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CK-12 Physics - Intermediate Workbook



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CHAPTER **1**

What is Science? Worksheets

Chapter Outline

- 1.1 SCIENTIFIC INQUIRY
 - 1.2 FUNDAMENTAL UNITS AND STANDARD UNITS
 - 1.3 UNIT CONVERSIONS
 - 1.4 MEASUREMENT AND RECORDING DATA
 - 1.5 WORKING WITH ERROR
 - 1.6 REFERENCES
-

1.1 Scientific Inquiry

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Explain the role of using postulates in science.

1. Why is your friend incorrect when they state, "But that is *only* a scientific theory"?
2. Choose two important steps in a scientific investigation and describe them below.

Lesson Objective: Explain the role of mathematics in science.

3. Give an example in which we use numbers to describe something in the physical world around us.
4. Why do you think scientists record their experimental data as numbers instead of drawing representative pictures?

Lesson Objective: Explain how scientists investigate nature by ensuring their models can be proven incorrect (falsifiable) and are tested by many independent researchers.

5. Develop a scientific investigation to address the following question: "Does heating a cup of water allow it to dissolve more salt?"
6. Is there only one correct way to develop a scientific explanation?

Lesson Objective: Describe the difference between a hypothesis, theory, and law.

7. What is a hypothesis? Give an example.
8. What is a scientific theory? Give an example.

9. What is a scientific law? Give an example.

Lesson Objective: Explain that new theories explain phenomena more accurately than preexisting theories, and such theories are consistent with the correct predictions of previous theories.

10. Why is it important that scientific theories are able to change?
11. Why does science involve repeating experiments and examining sources of error?

Lesson Objective: Describe the scientific method.



FIGURE 1.1

11. List three observations regarding the image 1.1.
12. Pick one observation from your list above and develop a hypothesis. Be sure to include your reasoning for this prediction.

1.2 Fundamental Units and Standard Units

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: List and use fundamental units in the study of mechanics.

1. What is a fundamental unit?
2. What is an example of a fundamental unit?
3. Give an example of how fundamental units can be used to derive another units.
4. Force is measured in Newtons. If the equation for Force is $F = ma$, how can you express Newtons in fundamental units?

Lesson Objective: List and use standard units in the study of mechanics.

5. The standard unit for mass is _____.
6. The standard unit for temperature is _____.
7. Make the following metric conversions:
 - a. 7.64 g to kg
 - b. 987 cm to m
 - c. 65 ms to s
8. Describe how the kilometer, centimeter and millimeter relate to the base unit of the meter.

Lesson Objective: Use dimensional analysis.

9. What is dimensional analysis? Give an example.
10. It is best to use dimensional analysis when:
 - a. making scientific observations
 - b. recording experimental data
 - c. deriving the units of a number

d. none of the above

11. Explain why the following equation does not correctly convert 5 centimeters into meters using dimensional analysis:
12. $5 \text{ cm} \times \frac{100 \text{ cm}}{1 \text{ m}} = 500 \frac{\text{cm}^2}{\text{m}}$
- 13.
- 14.
15. Use dimensional analysis to calculate how many dozen donuts you would need to order to feed a school of 456 students.

16. Use dimensional analysis to calculate how many quarters are in 50 dollars.

1.3 Unit Conversions

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Perform unit conversions.

1. What is a conversion factor?
2. Provide two examples of conversion factors.
3. Explain how a conversion factor is different from a measurement.
4. How many hours are there in 3 days?
5. An NFL linebacker weighs 252 lbs. What is his weight in kg if $1 \text{ lb} = 0.454 \text{ kg}$?

Properly use scientific notation.

6. When writing an extremely **small** number in scientific notation, the exponent will be:
 - a. Positive
 - b. Negative
 - c. Zero
 - d. None of the above
7. When writing an extremely **large** number in scientific notation, the exponent will be:
 - a. Positive
 - b. Negative
 - c. Zero
 - d. None of the above
8. Convert the following numbers to scientific notation.
 - a. 7000
 - b. 0.000 087
 - c. 543
 - d. 254000
9. Convert the following numbers out of scientific notation.

- a. 5.32×10^{-3}
- b. 6.35×10^5
- c. 4.2×10^4
- d. 3.5×10^{-4}

10. Solve the following problems and write your answer in scientific notation.

- a. $(9.0 \times 10^9) \times (2.7 \times 10^{-4})$
- b. $(5.0 \times 10^{-6}) \div (3.5 \times 10^2)$

1.4 Measurement and Recording Data

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Describe measurement.

1. A measurement is based on
 - a. qualitative observations
 - b. quantitative observations
 - c. hypotheses
 - d. none of the above
2. Which one of the following is a reasonable measurement for the height of a coconut palm tree?
 - a. 250 m
 - b. 25 m
 - c. 2.5 m
 - d. 0.25 m

Explain what is meant by significant digits.

3. What are significant figures?
4. What are significant figure rules involving zero?
5. What is a right-end zero?
6. What is a left-end zero?

Determine the number of significant digits in a measurement.

7. Round the following numbers to 3 significant figures:
 - a. 8.666
 - b. 123,456,789
 - c. 5.363
 - d. 0.00632
 - e. 407.5
8. Determine the number of significant figure in each of the following:

- a. 15.42
 - b. 0.00000000000078
 - c. 9.06
 - d. 1.5×10^5
 - e. 909,000
 - f. 909,000.00
9. Apply the rule of zeros to determine the amount of significant figures in the following measurements:
- a. 900 m
 - b. 0.00000053 mm
 - c. 89,000 kg
 - d. 6,000,000,000,000.0 g

Add, subtract, multiply, and divide with significant digits.

10. Solve each of the following, keeping the correct number of significant figures in the answer:
- a. $2.4 + 13.5 + 3.38 =$
 - b. $0.050 \times 0.000080 =$
 - c. $0.025/0.00755 =$
11. When doing math with significant figures, what determines the number of significant figures in the answer?

Use scientific notation.

12. Convert the following numbers to scientific notation.
- a. 765000
 - b. 87
 - c. 0.0000543
 - d. 5500
13. Convert the following numbers out of scientific notation.
- a. 5.67×10^{-3}
 - b. 6.0×10^5
 - c. 2.456×10^4
 - d. 3.29×10^4

1.5 Working with Error

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Describe systematic and random error.

1. What is a systematic error?
2. What is a random error?
3. What is an example of a systematic error?
4. What is an example of a random error?
5. When using a force probe, a physics student forgets to calibrate the instrument. This will most likely result in:
 - a. A systematic error
 - b. A random error
 - c. Both A B
 - d. None of the above

Explain precision and accuracy as they relate to error.

6. What is accuracy?
7. What is precision?
8. The mass of a particular red clay brick is 3 kg.
 1. Provide an example of a data set that is both accurate and precise.
 2. Provide an example of a data set that is not accurate and but is precise.

1.6 References

1. Jon Clegg. <http://www.flickr.com/photos/jonclegg/4457694598/> . CC-BY 2.0

CHAPTER

2

One-Dimensional Motion Worksheets

Chapter Outline

- 2.1 LOCATING AN OBJECT: DISTANCE AND DISPLACEMENT
 - 2.2 SPEED AND VELOCITY IN ONE DIMENSION
 - 2.3 AVERAGE SPEED, VELOCITY, AND INSTANTANEOUS VELOCITY
 - 2.4 UNIFORM ACCELERATION
 - 2.5 THE KINEMATIC EQUATIONS
 - 2.6 REFERENCES
-

2.1 Locating an Object: Distance and Displacement

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Define scalar and vector.

1. In your own words, explain why displacement is a vector.
2. In your own words, explain why distance is scalar.
3. How do we use positive and negative signs to communicate the direction of a vector?

Lesson Objective: Define distance and displacement.

Lisa traveled 7 miles to the nearest movie theater. She watched a movie and drove back home.

4. What total distance did Lisa travel?
5. What is Lisa's displacement?

Describe a real-life example for each of the following scenarios:

6. The distance an object travels is larger than its displacement.
7. The distance an object travels is equal to its displacement.
8. An object travels a positive distance but has zero displacement.

Lesson Objective: Distinguish between distance and displacement.

Joe hits a home run 200 ft over left field.

9. Is 200 feet the ball's distance or displacement?
10. Which is greater, the ball's distance or displacement?
11. If the bases are 90 ft apart, what is the distance Joe travels if he hits a home run and runs around all 4 bases?
12. What is Joe's displacement after his run around the bases?

Lesson Objective: Graphically model distance and displacement.

While relaxing on a blanket in the park, Sonia observes a lizard moving quickly about. She immediately gets out her notebook and creates the following data table of the lizard's movements:

13. Graphically model the distance the lizard has traveled.
14. Graphically model the displacement the lizard has traveled.

2.2 Speed and Velocity in One Dimension

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Define constant speed and velocity.

1. In your own words, define constant speed and provide an example of an object moving with a constant speed.
2. When calculating the velocity of a moving object, do you need to consider the distance traveled or the object's displacement? Explain.
3. You are flying 2586 miles from San Francisco to New York. An hour into the flight, you are 600 miles from San Francisco. What is your speed in m/s?
4. The pilot looks at the speedometer on the plane and it reads 615 mph. This is a measure of the:
 - a. Average speed
 - b. Instantaneous speed
 - c. Average velocity
 - d. Instantaneous velocity

Lesson Objective: Distinguish between speed and velocity.

You get in your car to drive to school at 7:33 am and drive 10 miles north at a constant speed until 7:45 am, when you realize you left your homework on the kitchen table. You turn around and drive 10 miles south back to your house and retrieve your homework at 8:00 am. You get back in the car and drive 15 miles north to school at a constant speed arriving at school at 8:29 am sharp, just in time to make it before the bell rings.

5. What is your average speed in m/s?
6. What is your average velocity?
7. If you looked at your speedometer on your drive to school and it read 30mph, this value describes your
 - a. Instantaneous speed
 - b. Average speed
 - c. Instantaneous velocity
 - d. Average velocity

Lesson Objective: Determine velocity from position-time graphs.

Describe the direction of motion of the following objects based on the slope of their position-time graphs:

8. Positive slope
9. Negative slope
10. Slope equals zero (horizontal line)
11. The following data table depicts the motion of a mouse as it runs rightward across a street. Create a position-time graph and use your graph to derive the mouse's velocity.

2.3 Average Speed, Velocity, and Instantaneous Velocity

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Calculate average speed for varying rates.

The data table below describes the motion of a marble. Use the information in the data table to answer questions #1-6.

1. At $t = 29$ s, what is the position of the marble?
2. Solve for the total distance traveled by the marble.
3. Solve for the average speed of the marble.
4. Solve for the displacement of the marble.
5. Solve for the average velocity of the marble.
6. Create a position-time graph for the marble.

Lesson Objective: Explain what is meant by instantaneous velocity.

The data table below describes the motion of a paper airplane. Use the information in the data table to answer questions #7-12.

7. Complete the table above by solving for the instantaneous velocity of the paper airplane.
8. Solve for the average velocity of the paper airplane.
9. What is the instantaneous velocity of the paper airplane at $t=6$ s?
10. Explain why the instantaneous velocity at $t=6$ s and the average velocity of the paper airplane are different values.

11. Create a position-time graph for the paper airplane.
12. Explain how you could use your graph determine the paper plane's instantaneous velocity at 7 s.

2.4 Uniform Acceleration

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Define and explain acceleration.

1. Complete the chart below:
2. Explain how an object can have a rightward velocity and a leftward acceleration.
3. If an object is moving rightward and speeding up, the sign of the acceleration must be
 - a. Positive
 - b. Negative
4. Explain the reason for your answer in question #3.
5. Explain why the following statement is a misconception, "An object does not accelerate if it remains at the same speed but changes direction".

Provide an example for each of the following scenarios described in #6-7:

6. A moving object with a large velocity and a small acceleration.
7. A moving object with a positive velocity and a negative acceleration.

Use the information in the chart below to answer questions #8-10.

8. What is the average acceleration?
9. Create a v-t graph
10. Describe how you could use the graph to derive acceleration?

2.5 The Kinematic Equations

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Interpret area in an acceleration-time graph.

Use the graph below for questions #1-3.

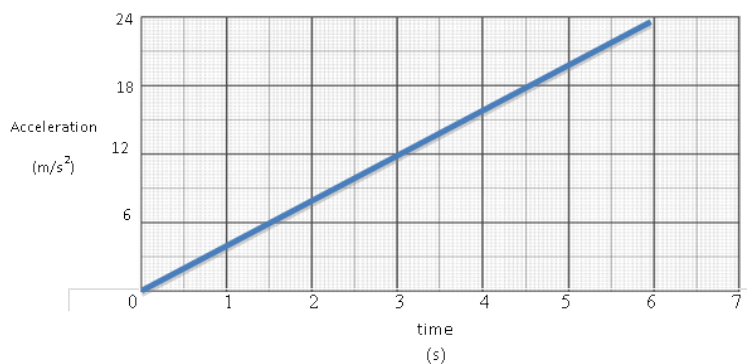


FIGURE 2.1

- Without doing any calculations, will the velocity at $t=3$ s be positive, negative or zero?
 - positive
 - negative
 - zero
- Explain the reason for your choice in question #1:
- Calculate the instantaneous velocity at $t=3$ s.

Lesson Objective: Represent motion using a velocity-time graph.

Draw the resulting velocity-time graphs for the given position-time graphs in questions #4-6.

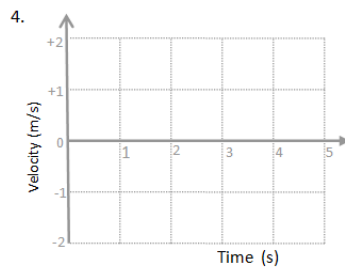
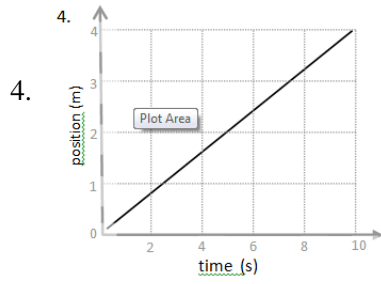


FIGURE 2.2

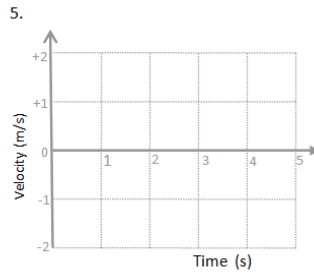
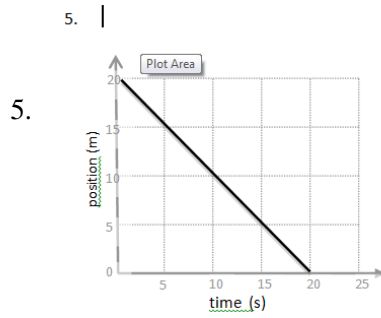


FIGURE 2.3

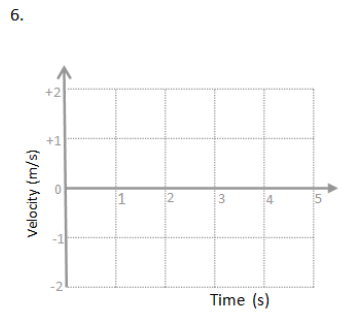
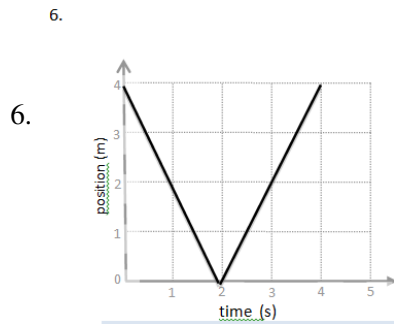


FIGURE 2.4

Lesson Objective: Interpret slope and area in a velocity-time graph.

