Chapter 8 Vocab and Review

8 REVIEW

Concept Summary

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REVIEW

For: Self-Assessment

Visit: PHSchool.com

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Teaching Resources

• TeacherEXPRESS

• Virtual Physics Lab 11

• Conceptual Physics Alive!

 DVDs Momentum

think! Answers

8.1

The roller skate and truck can have the

same momentum if the speed of the roller

skate is much greater than the speed of the

truck. How much greater? As many times

greater as the truck’s mass is greater than

the roller skate’s mass. Get it? For example,

a 1000-kg truck backing out of a drive-

way at 0.01 m/s has the same momentum

as a 1-kg skate going 10 m/s. Both have

momentum = 10 kg m/s.

No. The impulse would be the same for

either surface because the same momen-

tum change occurs for each. It is the force

that is less for the impulse on the carpet

because of the greater time of momentum

change.

Since the time of impact increases five

times, the force of impact will be reduced

five times.

Yes, because no acceleration means that no

change occurs in velocity or in momentum

(mass velocity). Another line of reason-

ing is simply that no net force means there

is no net impulse and thus no change in

momentum.

The mass of the stuck-together gliders is

four times that of the unloaded glider.

Thus, the postcollision velocity of the

stuck-together gliders is one-fourth of the

unloaded glider’s velocity before collision.

This velocity is in the same direction as

before, since the direction as well as the

amount of momentum is conserved.

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A moving object can have a large mo-

mentum if it has a large mass, a high

speed, or both.

The change in momentum depends on

the force that acts and the length of time

it acts.

The impulse required to bring an ob-

ject to a stop and then to “throw it back

again” is greater than the impulse re-

quired merely to bring the object to a

stop.

The law of conservation of momentum

states that in the absence of an external

force, the momentum of a system re-

mains unchanged.

Whenever objects collide in the absence

of external forces, the net momentum of

both objects before collision equals the

net momentum of both objects after col-

lision.

The vector sum of the momenta is the

same before and after a collision.

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8.2.1

8.2.2

8.4

Key Terms

momentum (p. 125)

impulse (p. 126)

law of conservation

 of momentum (p. 131)

elastic

 collision (p. 132)

inelastic

 collision (p. 133)

8.5

CHAPTER 8

MOMENTUM

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ASSESS

Check Concepts

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Check Concepts

Section 8.1

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9. In a car crash, why is it advantageous for an

 occupant to extend the time during which

 the collision takes place?

10. If the time of impact in a collision is extend-

 ed by four times, how much does the force

 of impact change?

11. Why is it advantageous for a boxer to ride

 with the punch? Why should he avoid mov-

 ing into an oncoming punch?

Section 8.3

1. Distinguish between mass and momentum.

 Which is inertia and which is inertia in

 motion?

2. a. Which has the greater mass, a heavy truck

 at rest or a rolling skateboard?

 b. Which has greater momentum?

3. Distinguish between force and impulse.

Section 8.2

4. Distinguish between impact and impulse.

 Which designates a force and which is force

 multiplied by time?

5. When the force of impact on an object is

 extended in time, does the impulse increase

 or decrease?

6. Distinguish between impulse and momen-

 tum. Which is force time and which is

 inertia in motion?

7. Does impulse equal momentum, or a change

 in momentum?

12. Visualize yourself on a skateboard.

 a. When you throw a ball, do you experi-

 ence an impulse?

 b. Do you experience an impulse when you

 catch a ball of the same speed?

 c. Do you experience an impulse when you

 catch it and then throw it out again?

 d. Which impulse is greatest?

13. Why is more impulse delivered during a

 collision when bouncing occurs than during

 one when it doesn’t?

14. Why is the Pelton Wheel an improvement

 over paddle wheels with flat blades?

8. For a constant force, suppose the duration

 of impact on an object is doubled.

 a. How much is the impulse increased?

 b. How much is the resulting change in

 momentum increased?

Section 8.4

15. In terms of momentum conservation, why

 does a cannon recoil when fired?

16. What does it mean to say that momentum is

 conserved?

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Section 8.5Concept

17. Distinguish between an elastic and an in-

 elastic collision.

18. Imagine that you are hovering next to the

 space shuttle in an Earth orbit. Your buddy

 of equal mass, who is moving at 4 km/h

 with respect to the shuttle, bumps into you.

 If he holds onto you, how fast do you both

 move with respect to the ship?

Summary

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21. Below are before-and-after pictures of a

 car’s speed. The mass of the car doesn’t

 change.

Think and Rank

Section 8.6

19. Is momentum conserved for colliding

 objects that are moving at angles to one

 another? Explain.

Think and Rank

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Rank the following from greatest to least.

a. the magnitude of momentum change

b. the magnitude of the impulse producing

 the momentum change

22. Jogging Jake runs along a train flatcar that

 moves at the velocities shown. In each case,

 Jake’s velocity is given relative to the car.

