Physics Practice Test

The *Physics Practice Test* is provided as a *Blackline Master* on your *Teacher Resources CD*.

3b Blackline Master

Content Review

Have students take the practice test to evaluate their understanding. Students should use their results in conjunction with the checklist to evaluate and review their understanding of the physics concepts.

1. b

2. d

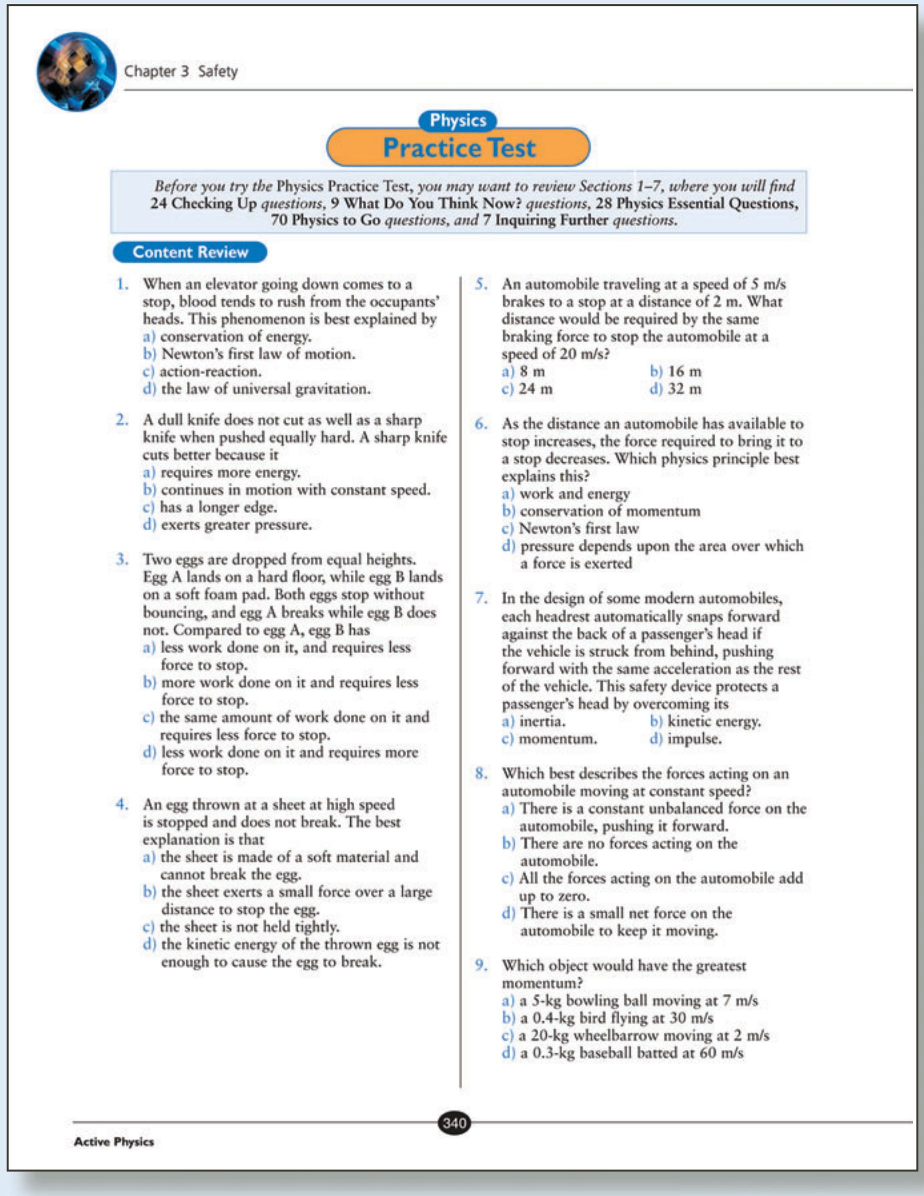
Pushing on a dull and a sharp knife with equal force distributes that force to the place of contact of the edge. The smaller the area of the edge, the greater the pressure (or force per area) at the edge, and hence, the better it cuts.

3. c

4. b

5. d

This question applies the $v^2 = 2ad$ rule, where the stopping distance increases as the square of the velocity. Since the velocity has increased by a factor of 4, from 5 m/s to 20 m/s, the stopping distance will increase by a factor of 4 squared or 16. Thus, the new stopping distance will be 16 times larger than the previous stopping distance or 16 m × 2, which equals 32 m.