Use the velocity-time graph below to answer questions #7-12.

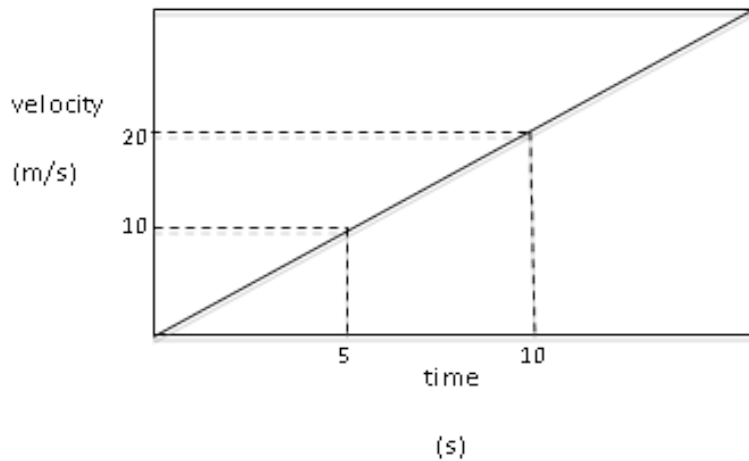


FIGURE 2.5

7. Without doing any calculations, predict the sign of the displacement according to the graph above.
 - a. positive
 - b. negative
 - c. zero
8. Explain the reason for your choice in question #6.
9. Calculate the displacement at $t=10$ s.
10. Without doing any calculations, will the average acceleration be positive, negative or zero?
 - a. positive
 - b. negative
 - c. zero
11. Explain the reason for your choice in question #10.
12. Calculate the instantaneous acceleration at $t=10$ s.

2.6 References

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4. . . CK-12 Foundation
5. . . CK-12 Foundation

CHAPTER

3

Two-Dimensional Motion Worksheets

Chapter Outline

- 3.1 INDEPENDENCE OF MOTION ALONG EACH DIMENSION
 - 3.2 VECTOR REPRESENTATION
 - 3.3 INERTIAL FRAMES AND RELATIVE MOTION
 - 3.4 PROJECTILE MOTION
-

3.1 Independence of Motion Along Each Dimension

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how motion along each axis can be resolved independently

1. Provide a real-world example that supports this concept: Motion in each dimension works independently.
2. A penny is dropped from 2 m high. How long does it take the penny to hit the floor?
3. A penny is pushed horizontally off a desk 2m high. How long does it take the penny to hit the floor?
4. Compare your answers to question #2 and question #3. Provide a reason for any similarities or differences.
5. Create a horizontal position-time (x-t) graph and a vertical position-time (y-t) graph for a penny that is pushed off a table that is 2 m high with an initial x-velocity of 3.6 m/s.

Lesson Objective: Solve problems involving objects, which are simultaneously under the influence of uniform acceleration and constant velocity along different dimensions

6. Complete the chart below, describing the two-dimensional motion of a soccer ball that is kicked from the ground with an initial horizontal velocity of +3 m/s and an initial vertical velocity of +5 m/s.

3.2 Vector Representation

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Explain the relationship between coordinates and components.

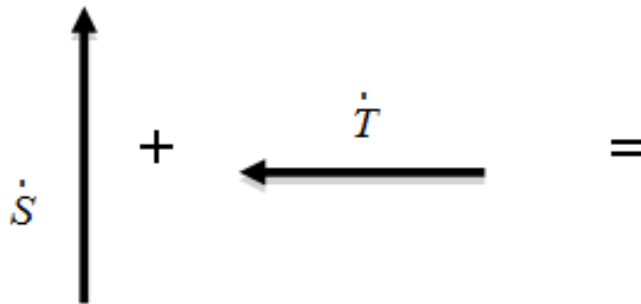
1. In your own words, describe the components of a two-dimensional vector.
2. Provide an example of a two-dimensional vector and break it up into its components.
3. Explain the relationship between coordinates and components.

Lesson Objective: Use vectors and vector components to add and subtract vectors.

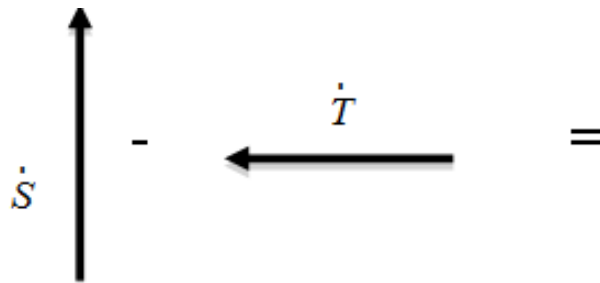
Use the following prompt for questions #4-5:

Vector \vec{A} has components (15,-2) and Vector \vec{B} has components (-1,9).

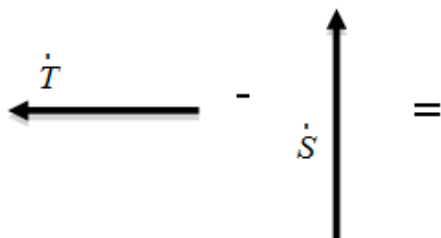
4. Find the sum of \vec{A} and \vec{B} ; call the result \vec{C} .
5. Find the difference $\vec{B} - \vec{A}$; call the result \vec{D} .
6. Draw the resultant vector of $(\vec{S} + \vec{T})$.



7. Draw the resultant vector of $(\vec{S} - \vec{T})$.

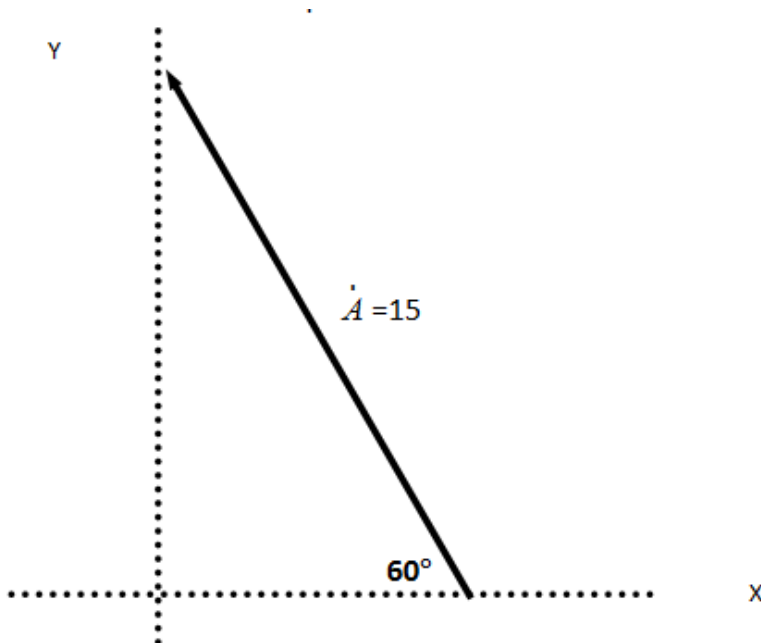


8. Draw the resultant vector of $(\vec{T} - \vec{S})$.



Lesson Objective: Use trigonometric relationships to express vector components.

Use the diagram below of Vector \vec{A} to answer questions #9-13.



9. Describe how you could use trigonometry to solve for the magnitude of the X and Y components of the two-dimensional vector \vec{A} .
10. Use trigonometry to solve for the magnitude of the x-component of Vector \vec{A} .
11. Use trigonometry to solve for the magnitude of the y-component of Vector \vec{A} .

12. What is the direction of the x-component of Vector \vec{A} ?
- a. North
 - b. South
 - c. East
 - d. West
13. What is the direction of the y-component of Vector \vec{A} ?
- a. North
 - b. South
 - c. East
 - d. West

3.3 Inertial Frames and Relative Motion

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Explain frames of reference and inertial frames..

1. What is a frame of reference? Provide an example
2. What is an inertial frame of reference? Provide an example.
3. Circle the objects below that could be used as a frame of reference.
 - A plane traveling at a constant velocity of 500 mph
 - Your desk
 - The finish line of a race
 - A car using cruise control, traveling at 65 mph on the highway
 - A ball in the air, accelerating at -10 m/s^2 due to the Earth's gravity
4. Explain the reason for your answer in the question above.

Lesson Objective: Solve problems involving relative motion in one dimension.

Use the following prompt for questions #5-8:

Car A is traveling 25 mph east on one side of the road.

Car B is traveling 50 mph west on the other side of the road.

5. What is the velocity of Car B relative to Car A?
 - a. 25 mph
 - b. -50 mph
 - c. 75 mph
 - d. -75 mph
6. Explain the reason for your choice above.
7. What is the velocity of Car A relative to Car B?
 1. 25 mph
 2. -50 mph
 3. 75 mph

4. -75 mph
8. Explain the reason for your choice above.

Lesson Objective: Solve problems involving relative motion in two dimensions.

Use the following prompt for questions #9-12:

A plane travels with a velocity of +30 m/s north.

Determine the magnitude and direction of the resultant velocity of the plane if it encounters the following:

9. -10 m/s southern headwind
10. +10 m/s northern tailwind
11. +10 m/s eastern crosswind
12. -10 m/s western crosswind

3.4 Projectile Motion

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Draw and interpret graphs involving two-dimensional projectile motion

Draw a general sketch of the following graphs **for a projectile moving rightward**. In your own words, describe what the graph means.

1. X-T: Position in the X direction as a function of time

2. Y-T: Position in the Y direction as a function of time

3. V_x -T: Velocity in the X direction as a function of time

4. V_y -T: Velocity in the Y direction as a function of time

Lesson Objective: Solve for the instantaneous velocity of a projectile

5. You throw a baseball with an initial horizontal velocity of 1 m/s east. What will the final horizontal velocity be when your teammate catches it 0.4s later?

6. A bowling ball is rolled with an initial horizontal velocity of 12 m/s rightward and hits the pins 1.5 seconds later. What is the initial vertical velocity of the bowling ball?

Use the following prompt for questions #7-8.

A frog jumps with a velocity of 0.25 m/s at an angle of 30°.

7. What is the magnitude of the frog's initial horizontal velocity?
8. What is the magnitude of the frog's initial vertical velocity?

Use the following prompt for questions #9-10.

A marble is rolled horizontally off the edge of a 1.5 m table and lands 0.7 m away.

9. At what time did the marble hit the ground?
10. What was the initial horizontal velocity of the marble?

Lesson Objective: Predict a projectile's range

11. The five darts described below are all thrown from the same initial position. Which will hit the ground first?
- Dart A, with an initial vertical velocity of 20 m/s upward and an initial horizontal velocity of 0 m/s.
 - Dart B, with an initial vertical velocity of 10 m/s upward and an initial horizontal velocity of 10 m/s.
 - Dart C, with an initial vertical velocity of 15 m/s upward and an initial horizontal velocity of 0 m/s.
 - Dart D, with an initial vertical velocity of 5 m/s upward and an initial horizontal velocity of 20 m/s.
12. Neglecting air resistance, what would happen if you were a passenger in a convertible automobile traveling at a constant velocity and threw a ball straight up in the air?
- It would land behind the car
 - It would land in front of the car
 - It would land in the car
 - None of the above
13. Explain the reasoning for your answer choice to question #12.
14. A tennis ball is hit with an initial velocity of 15 m/s at an angle of 40°. What is the horizontal displacement of the ball after 2 s?

CHAPTER

4

Newton's Three Laws Worksheets

Chapter Outline

- 4.1 NEWTON'S FIRST LAW
 - 4.2 NEWTON'S SECOND LAW
 - 4.3 NEWTON'S THIRD LAW
-

4.1 Newton's First Law

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Describe what force is and different types of forces.

1. In your own words, what is a force?
2. When do forces exist?
3. What are some examples of contact forces?
4. What are some examples of forces that act at a distance?
5. What is the standard metric unit used to measure force?
 - a. Kilogram (kg)
 - b. Meter (m)
 - c. Second (s)
 - d. Newton (N)
6. Is force a vector or scalar quantity? Circle the correct answer and explain the reason for your choice in the space provided.
 - a. Vector
 - b. ScalarExplanation:
7. Which of the following statements correctly describes the net force?
 - a. An upward force acting on an object
 - b. A force acting at a distance
 - c. A contact force
 - d. The sum of all the forces acting on an object

Lesson Objective: Understand the meaning of inertia and Newton's First Law.

8. How will the same amount of force affect a small rock compared to a giant boulder?

9. Explain why the following statement is false. "A water bottle is sitting on a table. Since it is not moving, there are no forces acting on it."

10. An airplane is moving at a constant velocity of 270 m/s (600 mph). What is the net force on the airplane?

4.2 Newton's Second Law

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Define Newton's Second Law and net force.

According to Newton's Second Law of Motion, label each of the statements below as true or false.

1. (True/False): If an object experiences a net force, its velocity will change.
2. (True/False): The more force you apply to an object, the less it will accelerate.
3. (True/False): If all of the forces acting on an object are balanced, its velocity will change.
4. (True/False): A force is required to keep an object moving.
5. (True/False): If all of the forces acting on an object are not balanced, the object will accelerate.
6. (True/False): A force is required in order to slow down a moving object.
7. (True/False): If all the forces acting on an object are unbalanced, then there will be a net force on the object.
8. (True/False): A force is not required to speed up a moving object.
9. (True/False): If no force is applied to an already moving object, it will stop moving.
10. (True/False): The more massive an object, the more force it will take to change its motion.

Lesson Objective: Calculate acceleration from force and mass.

For questions #11-13, determine the resulting acceleration when a +15 N net force is applied to the following objects:

11. A 5 kg massive object
12. A 15 kg massive object
13. A 25 kg massive object
14. In your own words, explain why the same net force results in different accelerations in question #11-13 above.

