11.1 Impulse and Momentum.

**What is momentum?**

Momentum is mass in motion!

\[ p = m \, v \]

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

**Impulse and Momentum**

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<td>11.1</td>
<td>I can define, analyze, and solve problems involving impulse and linear momentum.</td>
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**Headlines**

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

**Momentum**

Vector or Scalar? **Vector**

Units? \[ \text{kg} \, \text{m/s} = \text{kg} \, \text{m} \, \text{s}^{-1} \]

Relationship? **Direct Proportional**
### Changing Momentum

**Impulse-Momentum Theorem**

\[ F = m \cdot a \]

\[ F = \frac{m \cdot V_f - m \cdot V_i}{t} \]

### IN CLASS PROBLEMS

1. Calculate the momentum of the following objects:
   a) 110-kg football player running at 8.00 m/s.
   b) How fast would you need to throw a 0.410-kg football so that it has the same momentum as the football player?

2. 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.
   a) What is the impulse on the puck?
   b) If the collision takes 5.0 x 10^-4 s, what is the average force on the puck?
Calculate the momentum of the following objects:

1. 110-kg football player running at 8.00 m/s.

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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.

a) What is the impulse on the puck?

\[ \Delta P = p_f - p_i = m(v_f - v_i) = (0.115 \text{ kg})(37 \text{ m/s} - (-25 \text{ m/s})) = 11.4 \text{ kg m/s} \]

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

\[ F = \frac{\Delta P}{t} = \frac{11.4 \text{ kg m/s}}{5.0 \times 10^{-4} \text{ s}} = 2.28 \times 10^4 \text{ N} \]

PRACTICE PROBLEMS

(1-8)