

## 4.E: Impulse and Momentum (Exercise)

### Conceptual Questions

#### 5.1: Linear Momentum and Force

1. An object that has a small mass and an object that has a large mass have the same momentum. Which object has the largest kinetic energy?
2. An object that has a small mass and an object that has a large mass have the same kinetic energy. Which mass has the largest momentum?

#### Professional Application

3. Football coaches advise players to block, hit, and tackle with their feet on the ground rather than by leaping through the air. Using the concepts of momentum, work, and energy, explain how a football player can be more effective with his feet on the ground.
4. How can a small force impart the same momentum to an object as a large force?

#### 5.2: Impulse

#### Professional Application

5. Explain in terms of impulse how padding reduces forces in a collision. State this in terms of a real example, such as the advantages of a carpeted vs. tile floor for a day care center.
6. While jumping on a trampoline, sometimes you land on your back and other times on your feet. In which case can you reach a greater height and why?

#### Professional Application

7. Tennis racquets have “sweet spots.” If the ball hits a sweet spot then the player's arm is not jarred as much as it would be otherwise. Explain why this is the case.

#### 5.3: Conservation of Momentum

#### Professional Application

8. If you dive into water, you reach greater depths than if you do a belly flop. Explain this difference in depth using the concept of conservation of energy. Explain this difference in depth using what you have learned in this chapter.
9. Under what circumstances is momentum conserved?
10. Can momentum be conserved for a system if there are external forces acting on the system? If so, under what conditions? If not, why not?
11. Momentum for a system can be conserved in one direction while not being conserved in another. What is the angle between the directions? Give an example.

#### Professional Application

12. Explain in terms of momentum and Newton's laws how a car's air resistance is due in part to the fact that it pushes air in its direction of motion.
13. Can objects in a system have momentum while the momentum of the system is zero? Explain your answer.
14. Must the total energy of a system be conserved whenever its momentum is conserved? Explain why or why not.

#### 5.4: Elastic Collisions in One Dimension

15. What physical quantities are conserved in an elastic collision?
16. Give examples of elastic (or nearly elastic) collisions from everyday experiences.

#### 5.5: Inelastic Collisions in One Dimension

17. What is an inelastic collision? What is a perfectly inelastic collision?

**18.** Mixed-pair ice skaters performing in a show are standing motionless at arms length just before starting a routine. They reach out, clasp hands, and pull themselves together by only using their arms. Assuming there is no friction between the blades of their skates and the ice, what is their velocity after their bodies meet?

**19.** A small pickup truck that has a camper shell slowly coasts toward a red light with negligible friction. Two dogs in the back of the truck are moving and making various inelastic collisions with each other and the walls. What is the effect of the dogs on the motion of the center of mass of the system (truck plus entire load)? What is their effect on the motion of the truck?

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