Rank each of the following sets of scenarios in

order of the quantity or property involved. List

them from left to right. If scenarios have equal

rankings, then separate them with an equal sign.

(e.g., A = B)

20. The balls have different masses and speeds.

Rank the following from greatest to least.

a. momentum

b. the impulse needed to stop them

Rank the following from greatest to least.

a. the magnitude of Jake’s momentum rela-

 tive to the car

b. Jake’s momentum to the right relative to

 an observer at rest on the ground

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Plug and Chug

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 ASSESS

(continued)

23. Rick pushes crates starting at ••••••Concept Summary rest across

a floor for 3 seconds with a net force as

shown.

Think and Explain

28. A lunar vehicle is tested on Earth at a

 speed of 10 km/h. When it travels as fast

 on the moon, is its momentum more, less,

 or the same?

29. When you ride a bicycle at full speed and

 the bike stops suddenly, why do you have

 to push hard on the handlebars to keep

 from flying forward?

30. Can Andrew produce a net impulse on an

 automobile by sitting inside and pushing

 on the dashboard? Can the internal forces

 within a soccer ball produce an impulse

 on the soccer ball that will change its

 momentum?

31. Brian tries to jump from his canoe to the

 dock. He lands in the water, delighting his

 companions. What’s your explanation for

 his mishap?

32. Jason throws a ball horizontally while

 standing on roller skates. He rolls back-

 ward with a momentum that matches that

 of the ball. Will he end up rolling back-

 ward if he goes through the motions of

 throwing the ball, but does not let go of

 it? Explain.

33. The example in the previous question

 can be explained in terms of momentum

 conservation and in terms of Newton’s

 third law. Assuming you’ve answered it in

 terms of momentum conservation, an-

 swer it also in terms of Newton’s third law

 (or vice versa if you answered already via

 Newton’s third law).

For each crate, rank the following from

greatest to least.

a. change in momentum

b. final speed

c. momentum in 3 seconds

Plug and Chug

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The key equations of the chapter are shown below

in bold type.

Momentum

m

v

24. Calculate the momentum of a 10-kg bowl-

 ing ball rolling at 2 m/s.

25. Calculate the momentum of a 50-kg carton

 that slides at 4 m/s across an icy surface.

Impulse

Ft

26. Calculate the impulse when an average

 force of 10 N is exerted on a cart for 2.5 s.

27. Calculate the impulse when an average

 force of 10 N acts on a cart for 5.0 s.

Think and Explain

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For answers to Think and Explains and Think

and Solves, you may express momentum with the

symbol p. Then p mv.

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Concept Summary ••••••34. In the previous chapter, rocket propulsion

was explained in terms of Newton’s third

law. That is, the force that propels a rocket

is from the exhaust gases pushing against

the rocket, the reaction to the force the

rocket exerts on the exhaust gases. Explain

rocket propulsion in terms of momentum

conservation.

35. In terms of impulse and momentum, why

 are air bags in automobiles a good idea?

42. Many years ago, automobiles were manufac-

 tured to be as rigid as possible. Today’s autos

 are designed to crumple upon impact. Why?

43. Why is it difficult for a firefighter to hold a

 hose that ejects large amounts of water at

 high speed?

44. You can’t throw a raw egg against a wall

 without breaking the shell, but you can

 throw it at the same speed into a sagging

 sheet without breaking it. Explain.

45. Why can Muhammad exert a greater punch-

 ing force with his bare fist than he can while

 wearing a boxing glove?

36. Why do gymnasts use floor mats that are

 very thick?

37. When jumping from a significant

 height, why is it advantageous to land with

 your knees slightly bent?

38. In terms of impulse and momentum, why

 are nylon ropes, which stretch consider-

 ably under tension, favored by mountain

 climbers?

39. Would it be a dangerous mistake for a

 bungee jumper to use a steel cable rather

 than an elastic cord?

40. When catching a foul ball at a baseball

 game, why is it important to extend your

 bare hands upward so they can move down-

 ward as the ball is being caught?

41. Why would it be a poor idea to have the

 back of your hand up against the outfield

 wall when you catch a long fly ball?

46. Why do 6-ounce boxing gloves hit harder

 than 16-ounce gloves?

47. Suppose you roll a bowling ball into a pillow

 and the ball stops. Now suppose you roll it

 against a spring and it bounces back with an

 equal and opposite momentum.

 a. Which object exerts a greater impulse, the

 pillow or the spring?

 b. If the time it takes the pillow to stop the

 ball is the same as the time of contact of

 the ball with the spring, how do the aver-

 age forces exerted on the ball compare?

