Date ____________ Period ____________ Name ____________________

CHAPTER 9

Study Guide

Momentum and Its Conservation

Vocabulary Review

Write the term that correctly completes the statement. Use each term once.

angular impulse-angular momentum theorem
momentum
angular momentum
closed system
impulse
impulse-momentum theorem
isolated system
law of conservation of angular momentum
law of conservation of momentum

1. ____________________ The product of a rotating object's moment of inertia and its angular velocity is the _____ of the object.

2. ____________________ The _____ states that the momentum of any closed, isolated system does not change.

3. ____________________ The _____ states that the angular impulse on an object equals the difference in the object's final and initial angular momenta.

4. ____________________ The _____ states that an object's initial angular momentum equals its final angular momentum when no external torque acts on the object.

5. ____________________ In a(n) _____, mass in neither gained nor lost.

6. ____________________ The product of the average force on an object and the time interval over which it acts is _____.

7. ____________________ In a(n) _____, no net external force is exerted on the system.

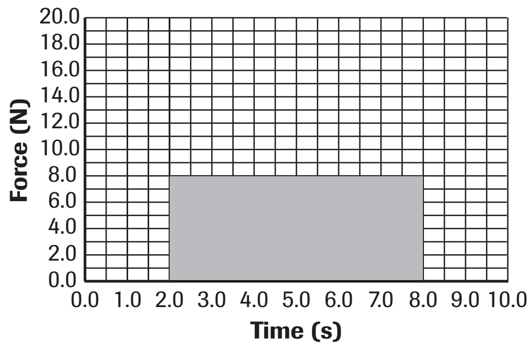
8. ____________________ When mass is multiplied by velocity, the answer is a measure of _____.

9. ____________________ The _____ states that the impulse on an object is equal to the change in the object's momentum.

Section 9.1 Impulse and Momentum

In your textbook, read about relating impulse and momentum on pages 230–231.

The diagram shows the force-time graph for a force acting on a 12.0-kg cart initially at rest on a frictionless surface. Use the diagram to answer questions 1–8. Show your calculations where necessary.



1. What is the magnitude of the force acting on the cart? ____________________

2. How long does the force act on the cart? ____________________

3. The shaded area of the graph represents ____________________.

4. The algebraic expression that represents the shaded area of the graph is

____________________.

5. What is the amount of impulse acting on the cart? ____________________

6. The algebraic expression that represents the momentum of the cart is

____________________.

7. What is the change in momentum of the cart?

8. The final velocity of the cart is ____________________.

In your textbook, read about using the impulse-momentum theorem on page 231.

Read each statement below. For each situation, calculate v_i, v_f, p_i, p_f, ***the impulse vector*** $F\Delta t$, ***and the amount of force needed for the change to occur. All situations refer to a truck with a mass of 2840 kg.***

9. The truck has a velocity of 8.30 m/s and comes to a stop in 15.0 s.

10. The truck, initially at rest, reaches a velocity of 8.30 m/s in 20.0 s.

11. The truck is at rest. In 5.00 s, the truck backs up to a speed of 1.38 m/s.

12. The truck is moving backward with a velocity of 1.38 m/s and comes to a stop in 5.00 s.

In your textbook, read about the impulse-momentum theorem as it applies to air bags on page 231.

Answer the following questions. Use complete sentences.

13. List two ways in which impulse can be increased.

____

____

____

14. How does an air bag reduce injuries that would be caused by the steering wheel during an accident? Write your answer in terms of impulse.

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____

In your textbook, read about angular momentum on pages 233–235.

Read each statement below. If the statement is true, write* true*. If the statement is false, rewrite the italicized part to make the statement true.

________ **15.** The moment of inertia of a fixed, solid object *cannot* be changed.

________ **16.** *Linear* momentum is the product of the moment of inertia and angular velocity for a rotating object.

________ **17.** A change in *torque* on an object results in a change in angular momentum.

________ **18.** As an ice skater spins and pulls her arms closer to her body, her angular momentum *decreases* because of the change in her moment of inertia.

________ **19.** An object's moment of inertia depends upon the *distribution of mass* about the axis of rotation.

________ **20.** As each planet orbits the Sun, its angular momentum is *zero* because the gravitational torque on each planet is zero.

