Chapter 2 Notes

Forces

Section 2.3-2.4 Notes

- Newton's Laws of Motion

Key Concepts

- What are Newton's first, second and third laws of motion?
- How can you determine momentum of an object?
- What is the law of conservation of momentum?

Newton's First Law

- An object at rest will stay at rest
  - AND
- An object in motion will stay in motion
  - UNLESS
- Acted on by an unbalanced force

Inertia

- (another name for Newton's first law)
- Tendency of an object to resist change in motion
- Greater mass = greater inertia

Newton's Second Law

- Acceleration depends on the object's mass and on the net force acting on the object

- $\text{Acceleration} = \frac{\text{net force}}{\text{mass}}$

- Units = Newton

How can you increase acceleration?

- Acceleration $= \frac{\text{net force}}{\text{mass}}$

- Increase the force
  - OR
- Decrease the mass

Newton's 1st and 2nd Laws

- video

Calculating Force

Math Sample Problem

- A speedboat pulls a 55-kg water-skier. The force causes the skier to accelerate at 2.0 m/s^2. Calculate the net force that causes this acceleration.

- Read and Understand

- **What information have you been given?**
- Mass of the water-skier (m) = 55 kg
- Acceleration of the water-skier (a) = 2.0 m/s^2

Math Calculating Force

Sample Problem

- A speedboat pulls a 55-kg water-skier. The force causes the skier to accelerate at 2.0 m/s^2. Calculate the net force that causes this acceleration.
- Plan and Solve
- **What quantity are you trying to calculate?**
- The net force (F_{net}) = __
- **What formula contains the given quantities and the unknown quantity?**
- $a = F_{net}/m$ or $F_{net} = m \times a$
- **Perform the calculation.**
- $F_{net} = m \times a = 55\ kg \times 2.0\ m/s^2$
- $F = 110\ kg \cdot m/s^2$
- $F = 110\ N$

Calculating Force

Math Sample Problem

- A speedboat pulls a 55-kg water-skier. The force causes the skier to accelerate at 2.0 m/s^2. Calculate the net force that causes this acceleration.

- Look Back and Check

- **Does your answer make sense?**
- A net force of 110 N is required to accelerate the water-skier. This may not seem like enough force, but it does not include the force of the speedboat's pull that overcomes friction.

Math Practice

Calculating Force

- **Practice Problem**

- What is the net force on a 1,000-kg object accelerating at 3 m/s^2?

- 3,000 N (1,000 kg X 3 m/s^2)

End of Slide

Math Practice

Calculating Force

- **Practice Problem**

- What net force is needed to accelerate a 25-kg cart
- at 14 m/s^2?

- 350 N (25 kg X 14 m/s^2)

End of Slide

Newton's Third Law

- For every action, there is an equal and opposite reaction

- If one object exerts a force on another object, the second object exerts an equal force in the opposite direction on the first!

Newton's Third Law

- Examples:
  - Jumping
    - You push on ground
    - Ground pushes back on you with equal force
  - Canoeing
    - You push water with paddle
    - Water pushes back on paddle, causing canoe to move forward

Newton's 3rd Law

- video

Newton's Third Law

- You cannot always detect Earth's equal and opposite reaction because Earth's inertia is so great that its acceleration is too small to notice!

Momentum

- “quantity of motion”
- Momentum = mass x velocity
- Kg·m/s

Momentum

Momentum = mass x velocity

- The momentum of an object is in the same direction as its velocity
- More momentum = harder to stop
- How can you increase momentum?
  - Increase mass or
  - Increase velocity (speed & direction)

Math Sample Problem

Calculating Momentum

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

- Read and Understand

- What information have you been given?
- Mass of smaller sledgehammer = 3.0 kg
- Velocity of smaller sledgehammer = 1.5 m/s
- Mass of larger sledgehammer = 4.0 kg
- Velocity of larger sledgehammer = 0.9 m/s

Math Sample Problem

Calculating Momentum

- Which has more momentum: a 3.0-kg sledgehammer swung at 1.5 m/s or a 4.0-kg sledgehammer swung at 0.9 m/s?
- Plan and Solve
- **What quantities are you trying to calculate?**
- The momentum of each sledgehammer = __
- **What formula contains the given quantities and the unknown quantity?**
- Momentum = Mass X Velocity
- **Perform the calculation.**
- Smaller sledgehammer = 3.0 km X 1.5 m/s = 4.5 kg • m/s
- Smaller sledgehammer = 4.0 km X 0.9 m/s = 3.6 kg • m/s

Math Sample Problem

Calculating Momentum

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

- Look Back and Check

- **Does your answer make sense?**
- The 3.0-kg hammer has more momentum than the 4.0-kg one. This answer makes sense because the 3.0-kg hammer is swung at a greater velocity.

Math Practice

Calculating Momentum

- **Practice Problem**

- What is the momentum of a bird with a mass of 0.018 kg flying at 15 m/s?

