

Physics

Semester 2: Weeks 1 – 2

January 6 – 16, 2026

Tuesday / Wednesday (Jan 6th and 7th)

- **T:** 7D - Calculate and describe the impulse and momentum of physical systems using examples such as automobile safety features, athletics and rockets
- 7E - Analyze the conservation of momentum in inelastic and elastic collisions in one dimension qualitatively using models, diagrams and simulations
- **O:** I will be able to begin understanding the concept of momentum
- **D:** by analyzing a video, answering questions about the video, taking notes on momentum, and solving problems.
- **A:** momentum
- **Y:** What are the components of momentum?

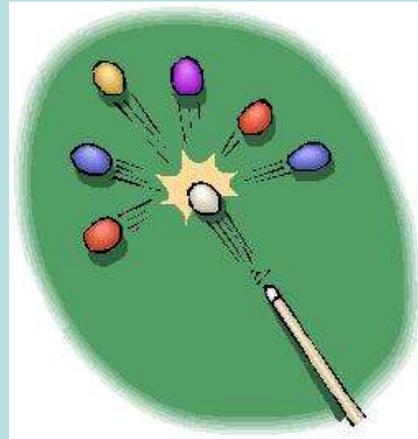
Journal 4.1

- Same requirements as always, write **today's date**, write the prompt, and write at least 4 complete sentences in response to the prompt.
- Prompt: **Get to know your group.**
 - Instructions: Each person in your group will share the following information for you to write down as your journal.
 - Name (yes, some of you have no idea what your classmates' names are)
 - Age
 - Birthday
 - A fun fact about them that has nothing to do with school.

Thursday / Friday (Jan 8th & 9th)

- T: **7D** - Calculate and describe the impulse and momentum of physical systems using examples such as automobile safety features, athletics and rockets
- **7E** - Analyze the conservation of momentum in inelastic and elastic collisions in one dimension qualitatively using models, diagrams and simulations
- O: I will improve my understanding of momentum and collisions
- D: by watching a video, taking notes, and participating in a class discussion, and completing a PhET simulation
- A: momentum, conservation of momentum
- Y: How does a change in momentum affect the environment of an object?

Unit 5 - Momentum



- **All moving objects have what Newton called a “quantity of motion.”**
- **Today we call it momentum.**

- **Momentum = Mass x Velocity**
- **Mass is measured in kilograms**
- **Velocity is measured in meters per second**
- **Momentum is measured in kilogram-meters per second (kg x m/s).**
- **Momentum is a vector (magnitude and direction)**

- **The more momentum a moving object has, the harder it is to stop.**
- **More mass = more momentum (at the same speed)**
 - **Car vs baseball at 20 m/s**