Chapter 3 Safety

Physics Practice Test

Before you try the Physics Practice Test, *you may want to review Sections 1–7, where you will find* 24 Checking Up *questions,* 9 What Do You Think Now? *questions,* 28 Physics Essential Questions, 70 Physics to Go *questions, and* 7 Inquiring Further *questions.*

Content Review

1. When an elevator going down comes to a stop, blood tends to rush from the occupants' heads. This phenomenon is best explained by
   a) conservation of energy.
   b) Newton's first law of motion.
   c) action-reaction.
   d) the law of universal gravitation.

2. A dull knife does not cut as well as a sharp knife when pushed equally hard. A sharp knife cuts better because it
   a) requires more energy.
   b) continues in motion with constant speed.
   c) has a longer edge.
   d) exerts greater pressure.

3. Two eggs are dropped from equal heights. Egg A lands on a hard floor, while egg B lands on a soft foam pad. Both eggs stop without bouncing, and egg A breaks while egg B does not. Compared to egg A, egg B has
   a) less work done on it, and requires less force to stop.
   b) more work done on it and requires less force to stop.
   c) the same amount of work done on it and requires less force to stop.
   d) less work done on it and requires more force to stop.

4. An egg thrown at a sheet at high speed is stopped and does not break. The best explanation is that
   a) the sheet is made of a soft material and cannot break the egg.
   b) the sheet exerts a small force over a large distance to stop the egg.
   c) the sheet is not held tightly.
   d) the kinetic energy of the thrown egg is not enough to cause the egg to break.

5. An automobile traveling at a speed of 5 m/s brakes to a stop at a distance of 2 m. What distance would be required by the same braking force to stop the automobile at a speed of 20 m/s?
   a) 8 m b) 16 m
   c) 24 m d) 32 m

6. As the distance an automobile has available to stop increases, the force required to bring it to a stop decreases. Which physics principle best explains this?
   a) work and energy
   b) conservation of momentum
   c) Newton's first law
   d) pressure depends upon the area over which a force is exerted

7. In the design of some modern automobiles, each headrest automatically snaps forward against the back of a passenger's head if the vehicle is struck from behind, pushing forward with the same acceleration as the rest of the vehicle. This safety device protects a passenger's head by overcoming its
   a) inertia. b) kinetic energy.
   c) momentum. d) impulse.

8. Which best describes the forces acting on an automobile moving at constant speed?
   a) There is a constant unbalanced force on the automobile, pushing it forward.
   b) There are no forces acting on the automobile.
   c) All the forces acting on the automobile add up to zero.
   d) There is a small net force on the automobile to keep it moving.

9. Which object would have the greatest momentum?
   a) a 5-kg bowling ball moving at 7 m/s
   b) a 0.4-kg bird flying at 30 m/s
   c) a 20-kg wheelbarrow moving at 2 m/s
   d) a 0.3-kg baseball batted at 60 m/s