- 0.27 kg·m/s (0.018 kg X 15 m/s = 0.27 kg·m/s)

End of Slide

Math Practice

Calculating Momentum

- **Practice Problem**

- A golf ball travels at 16 m/s, while a baseball moves at 7 m/s. The mass of the golf ball is 0.045 kg and the mass of the baseball is 0.14 kg. Which has the greater momentum?

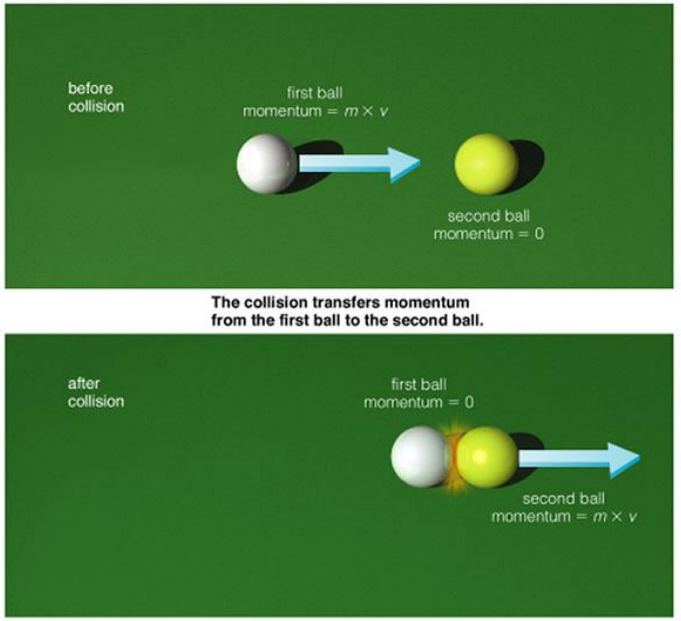
- Golf ball: 0.045 kg X 16 m/s = 0.72 kg·m/s
- Baseball: 0.14 kg X 7 m/s = 0.98 kg·m/s
- The baseball has greater momentum.

End of Slide

Law of Conservation of Momentum

- The total momentum of objects that interact DOES NOT CHANGE – unless acted on by outside forces

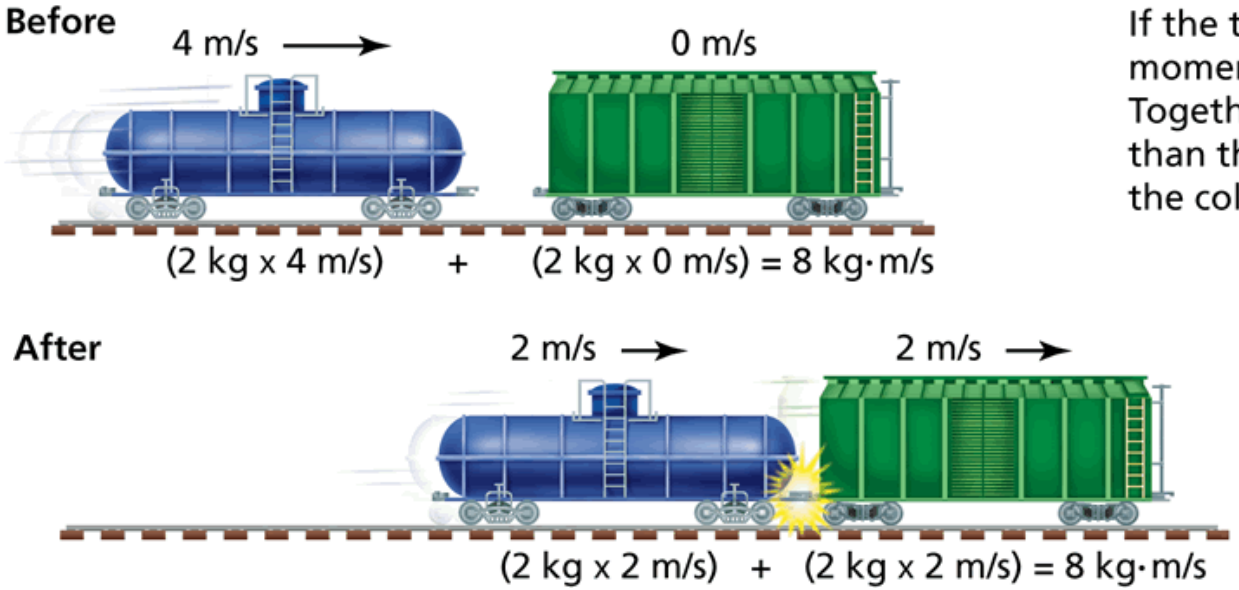
- Momentum may be transferred, but never lost



Conservation of Momentum

- In the absence of friction, momentum is conserved when two train cars collide.

C Two Connected Objects



If the two cars couple together, momentum is still conserved. Together, the cars move slower than the blue car did before the collision.

Momentum Activity

- Cgp-3024
- Animated Train Car activity

Teacher notes

- Video field trip – forces on roller coasters
- Bill Nye – Momentum (Jay)
- Newton's laws video from united streaming
- TLC Elementary School: Rules of Motion and Forces