- **More velocity = more momentum**

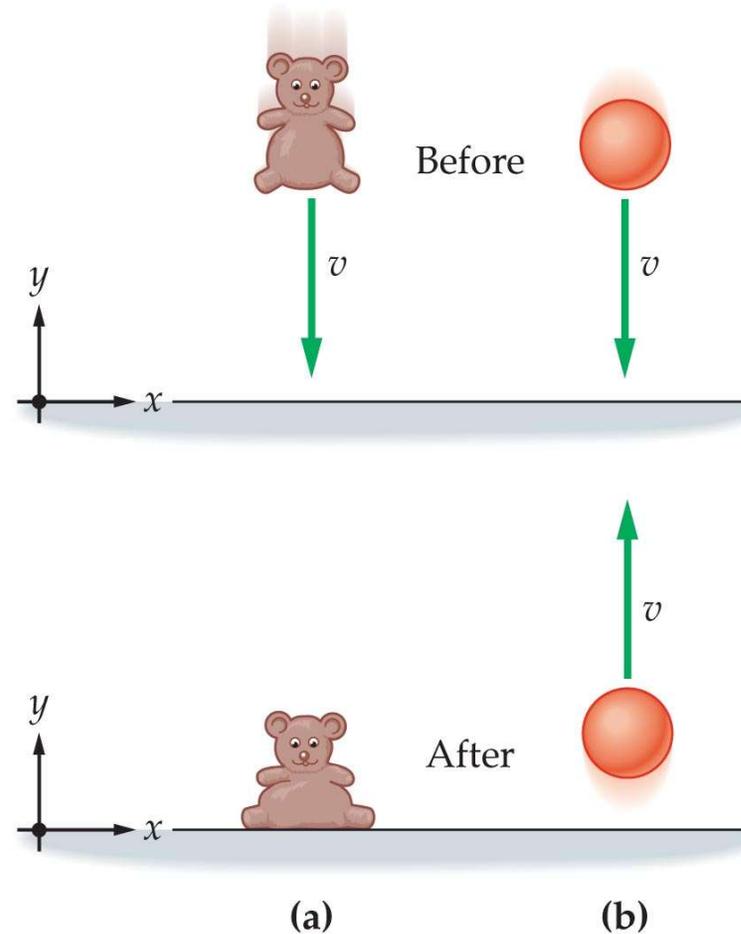
- **Slow car vs fast car**

Sample Momentum Problems

- **Which has more momentum: a 3.0 kg sledgehammer swung at 1.5m/s, or a 4.0 kg sledgehammer swung at 0.9 m/s?**

Change in Momentum

- Assuming the ball and bear weigh the same thing, which one has a greater change in momentum?



Momentum

- If the beanbag has a mass of 1 kg and is moving downward with a speed of 4 m/s just before coming to rest on the floor, then its change in momentum is

$$\Delta \vec{p} = \vec{p}_f - \vec{p}_i = 0 - (-4 \text{ kg} \cdot \text{m/s}) = 4 \text{ kg} \cdot \text{m/s}$$

- A 1-kg rubber ball with a speed of 4 m/s just before hitting the floor will bounce upward with the same speed. Therefore, the ball's change in momentum is

$$\Delta \vec{p} = \vec{p}_f - \vec{p}_i = (4 \text{ kg} \cdot \text{m/s}) - (-4 \text{ kg} \cdot \text{m/s}) = 8 \text{ kg} \cdot \text{m/s}$$

Momentum

- The total momentum of a system of objects is the vector sum of the momentums of all the individual objects:

Total Momentum, \vec{p}_{total}

total momentum = momentum 1 + momentum 2 + \dots

$$\vec{p}_{\text{total}} = \vec{p}_1 + \vec{p}_2 + \dots$$

SI units: $\text{kg} \cdot \text{m/s}$

- Due to the vector nature of momentum, it is possible for a system of several moving objects to have a total momentum that is positive, negative, or zero.

Definition of Impulse, \vec{I}

impulse = force \times time interval

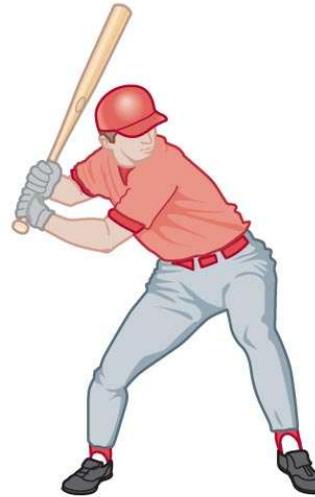
$$\vec{I} = \vec{F} \Delta t$$

SI units: $\text{N} \cdot \text{s} = \text{kg} \cdot \text{m/s}$

Impulse

- When a force acts on an object, it changes the object's momentum.
- A version of Newton's 2nd Law

$$\vec{\mathbf{F}} = \frac{\Delta \vec{\mathbf{p}}}{\Delta t}$$



Impulse

- Rearranging this equation, we get $\vec{F}\Delta t = \Delta\vec{p}$

Momentum-Impulse Theorem

impulse = force \times time = change in momentum

$$\vec{I} = \vec{F}\Delta t = \Delta\vec{p}$$

Impulse

- In your groups:

Discuss the concepts of impulse and momentum from the picture. Use these sentence stems:

The momentum of the rain vs hail _____.

The impulse of the rain vs hail _____.



Impulse

- A person standing under an umbrella experiences rain, which later turns to hail. Is the force required to hold the umbrella upright in the hail greater than, less than, or equal to the force required to hold it in the rain?
- The rain tends to splatter and fall off the umbrella, while the hail tends to bounce back upward. This means that the change in momentum is greater for the hail. Therefore, the impulse and force are greater in the hail.