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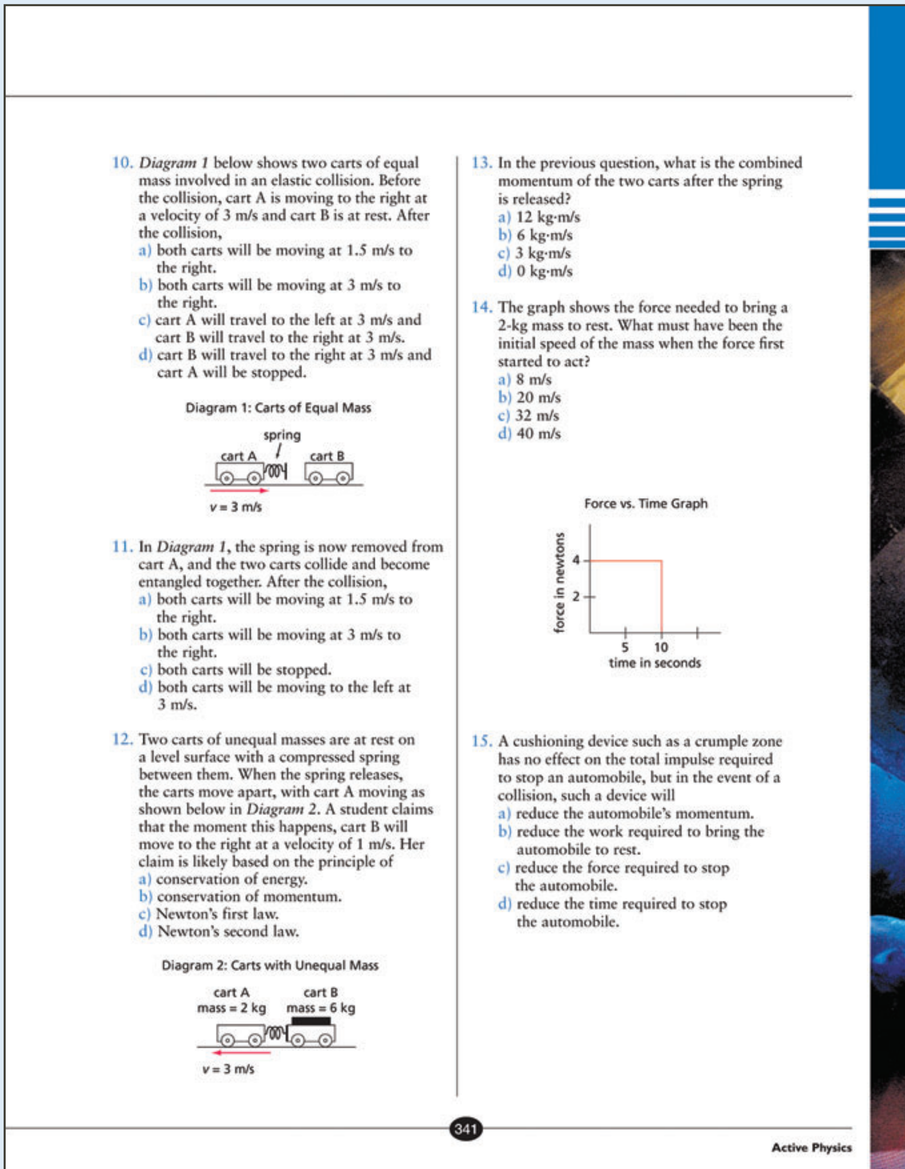
Active Physics

6. a

7. a

8. c

9. c



10. *Diagram 1* below shows two carts of equal mass involved in an elastic collision. Before the collision, cart A is moving to the right at a velocity of 3 m/s and cart B is at rest. After the collision,
a) both carts will be moving at 1.5 m/s to the right.
b) both carts will be moving at 3 m/s to the right.
c) cart A will travel to the left at 3 m/s and cart B will travel to the right at 3 m/s.
d) cart B will travel to the right at 3 m/s and cart A will be stopped.

Diagram 1: Carts of Equal Mass

11. In *Diagram 1*, the spring is now removed from cart A, and the two carts collide and become entangled together. After the collision,
a) both carts will be moving at 1.5 m/s to the right.
b) both carts will be moving at 3 m/s to the right.
c) both carts will be stopped.
d) both carts will be moving to the left at 3 m/s.

12. Two carts of unequal masses are at rest on a level surface with a compressed spring between them. When the spring releases, the carts move apart, with cart A moving as shown below in *Diagram 2*. A student claims that the moment this happens, cart B will move to the right at a velocity of 1 m/s. Her claim is likely based on the principle of
a) conservation of energy.
b) conservation of momentum.
c) Newton's first law.
d) Newton's second law.

Diagram 2: Carts with Unequal Mass

13. In the previous question, what is the combined momentum of the two carts after the spring is released?
a) 12 kg·m/s
b) 6 kg·m/s
c) 3 kg·m/s
d) 0 kg·m/s

14. The graph shows the force needed to bring a 2-kg mass to rest. What must have been the initial speed of the mass when the force first started to act?
a) 8 m/s
b) 20 m/s
c) 32 m/s
d) 40 m/s

Force vs. Time Graph

15. A cushioning device such as a crumple zone has no effect on the total impulse required to stop an automobile, but in the event of a collision, such a device will
a) reduce the automobile's momentum.
b) reduce the work required to bring the automobile to rest.
c) reduce the force required to stop the automobile.
d) reduce the time required to stop the automobile.