Lesson Objective: Calculate force from acceleration and mass.

15. A motorcycle with a mass of 200 kg is moving at a constant velocity of +11 m/s. Calculate the magnitude of the net force on the motorcycle.

16. What net force is required to accelerate a 60 g tennis ball $+15 \text{ m/s}^2$?
17. A runner with a mass of 60 kg begins from rest and increases his speed to 3 m/s in 60 s. What is the net force on the runner?

Lesson Objective: Calculate mass from force and acceleration.

18. A net force of $+100 \text{ N}$ was exerted on an object to increase its speed 10 m/s in 5 s. Calculate the mass of the object.

Use the following prompt for questions #19-20:

The mass of an object is 5 kg on Earth.

19. What is the object's weight on Earth?
 - a. 5 kg
 - b. 50 kg
 - c. 5 N
 - d. 50 N
20. What is its mass on Mars?
 - a. 5 kg
 - b. 50 kg
 - c. 5 N
 - d. 50 N

4.3 Newton's Third Law

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand Newton's Third Law.

Use the following prompt for questions #1-3:

A box is pushed horizontally on the Earth.

For each of the following forces acting on a box, identify the reaction force according to Newton's third law of motion and the concept of action-reaction force pairs. Be sure to specify the following:

- the direction of the reaction force
- the type of the reaction force
- the object which the reaction force is acting on

1. Action: A rightward frictional force from the Earth acting on the box.
2. Action: A downward gravitational force from the Earth acting on the box.
3. Action: An upward normal force from the Earth acting on the box.

Lesson Objective: Understand the difference between countering force and action-reaction.

Use the following prompt for questions #4-7:

A gravitational force of -100 N from the Earth acts on a box.

4. What is the countering force to the force described above?
 - a. -100 N gravitational force from the box on the Earth
 - b. +100 N gravitational force from the box on the Earth
 - c. -100 N normal force from the Earth on the box
 - d. +100 N normal force from the Earth on the box
5. Explain the reason for your choice above.
6. What is the reaction force according to Newton's 3rd law of motion?

- a. -100 N gravitational force from the box on the Earth
 - b. +100 N gravitational force from the box on the Earth
 - c. -100 N normal force from the Earth on the box
 - d. +100 N normal force from the Earth on the box
7. Explain the reason for your choice above.

Lesson Objective: Use Newton's three laws to solve problems in one dimension.

Newton's three laws of motion explain the motion of objects as we observe in our everyday lives. In your own words, explain each of Newton's three laws and illustrate each of the laws using the example of the motion of a box on the Earth.

8. Newton's 1st Law of Motion:
9. Newton's 2nd Law of Motion:
10. Newton's 3rd Law of Motion:

CHAPTER

5

Forces in Two Dimensions Worksheets

Chapter Outline

- 5.1 **NORMAL FORCE AND FRICTION FORCE**
 - 5.2 **INCLINED PLANES**
 - 5.3 **CIRCULAR MOTION**
 - 5.4 **FORCES IN TRANSLATIONAL EQUILIBRIUM**
-

5.1 Normal Force and Friction Force

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how to solve problems involving the normal force.

Use the following prompt for questions #1-5.

Lisa's mass is 68 kg. She is in an elevator that is moving down and speeding up with an acceleration of -1.5 m/s^2

1. Draw a free-body diagram to illustrate all of the forces acting on Lisa.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.
11. What is the magnitude and direction of the force due to Earth's gravity acting on Lisa?
12. What is the magnitude and direction of the net force acting on Lisa?
13. What is the magnitude and direction of the normal force acting on Lisa?
14. In your own words, explain how the forces acting on Lisa are responsible for her motion according to Newton's laws.

Lesson Objective: Understand how to solve problems involving friction.

Use the following prompt for questions #6-10:

A dog pushes a chew toy with a mass of 3 kg horizontally on the kitchen floor. The coefficient of static friction is 0.8 and the coefficient of kinetic friction is 0.4.

6. What is the normal force acting on the chew toy?

7. How much force did it take to get the chew toy to start moving? (Hint: How much force did it take to overcome the force of static friction?)

8. How much force does it take to get the chew toy to continue sliding across the kitchen floor?

9. Which of the following would help decrease the force of kinetic friction on the chew toy?
 - a. Pushing down on the chew toy
 - b. Lifting the chew toy off the floor a little
 - c. Sliding the chew toy on a carpeted floor (with a coefficient of kinetic friction of 0.8)

10. Explain the reason for your choice above.

5.2 Inclined Planes

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how to analyze and work with forces on inclined planes.

Determine if the following statements are true or false. If false, make the statement true.

1. (True/False) If the weight of a 50 kg box on a flat surface is 500 N, then its weight on an inclined plane will be smaller than 500 N.
2. (True/False) If the weight of a 50kg box on a flat surface is 500 N, then the normal force exerted on it when placed on an inclined plane will be smaller than 500 N.
3. (True/False) The direction of the normal force on an object resting on an inclined plane is always opposing the direction of the force due to gravity.

Use the following prompt for questions #4-7:

A 50 kg box is sliding down a hill with an incline of 30 degrees.

4. What is the weight of the box?
5. What is the horizontal (x) component of the weight of the box?
6. What is the vertical (y) component of the weight of the box?
7. What is the normal force on the box?

Lesson Objective: Understand how to apply Newton's Second Law to the inclined plane problems.

Use the following prompt for questions #8-10:

A 50 kg box is sliding down a hill with an incline of 30 degrees.

8. If sliding at a constant speed, what is the force of kinetic friction on the box?
- 9.
- 10.
11. If accelerating at -1 m/s^2 , what is the force of kinetic friction on the box?

12. If accelerating at -3 m/s^2 , what is the force of kinetic friction on the box?

5.3 Circular Motion

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand that in circular motion there is always an acceleration (and hence a force) that points to the center of the circle defined by the objects motion. This force changes the direction of the velocity vector of the object but not magnitude (the object's speed).

Use the following prompt for questions #1-5:

The International Space Station orbits the Earth.

- The centripetal force on the International Space Station is due to
 - The force of gravity
 - The force of kinetic friction
 - The force of static friction
 - The tension force of a rope
- The direction of the centripetal force on the International Space Station is
 - Downward
 - Upward
 - Clockwise
 - Toward the center of the circular orbit
- The direction of the International Space Station's acceleration is
 - Downward
 - Upward
 - Clockwise
 - Toward the center of the circular orbit
- Explain why the International Space Station needed rockets to get into orbit, but doesn't need rockets to keep it in orbit.
- Dispel the following misconception: "The astronauts on the International Space Station are floating because there is no gravity in space."

Lesson Objective: Understand how to calculate that speed using the period of motion and the distance of its path (circumference of the circle it traces out).

Calculate the magnitude and direction of the centripetal acceleration of the following objects moving in a circle:

6. A 2000 kg truck drives along a circular round a bout with a radius of 20 m at a constant speed of 10 m/s.
7. A 0.08 kg marble moves in a circle with a radius of 0.5 m at a constant speed of 3 m/s.
8. A 64 kg skater travels around a skate rink with a radius of 25 m at a constant speed of 2.2 m/s.

Calculate the speed of the following objects moving in a circle:

9. A 1000 kg racecar drives along a circular track with a radius of 50 m with an acceleration of 4m/s^2 .
10. A 70 kg runner runs around a track with a radius of 36.8 m with an acceleration of 3 m/s^2 .

5.4 Forces in Translational Equilibrium

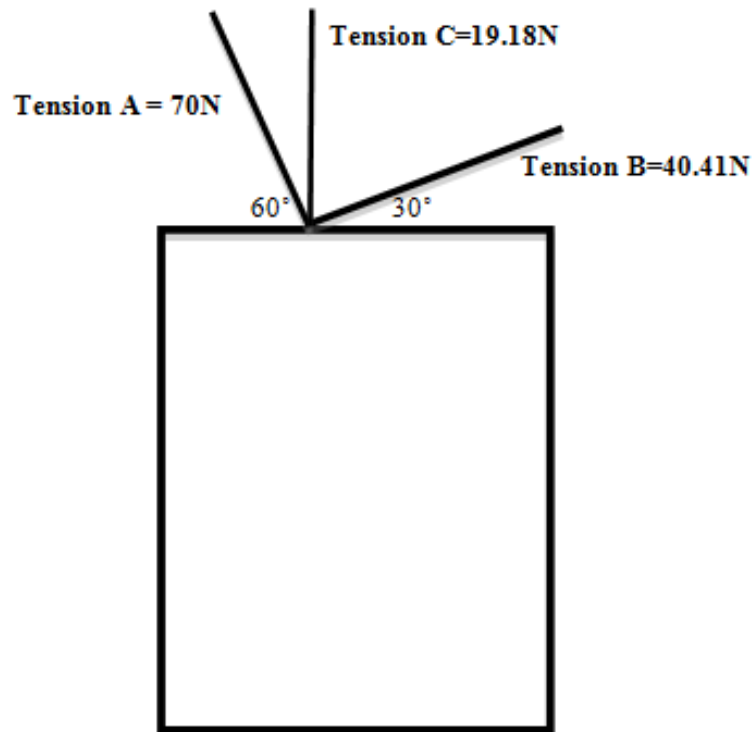
Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how to apply Newton's Second Law under equilibrium conditions in two dimensions.

A 10 kg picture is hanging in static equilibrium on a wall by three wires as depicted below.



Complete the following chart using your understanding of Newton's Second Law under equilibrium conditions in two dimensions.

CHAPTER **6**

Work and Energy Worksheets

Chapter Outline

- 6.1 WORK
 - 6.2 ENERGY
 - 6.3 ENERGY CONSERVATION
 - 6.4 POWER
-

6.1 Work

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how work is defined in physics.

1. In your own words, described the concept of work in physics.

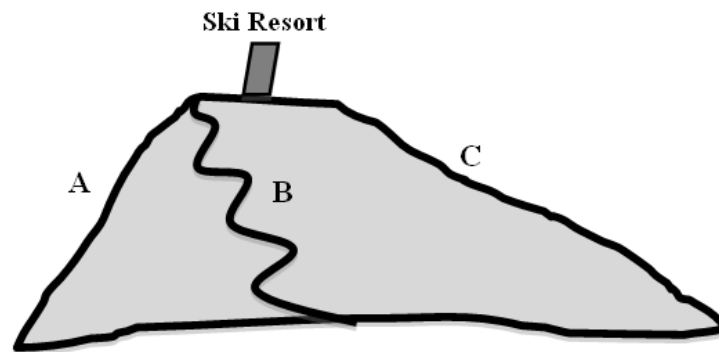
Read the following statements and determine whether or not they represent examples of work (in the scientific sense). Circle YES or NO, and EXPLAIN the reasoning behind your choice.

2. Sonia applies a enough force to move her couch 15 m across the room.
YES / NO. Explain:
3. Jeffrey gets extremely tired after applying a force to a giant boulder that does not move.
YES / NO. Explain:
4. Joe applies enough force to lift a 100 lb barbell directly over his head.
YES / NO. Explain:
5. A woman is applying an upward normal force to hold her purse and walking rightward.
YES / NO. Explain:
6. Which of the following statements correctly describes the relationship between force, distance and work in a simple machine?
 - a. Simple machines increase the amount of force needed to move an object by decreasing the distance over which the force is applied. The work increases as well.
 - b. Simple machines increase the amount of force needed to move an object by decreasing the distance over which the force is applied. The overall work stays the same.
 - c. Simple machines decrease the amount of force needed to move an object by increasing the distance over which the force is applied. The amount of work decreases.
 - d. Simple machines decrease the amount of force needed to move an object by increasing the distance over which the force is applied. The overall work stays the same.

Lesson Objective: Be able to solve problems involving work.

Use the prompt below for questions #7-10:

Three different families, each driving a 2000kg rental minivan, decide to drive to a ski resort for winter break. The first family takes Route A, the second family takes Route B, and the third family takes Route C.



7. How much work does it take to get to the ski resort?
8. How much force does it take the family traveling on Route B to get to the ski resort?
9. How much force does it take the family traveling on Route C to the ski resort?
10. Did the family that took Route A use more, less, or the same amount of energy to get to the ski resort as the family that took Route B? Explain.

6.2 Energy

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand the relationship between work and energy.

Use the following prompt for questions #1-4:

You lift a 1 kg object from the floor to the top of a 1.5 m high table.

1. What is the force needed to lift the object to the table?
- 2.
- 3.
4. How much work must you do to lift the object to the table?

5. How much energy is needed to lift the object to the table?

6. Once the object is resting on the table, where does the energy go?

Lesson Objective: Be able to distinguish between kinetic and potential energy.

Use the following prompt for questions # 5-7:

A diver climbs a ladder to the top of a diving board. Once he reaches the top, he stands on top of the diving board. Then, he jumps off the diving board into a pool.

5. Which of the following points describes when the diver does work?
 - a. When the diver climbs the ladder
 - b. When the diver stands on the diving board.
 - c. When the diver is falling into the pool
 - d. None of the above
6. At which of the following points does the diver have the most potential energy?
 - a. When the diver climbs the ladder
 - b. When the diver stands on the diving board.
 - c. When the diver is falling into the pool
 - d. None of the above
7. At which of the following points does the diver have the most kinetic energy?

- a. When the diver climbs the ladder
- b. When the diver stands on the diving board.
- c. When the diver is falling into the pool
- d. None of the above

Lesson Objective: Understand the role of friction as it pertains to work and energy.

Use the following prompt for questions #8-9:

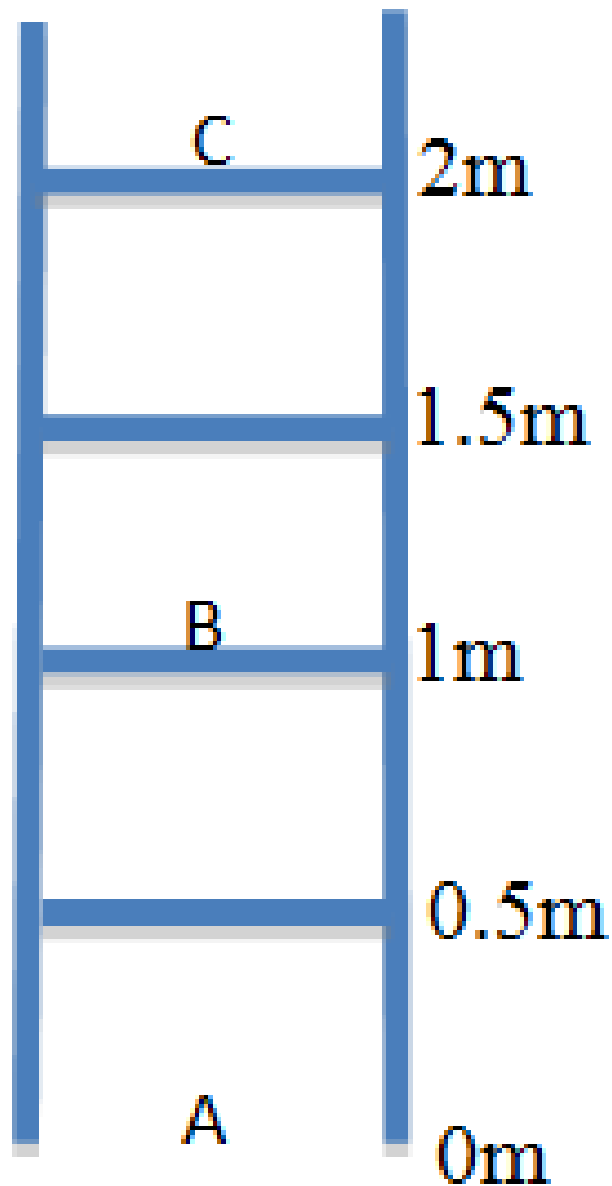
Joe pushes a box rightward with a force of 3 N, causing it to slide 2m across the floor at a constant speed.

