Reinforcement & Vocabulary Review Worksheets

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1. Click a bookmark on the left.

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1. Click the Print button.

2. When the Print window opens, type in a range of pages to print.

The page numbers are displayed in the bar at the bottom of the document. In the example below, “1 of 151” means that the current page is page 1 in a file of 151 pages.
The Plane Truth

Complete this worksheet after you finish reading Chapter 1, Section 2.

You plan to enter a paper airplane contest sponsored by Talkin’ Physical Science magazine. The person whose airplane flies the farthest wins a lifetime subscription to the magazine! The week before the contest, you watch an airplane landing at a nearby airport. You notice that the wings of the airplane have flaps, as shown in the illustration at right. The paper airplanes you’ve been testing do not have wing flaps.

What question would you ask yourself based on these observations? Write your question in the space below for “State the problem.” Then tell how you could use the other steps in the scientific method to investigate the problem.

1. State the problem.

2. Form a hypothesis.

3. Test the hypothesis.

4. Analyze the results.

5. Draw conclusions.
After finishing Chapter 1, give this puzzle a try!

**ACROSS**

1. the ratio of an object's mass to its volume
2. the amount of space something occupies
3. any use of the senses to gather information
4. the application of knowledge, tools, and materials to accomplish tasks
5. measure of the amount of matter in an object
6. Scientists use the _____ System of Units so they can share and compare results.
10. measure of how much surface an object has
13. Scientists use the _____ method to solve problems and answer questions.
15. measure of how hot or cold something is
16. The study of matter and energy is called _____ science.

**DOWN**

1. A quantity formed from the combination of other measurements is a _____ quantity.
2. a possible explanation or answer to a question
3. A representation of a salt crystal made out of table-tennis balls is a _____ of the crystal.
4. Scientists use the _____ method to solve problems and answer questions.
5. an experimental boat that imitates the way a penguin swims
6. in science, a summary of many experimental results and observations
7. a scientific explanation for a range of hypotheses and observations supported by testing
8. pieces of information acquired through experimentation
9. the basic SI unit of length
A Matter of Density

Complete this worksheet after you finish reading Chapter 2, Section 2.

Imagine that you work at a chemical plant. This morning, four different liquid chemicals accidentally spilled into the same tank. Luckily, none of the liquids reacted with each other! Also, you know the liquids do not dissolve in one another, so they must have settled in the tank in four separate layers. The sides of the tank are made of steel, so you can only see the surface of what’s inside. But you need to remove the red chemical to use in a reaction later this afternoon. How will you find and remove the red chemical? By finding the chemicals’ different densities, of course!

The following liquids were spilled into the tank:

- a green liquid that has a volume of 48 L and a mass of 36 kg
- a blue liquid that has a volume of 144 L and a mass of 129.6 kg
- a red liquid that has a volume of 96 L and a mass of 115.2 kg
- a black liquid that has a volume of 120 L and a mass of 96 kg

1. Calculate the density of each liquid.
   - Green liquid: \( \frac{36 \text{ kg}}{48 \text{ L}} \)
   - Blue liquid: \( \frac{129.6 \text{ kg}}{144 \text{ L}} \)
   - Red liquid: \( \frac{115.2 \text{ kg}}{96 \text{ L}} \)
   - Black liquid: \( \frac{96 \text{ kg}}{120 \text{ L}} \)

2. Determine the order in which the liquids have settled in the tank.
   - First (bottom): green liquid
   - Second: blue liquid
   - Third: red liquid
   - Fourth (top): black liquid

3. Use colored pencils to sketch the liquid layers in the container in the diagram on the next page.

4. What kind of property did you use to distinguish between these four chemicals?
   - a. a chemical property
   - b. a physical property
   - c. a liquid property
   - d. None of the above
5. Now that you know where the red chemical is inside the tank, how can you remove it?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Complete the puzzle after you finish reading Chapter 2.
Fill in each blank with the correct word. Then find the words in the puzzle. Words in the puzzle can be spelled forward or backward and can be vertical, horizontal, or diagonal.

1. The tendency of an object to resist any change in motion is called __________________________.

2. When water is in a container, the surface of the water is curved. This curve is called the __________________________.

3. The amount of space occupied by an object is its __________________________.

4. Iron __________________________ is also known as fool’s gold.

5. The __________________________ of an object is the amount of matter in the object. The SI unit for expressing this quantity is the __________________________.

6. The force that causes an object to feel a “pull” toward Earth is called __________________________. The measure of this force is the object’s __________________________. The SI unit for expressing this force is the __________________________.

7. __________________________ is anything that has volume and mass.

8. __________________________ is mass divided by unit volume.

9. A __________________________ change occurs when one or more substances are changed into entirely new substances with different properties.

10. Examples of __________________________ properties are color and odor.

11. A __________________________ property is always the same, whether the sample observed is large or small.
Search for Matter, continued

W  P  F  X  D  E  N  S  I  T  Y  E  P  C
R  E  V  Q  C  J  N  D  Q  W  M  I  I  J
B  P  I  N  E  W  T  O  N  U  A  T  G  K
A  E  F  G  E  X  J  O  L  N  S  I  K  I
G  X  C  J  H  H  P  O  D  I  I  I  K  L
R  Y  M  H  R  T  V  V  R  C  N  Q  P  O
A  S  A  K  E  T  S  E  M  A  E  X  H  G
V  T  S  L  D  M  T  N  F  M  R  U  Y  R
I  W  S  N  N  C  I  M  V  X  T  Z  S  A
T  Y  U  K  A  C  G  C  A  X  I  N  I  M
Y  O  D  R  J  I  N  T  A  T  A  Q  C  M
P  T  A  P  Y  R  I  T  E  L  T  R  A  W
C  H  Z  M  M  P  V  Q  P  B  Z  E  L  B
C  T  Z  C  M  E  N  I  S  C  U  S  R  P
Complete this worksheet after you finish reading Chapter 3, Section 2.
Each figure below shows a container that is meant to hold one state of matter. Identify the state of matter, and write the state on the line below the corresponding figure. Then write each of the descriptions listed below in the correct boxes. Some descriptions may go in more than one box.