Impulse

- Longer time equals smaller force $\vec{\mathbf{I}} = \vec{\mathbf{F}} \Delta t = \vec{\mathbf{F}} \Delta t$

Conservation of Momentum

If the total force acting on an object is zero, its momentum cannot change. In other words, its momentum is conserved.

$$\vec{\mathbf{p}}_f = \vec{\mathbf{p}}_i$$

Conservation of Momentum

- Momentum conservation applies to all systems, regardless of size.
- Total P before a collision and after must be the same.

Monday / Tuesday (Jan 12 & 13)

- Worksheet and Collision Lab

- T: **7D** - Calculate and describe the impulse and momentum of physical systems using examples such as automobile safety features, athletics and rockets
- **7E** - Analyze the conservation of momentum in inelastic and elastic collisions in one dimension qualitatively using models, diagrams and simulations
- O: I will improve my understanding of momentum and collisions
- D: by watching a video, taking notes, and participating in a class discussion, and completing a worksheet and a lab.
- A: momentum, conservation of momentum
- Y: How does a change in momentum affect the environment of an object?

Conservation of Momentum

- Momentum conservation applies to the largest possible system—the universe. The exploding star in the photo below sends material out in opposite directions, thus ensuring that its total momentum is unchanged.



Conservation of Momentum

- Momentum conservation may cause objects to recoil. Recoil is the backward motion caused by two objects pushing off one another.
- Recoil occurs when a gun is fired or, as is shown in the figure below, when a firefighter directs a stream of water from a fire hose.
- In all cases, recoil is a result of momentum conservation.

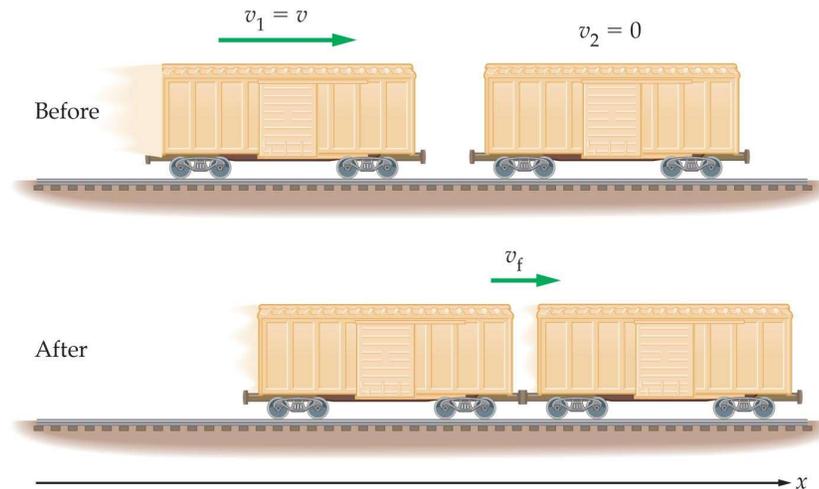
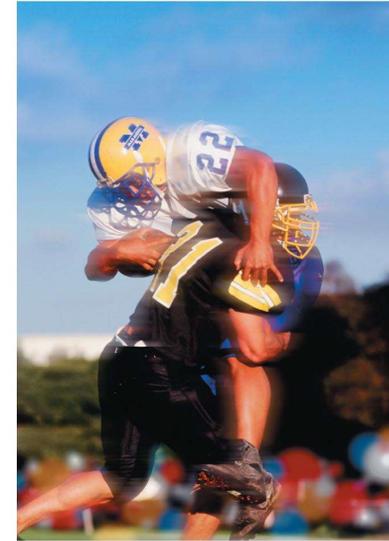
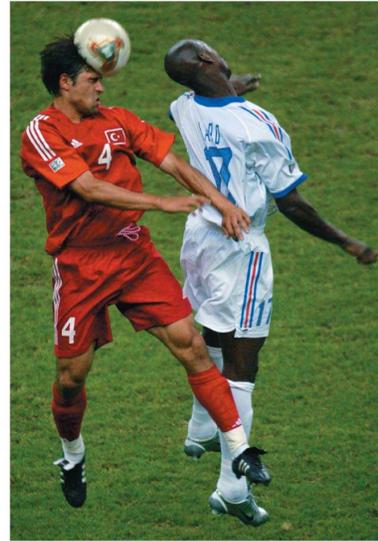


Collisions

- A collision in which the kinetic energy is conserved is referred to as an elastic collision. In an elastic collision, the final kinetic energy of the system is equal to its initial kinetic energy.
- A collision in which the kinetic energy is not conserved is called an inelastic collision. In an inelastic collision, the final kinetic energy is less than the initial kinetic energy.