8. How much work did Joe do on the box?
9. How much work was done by friction on the box?

Lesson Objective: Be able to solve problems involving kinetic and potential energy and friction.

Use the following prompt for questions #10-13:

A 65 kg person climbs the ladder below.



10. At which point does this person have maximum potential energy?

- a. Point A
- b. Point B
- c. Point C
- d. None of the above

Justify your answer by solving for the Potential Energy at points A-C below.

11. Potential Energy at Point A:

12. Potential Energy at Point B:

13. Potential Energy at Point C:

6.3 Energy Conservation

Worksheet

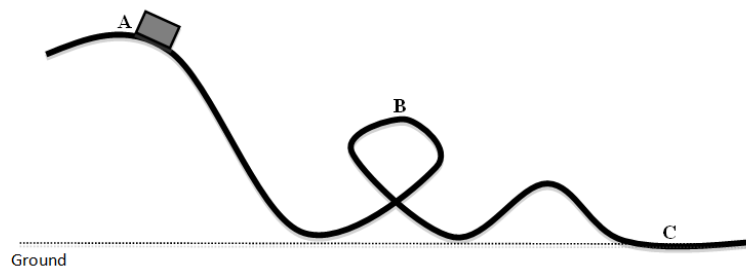
Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand the meaning of energy conservation.

Use the following prompt for questions #1-5:

The total mechanical energy of the roller coaster below is 1800 J. The mass of the cart is 100 kg and the velocity at Point C is +6 m/s. Assume no energy is lost due to dissipative forces such as friction.

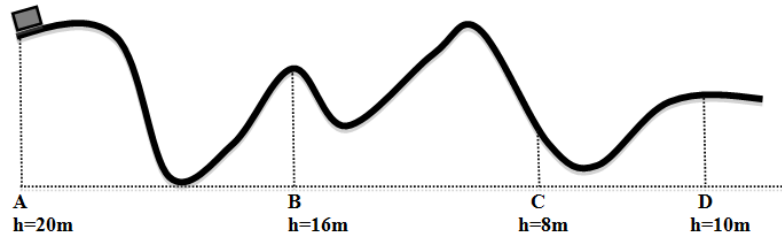


1. What is the total mechanical energy at Point A?
 - a. 1000 J
 - b. 1800 J
 - c. 2800 J
 - d. Not enough information to determine
2. What is the total mechanical energy at Point B?
 - a. 1000 J
 - b. 1800 J
 - c. 2800 J
 - d. Not enough information to determine
3. What is the total mechanical energy at Point C?
 - a. 1000 J
 - b. 1800 J
 - c. 2800 J
 - d. Not enough information to determine
4. When does the cart have maximum potential energy?
 - a. Point A
 - b. Point B
 - c. Point C
 - d. Not enough information to determine

5. When does the cart have maximum kinetic energy?
- Point A
 - Point B
 - Point C
 - Not enough information to determine

Lesson Objective: Be able to use energy conservation in solving problems.

Use your understanding of energy conservation to complete the following chart regarding the roller coaster below. Assume no energy is lost due to dissipative forces such as friction.



6.4 Power

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how power is defined in physics.

1. In physics, power depends on what two factors?
2. In your own words, describe the relationship between power and the amount of time it takes to do work.

Use the following prompt for questions #3-5:

Lisa expends 180 W of power by doing 1800 J of work in 10 s.

Determines what happens to her power output in the following situations:

3. She takes twice as long to do the same amount of work
4. It takes her half the time to do the same amount of work
5. Did your calculations in the problems above align with your answer to question #2?

Lesson Objective: Be able to solve problems involving power.

Use the following prompt for questions #6-8:

A piano with a mass of 130 kg is lifted 10m above the ground in 5 s by a crane.

6. What is the power used by the crane, measured in watts?
7. What is the power used by the crane, measured in kilowatts?

8. What is the power used by the crane, measured in horsepower?

Use the following prompt for questions #9-10:

A second piano with the same mass is lifted 10m above the ground in 15 s by a forklift.

9. Which does the most work, the crane or the forklift? Explain.
10. Which expends the most power, the crane or the forklift? Explain

CHAPTER

7

Momentum Worksheets

Chapter Outline

- 7.1 **MOMENTUM AND IMPULSE**
 - 7.2 **CONSERVATION OF MOMENTUM IN ONE DIMENSION**
 - 7.3 **CONSERVATION OF MOMENTUM IN TWO DIMENSIONS**
-

7.1 Momentum and Impulse

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Know how momentum is defined.

1. What two factors does momentum depend on?
2. Describe two ways in which a skateboarder could increase their momentum.
3. Is it possible for a 1 kg object to have the same momentum as a 100 kg object? Explain.
4. Circle the object with the greater momentum:
 - A bus at rest
 - A car traveling 65 mph on the freeway
5. Explain the reason for your choice above.

Lesson Objective: Be able to solve problems using momentum.

Calculate the momentum of the following massive objects in motion for questions #6-8:

6. A 533 kg blimp moving east at +75 m/s.
7. A 900 kg rocket moving northwest at 7800 m/s.
8. A 105 kg hang glider moving west at -15 m/s.
9. Which has more momentum:
 - A 36,000 kg semi truck moving -2 m/s leftward
 - A 0.01 kg bullet traveling at -3000 m/s leftward
10. Explain the reason for your choice.

7.2 Conservation of Momentum in One Dimension

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Learn the meaning of impulse force and how to calculate both impulse and impulse force in various situations.

Use the following prompt for questions #1-10:

While driving on a highway, a semi truck hits a fly.

Determine if the following statements are true or false by circling the correct answer. Then, explain the reason for your choice.

1. The magnitude of contact force between the fly and the semi truck are the same.
True / False. Explain:
2. The direction of contact force between the fly and the semi truck are the same.
True / False. Explain:
3. The time of the collision experienced by the fly and the semi truck are the same.
True / False. Explain:
4. The magnitude of the impulse experienced by both the fly and semi truck is the same.
True / False. Explain:
5. The direction of the impulse experienced by both the fly and semi truck is the same.
True / False. Explain:
6. The magnitude of the change in momentum for the both the fly and semi truck is the same.
True / False. Explain:
7. The direction of the change in momentum for the both the fly and semi truck is the same.
True / False. Explain:

8. The magnitude of the acceleration experienced by both the fly and semi truck is the same.
True / False. Explain:

9. The direction of the acceleration experienced by both the fly and semi truck is the same.
True / False. Explain:

10. The magnitude of the change in velocity for the fly and semi truck is the same.
True / False. Explain:

7.3 Conservation of Momentum in Two Dimensions

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand conservation of momentum.

1. In your own words, describe what it means for the total momentum of a system to be conserved.
2. Provide a real world example that illustrates the conservation of momentum.
3. Set up an equation, using only the variables for mass (m) and velocity (v), which represents the total momentum of a cannon and a cannon ball before and after an explosion.
4. Set up an equation, using only the variables for mass (m) and velocity (v), which represents the total momentum of a tennis ball and racket before and after the racket hits the ball.
5. Set up an equation, using only the variables for mass (m) and velocity (v), which represents the total momentum before and after a fly is hit by a fly swatter (and sticks to it).

Lesson Objective: Be able to solve problems using the conservation of momentum.

Use the following prompt for questions #6-10:

In the Homecoming football game, a fullback ($m=60\text{kg}$) moves rightward at a velocity of $+2\text{ m/s}$ and a linebacker ($\text{mass} = 80\text{kg}$) moves leftward with a velocity of -3 m/s until they collide and move together.

6. What is the initial momentum of the fullback?
7. What is the initial momentum of the linebacker?
8. What is the initial total momentum of the system?
9. What is the final total momentum of the system?

10. What is the final speed of the fullback and linebacker and they move together after the collision?

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand the difference between elastic and inelastic collisions.

Categorize each of the following collisions in questions #1-5 as elastic or inelastic by circling the correct answer.

1. (Elastic / Inelastic) A white cue ball hits the black 8-ball in a game of pool. They bounce off each other, but both move in the same direction.
2. (Elastic / Inelastic) Brittany catches a beach ball.
3. (Elastic / Inelastic) A tennis ball hits a racket and both move in the opposite direction after the collision.
4. (Elastic / Inelastic) A fullback tackles a linebacker and they move together in the air.
5. (Elastic / Inelastic) A dog catches a ball in his mouth.
6. Describe how you distinguished between elastic and inelastic collisions in the section above.

Lesson Objective: Be able to solve problems using both energy and momentum conservation.

Use the following prompt for questions #7-8:

A skateboarder (mass = 75 kg) is standing at rest on a skateboard. His friend throws him a football (mass = 0.45 kg) with a velocity of +6 m/s rightward. Assume the ground is frictionless.

7. What type of collision is this, elastic or inelastic? Explain.
8. What is the velocity of the skateboarder (and the football) after he catches the ball?

Use the following prompt for questions #9-10:

A 0.145 kg baseball is moving through the air. At point A, the baseball is 2 m high and moving with a velocity of +15 m/s rightward. At point B, the baseball is 3 m high and moving with an unknown velocity.

9. Use the principle of conservation of energy to determine the velocity of the baseball at point B.

10. Determine the momentum of the baseball at point B.

CHAPTER **8**

Statics Worksheets

Chapter Outline

- 8.1 ANGULAR MOMENTUM
 - 8.2 TORQUE
 - 8.3 TWO CONDITIONS OF EQUILIBRIUM
 - 8.4 APPLICATIONS OF EQUILIBRIUM CONDITIONS
-

8.1 Angular Momentum

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand what angular momentum is and how to use it in solving problems.

In your own words, describe the following concepts in questions #1-3:

1. Rotational Inertia:
2. Angular Velocity:
3. Conservation of Angular Momentum:
4. Describe the effect of moving a mass closer to its axis of rotation.
5. Provide a real world example that illustrates the effect of moving a mass closer to its axis of rotating.
6. What is the angular momentum of a gymnast at rest with a rotational inertia of $60 \text{ kg}\cdot\text{m}^2$?
 - a. $0 \text{ kg}\cdot\text{m}^2/\text{s}$
 - b. $10 \text{ kg}\cdot\text{m}^2/\text{s}$
 - c. $180 \text{ kg}\cdot\text{m}^2/\text{s}$
 - d. $1800 \text{ kg}\cdot\text{m}^2/\text{s}$
7. What is the angular momentum of a gymnast that has an angular velocity of 3 rad/s and a rotational inertia of $60 \text{ kg}\cdot\text{m}^2$?
 - a. $0 \text{ kg}\cdot\text{m}^2/\text{s}$
 - b. $10 \text{ kg}\cdot\text{m}^2/\text{s}$
 - c. $180 \text{ kg}\cdot\text{m}^2/\text{s}$
 - d. $1800 \text{ kg}\cdot\text{m}^2/\text{s}$
8. If the rotational inertia of a rotating object is decreased by a factor of 4, what is the resulting angular velocity according to the conservation of angular momentum?
 - a. 2ω
 - b. 4ω
 - c. 6ω
 - d. 8ω

9. Lisa is an ice skater. During a rotation, her initial angular velocity is 4 rev/s. She moves her arms in order to decrease her rotational inertia by 50%. Assuming the angular momentum of the system is conserved, determine Lisa's resulting angular velocity.

10. What is the major difference between linear momentum and angular momentum?

8.2 Torque

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand what torque is and how to use it in solving problems.

1. In your own words, define torque.
2. What are the units of torque?
 - a. $\text{kg}\cdot\text{m}^2/\text{s}$
 - b. $\text{kg}\cdot\text{m}/\text{s}^2$
 - c. N
 - d. $\text{N}\cdot\text{m}$
3. In your own words, describe the requirements to produce a torque?
4. Explain why the following statement is false, "A torque is a force."
5. Explain why a wrench with a long handle has a better mechanical advantage than a wrench with a short handle.
6. Explain the physics behind why football coaches instruct players to stay as low as possible.
7. The door to your physics classroom has a width of 0.7 m and requires a torque of 12 $\text{N}\cdot\text{m}$ to open. If the doorknob is position 0.05 m from the left edge of the door, what is the minimum force that must be applied to open the door?
8. Determine the magnitude of the perpendicular force that must be applied to a see-saw to cause a torque of 75 $\text{N}\cdot\text{m}$, 2.5 meters away from the center fulcrum.

Use the following prompt for questions #9-10:

A bookshelf with a mass of 3 kg extends 0.33 m from a wall and remains stationary.

9. Calculate the magnitude of the torque due to the force of gravity on the bookshelf.

10. Explain why the bookshelf not rotating.

8.3 Two Conditions of Equilibrium

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand the necessity for two conditions of equilibrium to ensure static equilibrium.

Describe the requirements for an object to achieve the following:

1. Rotational equilibrium
2. Translational equilibrium
3. Static equilibrium
4. Which of the following is in rotational equilibrium?
 - a. A wrench experiencing a net torque of $9 \text{ N}\cdot\text{m}$
 - b. A wrench rotating with an angular acceleration of 9 rad/s^2
 - c. A wrench experiencing both a clockwise torque of $-9 \text{ N}\cdot\text{m}$ and a counterclockwise torque of $+9 \text{ N}\cdot\text{m}$
 - d. A wrench experiencing a net force of zero Newtons
5. Which of the following is in translational equilibrium?
 - a. A football experiencing a net force of $+9 \text{ N}$
 - b. A football experiencing a downward force due to gravity of -4.3 N
 - c. A football accelerating at a rate of 9 m/s^2
 - d. A football at rest on the field right before kick off.
6. Which of the following objects is in static equilibrium?
 - a. A wrench rotating with an angular acceleration of 9 rad/s^2
 - b. A wrench experiencing both a clockwise torque of $-9 \text{ N}\cdot\text{m}$ and a counterclockwise torque of $+9 \text{ N}\cdot\text{m}$
 - c. A football accelerating at a rate of 9 m/s^2
 - d. A football at rest on the field right before kick off.

