Momentum

Chapter 8

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Objectives

- Describe momentum
- Demonstrate knowledge of the impulse-momentum theorum
- Solve conservation of momentum problems

- Car activity

2

Momentum

- When do you observe momentum?
- How can you change momentum?
- p = m v

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Conservation of momentum

- Conservation of momentum—the p in a closed, isolated system does not change
- m does not change
- No outside forces

- p before = p after

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Collisions

- **Elastic collisions**
- Bounce apart, kinetic energy is unchanged

- **Inelastic collisions**
- Stick together, kinetic energy is changed

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Collisions

- **Elastic collisions**
- Examples?

- **Inelastic collisions**
- Examples?

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Collision Problem 1—DON'T SOLVE YET!

- A 1000-kg VW bug is stopped in traffic when it is rear-ended by a 35 000-kg semi traveling 12 m/s. If the two stick together, how fast do the two move together immediately after the collision?

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Collision Problem 2—DON'T SOLVE YET!

- This time the 1000-kg bug is booking at 27 m/s heading north. The 35 000-kg semi is traveling at 30 m/s north when it rear-ends the VW. What is the velocity of the bug after impact? (Assume an **elastic** collision and the truck's final velocity is 29 m/s)

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Collisions

- **Elastic collisions**
  - Bounce apart, kinetic energy is unchanged
  - $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$
- **Inelastic collisions**
  - Stick together, kinetic energy is changed
  - $m_1v_1 + m_2v_2 = (m_1 + m_2)\, v_f$

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Collision Problem 1—SOLVE

- A 1000-kg VW bug is stopped in traffic when it is rear-ended by a 35 000-kg semi traveling 12 m/s. If the two stick together, how fast do the two move together immediately after the collision? 12 m/s

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Collision Problem 2—SOLVE

- This time the 1000-kg bug is booking at 27 m/s heading north. The 35 000-kg semi is traveling at 30 m/s north when it rear-ends the VW. What is the velocity of the bug after impact? (Assume an **elastic** collision and the truck's final velocity is 29 m/s) 62 m/s

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Collision Problem 3

- The 1000-kg VW is traveling **south** on I-25 at 25 m/s. The semi is driving at 30 m/s **north** when it crosses the median. What is the resultant velocity if this is an **inelastic** collision? 28.5 m/s

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Collision Problem 4

- You try to jump from a motionless canoe to the dock. You have a mass of 75.0 kg and the canoe is 50.0 kg. If you leap with a velocity of 3.0 m/s, with what speed does the canoe move away? 4.5 m/s away from you

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Collision Problem 5

- Tom the (75 kg) inept but resourceful astronaut forgets to leash himself to the space shuttle during his spacewalk. He is holding a tool kit. To get back, he throws a 2.0 kg hammer away from the space shuttle with a velocity of 5 m/s. What is his velocity (magnitude and direction)? 1.3 m/s opposite direction from hammer

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Impulse-Momentum

- Impulse = FΔt
- FΔt = mΔv

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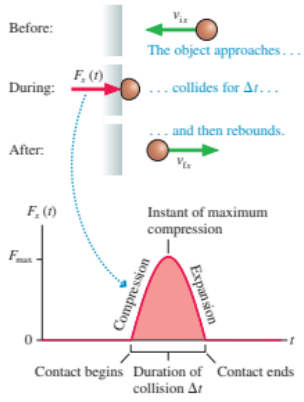

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Baseball hit

- Baseball hitting wall

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Tennis ball hit

- Tennis ball hitting racket video

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Just for fun

- Just for fun

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Impulse Problem 6

- A batter hits a fastball. The 145 g ball is thrown with a velocity of 38 m/s and clears the outfield fence with a velocity of 52 m/s. If the ball is in contact with the bat for 3.0 x 10^{-4} s, with what force does the batter need to swing? 43 500 N

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Force-time graphs

- How would you calculate impulse?
- How would you calculate the change in velocity?

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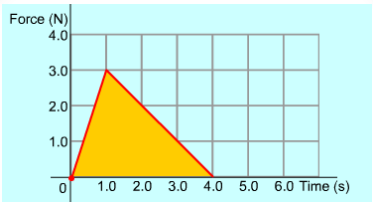
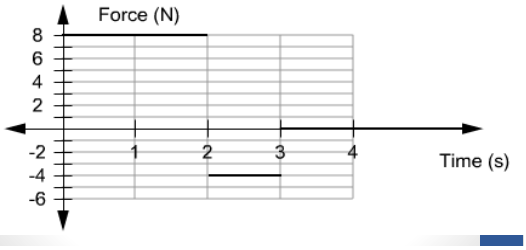


An object has force applied to it in a constant direction. The graph shows how the force varies with time. If the object has a mass of 5.0 kg, what is its change in velocity over the time the force is applied?

Graph Problem 8

The graph shows the net force applied on a 0.15 kg object over a 3.0 s time interval. (a) What is the average force applied to the object over the 3.0 seconds? (b) What is the impulse? (c) What is its change in velocity?



Impulse Problem 9

- A 60.0 kg person is moving at 25 m/s in a car when it hits a wall and comes to a stop in 0.20 seconds. What is the average force on the person? 7500 N

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