Edgenuity

Warm-Up | Conservation of Momentum

Lesson Question

How is momentum conserved?

Lesson Goals

Describe the law of conservation of momentum.

Apply the law of conservation of momentum to analyze collisions between objects.

Solve problems involving the conservation of momentum.

Words to Know

Write the letter of the definition next to the matching word as you work through the lesson. You may use the glossary to help you.

D kinetic energy

B elastic collision

E law of conservation of momentum

C inelastic collision

A closed system

A. a group of related objects that interact and form a complex whole without being affected by outside forces

B. a collision in which kinetic energy is conserved

C. a collision in which the final kinetic energy is less than the initial kinetic energy

D. the energy an object or particle has due to its motion

E. the law that states the total momentum of all interacting objects must remain the same

Momentum

- Momentum (p) is an object's mass multiplied by its velocity.
  - Unit of $\text{kg} \cdot \frac{\text{m}}{\text{s}}$

$$p = mv$$

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Closed System

- A group of related objects that [interact] and form a complex whole without being affected by outside [forces] is a **closed system**.

Total Momentum in a System

- Total momentum (p_{tot}) is the sum of the momentums in a [closed] system.

$$p_{tot} = p_1 + p_2 + \ldots p_n$$

- We know that p, momentum, is equal to mass times [velocity].

$$p = mv$$

$$p_{tot} = m_1v_1 + m_2v_2 + \ldots m_nv_n$$

Law of Conservation of Momentum

- The law of conservation of momentum states that the total momentum of [interacting] objects does not change in a closed system.

$$p_i = p_f$$

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Types of Collisions

- **Kinetic energy** is the energy an object or particle has due to its motion.
- A collision in which some kinetic energy is transferred is called an [inelastic] **collision**.
- A perfectly inelastic collision occurs when the objects move as [one] object after they collide.
  - Momentum is [conserved].
  - Energy is conserved.
  - The maximum amount of [kinetic] energy is converted.

Perfectly Inelastic Collisions

- Not all inelastic collisions are perfectly inelastic collisions. Most inelastic collisions:
  - are simply inelastic collisions.
  - convert kinetic energy to [potential] energy, noise, or heat.
  - create potential energy by [deforming] an object.

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Formulas for Perfectly Inelastic Collisions

We have two different masses, and they each have their own velocity before the collision. Then the two masses collide and [stick] together, and that has its own final velocity.

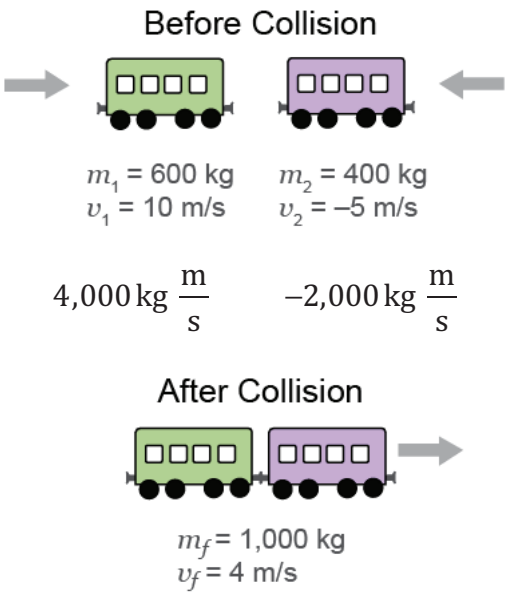
$$m_1v_1 + m_2v_2 = (m_1 + m_2)v_f$$

$$v_f = \frac{m_1v_1 + m_2v_2}{m_1 + m_2}$$

Perfectly Inelastic Collisions

- Two or more objects collide and stick together to become one object with one [velocity].
  - The individual masses combine.
  - All objects have the same velocity.

$$p = mv \qquad 6{,}000 - 2{,}000 = 4{,}000\ \text{kg}\frac{\text{m}}{\text{s}}$$



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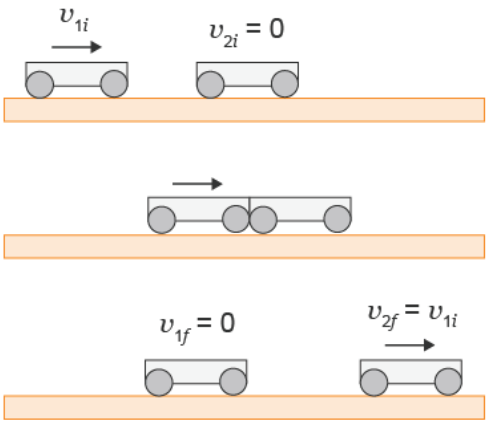
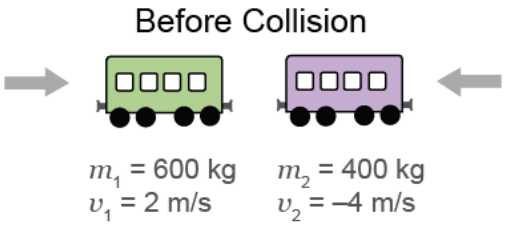
Elastic Collisions

- A collision in which kinetic energy is conserved is an **elastic collision**.
  - Momentum is also conserved.

$m_1v_{1i} + m_2v_{2i} =$ $m_1v_{1f} + m_2v_{2f}$

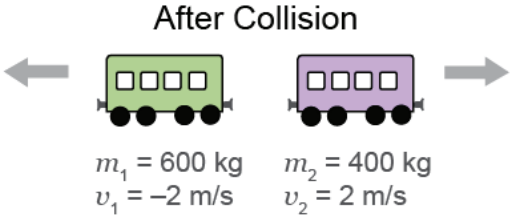


- Two or more objects collide and bounce apart with separate velocities.
  - They keep their original masses.
  - The velocities may change.



$p_{tot} =$ $-400\ \text{kg}\frac{\text{m}}{\text{s}}$ → $1{,}200\ \text{kg}\frac{\text{m}}{\text{s}}$ $-1{,}600\ \text{kg}\frac{\text{m}}{\text{s}}$

$p_{tot} =$ $-400\ \text{kg}\frac{\text{m}}{\text{s}}$



$-1{,}200\ \text{kg}\frac{\text{m}}{\text{s}}$ $800\ \text{kg}\frac{\text{m}}{\text{s}}$

Summary | Conservation of Momentum

Lesson Question

How is momentum conserved?

Answer

(Sample answer) Momentum is conserved in much the same way as energy. As long as you have a closed system, where all of the outside forces sum to zero, momentum will be conserved.

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Review: Key Concepts

- Momentum is conserved in much the same way as [energy]. As long as there is a closed system, in which all of the outside forces sum to zero, momentum will be conserved.
- Momentum can be used to analyze [collisions].
- There are three types of collisions.
  - Elastic
  - Inelastic
  - Perfectly inelastic

Summary | Conservation of Momentum

Use this space to write any questions or thoughts about this lesson.