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MOMENTUM

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(continued)

48. If you topple from your treehouse, you’ll

continuously gain momentum as you fall to

the ground below. Doesn’t this violate the

law of conservation of momentum? Defend

your answer.

Think and Solve

49. If a fully loaded shopping cart and an

 empty one traveling at the same speed have

 a head-on collision, which cart will experi-

 ence the greater force of impact? The greater Think and Solve ••••••

 impulse? The greater change in momentum?

 54. Using units, show that kg.m/s is equiva-

 The greater acceleration?

 lent to N.s.

50. A bug and the windshield of a fast-moving

 car collide. Indicate whether each of the fol- 55. A 1000-kg car moving at 20 m/s slams into

 a building and comes to a halt. Which of the

 lowing statements is true or false.

 following questions can be answered using

 a. The forces of impact on the bug and on

 the given information, and which one can-

 the car are the same size.

 not be answered? Explain.

 b. The impulses on the bug and on the car

 a. What impulse acts on the car?

 are the same size.

 b. What is the force of impact on the car?

 c. The changes in speed of the bug and of

 the car are the same.56. A car with a mass of 1000 kg moves at

 d. The changes in momentum of the bug20 m/s. What braking force is needed to

 and of the car are the same size.bring the car to a halt in 10 s?

51. What difference in recoil would you expect

 in firing a solid ball versus firing a hollow

 ball from the same cannon? Explain.

57. A 2-kg blob of putty moving at 3 m/s slams

 into a 2-kg blob of putty at rest.

 a. Calculate the speed of the two stuck-

 together blobs of putty immediately

 after colliding.

 b. Calculate the speed of the two blobs if

 the one at rest was 4 kg.

58. A 1-kg dart moving horizontally at 10 m/s

 strikes and sticks to a wood block of mass

 9 kg, which slides across a friction-free level

 surface. What is the speed of the block and

 the dart after the collision?

53. A proton from an accelerator strikes an

 atom. An electron is observed flying for-

 ward in the same direction the proton was

 moving and at a speed much greater than

 the speed of the proton. What conclusion

 can you draw about the relative mass of a

 proton and an electron?

52. A group of playful astronauts, each with a

 bag full of balls, form a circle as they free-

 fall in space. Describe what happens when

 they begin tossing balls simultaneously to

 one another.

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8 ASSESS

59. Assume an 8-kg bowling ball moving atConcept Summary ••••••

2 m/s bounces off a spring at the same

speed that it had before bouncing.

a. What is its momentum of recoil?

b. What is its change in momentum?

 (Hint: What is the change in temperature

 when something goes from 1° to –1°?)

c. If the interaction with the spring occurs

 in 0.5 s, calculate the average force the

 spring exerts on it.

65. A 5-kg fish swimming 1 m/s swallows an

 absent-minded 1-kg fish at rest. What is the

 speed of the large fish immediately after

 lunch? What would its speed be if the small

 fish were swimming toward it at 4 m/s?

60. Brakes are applied in bringing a 1200-kg

 car moving at 25 m/s to rest in 20.0 s. Show

 that the amount of braking force is 1500 N.

61. A 20.0-kg mass moving at a speed of

 3.0 m/s is stopped by a constant force of

 15.0 N. Show that the stopping time re-

 quired is 4.0 s.

62. A 1-kg ostrich egg is thrown at 2 m/s at

 a bed sheet and is brought to rest in 0.2 s.

 Show that the average amount of force on

 the egg is 10 N.

63. A railroad diesel engine weighs four times

 as much as a freight car. If the diesel engine

 coasts at 5 km/h into a freight car that is

 at rest, how fast do the two coast after they

 couple?

64. A comic-strip superhero meets an

 asteroid in outer space and hurls it at

 100 m/s. The asteroid is a thousand times

 more massive than the superhero is. In the

 strip, the superhero is seen at rest after the

 throw. Taking physics into account, what

 would be his recoil speed? What is this in

 miles per hour?

Activity

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66. Visit your local pool or billiards parlor and

 bone up on momentum conservation. Note

 that no matter how complicated the colli-

 sion of balls, the momentum along the line

 of action of the cue ball before impact is the

 same as the combined momentum of all the

 balls along this direction after impact. Also,

 the components of momenta perpendicu-

 lar to this line of action add to zero after

 impact, the same value as before impact in

 this direction. When rotational skidding,

 English, is imparted by striking the cue ball

 off center, rotational momentum, which is

 also conserved, somewhat complicates the

 analysis. But regardless of how the cue ball

 is struck, in the absence of external forces,

 both linear and rotational momentum are

 always conserved. Pool or billiards offers a

 first-rate exhibition of momentum conser-

 vation in action.

Activity

Teaching Resources

More Problem-Solving Practice

Appendix F

CHAPTER 8

MOMENTUM

• Computer Test Bank

• Chapter and Unit Tests

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