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Active Physics

10. d

11. a

This is a perfectly inelastic collision. Momentum is conserved, but energy is not. Students should realize that the final velocity of the carts must be the same as the initial. Below, the positive direction is chosen to the left.

$$p_{\text{initial}} = p_{\text{final}}$$

$$mv_{\text{initial A}} + mv_{\text{initial B}} = 2mv_{\text{final}}$$

$$m(3\text{ m/s}) + 0 = 2mv_{\text{final}}$$

$$v_{\text{final}} = \frac{m(3\text{ m/s})}{2m} = 1.5\text{ m/s}.$$

12. b

13. d

Students should reason this by noting that the total momentum of the system is conserved. Because the momentum of the system before the event was zero, it must be zero after the event.

14. b

Using the impulse-momentum theory, students should be able to calculate the initial speed.

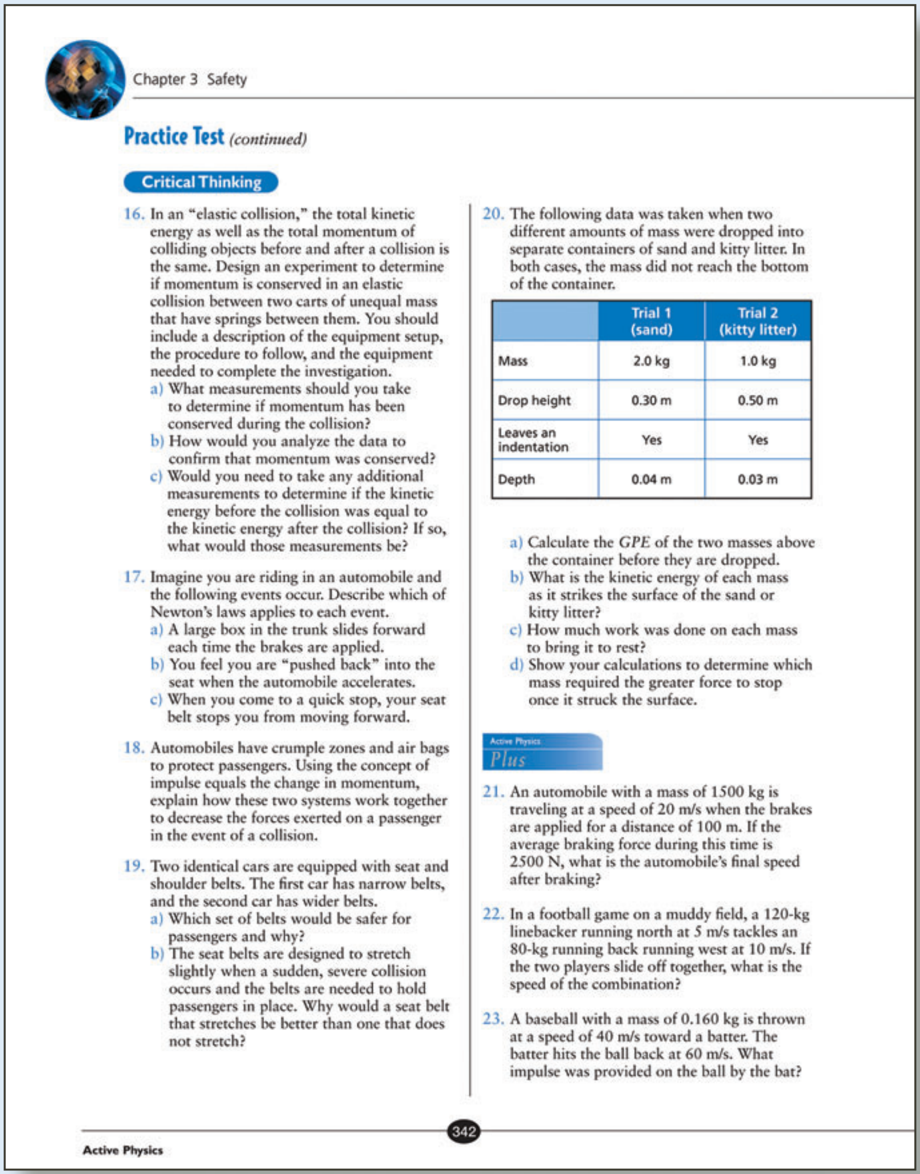
$F\Delta t = m\Delta v$

$(4\text{ N})(10\text{ s}) = (2\text{ kg})\Delta v$,

$\Delta v = 20$ m/s, indicating the initial velocity points in the direction opposite to the applied force.