Collisions

- The figure below shows an example of an essentially elastic collision on the left and an inelastic collision on the right.
- An inelastic collision where the colliding objects stick together is referred to as a completely inelastic collision. See the figure below for an example of a completely inelastic collision.



Collisions

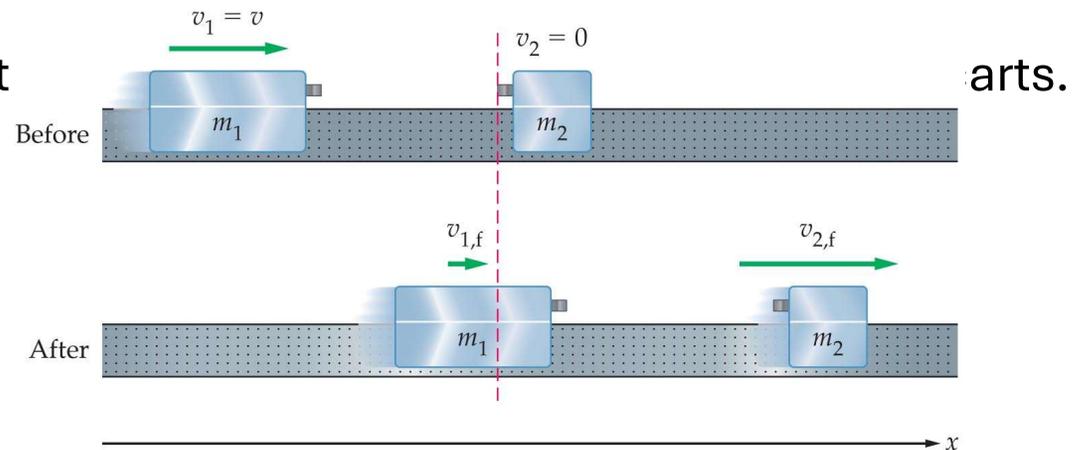
- In the previous example, the mass doubles and the speed is halved. Thus, the final kinetic energy is

$$KE_f = \frac{1}{2}(2m)\left(\frac{v}{2}\right)^2 = \frac{1}{4}mv^2 = \frac{1}{2}(KE_i)$$

- Therefore, one-half of the initial kinetic energy is converted into other forms of energy such as sound and heat.

Collisions

- Elastic collisions are analyzed using both momentum and kinetic energy conservation.
- The figure below shows t



- If the masses of the carts are m_1 and m_2 , respectively, then momentum conservation may be expressed as follows:

$$m_1 v = m_1 v_{1,f} + m_2 v_{2,f}$$

Collisions

- The fact that this is an elastic collision means that the final velocities must also satisfy energy conservation:

$$\frac{1}{2}m_1v^2 = \frac{1}{2}m_1v_{1,f}^2 + \frac{1}{2}m_2v_{2,f}^2$$

- Momentum conservation and kinetic energy conservation have provided us with two equations with two unknowns, $v_{1,f}$ and $v_{2,f}$. Straightforward algebra yields the following results:

$$v_{1,f} = \left(\frac{m_1 - m_2}{m_1 + m_2} \right) v \quad v_{2,f} = \left(\frac{2m_1}{m_1 + m_2} \right) v$$

Wednesday / Thursday (Jan 14 & 15)

- Go over worksheet and conduct test review

Journal 4.2

- What are some things you can do to ensure success in all your classes?

- T: **7D** - Calculate and describe the impulse and momentum of physical systems using examples such as automobile safety features, athletics and rockets
- **7E** - Analyze the conservation of momentum in inelastic and elastic collisions in one dimension qualitatively using models, diagrams and simulations
- O: I will reenforce my understanding of momentum in preparation of my DCA
- D: by going over the worksheet from last class and conducting a test review.
- A: momentum, conservation of momentum
- Y: How does a change in momentum affect the environment of an object?

Launch

- Don't forget that tomorrow is a C-day

Friday (C-day, Jan 16)

- Notes / Study for test

Launch

- Enjoy your long weekend 😊