

M OMENTUM

UNIT 9

Impulse and Momentum

LEARNING TARGET	DESCRIPTION
9.1	I can define, analyze, and solve problems involving impulse and linear momentum.



Impulse and Momentum

A car is cruising down Grand Avenue toward you, at a speed of 16 m/s (~35 mph).

Can you stop it by standing in front of it and holding out your hand?



What is momentum?



Headlines

"The Broncs are gaining momentum as they head to the state tournament."

Momentum

Momentum is mass in motion!

$$p = m v$$

Momentum is equal to the mass of an object times the object's velocity.

Momentum

Vector or Scalar?

$$\vec{p} = m \vec{v}$$

Units? $\frac{kg \cdot m}{s}$ $kg \cdot \frac{m}{s}$

Relationship? *Direct Proportional*

Changing Momentum



Changing Momentum

Impulse = Change in Momentum

$$\text{Impulse} = \Delta p = p_f - p_i$$

Impulse-Momentum Theorem

$$F = m a$$

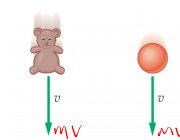
$$F = m \frac{\Delta v}{t} = \frac{m}{1} \frac{(v_f - v_i)}{t}$$

$$t \cdot F = \frac{mv_f - mv_i}{t} \cdot t$$

Impulse-Momentum Theorem

$$F \Delta t = p_f - p_i$$

Bear and Bouncy Ball



Bear Ball Same
2 6 5

$$\Delta p = p_f - p_i$$

$$\Delta p = mv_f - mv_i \quad \Delta p = mv_f - mv_i$$

$$\Delta p = -mv_i \quad v_f = -v_i$$

$$\Delta p = m(v_f) - mv_i$$

$$\Delta p = -mv_i - mv_i$$

$$\Delta p = -2mv_i$$

IN CLASS PROBLEMS

Calculate the momentum of the following objects:

- 110-kg football player running at 8.00 m/s.
- How fast would you need to throw a 0.410-kg football so that it has the same momentum as the football player?
- A hockey puck has a mass of 0.115 kg and strikes the pole of the net at 37 m/s. It bounces off in the opposite direction at 25 m/s.
 - What is the impulse on the puck?
 - If the collision takes 5.0×10^{-4} s, what is the average force on the puck?

IN CLASS PROBLEMS

Calculate the momentum of the following objects:



- 110-kg football player running at 8.00 m/s.
- How fast would you need to throw a 0.410-kg football so that it has the same momentum as the football player?

$$\vec{p} = m\vec{v} = (110 \text{ kg})(8 \text{ m/s}) = 880 \frac{\text{kg}\cdot\text{m}}{\text{s}}$$

$$p = mv \quad \frac{p}{m} = v = \frac{880 \frac{\text{kg}\cdot\text{m}}{\text{s}}}{0.410 \text{ kg}}$$

$$v = 2100 \text{ m/s}$$

IN CLASS PROBLEMS

A hockey puck has a mass of 0.115 kg and strikes the pole of the net at 37 m/s. It bounces off in the opposite direction at 25 m/s. $v_i = 37 \text{ m/s}$, $v_f = -25 \text{ m/s}$

a) What is the impulse on the puck?

$$\Delta p = p_f - p_i = mv_f - mv_i = (0.115 \text{ kg})(-25 \text{ m/s}) - (0.115 \text{ kg})(37 \text{ m/s})$$

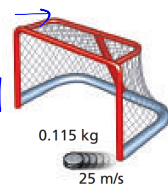
b) If the collision takes 5.0×10^{-4} s, what is the average force on the puck?

$$0.0005 \text{ s} \quad \Delta p = -7.1 \frac{\text{kg}\cdot\text{m}}{\text{s}}$$

$$F \cdot t = \Delta p$$

$$F = \frac{\Delta p}{t} = -1.4 \times 10^4 \text{ N}$$

$$14,000 \text{ N}$$



PRACTICE

PRACTICE PROBLEMS (1-4)