_{net}\,t = m\Delta v$

F_{net} ↓ ; t ↑ ; $m\Delta v$ const. const.

more time to slow down means less force required.