________ **21.** A planet moves *slower* when its distance from the Sun decreases.

Section 9.2 Conservation of Momentum

In your textbook, read about two-particle collisions on pages 236–237.

Read the following sentences. Use complete sentences to comment on items 1–3.

Two balls, A and B, are traveling at different speeds and have different masses. They collide head-on and rebound in opposite directions as part of a closed, isolated system.

1. the force that ball A exerts on ball B and the force that ball B exerts on ball A

____

____

____

2. the impulses received by both balls

____

____

____

3. the total momenta of the balls before the collision and after the collision

____

____

____

In your textbook, read about momentum in a closed, isolated system on pages 236–237.
Write the term that correctly completes the statement. Use each term once.

change	**external forces**	**isolated system**
closed system	**interaction**	**law of conservation of momentum**
conditions	**internal forces**	

A(n) (**4**) ______________ is a system that does not gain or lose mass. Within such a system, all forces are (**5**) ______________. Forces that are outside this system are (**6**) ______________. This system is a(n) (**7**) ______________ when the net external force on it is zero. The (**8**) ______________ states that the momentum of the system does not (**9**) ______________ if the system has no net external forces acting on it. You can use this law to relate (**10**) ______________ before and after an interaction even if you do not know any details of the (**11**) ______________.

In your textbook, read about recoil on pages 238–239.
Write* less than zero, zero, *or* greater than zero *in the blanks for questions 12–15. For questions 16 and 17, circle the answer that best completes the statement.

Two in-line skaters are standing still on a surface that is smooth so that there are no external forces. The first skater gives the second skater a push in one particular direction. The momentum of the system before the push is (**12**) ______________. The momentum of the system after the push is (**13**) ______________. The momentum of the first skater after the collision is (**14**) ______________, and that of the second skater is (**15**) ______________.

16. The momentum of the first skater after the push can be written as $\boldsymbol{p}_{\mathrm{Af}}$, or it can be written as

a. $\boldsymbol{p}_{\mathrm{Ai}}$

b. $+\boldsymbol{p}_{\mathrm{Bf}}$

c. $-\boldsymbol{p}_{\mathrm{Bf}}$

d. 0

17. If the velocity of the second skater after the push is represented by v_{Bf}, the velocity of the first skater after the push is

a. $+\frac{m_{\mathrm{A}}}{m_{\mathrm{B}}} v_{\mathrm{Bf}}$

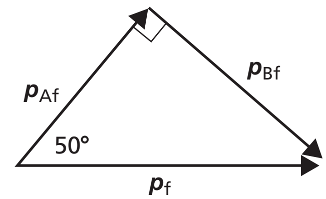
b. 0

c. $-\frac{m_{\mathrm{B}}}{m_{\mathrm{A}}} v_{\mathrm{Bf}}$

d. $-\frac{m_{\mathrm{A}}}{m_{\mathrm{B}}} v_{\mathrm{Bf}}$

In your textbook, read about two-dimensional collisions on page 241.

Read the paragraph below. Label the momentum diagram at right, indicating the final momentum of the system, p_f; the momenta of both balls after the collision, p_{Af} and p_{Bf}; the right angle; and the 50.0° angle.



A 4.0-kg ball, A, is moving at a speed of 3.0 m/s. It collides with a stationary ball, B, of the same mass. After the collision, ball A moves off in a direction of 50.0° to the left of its original direction. Ball B moves off in a direction of 90.0° to the right of ball A's final direction.

For each description given, write the letter of the matching term.

______ **18.** the magnitude of the total momentum of the system before the collision

______ **19.** the magnitude of the total momentum of the system after the collision

______ **20.** the magnitude of ball A's final momentum

______ **21.** the magnitude of ball B's final momentum

a. (12 kg·m/s)(cos 50.0°)

b. 12 kg·m/s

c. (12 kg·m/s)(sin 50.0°)

d. p_{Ai}

22. Skater N, 58.9 kg, is moving north at a speed of 7.8 m/s when she collides with Skater E, 72.6 kg, moving east at 3.5 m/s. The two skaters are stuck together. In what direction and with what speed do they move after the collision? Draw and label a momentum-vector diagram. Show your calculations.