8.4 Applications of Equilibrium Conditions

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Use the conditions of equilibrium to solve problems.

Use the following prompt for questions #1-5:

Jack and Jill sit on a long seesaw that is in rotational equilibrium. Jack has a mass of 35 kg and sits 3 m from the center axis. Jill has a mass of 20 kg.

1. What is the force due to gravity on Jack?
2. What is the force due to gravity on Jill?
3. What is the magnitude of torque that Jack exerts on the seesaw?
4. What is the net torque on the seesaw?
5. How far away from the center axis is Jill sitting?

CHAPTER

9

Newton's Universal Law of Gravity Worksheets

Chapter Outline

- 9.1 KEPLER'S LAWS
 - 9.2 NEWTON'S UNIVERSAL LAW OF GRAVITY
 - 9.3 CIRCULAR ORBITS
-

9.1 Kepler's Laws

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand Kepler's Laws.

1. Create a sketch the shape of the Earth's orbit around the sun.
2. What is an astronomical unit?

For questions #3-8, match each of the following laws with their correct explanation:

A. Kepler's First Law

B. Kepler's Second Law

C. Kepler's Third Law

D. Newton's First Law

E. Newton's Second Law

F. Newton's Third Law

3. _____ For every action, there is an equal and opposite reaction.
4. _____ A planet will move at a faster speed when positioned closer to the sun.
5. _____ The orbit of each planet about the sun is an ellipse with the sun at one of the foci.
6. _____ An object at rest will stay at rest, and an object in motion will remain in motion, unless acted upon by an unbalanced net force.
7. _____ $F_{Net}=ma$
8. _____ The square of the time for one orbital period of a planet about the sun is proportional to the cube of the average distance between the sun and the planet.

Lesson Objective: Use Kepler's Third Law to solve problems.

9. Express Kepler's Third Law of Motion in your own words.
10. Express Kepler's Third Law of Motion as an equation.
11. Use Kepler's Third Law of Motion to solve for the constant of proportionality (k) if the period of the Earth around the sun is one year and the distance of the Earth to the sun is one AU.

12. Use Kepler's Third Law of Motion to solve for the period of Pluto around the sun, in years, if the distance of Pluto to the sun is 39.5 AU.

13. Use Kepler's Third Law of Motion to determine the distance of Mars to the sun, in AU, if the period of Mars around the sun is 1.87 years.

9.2 Newton's Universal Law of Gravity

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand Newton's Universal Law of Gravity.

In your own words, describe each the following three terms:

1. Universal:
2. Law:
3. Gravity
4. Use your answers to questions #1-3 to re-write Newton's Universal Law of Gravity in your own words.
5. Explain why Newton's Universal Law of Gravity is categorized as an inverse-square law.

Label the following statements in #6-10 as true or false by circling the correct answer.

6. Of the four fundamental forces in nature, gravity is the weakest force.
 - a. True
 - b. False
7. The moon is in free fall around the Earth.
 - a. True
 - b. False
8. Mars is in free fall around the sun.
 - a. True
 - b. False
9. The force acting on an apple as it falls from a tree is different from the force acting on Venus as it orbits the sun.
 - a. True
 - b. False
10. The Earth is pulling down on me with a force due to gravity and I am pulling up on the Earth with a force due to gravity of equal magnitude.

- a. True
- b. False

Lesson Objective: Use Newton's Universal Law to solve problems.

11. Based on your understanding of Newton's Universal Law of Gravity, can a massive object ever be weightless?

Refer to the equation for Newton's Universal Law of Gravity ($F = \frac{Gm_1m_2}{r^2}$) to answer questions #12-15:

12. If the distance between two objects is doubled, the force of gravity will
- a. Double
 - b. Quadruple
 - c. Decrease by a factor of 4
 - d. Decrease by a factor of 16
13. If the distance between two objects is quadrupled, the force of gravity will
- a. Double
 - b. Quadruple
 - c. Decrease by a factor of 4
 - d. Decrease by a factor of 16
14. If the mass of an object is doubled, the force of gravity will
- a. Double
 - b. Quadruple
 - c. Decrease by a factor of 4
 - d. Decrease by a factor of 16
15. If the mass of both objects are doubled, the force of gravity will
- a. Double
 - b. Quadruple
 - c. Decrease by a factor of 4
 - d. Decrease by a factor of 16

9.3 Circular Orbits

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Use Newton's Universal Law of Gravity and Kepler's Third Law to solve problems.

1. Describe the major difference between the orbits of planets and the orbits of satellites.
2. When solving problems involving circular orbits, you must consider which of the following?
 - a. Centripetal acceleration
 - b. Universal gravity
 - c. Both A B
 - d. None of the above
3. What is the distance from the center of the Earth of a satellite orbiting at a distance equal to the Earth's radius (R_e)?
 - a. $\frac{1}{2} R_e$
 - b. R_e
 - c. $2 R_e$
 - d. $3 R_e$
4. Write an equation that could be used to calculate the force due to gravity acting on a satellite orbiting at a distance equal to the Earth's radius (R_e).
5. Calculate the acceleration of a satellite orbiting at a distance equal to the Earth's radius (R_e).
6. Calculate the velocity of a satellite orbiting at a distance equal to the Earth's radius (R_e).

CHAPTER **10** Periodic Motion Worksheets

Chapter Outline

- 10.1 SIMPLE HARMONIC MOTION
 - 10.2 MASS ON A SPRING
 - 10.3 SIMPLE PENDULUM
 - 10.4 WAVES AND WAVE PROPERTIES
-

10.1 Simple Harmonic Motion

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand periodic motion.

1. Develop a list of requirements for periodic motion.
2. Use your list of requirements above to identify all of the objects that exhibit periodic motion. Circle your answer choices below.
 - a. The pendulum in a grandfather clock
 - b. A basketball player jumping in the air
 - c. An arrow flying toward a target
 - d. A tetherball rotating around a pole
 - e. The Earth rotating around the sun
 - f. A child on a swing
 - g. A vibrating guitar string
 - h. A car on the freeway
 - i. A rider on a merry-go-round
 - j. A mass on a spring

Lesson Objective: Understand simple harmonic motion.

3. Describe the connection between periodic motion and simple harmonic motion (SHM).
4. Describe the connection between uniform circular motion and simple harmonic motion (SHM).

5. What are the requirements for simple harmonic motion (SHM)?
6. Explain why a child on a swing exemplifies simple harmonic motion.
7. Sketch the general shape of a position-time ($x-t$) graph of an object in simple harmonic motion.

10.2 Mass on a Spring

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Solve problems dealing with Simple Harmonic Motion.

1. Circle all the variables below that affect the period (T) of a spring-mass system.
 - a. Force on the spring (F_{spring})
 - b. Spring constant (k)
 - c. Distance a spring is stretched (x)
 - d. Mass (m)
 - e. Force due to gravity ($F_{gravity}$)
 - f. Gravitational constant (g)

2. Circle all the following statements that correctly describe the restoring force in a mass-spring system.
 - a. The restoring force causes the mass-spring system to move toward the point of equilibrium
 - b. The restoring force cause the mass-spring system to move away from the point of equilibrium
 - c. The direction of the restoring force is always opposite of the displacement of the mass-spring system
 - d. The direction of the restoring force is always the same as the displacement of the mass-spring system
 - e. The magnitude of the restoring force is directly proportional to the displacement of the mass-spring system
 - f. The magnitude of the restoring force is inversely proportional to the displacement of the mass-spring system

Use the following prompt for questions #3-7:

A 3 kg mass is hung on a spring that stretches 15 cm.

3. What is the spring constant (k) of the mass-spring system?

4. What is the period (T) of the mass-spring system?
5. What is the frequency (f) of this mass-spring system?
6. What is the amplitude of this mass-spring system?
7. How many times does this mass-spring system pass through the point of equilibrium if it vibrates for 10 seconds?

10.3 Simple Pendulum

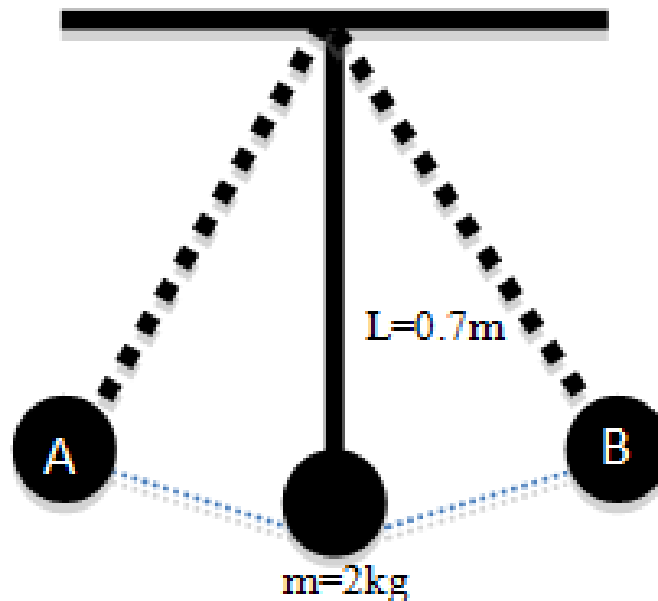
Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand a simple pendulum.

Use the illustration of the pendulum below to answer questions #1-5:



1. Using words only, describe the period of the pendulum above.
2. Calculate the period of the pendulum.
3. Using words only, describe the frequency of the pendulum.
4. Calculate the frequency of the pendulum.
5. Sketch a position-time (x-t) graph of the pendulum as it moves back and forth from point A to point B.

Lesson Objective: Solve problems involving a simple pendulum.

If a period of a pendulum with a 2m string is 2.8 seconds on Earth, calculate the **period** of the pendulum in the following situations:

6. The mass of the pendulum bob is doubled
7. The length of the string is halved
8. The amplitude of the pendulum increases
9. An astronaut takes the pendulum to the moon where the gravitational constant, g , is 1.6N/kg
10. A spaceship takes the pendulum to Saturn, where the gravitational constant, g , is 11.2 N/kg .

10.4 Waves and Wave Properties

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Be able to distinguish between types of waves.

1. What does a wave transport?
2. Explain how to distinguish between a longitudinal wave and a transverse wave.
3. Explain why a beach ball in the ocean will bob vertically up and down as a wave travels horizontally to the shore.
4. Explain why a sound wave is classified as a longitudinal wave.

Use the following information to answer questions #5-6

A coiled spring, such as a slinky, can produce both transverse and longitudinal waves.

5. Describe how to move a slinky in order to produce a longitudinal wave.
6. Describe how to move a slinky in order to produce a transverse wave.

Lesson Objective: Be able to recognize the behavior of waves.

Classify each of the following examples of wave phenomena in questions #7-10 as a result of reflection, refraction, or diffraction. Then, explain the reason for your choice.

7. Light passing through a small crack in the door illuminates an entire room
 - Reflection
 - Refraction
 - Diffraction

Explain:

8. A microscope bends light to magnify objects

- Reflection
- Refraction
- Diffraction

Explain:

9. Your voice echoes in an empty room

- Reflection
- Refraction
- Diffraction

Explain:

10. A telescope bends light in order to view objects very far away

- Reflection
- Refraction
- Diffraction

Explain:

CHAPTER **11**

Vibrations and Sound Worksheets

Chapter Outline

- 11.1 TRANSMISSION OF SOUND
 - 11.2 WAVE SPEED
 - 11.3 RESONANCE WITH SOUND WAVES
 - 11.4 DOPPLER EFFECT
-

11.1 Transmission of Sound

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Describe how mechanical waves are transmitted.

1. Describe the conditions necessary to create a sound wave.
2. How are mechanical waves transmitted?
3. Why are sound waves classified as mechanical waves?
4. In your own words, define the term “medium”.
5. Predict what would happen to the vibration caused by your vocal cords if you screamed in outer space.

Lesson Objective: Explain what is meant by the superposition of waves and interference.

For questions #6-8, define the following terms in your own words:

6. Superposition
7. Constructive Interference
8. Destructive Interference
9. Explain how two sound waves can interfere to cancel each other out.
10. Explain how two sound waves can interfere to create a louder sound.
11. Explain the relationship between wave interference and beats.

Use the following prompt to answer question #12:

Two sound waves have different amplitudes but the same wavelength and period. The first wave has an amplitude of 5 m and the second wave has an amplitude of 2 m.

12. Which of the following statements is correct?
- The maximum amplitude created as a result of their superposition is 3 m.
 - The minimum amplitude of created as a result of their superposition is 3 m.
 - The two waves will only experience constructive interference.
 - The two waves will only experience destructive interference.

11.2 Wave Speed

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Solve problems involving wavelength, wave speed, and frequency.

Use the image of Wave A below to answer questions #1-5:

1. What is the **period** of Wave A?
 - a. 1 s
 - b. 4 s
 - c. 5 s
 - d. 7 s
2. What is the frequency of Wave A?
 - a. 0 Hz
 - b. 0.1 Hz
 - c. 0.2 Hz
 - d. 0.4 Hz
3. What is the amplitude of Wave A?
 - a. 0 m
 - b. 8 m
 - c. 12 m
 - d. 16 m
4. If the frequency of Wave A increased, what would happen to the wavelength?
 - a. Increase
 - b. Decrease
 - c. Stay the same
 - d. Not enough information to determine
5. If the frequency of Wave A increased, what would happen to the wave speed?
 - a. Increase
 - b. Decrease
 - c. Stay the same
 - d. Not enough information to determine

Describe the affect on the following properties of a sound wave as it travels from a violin string, through the air, to the ear of the violinist by circling the correct choice. Then, explain the reason for your choice.

6. Wave Speed
 - Changes
 - Remains the Same

Explain:

7. Frequency
Changes
Remains the Same
Explain:

8. Wavelength
Changes
Remains the Same
Explain:

9. Calculate the wavelength of sound waves that bats can hear if they occur at frequencies around 80,000 Hz.

10. Calculate the wavelength of sound waves that humans can hear if they occur at a maximum frequency of 20,000 Hz.

11.3 Resonance with Sound Waves

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand the conditions for resonance.

1. Describe the condition(s) necessary for resonance to occur.
2. Describe an example of resonance in detail, demonstrating your understanding of the concept.

Lesson Objective: Solve problems with strings and pipes using the condition for resonance.

Use the following prompt for questions #3-5:

A 0.3 m violin string vibrates in the third harmonic at 3430 Hz.

3. Create a sketch of the standing wave on the violin string at the third harmonic.
4. Calculate the speed of the wave on the violin string above.
5. Compare the velocity of the wave on the violin string (your answer to question #2) to the velocity of the sound wave it creates in the air. If the two velocities differ, explain why.