15. c

CHAPTER 3



Practice Test *(continued)*

Critical Thinking

16. In an "elastic collision," the total kinetic energy as well as the total momentum of colliding objects before and after a collision is the same. Design an experiment to determine if momentum is conserved in an elastic collision between two carts of unequal mass that have springs between them. You should include a description of the equipment setup, the procedure to follow, and the equipment needed to complete the investigation.
    a) What measurements should you take to determine if momentum has been conserved during the collision?
    b) How would you analyze the data to confirm that momentum was conserved?
    c) Would you need to take any additional measurements to determine if the kinetic energy before the collision was equal to the kinetic energy after the collision? If so, what would those measurements be?

17. Imagine you are riding in an automobile and the following events occur. Describe which of Newton's laws applies to each event.
    a) A large box in the trunk slides forward each time the brakes are applied.
    b) You feel you are "pushed back" into the seat when the automobile accelerates.
    c) When you come to a quick stop, your seat belt stops you from moving forward.

18. Automobiles have crumple zones and air bags to protect passengers. Using the concept of impulse equals the change in momentum, explain how these two systems work together to decrease the forces exerted on a passenger in the event of a collision.

19. Two identical cars are equipped with seat and shoulder belts. The first car has narrow belts, and the second car has wider belts.
    a) Which set of belts would be safer for passengers and why?
    b) The seat belts are designed to stretch slightly when a sudden, severe collision occurs and the belts are needed to hold passengers in place. Why would a seat belt that stretches be better than one that does not stretch?

20. The following data was taken when two different amounts of mass were dropped into separate containers of sand and kitty litter. In both cases, the mass did not reach the bottom of the container.

	Trial 1 (sand)	Trial 2 (kitty litter)
Mass	2.0 kg	1.0 kg
Drop height	0.30 m	0.50 m
Leaves an indentation	Yes	Yes
Depth	0.04 m	0.03 m

    a) Calculate the *GPE* of the two masses above the container before they are dropped.
    b) What is the kinetic energy of each mass as it strikes the surface of the sand or kitty litter?
    c) How much work was done on each mass to bring it to rest?
    d) Show your calculations to determine which mass required the greater force to stop once it struck the surface.

Active Physics *Plus*

21. An automobile with a mass of 1500 kg is traveling at a speed of 20 m/s when the brakes are applied for a distance of 100 m. If the average braking force during this time is 2500 N, what is the automobile's final speed after braking?

22. In a football game on a muddy field, a 120-kg linebacker running north at 5 m/s tackles an 80-kg running back running west at 10 m/s. If the two players slide off together, what is the speed of the combination?

23. A baseball with a mass of 0.160 kg is thrown at a speed of 40 m/s toward a batter. The batter hits the ball back at 60 m/s. What impulse was provided on the ball by the bat?

Critical Thinking

16.a)

Measure the masses of each cart before and after the collision, and the velocities of each cart immediately before and immediately after the collision.

16.b)

Calculate the total momentum before the collision and after the collision. These should be equal to each other, within experimental uncertainty, if momentum is conserved. Otherwise it is not conserved.

$p_{\text{initial}} = p_{\text{final}}$

$mv_{\text{initial A}} + mv_{\text{initial B}} =$

$mv_{\text{final A}} + mv_{\text{final B}}$

16.c)

No additional measurements would be needed. The measured quantities could be used to determine the kinetic energy by using the formula

$KE_{\text{initial}} = \frac{1}{2}mv^2_{\text{initial A}} + \frac{1}{2}mv^2_{\text{initial B}}$

$KE_{\text{final}} = \frac{1}{2}mv^2_{\text{final A}} + \frac{1}{2}mv^2_{\text{final B}}$

17.a)

Newton's first law: An object in motion stays in motion until a force acts on it. The box keeps moving forward because the force of friction between the box and the truck is not great enough to hold it in place when the forward moving truck applies its brakes.

17.b)

Newton's first law and second law: An object at rest stays at rest and an object in motion stays in motion unless a net external force acts on it. Before the automobile accelerates (in the forward direction) you are moving with the automobile at a constant speed and direction (the speed can be zero). When the automobile begins to move faster, you do not move until an external force acts on you to push you forward. The frictional force from the bottom of the seat is not great enough to do this, and is not directly applied to your upper torso. Your torso is pushed forward by the seat back (Newton's second law). The organs within you are pushed forward by your body cavity. This creates the sensation of being pushed back in your seat.

