Model Name:
Impulsive-Force Model

Description
This model describes the relationship between impulse and momentum.

Properties:
Measured → nothing new

Calculated

momentum $\vec{p}$ [kg·m/s OR N·s]

impulse $\vec{J}$ [kg·m/s OR N·s]

REPRESENTATIONS

- Written/verbal
- Diagrammatic
  - Conservation of momentum diagrams
- Mathematic
  - $\bar{J} = \bar{F}\Delta t = m\Delta\bar{v}$
  - $\bar{p} = m\bar{v}$
  - $\bar{p}_i = \bar{p}_f$

$$m_1\bar{v}_{1i} + m_2\bar{v}_{2i} + \ldots = m_1\bar{v}_{1f} + m_2\bar{v}_{2f} + \ldots$$

- Graphical
  - $\frac{v_A}{v_B}$ versus $\frac{m_B}{m_A}$

Rules of Behavior

- Unless outside work is put in, momentum is always conserved.
- Types of collisions
  - Elastic → hit-and-bounce
  - Inelastic → hit-and-stick
  - Inelastic → explosion
- Impulse is directly related to the change in momentum.

A ball of mass 0.25 kg is thrown from 0 m/s to 25 m/s.

a) What is the impulse on the ball?

b) If the momentum changes in 1.25 s, what is the force acting on the ball during this time?

a) $v_i = 0$ m/s
$v_f = 25$ m/s
$m = 0.25$ kg

$\bar{J} = m\Delta v$
$= m(v_f - v_i)$
$= 6.25$ kg m/s

b) $F = ?$
$J = 6.25$ kg m/s
$t = 1.25$ s

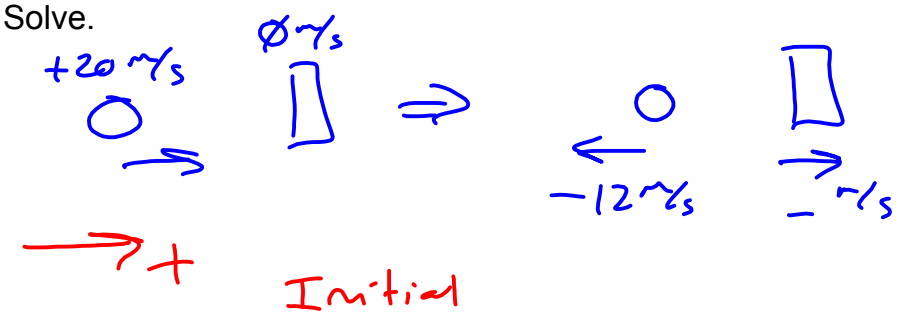
$\bar{J} = \bar{F}\Delta t$
$F = \frac{J}{\Delta t}$
$= 5$ N

A 0.25 kg ball with an initial velocity of 20 m/s collides with the back of a baseball player's glove (in an unfortunate turn of events). The ball rebounds with a velocity of 12 m/s, and the mass of the glove is 1.25 kg. What is the velocity of the glove? Assume the initial velocity of the glove is 0 m/s.

a) Draw a conservation of momentum diagram.

b) Conservation of momentum equation.

c) Solve.

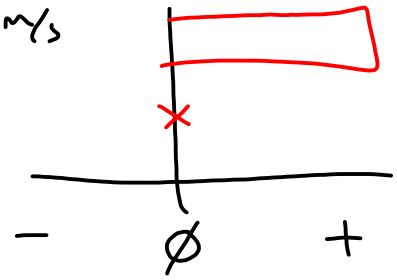


Initial

ball 0.25 kg at 20 m/s

glove

$\bar{P}_i = m_b \bar{v}_{bi}$

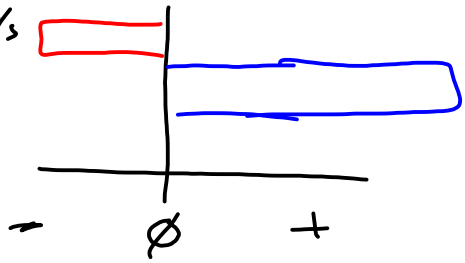


Final

ball 0.25 kg at −12 m/s

glove 1.25 kg at ?

$\bar{P}_f = m_b \bar{v}_{bf} + m_g \bar{v}_{gf}$



$$\bar{P}_i = \bar{P}_f$$

$$m_b \bar{v}_{bi} = m_b \bar{v}_{bf} + m_g \bar{v}_{gf}$$

$$v_{gf} = \frac{m_b \bar{v}_{bi} - m_b \bar{v}_{bf}}{m_g}$$

$$= \frac{(0.25\ \text{kg})(20\ \text{m/s}) - (0.25\ \text{kg})(-12\ \text{m/s})}{1.25\ \text{kg}}$$

$$= 6.4\ \text{m/s}$$

Quiz 1 Rubric

1, 2, 3 → 1 point for correct equation,

3 points for correct answer, 1 point for correct units

4 → 2 points for correct explanation

Quiz 2 Rubric

Conservation of momentum diagram

Object 1 initial → 3 points

Object 2 initial → 3 points

Objects 1/2 final → 3 points

Conservation of momentum equation → 3 points

Final velocity → 3 points for correct answer,

1 point for correct units