Use the following prompt for questions #6-8:

A sound wave travels through a 2 m organ pipe, open at both ends, with a speed of 343 m/s.

6. Calculate the frequency and provide a sketch of the standing wave created at the 1st Harmonic in the space below:
7. Calculate the frequency and provide a sketch of the standing wave created at the 2nd Harmonic in the space below:
8. Calculate the frequency and provide a sketch of the standing wave created at the 3rd Harmonic in the space below:

Use the image of a standing wave produced in a pipe closed at one end to answer questions #9-10:

9. How many nodes are present in the standing wave illustrated above?
 - a. Zero
 - b. One
 - c. Two
 - d. Three
10. What is the harmonic of the standing wave illustrated above?
 - a. First
 - b. Second
 - c. Third
 - d. Fourth

11.4 Doppler Effect

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand the Doppler effect.

1. In your own words, explain why a sound becomes higher in pitch as it approaches you.

Demonstrate your understanding of how the Doppler effect influences the following properties of sound waves as a result of a sound source traveling away from an observer by answering questions #2-7 below:

2. Wavelength
 - a. Increases
 - b. Decreases
 - c. Remains constant
3. Frequency
 - a. Increases
 - b. Decreases
 - c. Remains constant
4. Wave Speed
 - a. Increases
 - b. Decreases
 - c. Remains constant
5. Amplitude
 - a. Increases
 - b. Decreases
 - c. Remains constant
6. The perceived pitch decreases as a result of the change in
 - a. Wavelength
 - b. Wave speed
 - c. Frequency
 - d. Amplitude
7. The perceived loudness decreases as a result of the change in
 - a. Wavelength
 - b. Wave speed
 - c. Frequency
 - d. Amplitude

8. An ambulance is driving with a velocity of 11 m/s and its siren blaring at 670 Hz. Calculate the frequency you hear as it approaches you in the space below.

CHAPTER **12**

Fluid Mechanics Worksheets

Chapter Outline

- 12.1 PRESSURE IN FLUIDS
 - 12.2 MEASURING PRESSURE
 - 12.3 PASCAL'S LAW
 - 12.4 ARCHIMEDES' LAW
 - 12.5 BERNOULLI'S LAW
-

12.1 Pressure in Fluids

Lesson Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand density and be able to solve problems with density.

1. In your own words, explain the difference between weight and density.
2. Provide an example of two objects with the same weight and different densities.

Use the following prompt for questions #3-5:

A wood block made of pine has a mass of 3.7 g and a volume of 10 cm³.

3. Calculate the density of the wood block in kg/m³.
4. Calculate the specific gravity of the wood block compared to water (1000 kg/m³).
5. Using your calculations above, do you believe the wood block will sink or float when placed in a pool of water? Explain.

Lesson Objective: Understand pressure and be able to solve problems with pressure.

6. In your own words, explain the difference between force and pressure.
7. Provide an example of two objects with the same force and different pressures.

Describe how the following variables affect the pressure of a fluid at rest in the space provided:

8. Volume

9. Shape of the Container
10. Density
11. Depth
12. The size of the container
13. Calculate the amount of force exerted by the atmosphere on the roof of your house (area = 95 m^2) if the pressure is $101,000 \text{ Pa}$.

12.2 Measuring Pressure

Lesson Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how atmospheric pressure is measured.

1. Is the following statement true or false, “Air molecules have a weight”.
 - a. True
 - b. False
2. Describe atmospheric pressure in your own words.
3. Explain why the roof of your house does not collapse under atmospheric pressure?

Briefly explain how atmospheric pressure is related to each of the following:

4. A drinking straw
5. A suction cup
6. A vacuum cleaner
7. What instrument do we use to measure the pressure of the atmosphere?
8. The atmospheric pressure in the mountains is the atmospheric pressure at sea level.
 - a. Greater than
 - b. Less than
 - c. Equal to
 - d. Not enough information to determine

Lesson Objective: Understand how gauge pressure is defined.

9. What is gauge pressure?

10. What is the total pressure of a tire with a gauge pressure of 151.7kPa?
- a. 101.3 kPa
 - b. 151.7 kPa
 - c. 253 kPa
 - d. 303.4 kPa

12.3 Pascal's Law

Lesson Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand and be able to solve problems using Pascal's Law.

1. Explain the connection between Pascal's Law and hydraulic machines.
2. Hydraulic lifts
 - a. obey the law of conservation of energy
 - b. produce more output energy than input energy
 - c. produce more output work than input work
 - d. do not provide a mechanical advantage
3. Draw a sketch of a hydraulic lift and label each of the parts.

Use the following prompt for questions #4-5

A hydraulic lift has a large piston with an area of 2.5 m^2 and a small piston with area of 1 m^2 .

4. What force must be applied by the large piston to lift a 1500 kg vehicle upward at a constant speed?
5. What force must be applied to the small piston to lift a 1500 kg vehicle upward at a constant speed?

12.4 Archimedes' Law

Lesson Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand buoyancy and how it applies to Archimedes' Law.

1. In your own words, describe displacement as it relates to fluid mechanics.
2. In your own words, describe the buoyant force.
3. Describe how does Archimedes' Law combines displacement and the buoyant force.

For questions #4-6, consider the following statements regarding a rubber ducky floating in a tub of water. Label each statement as true or false and include an explanation for your choice.

4. There are two forces acting on the rubber ducky.
 - a. True
 - b. False

Explain:

5. The magnitude of the buoyant force is equal to the weight of the rubber ducky.
 - a. True
 - b. False

Explain:

6. According to Archimedes' Law, the weight of the rubber ducky determines if it will float or not.
 - a. True
 - b. False

Explain:

Lesson Objective: Be able to solve problems using Archimedes' Law.

Use the following prompt for questions #7-10:

An aluminum cube with a volume of 1 m^3 has a density of 2700 kg/m^3 and is submerged in water with a density of 1000 kg/m^3 .

7. Calculate the weight of the aluminum cube.
8. Calculate the buoyant force on the aluminum cube.
9. Calculate the weight of the water displaced by the aluminum cube.
10. Will the aluminum cube sink or float? Provide an explanation for your choice.

12.5 Bernoulli's Law

Lesson Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand Bernoulli's principle and be able to discuss its implications.

Use Bernoulli's principle to answer the following questions:

1. When the speed of a fluid is high, the pressure is
2. Low
3. High
4. When the speed of a fluid is low, the pressure
5. Low
6. High
7. As air moves faster, the pressure
8. Decreases
9. Increases
10. As air moves slower, the pressure
11. Decreases
12. Increases
13. In baseball, a pitched curve ball causes air to spin faster on top of the ball and slower on the bottom of the ball, resulting in the ball traveling along a curved path. According to Bernoulli's principle, describe the pressure on the top of the ball compared to the bottom of the ball.

CHAPTER **13**

Heat Worksheets

Chapter Outline

- 13.1 TEMPERATURE
 - 13.2 KINETIC THEORY OF TEMPERATURE
 - 13.3 HEAT
 - 13.4 HEAT TRANSFER
 - 13.5 SPECIFIC HEAT
-

13.1 Temperature

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Explain what is meant by temperature.

1. Circle all of the following statements that correctly complete the following sentence:
2. Temperature is ...
 - a. the measurement that describes how hot or cold an object is
 - b. only used to determine the amount of heat in a liquid
 - c. related to the motion of the atoms in an object
 - d. the energy transferred between two objects
 - e. related to the average kinetic energy of the atoms in an object
 - f. the measure of how much heat is required to boil water
 - g. commonly measured with a thermometer
 - h. measured in Fahrenheit
 - i. measured in Celsius
 - j. measured in Kelvin
 - k. measured in calories
 - l. measured in Joules

Lesson Objective: Use the centigrade (Celsius) and Kelvin temperature scales.

2. Circle all of the following temperatures in which water will freeze:
 - a. 373 K
 - b. 212°F
 - c. 20°C
 - d. 32°F
 - e. 293 K
 - f. 0°C
 - g. 68°F
 - h. 273 K
 - i. 100°C
3. Circle all of the following temperatures in which water will boil:
 - a. 373 K
 - b. 212°F
 - c. 20°C
 - d. 293K
 - e. 68°F
 - f. 32°F
 - g. 0°C

- h. 273K
- i. 100°C

13.2 Kinetic Theory of Temperature

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Describe the relationship between temperature and kinetic energy.'

Describe the atomic movement in each of the following objects using words, pictures, or a combination of both:

1. A solid wood block
2. Water in a glass
3. Helium in a balloon
4. In your own words, describe the relationship between temperature and kinetic energy.
5. The internal energy (total energy) of a substance is
 - a. dependent only on the temperature
 - b. independent of the number of individual atoms
 - c. directly proportional to both the temperature and the number of individual atoms
 - d. the measure of the average kinetic energy of all the atoms
6. Which of the following objects has the highest average kinetic energy?
 - a. An ice cube
 - b. A pool of cool water
 - c. A cup of warm water
 - d. A cup of boiling water
7. Which of the following objects has the highest internal energy?
 - a. An ice cube
 - b. An large pool of water at room temperature
 - c. A cup of warm water
 - d. A cup of boiling water

13.3 Heat

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Explain the relationship between heat and energy transfer.

- Heat is the transfer of
 - Temperature
 - Energy
 - Mass
 - Force
- What causes heat to transfer from one object to another?
- Describe the direction of heat flow between two objects.
- In your own words, describe the difference between heat, temperature, and internal (thermal) energy.

Determine if the following statements are true or false. Then, explain the reason for your choice.

- A hot object contains a lot of heat.
True
False
Explain:
- Heat and temperature are two ways to describe the same thing.
True
False
Explain:

Lesson Objective: Describe how the calorie is a measure of energy.

- What does one calorie measure?

8. How many Joules of energy are in one calorie?
9. What is the difference between a calorie and a food calorie?
10. How many Joules of energy are in a food calorie?
11. Convert 400 food Calories into Joules.

13.4 Heat Transfer

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Describe how energy is transported through the processes of conduction, convection, and radiation.

1. How is heat transferred through the process of conduction?
2. Provide an example of heat transfer through conduction.
3. How is heat transferred through the process radiation?
4. Provide an example of heat transfer through radiation.
5. How is heat transferred through the process of convection?
6. Provide an example of heat transfer through convection.

13.5 Specific Heat

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Solve problems involving specific heat.

1. What is specific heat?
2. Describe the relationship between the specific heat value and the energy needed to produce a change in temperature.

Use the following prompt to answer questions #3-5

The specific heat of aluminum is $0.982 \text{ J/g}^\circ\text{C}$. The specific heat of wood is $1.760 \text{ J/g}^\circ\text{C}$.

3. Compare the amount of heat needed to raise the temperature of aluminum to that of wood.
4. If a piece of aluminum and a piece of wood were each exposed to one hour of sunlight, compare the amount of energy absorbed by each material.
5. If a piece of aluminum and a piece of wood were each exposed to one hour of sunlight, which one would experience an increase in temperature first?
6. Calculate the amount of joules required to raise the temperature of 17 g of wood from 20°C to 45°C using the equation .
7. Calculate the amount of joules required to raise the temperature of 17 g of aluminum from 20°C to 45°C using the equation .

CHAPTER **14**

Thermodynamics Worksheets

Chapter Outline

- 14.1 THE IDEAL GAS LAW
 - 14.2 FIRST LAW OF THERMODYNAMICS
 - 14.3 SECOND LAW OF THERMODYNAMICS
-

14.1 The Ideal Gas Law

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Explain the Ideal Gas Law.

1. What is an ideal gas?
2. Do ideal gases exist?
3. Under what conditions do gases act most ideal?
4. Under what conditions are gases not ideal?
5. What happens to the boiling point of water (100°C, 373K) in the mountains (at high altitudes)? Explain your answer with reference to the Ideal Gas Law.

Lesson Objective: Solve problems using the Ideal Gas Law.

Use the following prompt to answer questions #6-8:

An ideal gas takes up a volume of 20 liters, has a pressure of 1.3 atm, and a temperature of 301 K.

6. How many moles of the gas are present?
7. Avogadro's number defines one mole of a substance as having 6.022×10^{23} atoms. How many individual atoms of the gas are present?
8. If the temperature of the gas increases to 349 K and the pressure decreases to 1 atm, what is the new volume of the gas?

14.2 First Law of Thermodynamics

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Describe the First Law of Thermodynamics.

- The first law of thermodynamics is based on
 - The Conservation of Energy
 - Newton's Third Law
 - Kepler's First Law
 - The Conservation of Momentum
- A thermodynamic process that takes place at constant pressure is called a
 - Isobaric process
 - Isochoric process
 - Isothermal process
 - Adiabatic process
- A system in which only energy may enter or leave is a(n)
 - Isolated system
 - Closed system
 - Open system
 - None of the above
- Is the following statement true or false: "A given amount of work done on a system could raise the temperature of the system".
 - True
 - False
- The internal energy of a system will decrease when
 - Heat flows into the system
 - Work is done on the system
 - The system does work on the environment
 - None of the above
- Explain why the variable Q is positive when heat flows into a system.
- Explain why the variable W is negative when work is done by the system on the environment.
- What is the purpose of a heat reservoir?

Lesson Objective: Solve problems using the First Law of Thermodynamics.

9. Calculate the change in the internal energy of a system that does 500 J of work as a heat reservoir transfers 700 J of energy into the system.

10. Calculate the change in the internal energy of a system that transfers 300 J of heat to the environment.

14.3 Second Law of Thermodynamics

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand the second law of thermodynamics.

Label the following statements as true or false. Then, explain the reason for your choice.

1. Heat will always flow from hot to cold.

True

False

- Explain:

2. All natural processes are reversible.

True

False

- Explain:

Lesson Objective: Understand how to calculate the efficiency of a heat engine.

3. What is the function of a heat engine?
4. Which of the following are examples of a heat engine?
- Refrigerator
 - Oxygen tank
 - Microwave
 - Toaster

Match each of the following processes of an internal combustion engine with its proper description in questions #5-9.

- Intake
- Expansion
- Ignition
- Compression
- Exhaust

5. Gasoline and air are mixed together in a cylinder that expands against a piston.
6. A crankshaft moves the piston upward compressing the mixture.
7. At the instant of maximum compression, a spark plug releases an electric spark into the mixture, igniting the gasoline-air mixture and rapidly increasing the temperature in the cylinder.
8. The hot mixture Q_H expands rapidly.
9. The exhaust gases Q_L are ejected at a lower temperature as the piston and the process repeats.
10. Calculate the efficiency of a heat engine whose ignition transfers 7.25×10^3 J into the system and exhaust transfers 4.32×10^3 J out of the system.

Lesson Objective: Understand how a Carnot engine operates.