17.c)

Newton's first law and second law. When you move forward in your seat, it is due to Newton's first law because no net external force is acting on you. When your seat belt stops you, it is due to Newton's second law as it exerts a force on you to change your motion (it brings your forward motion relative to the vehicle) to rest.

18.

Both air bags and crumple zones increase the distance and time over which a force is exerted. The impulse momentum equation, $Ft = m\Delta v$ says that since the automobile will be stopped in the collision, increasing the time available to stop the automobile means less force will be required to stop the automobile and its occupants. The smaller the force needed, the less harm will come to the passengers.

19.a)

The wider seat belts are safer for passengers because they spread out the applied force from the seat belt over a greater area, reducing the amount of pressure at any one point applied from the seat belt to the passenger. This avoids the seat belt from cutting in to the passenger.

19.b)

A seat belt that stretches is safer because it supplies a force on the passenger over a greater distance, reducing the force necessary to stop the passenger, and hence, reducing the risk of possible injury.

20.a)

$GPE = mgh$

$GPE_{sand} =$

$(2.0 \text{ kg})(9.8 \text{ m/s}^2)(0.30 \text{ m}) =$

5.9 J

$GPE_{litter} =$

$(1.0 \text{ kg})(9.8 \text{ m/s}^2)(0.50 \text{ m}) =$

4.9 J

20.b)

$\Delta KE = -\Delta GPE$

$KE_{final} = GPE_{initial}$

$KE_{final\ sand} = 5.9 \text{ J}$

$KE_{final\ litter} = 4.9 \text{ J}$

20.c)

$W = \Delta KE$

$W_{sand} = \Delta KE_{sand} = 5.9 \text{ J}$

$W_{litter} = \Delta KE_{litter} = 4.9 \text{ J}$

20.d)

$F \cdot d = \Delta KE$

$$F_{sand} = \frac{\Delta KE_{sand}}{d_{sand}} = \frac{5.9 \text{ J}}{0.04 \text{ m}} = 148 \text{ N}$$

$$F_{litter} = \frac{\Delta KE_{litter}}{d_{litter}} = \frac{4.9 \text{ J}}{0.03 \text{ m}} = 163 \text{ N}$$

The litter trial required more force to stop the mass once it struck the surface.

21. Active Physics *Plus*

Students should use the work-energy theorem.

$W = F \cdot d = \Delta KE$

$F \cdot d = \frac{1}{2}mv_{final}^2 - \frac{1}{2}mv_{initial}^2$

$(-2500 \text{ N})(100 \text{ m}) =$

$\frac{1}{2}(1500 \text{ kg})v_{final}^2 -$

$\frac{1}{2}(1500 \text{ kg})(20 \text{ m/s})^2$

$-250{,}000 \text{ J} =$

$(750 \text{ kg})v_{final}^2 - 300{,}000 \text{ J}$

$50{,}000 \text{ J} = (750 \text{ kg})v_{final}^2$

$$v_{final} = \sqrt{\frac{50{,}000 \text{ J}}{750 \text{ kg}}} = 8 \text{ m/s}$$

22. Active Physics *Plus*

Students should use the conservation of momentum.

$p_{initial} = p_{final}$

$m_A v_{initial\ A} + m_B v_{initial\ B} = m_{A+B} v_{final}$

$(120 \text{ kg})(5 \text{ m/s, north}) +$

$(80 \text{ kg})(10 \text{ m/s, west}) =$

$(200 \text{ kg})v_{final}$

$$v_{final} = \frac{(120 \text{ kg})(5 \text{ m/s, north})}{(200 \text{ kg})} + \frac{(80 \text{ kg})(10 \text{ m/s, west})}{(200 \text{ kg})} =$$

$3 \text{ m/s, north} + 4 \text{ m/s, west}.$

Students can then add these components together to find the magnitude and direction of the final velocity. The magnitude (size) of the final velocity is 5 m/s at an angle of 53° west of north.

23. Active Physics *Plus*

$F\Delta t = m\Delta v = m(v_{final} - v_{initial})$

Assuming the direction of the incoming ball is positive, you have

$F\Delta t =$

$(0.160 \text{ kg})(-60 \text{ m/s} - 40 \text{ m/s}) =$

$-16 \text{ kg} \cdot \text{m/s}.$

CHAPTER 3