**NAME** _____ **PERIOD** ____

**UNIT 11 PRACTICE PROBLEMS** **AP PHYSICS**

## 11.1 IMPULSE AND MOMENTUM

1. A compact car, with mass 725 kg, is moving at 115 km/h toward the east.
   a. Find the magnitude and direction of its momentum.
   b. A second car, with a mass of 2175 kg, has the same momentum. What is its velocity?
2. A 0.150-kg baseball is dropped from rest. If the magnitude of the baseball's momentum is 0.780 kg□m/s just before it lands on the ground, from what height was it dropped?
3. Find the magnitude of the impulse delivered to a soccer ball when a player kicks it with a force of 1450 N. Assume that the player's foot is in contact with the ball for $5.80 \times 10^{-3}$ s.
4. In a typical golf swing, the club is in contact with the ball for about 0.0010 s. If the 45-g ball acquires a speed of 67 m/s, estimate the magnitude of the force exerted by the club on the ball.
5. When spiking a volleyball, a player changes the velocity of the ball from 4.2 m/s to -24 m/s along a certain direction. If the impulse delivered to the ball by the player is -9.3 kg·m/s what is the mass of the volleyball?
6. A 15.0-g marble is dropped from rest onto the floor 1.44 m below. **(a)** If the marble bounces straight upward to a height of 0.640 m, what is the magnitude and direction of the impulse delivered to the marble by the floor? **(b)** If the marble had bounced to a greater height, would the impulse delivered to it have been greater or less than the impulse found in part (a)? Explain.
7. To make a bounce pass, a player throws a 0.60-kg basketball toward the floor. The ball hits the floor with a speed of 5.4 m/s at an angle of 65° to the vertical. If the ball rebounds with the same speed and angle, what was the impulse delivered to it by the floor?
8. A 0.150-kg ball, moving in the positive direction at 12 m/s, is acted on by the impulse shown in the graph in **Figure 9-16**. What is the ball's speed at 4.0 s?

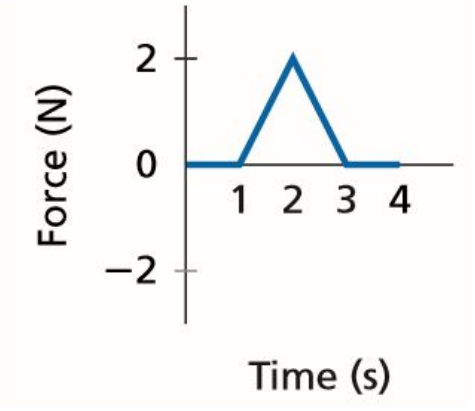


**Figure 9-16**

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**UNIT 11 PRACTICE PROBLEMS AP PHYSICS**

## 11.2 CONSERVATION OF MOMENTUM

9. Two ice skaters stand at rest in the center of an ice rink. When they push off against one another the 45-kg skater acquires a speed of 0.62 m/s. If the speed of the other skater is 0.89 m/s, what is this skater's mass?
10. An object initially at rest breaks into two pieces as the result of an explosion. One piece has twice the kinetic energy of the other piece. What is the ratio of the masses of the two pieces? Which piece has the larger mass?
11. A young hockey player stands at rest on the ice holding a 1.1-kg helmet. The player tosses the helmet with a speed of 6.2 m/s in a direction 13° above the horizontal, and recoils with a speed of 0.25 m/s. Find the mass of the hockey player.
12. A 92-kg astronaut and a 1200-kg satellite are at rest relative to the space shuttle. The astronaut pushes on the satellite, giving it a speed of 0.14 m/s directly away from the shuttle. Seven-and-a-half seconds later the astronaut comes into contact with the shuttle. What was the initial distance from the shuttle to the astronaut?
13. A plate drops onto a smooth floor and shatters into three pieces of equal mass. Two of the pieces go off with equal speeds *v* at right angles to one another. Find the speed and direction of the third piece.

## 11.3 COLLISIONS

14. A cart of mass *m* moves with a speed *v* on a frictionless air track and collides with an identical cart that is stationary. If the two carts stick together after the collision, what is the final kinetic energy of the system?
15. Two 78.0-kg hockey players skating at 5.25 m/s collide and stick together. If the angle between their initial directions was 115°, what is their speed after the collision?
16. A 0.430-kg block is attached to a horizontal spring that is at its equilibrium length, and whose force constant is 20.0 N/m. The block rests on a frictionless surface. A 0.0500-kg wad of putty is thrown horizontally at the block, hitting it with a speed of 2.30 m/s and sticking. How far does the putty-block system compress the spring?
17. A bullet with a mass of 4.0 g and a speed of 650 m/s is fired at a block of wood with a mass of 0.095 kg. The block rests on a frictionless surface, and is thin enough that the bullet passes completely through it. Immediately after the bullet exits the block, the speed of the block is 23 m/s. **(a)** What is the speed of the bullet when it exits the block? **(b)** Is the final kinetic energy of this system equal to, less than, or greater than the initial kinetic energy? Explain. **(c)** Verify your answer to part (b) by calculating the initial and final kinetic energies of the system.

18. A 722-kg car stopped at an intersection is rear-ended by a 1620-kg truck moving with a speed of 14.5 m/s. If the car was in neutral and its brakes were off, so that the collision is approximately elastic, find the final speed of both vehicles after the collision.
19. A 0.50-kg ball that is traveling at 6.0 m/s collides head-on with a 1.00-kg ball moving in the opposite direction at a speed of 12.0 m/s. The 0.50-kg ball bounces backward at 14 m/s after the collision. Find the speed of the second ball after the collision.
20. A 1383-kg car moving south at 11.2 m/s is struck by a 1732-kg car moving east at 31.3 m/s. The cars are stuck together. How fast and in what direction do they move immediately after the collision?
21. A stationary billiard ball, with a mass of 0.17 kg, is struck by an identical ball moving at 4.0 m/s. After the collision, the second ball moves 60.0° to the left of its original direction. The stationary ball moves 30.0° to the right of the moving ball's original direction. What is the velocity of each ball after the collision?
22. A 1345-kg car moving east at 15.7 m/s is struck by a 1923-kg car moving north. They are stuck together and move with an initial velocity of 14.5 m/s at $\theta$ = 63.5°. Was the north-moving car exceeding the 20.1 m/s speed limit?