11. What is a Carnot engine?

12. A Carnot engine relies on which of the following thermodynamic processes?
 - a. An Isochoric process
 - b. An Isothermal process
 - c. An Adiabatic process
 - d. Both B C

Lesson Objective: Understand that entropy is a measure of disorder.

13. Describe the Second Law of Thermodynamics in terms of entropy.

CHAPTER **15** Electrostatics Worksheets

Chapter Outline

- 15.1 STATIC ELECTRICITY
 - 15.2 COULOMB'S LAW
 - 15.3 ELECTROSTATIC FIELDS
-

15.1 Static Electricity

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how an imbalance of electric charge is produced.

1. Describe how an imbalance of charge can be produced through contact.
2. Describe how an imbalance of charge can be produced without contact.

Lesson Objective: Understand that there are two different kinds of electric charge.

3. Describe the differences between protons and electrons.
4. Describe the similarities between protons and electrons.

Lesson Objective: Understand that electric charge is conserved.

5. A person with a rubber soled shoe walks on carpet. As a result, the carpet becomes negatively charged and the person becomes positively charged. Describe how this demonstrates the conservation of electric charge.
6. In the scenario described above, the person becomes positively charged as a result of
 - a. Gaining protons
 - b. Loosing electrons
 - c. Induction
 - d. The creation of electric charge

Lesson Objective: Understand that electric charges hold atoms together.

Describe the electrostatic force between each of the following charged particles by circling the correct answer choice. Then, explain the reason for your choice.

7. Two protons
 - a. Repulsive
 - b. Attractive

Explain:

8. Two electrons
 - a. Repulsive
 - b. Attractive

Explain:

9. A proton and an electron
 - a. Repulsive
 - b. Attractive

Explain:

Lesson Objective: Understand the difference between conductors and insulators.

10. Describe one material that is a good conductor. Explain the reason for your choice.
11. Describe one material that is a good insulator. Explain the reason for your choice.

15.2 Coulomb's Law

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand Coulomb's Law.

According to Coulomb's law, describe the effect on the electrostatic force between two charged particles in the following scenarios:

1. The product of their charges is doubled
2. The product of their charges is decreased by a third
3. The separation of their distance is tripled
4. The separation of their distance is reduced by a factor of four

Lesson Objective: Understand how to solve problems using Coulomb's Law.

5. Calculate the magnitude of the electrostatic force between a $+ 8.0\mu\text{C}$ charged particle and a $+ 9.0\mu\text{C}$ charged particle separated by 0.5 cm.

15.3 Electrostatic Fields

Lesson 15.3 Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand what an electric field is.

1. Compare and contrast the gravitational field (g) and the electric field (E).
2. How is the strength of an electric field measured?
3. What are the units of an electric field?
 - a. Newtons (N)
 - b. Coulombs (C)
 - c. Newtons/Coulomb (N/C)
 - d. Newtons/Kilogram (N/kg)
4. The electric field lines from a positive charge
 - a. Point away from the charge
 - b. Point toward the charge
 - c. Run parallel to the charge
 - d. Do not exist
5. The density of electric field lines increases as the amount of
 - a. charge increases
 - b. charge decreases
 - c. mass increases
 - d. mass decreases

Lesson Objective: Understand how to solve electrostatic field problems.

Label the following statements regarding electric fields in questions #6-10 as true or false. Then, explain the reason for your choice.

6. Electric field lines point toward a positive charge.
 - a. True
 - b. False

Explain:

7. Electric field lines point in the direction a small, negative test charge would travel.
- True
 - False

Explain:

8. Electric field lines can never cross.
- True
 - False

Explain:

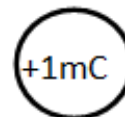
9. The denser the electric field lines, the greater the magnitude of the charge.
- True
 - False

Explain:

10. A charge of $+4C$ should have less electric field lines surrounding it compared to a $+2C$ charge.
- True
 - False

Explain:

11. A $+3.0\text{ mC}$ charge is placed in an electric field at a point where the magnitude of the electric field is $4.23 \times 10^5\text{ N/C}$. Calculate the magnitude of the electrostatic force acting on the charge.
12. Draw the electric field lines surrounding the charged particles below.



CHAPTER **16**

Electric Potential Worksheets

Chapter Outline

- 16.1 REVIEWING GRAVITATIONAL POTENTIAL ENERGY
 - 16.2 ELECTRIC POTENTIAL
 - 16.3 CAPACITANCE
 - 16.4 DIELECTRICS
 - 16.5 ELECTRICAL ENERGY STORAGE
-

16.1 Reviewing Gravitational Potential Energy

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Review and understand gravitational potential energy.

1. Describe how you could increase the gravitational potential energy of an empty box on the ground.

Use the following prompt for questions #2-5:

You lift a 10 kg box from the floor to the top of a 1.5 m shelf.

2. What is the force needed to lift the object to the table?
3. How much work must you do to lift the box to the top of the shelf?
4. How much energy is needed to lift the box to the top of the shelf?
5. Once the box is resting on the table, where does the energy go?

16.2 Electric Potential

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how to solve problems using electric potential energy.

1. List and describe all the variables that the electric potential energy depends on.
2. Describe the change in electric potential energy of an electron that moves from the negative plate of a parallel plate conductor to the positive plate.
3. Calculate the electric potential energy of a particle with a net charge of -2 nC and an electric potential difference of 2.27 V .

Lesson Objective: Understand how to solve problems using voltage differences.

4. What does voltage measure? What are the units of voltage?
5. Describe voltage in terms of the work done by the electric field in a parallel plate conductor.
6. Which of the following statements correctly describes the analogy between electric potential and gravitational potential?
 - a. A height above the Earth provides gravitational potential just as a voltage provides electric potential.
 - b. A height above the Earth provides gravitational potential just as a charge provides electric potential.
 - c. A massive object provides gravitational potential just as a voltage provides electric potential.
 - d. A gravitational force provides gravitational potential just as a voltage provides electric potential.
7. Explain the difference between electric potential and electric potential energy.
8. Calculate the electric potential at 4 cm in an electric field with a strength of 50 N/C .

Lesson Objective: Understand how to solve problems in a uniform electric field.

9. The units for an electric field are

- a. N/C
 - b. V/m
 - c. Both A B
 - d. None of the above
10. Determine the electric field in a 12V car battery that is 11cm long.

 11. Explain the relationship between the electric field and the electric potential energy of a charged particle.

 12. Calculate the change in voltage due to an electric field doing 50 J of work on a 0.5 C charge.

16.3 Capacitance

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand capacitance.

1. What is capacitance?
2. What is a parallel plate capacitor?
3. Explain the relationship between capacitance and a parallel plate capacitor.
4. List all the possible ways to increase the capacitance of a parallel plate capacitor.
5. The units of capacitance are
 - a. Coulombs/Volts
 - b. Farads
 - c. Both A B
 - d. None of the above
6. Explain why the following statement is false, “A parallel plate capacitor always has an overall positive charge.”
7. Describe the electric field between the two plates in a parallel plate capacitor.

Lesson Objective: Understand how to solve problems involving capacitance.

8. Calculate the electric potential difference between the plates of a parallel plate capacitor with a capacitance of 0.5 mF and 0.5 mC of charge.
9. Determine the area of the plates in a parallel plate capacitor that are 1mm apart and have a capacitance of 0.2 μF .
10. Determine the amount voltage required to apply 3 μC of charge to a capacitor with a capacitance of 150 pF.

16.4 Dielectrics

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand what a dielectric is and how it affects the capacitance of a capacitor.

1. What is a dielectric?
2. How does a dielectric affect the capacitance of a capacitor?
3. Describe the electric field created inside the dielectric.

Lesson Objective: Solve problems involving capacitors with dielectrics.

Use the following prompt for questions #4-7:

In physics class, you build a simple parallel plate capacitor using 1 mm square metal plates 2 mm apart.

4. Calculate the capacitance of your capacitor.
5. Calculate the amount of charged stored on this capacitor when you connect it to a 1.5 V battery.
6. If you added a rubber dielectric between the metal plates ($k = 2.8$), what would be the new capacitance?
7. How much more charge would be able to be stored due to the rubber dielectric ($k = 2.8$)?

16.5 Electrical Energy Storage

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how energy is stored in a capacitor.

1. How is energy stored in a capacitor?
2. Do capacitors obey the law of conservation of energy? Explain.
3. List one way to increase the electric potential energy of a charged object in an electric field.

For questions #4-6, determine if each statement is true or false. Then, explain the reason for your choice.

4. A battery does work on the charges in a capacitor.
True
False
Explain:
5. A battery provides the charges in a capacitor.
True
False
Explain:
6. A battery no longer works when it runs out of charge.
True
False
Explain:

Lesson Objective: Solve problems involving energy stored in capacitors.

7. Calculate the electric potential difference between the two plates of a capacitor with 5 microfarads of capacitance that is storing 10J of electric potential energy.

8. Determine the amount of electric potential energy stored by a capacitor that carries 1 picocoulombs of charge after being charged by a 12V battery.

CHAPTER 17**Circuits Worksheets****Chapter Outline**

- 17.1 ELECTRIC CURRENT**
 - 17.2 OHM'S LAW**
 - 17.3 RESISTIVITY**
 - 17.4 RESISTORS IN SERIES AND PARALLEL**
 - 17.5 MEASURING CURRENT AND VOLTAGE**
-

17.1 Electric Current

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how electric current is defined.

1. Explain what it means to describe current as a rate quantity.
2. What causes a high current?
3. How does current compare at different points along a simple circuit?
4. What are the necessary conditions for current to flow in a circuit?
5. Where do the charges come from that move through an electrical circuit?
6. The units for current are
 - a. Coulombs/second
 - b. Amperes
 - c. Volts
 - d. Both A B

Lesson Objective: Solve problems involving electric current.

7. Calculate the current produced by 3 C of charge passing a point along a circuit in 30 seconds.
8. Calculate the amount of charge that passes by a cross section of a wire in 1.5 minutes if the current along the wire is 0.3 amperes.

17.2 Ohm's Law

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how conventional current is defined.

1. Define conventional current.
2. What is the direction of conventional current?
3. What electrical charges actually move in a current? How does this differ from the definition and direction of conventional current?

Lesson Objective: Understand electrical resistance.

4. What is electrical resistance?
5. How are resistors used in electrical devices?
6. Provide an example of an electrical resistor.

Lesson Objective: Understand how to solve problems using Ohm's law.

7. According to Ohm's law, what happens to the current flowing through a circuit if the resistance is held constant and the voltage doubles?
8. According to Ohm's law, what happens to the current flowing through a circuit if the resistance is doubled and the voltage remains the same?
9. According to Ohm's law, how could you maintain a constant current if the resistance in a circuit is tripled?

10. What is the current that flows through a toaster, with an electrical resistance of 20 ohms, plugged into a wall outlet that provides 120 volts?

17.3 Resistivity

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how to solve problems involving resistivity.

1. Describe the relationship between resistivity and conductivity.
2. What does the gauge of a wire describe? Why is it important?
3. As the gauge of a wire increases, its resistivity
 - a. Increase
 - b. Decreases
 - c. Stays the same
 - d. Not enough information to determine
4. Compare and contrast the diameter, and resulting resistivity, of a 10-gauge wire with an 18-gauge wire.
5. Which is more conductive, a 12-gauge wire or a 24 gauge wire? Why?
6. Which of the following wires allows the greatest current to flow through it?
 - a. A 10 cm piece of 10-gauge wire
 - b. A 10 cm piece 12-gauge wire
 - c. A 10 cm piece of 18-gauge wire
 - d. A 10 cm piece of 22-gauge wire
7. Explain the reason for your choice in question #6.
8. Why do you think it is necessary for electricians to have access to wires with different gauges?
9. What is the relationship between the length of a wire and its resistivity?
10. Units of resistivity are
 - a. Ohms (Ω)

- b. Ohms meter ($\Omega \cdot m$)
 - c. Volts (V)
 - d. Amperes (A)
11. Describe an experiment that you could conduct to determine the resistivity of two wires made of different materials.
 12. Calculate the resistance of a copper wire ($r_{copper} = 1.7 \times 10^{-8}$) with a length of 20cm and a cross-sectional area of 4 mm^2 .

Lesson Objective: Understand how to read the resistor code.

Describe the information that can be derived from the following bands on a four-band resistor for questions #13-16:

13. The First Band:
14. The Second Band:
15. The Third Band:
16. The Fourth Band:

Use the following chart to determine the resistance in ohms of the four-band resistors in questions #17-20:

17. A resistor with a band color sequence of Brown, Red, Brown, Gold has a resistance of
 - a. 16
 - b. 3.9×10^2
 - c. 9.1×10^5
 - d. 120
18. A resistor with a band color sequence of Brown, Blue, Black, Gold
 - a. 16
 - b. 3.9×10^2
 - c. 9.1×10^5
 - d. 120
19. A resistor with a band color sequence of Orange, White, Red, Silver
 - a. 16
 - b. 3.9×10^2
 - c. 9.1×10^5
 - d. 120
20. A resistor with a band color sequence of White, Brown, Yellow, None
 - a. 16
 - b. 3.9×10^2

- c. 9.1×10^5
- d. 120

17.4 Resistors in Series and Parallel

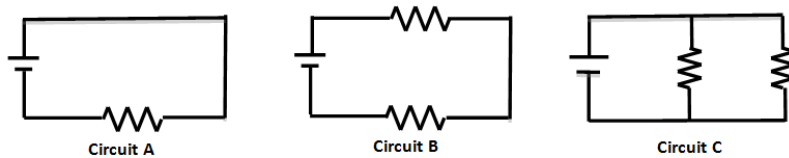
Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Be able to distinguish between a series and parallel circuit.

For questions #1-8, refer to the diagrams of circuits A, B, & C below. Each circuit has identical batteries (9 V) and resistors ($100\ \Omega$).

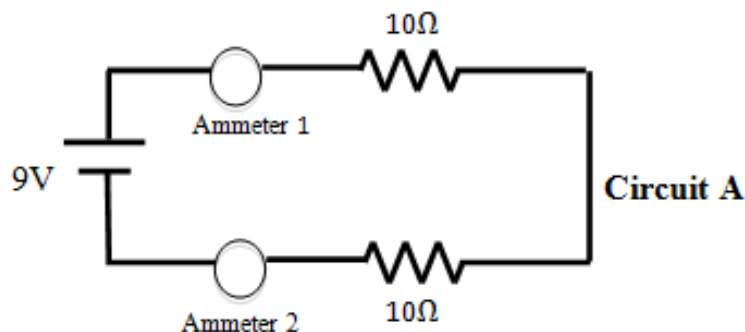


- Which circuit has two resistors connected in series?
 - Circuit A
 - Circuit B
 - Circuit C
 - None of the above
- Which circuit has two resistors connected in parallel?
 - Circuit A
 - Circuit B
 - Circuit C
 - None of the above
- Which of the following statements correctly describes the path of an electron in Circuit B?
 - All electrons pass through only one resistor
 - All electrons pass through both resistors
 - The electrons will not pass through either resistor
 - Not enough information to determine
- Which of the following statements correctly describes the path of an electron in circuit C?
 - All electrons pass through only one resistor
 - All electrons pass through both resistors
 - The electrons will not pass through either resistor
 - Not enough information to determine
- Which circuit has the total lowest current running through it?
 - Circuit A
 - Circuit B
 - Circuit C
 - None of the above

6. Explain the reason for your choice in question #5 above.
7. In which circuit(s) is the voltage drop across every resistor 9 V?
 - a. Circuit A
 - b. Circuit B
 - c. Circuit C
 - d. Circuit A C
8. Explain the reason for your choice in question #7 above.
9. If the resistors were light bulbs, predict what would happen if one of the bulbs burned out in circuit B.
10. If the resistors were light bulbs, predict what would happen if one of the bulbs burned out in circuit C.
11. If the resistors were light bulbs, predict what would happen to each bulb's brightness if another bulb was added in series to circuit B.
12. If another 9V battery was added to each circuit, which circuit would experience an increase in current?
 - a. Circuit A
 - b. Circuit B
 - c. Circuit C
 - d. All of the above

Lesson Objective: Solve problems involving circuits with resistors.

For questions #13-20, refer to the diagrams of circuits X & Y below. Each circuit has identical batteries (1.5V) and resistors ($10\ \Omega$).



13. What is the equivalent resistance of circuit X?
14. What is the equivalent resistance of circuit Y?
15. What is the total current running through circuit X?

16. What is the total current running through circuit Y?
17. What is the voltage drop across each resistor in circuit X?
18. What is the voltage drop across each resistor in circuit Y?
19. What is the current through each resistor in circuit X?
20. What is the current through each resistor in circuit Y?

17.5 Measuring Current and Voltage

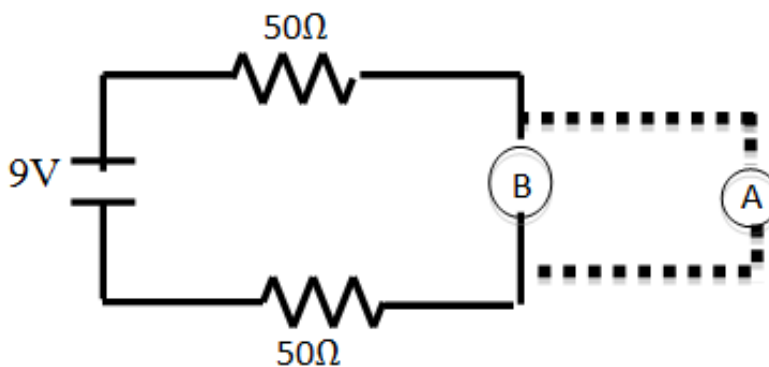
Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand how an ammeter is used.

Use the diagram of circuit X below to answer questions #1-2:

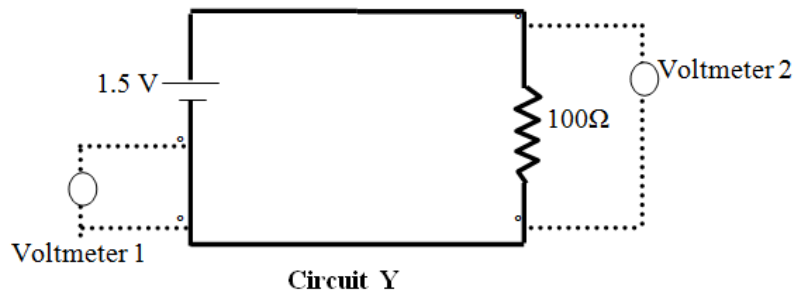


Circuit X

1. Where should an ammeter be placed in this circuit?
 - a. Point A
 - b. Point B
 - c. Point A and Point B
 - d. None of the above
2. What would the ammeter read?

Lesson Objective: Understand how a voltmeter is used.

Use the diagram of circuit Y below to answer questions #3-5:



3. What should voltmeter 1 read?
 - a. 0 V
 - b. 0.5 V
 - c. 0.75 V
 - d. 1.5 V
4. What should voltmeter 2 read?
 - a. 0 V
 - b. 0.5 V
 - c. 0.75 V
 - d. 1.5 V
5. Another $100\ \Omega$ resistor is added parallel to this circuit with a voltmeter (called voltmeter 3) connected across it. What should voltmeter 3 read?
 - a. 0 V
 - b. 0.5 V
 - c. 0.75 V
 - d. 1.5 V

CHAPTER

18**Magnetism Worksheets****Chapter Outline**

- 18.1 MAGNETIC FIELDS**
 - 18.2 THE MAGNETIC FORCE ACTING ON A CURRENT-CARRYING WIRE**
 - 18.3 MAGNETIC FORCE ON MOVING ELECTRIC CHARGES**
 - 18.4 A PRACTICAL APPLICATION OF MAGNETIC FIELDS**
-

18.1 Magnetic Fields

Worksheet

18.2 The Magnetic Force acting on a Current-Carrying Wire

Worksheet

18.3 Magnetic Force on Moving Electric Charges

Worksheet

18.4 A Practical Application of Magnetic Fields

Worksheet

CHAPTER **19**

Electromagnetism Worksheets

Chapter Outline

- 19.1 ELECTROMAGNETIC INDUCTION
 - 19.2 THE ELECTRIC GENERATOR
 - 19.3 ELECTRICAL POWER TRANSFER
 - 19.4 THE ELECTROMAGNETIC SPECTRUM
-

19.1 Electromagnetic Induction

Worksheet

19.2 The Electric Generator

Worksheet

19.3 Electrical Power Transfer

Worksheet

19.4 The Electromagnetic Spectrum

Worksheet

CHAPTER 20**Geometric Optics
Worksheets****Chapter Outline**

20.1 LIGHT AS A RAY AND THE LAW OF REFLECTION

20.2 CONCAVE AND CONVEX MIRRORS

20.3 INDEX OF REFRACTION

20.4 THIN LENSES

20.1 Light as a Ray and the Law of Reflection

Lesson Worksheet

20.2 Concave and Convex Mirrors

Lesson Worksheet

20.3 Index of Refraction

Lesson Worksheet

20.4 Thin Lenses

Lesson Worksheet

CHAPTER **21** **Physical Optics Worksheets**

Chapter Outline

- 21.1** **DISPERSION**
 - 21.2** **THE DOUBLE-SLIT EXPERIMENT**
 - 21.3** **THIN FILMS**
 - 21.4** **POLARIZATION**
-

21.1 Dispersion

Worksheet

21.2 The Double-Slit Experiment

Worksheet

21.3 Thin Films

Worksheet

21.4 Polarization

Worksheet

CHAPTER **22**

The Special Theory of Relativity

Chapter Outline

22.1 THE SPECIAL THEORY OF RELATIVITY

22.1 The Special Theory of Relativity

Worksheet

Name _____ Class _____ Date _____

Galilean Relativity

1. Provide TWO examples of inertial frames of reference in the space below.

Use the following prompt to answer questions #2-4:

Sound waves travel at approximately 343 m/s in air. Use the principles of Galilean Relativity to determine the relative velocity of the sound waves in each of the various inertial frames of reference below.

2. >
3. The sound waves observed by the pilot of a jet travelling at a constant 360 m/s, producing a sonic boom.
4. The sound waves observed by a driver of an ambulance traveling at 29 m/s (65 mph).
5. How does the observance of sound waves described in questions #2-3 differ from what was observed about the speed of light?

Time Dilation and Length Contraction

5. Which of the following statements correctly follow the theory of special relativity?
 - a. Absolute time and space do not exist
 - b. Space and time are interdependent
 - c. Any change in time must result in a change in space
 - d. All of the above
6. Which of the following statements correctly exemplifies time dilation?
 - a. A clock moving relative to an observer will run more slowly than a clock at rest relative to the observer
 - b. A clock moving relative to an observer will run more quickly than a clock at rest relative to the observer
 - c. A clock at rest relative to an observer will run more slowly than a clock moving relative to the observer
 - d. A clock at rest relative to an observer will run more quickly than a clock moving relative to the observer
7. As time dilates, the length of an object _____, in order to maintain the speed of light as constant.
 - a. Contracts

- b. Expands
 - c. Remains the same
 - d. Not enough information to determine
8. According to time dilation, clocks on the International Space Station (ISS) run slightly _____ than clocks on Earth.
- a. Faster
 - b. Slower
 - c. At the same rate
 - d. Not enough information to determine
9. According to time dilation, upon returning from a mission aboard the International Space Station (ISS), astronauts will be slightly _____ than if they had remained on Earth.
- a. Younger
 - b. Older
 - c. Same age
 - d. Not enough information to determine
10. According to the special theory of relativity, do astronauts aboard the ISS sense the dilatation of time? Explain the reason for your answer.

Simultaneity

11. Describe a thought experiment illustrating the relativity of simultaneous events.

Mass-Energy Equivalence

12. What is rest energy?
13. According to mass-energy equivalence, when the mass of an object decreases
- a. Energy is consumed
 - b. Energy is released
 - c. Matter is created
 - d. Matter is destroyed
14. Which equation can be used to calculate the rest energy of a stationary piece of matter?
- a. $KE = \frac{1}{2} mv^2$
 - b. $PE = mgh$
 - c. $E = mc^2$
 - d. $PE = \frac{1}{2} kx^2$

General Theory of Relativity

15. What is space-time and how does it fit into the general theory of relativity?

CHAPTER **23**

Quantum Physics Worksheets

Chapter Outline

23.1 QUANTUM PHYSICS

23.1 Quantum Physics

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Blackbody Radiation and Planck's Quantum Hypothesis

1. What is a quantum?
2. How did Planck's mathematical equation lead to a quantum hypothesis?
3. Use Planck's equation to calculate the energy of a photon of red light ($\lambda = 633 \text{ nm}$).
4. What is a blackbody? Why is it important to the development of Planck's quantum hypothesis?
5. Which of the following acts most similar to a blackbody?
 - a. The sun
 - b. A black hole
 - c. Both A B
 - d. None of the above

Photons and the Photoelectric Effect

6. What is a photon?
7. Describe the photoelectric effect.
8. Experimental results show that violet light incident on a metallic surface ejected electrons and green light incident on the same surface had no effect. Explain these results with reference to the photons and the photoelectric effect.

Wave-Particle Duality

9. What is wave-particle duality?

10. Describe an instance in which light behaves as a wave.
11. Describe an instance in which light behaves as a particle.
12. De Broglie suggested that
 - a. Particles with momentum have an associated wavelength
 - b. Moving matter exhibits wave-like behavior
 - c. The wavelength of matter can be calculated in the same way as the wavelength of light
 - d. All of the above

CHAPTER **24** **Atomic Physics Worksheets**

Chapter Outline

24.1 **ATOMIC PHYSICS**

24.1 Atomic Physics

Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Modeling the Atom

Describe the following models of the atom, including the scientists associated with developing each model and the supporting experimental evidence.

1. The plum pudding model
2. The nuclear model
3. The planetary model
4. The electron cloud model

The Bohr Atom

5. Describe the emission spectrum of hydrogen and its connection to the Bohr model of the atom.
6. What were some sources of error in Rutherford's planetary model of the atom? How did Bohr plan to resolve these inconsistencies?

7. Describe the arrangement of electrons in Bohr's atomic model.

8. Describe the quantization of energy in Bohr's atomic model.

Uncertainty Principle

9. What is the fundamental constraint described by the Heisenberg uncertainty principle?

10. The uncertainty principle is only applicable to
 - a. Quantum Mechanics
 - b. Astronomy
 - c. Macroscopic world
 - d. All of the above

CHAPTER **25**

Nuclear Physics

Chapter Outline

25.1 WORKSHEET

25.1 Worksheet

Name _____ Class _____ Date _____

Answer each of the questions below to show your achievement of the lesson objectives.

Lesson Objective: Understand magnetic flux.

The Nucleus

1. What are nucleons?
2. Describe the strong nuclear force and its connection to the stability of an atom's nucleus.

Radioactive Half-life

3. Which of the following spontaneous reactions exemplifies *alpha decay*?

- a. ${}_{56}^{137}\text{Ba} \rightarrow {}_{56}^{137}\text{Ba} + \gamma$
- b. ${}_{90}^{232}\text{Th} \rightarrow {}_{88}^{228}\text{Ra} + {}_2^4\text{He}$
- c. ${}_{6}^{14}\text{C} \rightarrow {}_7^{14}\text{N} + {}_{-1}^0\text{e}^- + \nu$
- d. All of the above

4. Explain the reason for your answer choice in question #3 above.

5. Which of the following spontaneous reactions exemplifies *beta decay*?

- a. ${}_{56}^{137}\text{Ba} \rightarrow {}_{56}^{137}\text{Ba} + \gamma$
- b. ${}_{90}^{232}\text{Th} \rightarrow {}_{88}^{228}\text{Ra} + {}_2^4\text{He}$
- c. ${}_{6}^{14}\text{C} \rightarrow {}_7^{14}\text{N} + {}_{-1}^0\text{e}^- + \nu$
- d. All of the above

6. Explain the reason for your answer choice in question #5 above.

7. Which of the following spontaneous reactions exemplifies *gamma decay*?

- a. ${}_{56}^{137}\text{Ba} \rightarrow {}_{56}^{137}\text{Ba} + \gamma$
- b. ${}_{90}^{232}\text{Th} \rightarrow {}_{88}^{228}\text{Ra} + {}_2^4\text{He}$
- c. ${}_{6}^{14}\text{C} \rightarrow {}_7^{14}\text{N} + {}_{-1}^0\text{e}^- + \nu$
- d. All of the above

8. Explain the reason for your answer choice in question #7 above.

Use the following prompt for questions #9-10:

A sample of 300 grams of a radioactive isotope with half-life of 10 years decays for 50 years.

9. The time period for the decay is equivalent to
 - a. 0.25 half-lives
 - b. 1 half-life
 - c. 4 half-lives
 - d. 5 half-lives
10. Calculate how much of the original isotope will remain at the end of the 50 year period.

Nuclear Fission and Fusion

11. Nuclear fission is a process in which
 - a. The repelling electromagnetic force between protons overcomes the attractive strong nuclear force between nucleons
 - b. Heavy nuclei split to become lighter nuclei
 - c. Heavy nuclei lose mass and release energy
 - d. All of the above
12. Nuclear fusion is a process in which
 - a. Extremely high temperatures are required
 - b. Light nuclei collide at high speed
 - c. Light nuclei lose mass and release energy
 - d. All of the above