Particles are close together.
Particles are held tightly in place by other particles.
Particles break away completely from one another.
Changes volume to fill its container.
Changes shape when placed in a different container.

<table>
<thead>
<tr>
<th>State of matter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>can be used in hydraulic systems</td>
</tr>
<tr>
<td></td>
<td>obeys Boyle’s law</td>
</tr>
<tr>
<td></td>
<td>amount of empty space can change</td>
</tr>
<tr>
<td></td>
<td>has definite shape</td>
</tr>
<tr>
<td></td>
<td>particles vibrate in place</td>
</tr>
<tr>
<td></td>
<td>does not change in volume</td>
</tr>
<tr>
<td></td>
<td>has surface tension</td>
</tr>
</tbody>
</table>

Name _______________________________________________ Date ________________ Class______________
Know Your States

After you finish Chapter 3, give this puzzle a try!
Use the clues below to complete the crossword puzzle.

ACROSS
3. to change state from a gas to a liquid
6. change of state from a solid to a gas
7. Particles have an orderly arrangement in this type of solid.
10. physical form in which a substance can exist
11. how your body is cooled when you perspire
14. changes shape but doesn’t change volume
15. He said that as the volume of a gas increases, its pressure decreases.
16. how molten metal changes into a solid
18. does not change shape when placed in a different container

DOWN
1. measure of the average speed of the particles of a substance
2. to change state from a solid to a liquid
4. Because of surface tension liquids form spherical ________.
5. has no definite shape or volume; conducts electric current
8. Particles are arranged in no particular order in this type of solid.
9. A change of state where energy is given off is called a(n) ________ change.
12. If a substance pours very slowly, it has a high ________.
13. A change of state reaction that ________ energy is endothermic.
15. how hot water changes to steam
17. changes shape and volume to fit container
Complete this worksheet after you finish reading Chapter 4, Section 3.
Label each figure below with the type of substance it BEST models: colloid, compound, element, solution, or suspension.

1. ________________________
2. ________________________
3. ________________________
4. ________________________
5. ________________________
Professor Jumble's Confusion

In her lab, Professor Jumble has four shelves labeled “Suspensions,” “Solutions,” “Compounds,” and “Colloids,” respectively. Last night, the professor set one beaker of clear liquid on each of the four shelves. When the professor walked into her lab this morning, all four beakers were on the same shelf, and she didn’t know which was which. She tested each beaker, and the results are below.

Use the test results to help Professor Jumble unjumble the beakers, and write the identity of each liquid in the blanks.

<table>
<thead>
<tr>
<th>Beaker A: ___________________________</th>
<th>Beaker B: ___________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Light passes right through.</td>
<td>• Light passes right through.</td>
</tr>
<tr>
<td>• Particles do not separate in a centrifuge or a filter.</td>
<td>• Particles do not separate in a centrifuge or a filter.</td>
</tr>
<tr>
<td>• Upon heating, the liquid evaporates, and a crystal powder remains.</td>
<td>• Upon heating, the liquid evaporates, but no residue remains.</td>
</tr>
<tr>
<td></td>
<td>• The particles could not be separated by any other physical changes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Beaker C: ___________________________</th>
<th>Beaker D: ___________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Liquid scatters light.</td>
<td>• Liquid scatters light.</td>
</tr>
<tr>
<td>• Liquid centrifuged into two different-colored layers.</td>
<td>• Liquid passes through a filter without leaving a residue.</td>
</tr>
<tr>
<td>• Particles were left behind in the filter.</td>
<td></td>
</tr>
</tbody>
</table>
## Chapter 4 Vocabulary Review Worksheet

**An ELEMENTary Word Puzzle**

Give this puzzle a try after you read Chapter 4.

Identify each term described by the clues. Then find and circle each term in the puzzle on the next page. Words may appear forward or backward, horizontally, vertically, or diagonally.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>amount of solute needed to make a saturated solution using a given amount of solvent at a certain temperature</td>
</tr>
<tr>
<td>2.</td>
<td>mixture in which dispersed particles are too light to settle out</td>
</tr>
<tr>
<td>3.</td>
<td>substance in which another is dissolved</td>
</tr>
<tr>
<td>4.</td>
<td>can be expressed as grams of solute per milliliter of solvent</td>
</tr>
<tr>
<td>5.</td>
<td>pure substance that cannot be separated into simpler substances by physical or chemical means</td>
</tr>
<tr>
<td>6.</td>
<td>two or more substances that are combined physically, not chemically</td>
</tr>
<tr>
<td>7.</td>
<td>pure substance made up of at least two elements that are chemically combined</td>
</tr>
<tr>
<td>8.</td>
<td>characteristic property measured in grams per cubic centimeter that tells a substance’s mass per unit volume</td>
</tr>
<tr>
<td>9.</td>
<td>element that has properties of both metals and nonmetals</td>
</tr>
<tr>
<td>10.</td>
<td>solid solution of a metal or a nonmetal dissolved in a metal</td>
</tr>
<tr>
<td>11.</td>
<td>dissolved substance</td>
</tr>
<tr>
<td>12.</td>
<td>shiny element; good conductor of thermal energy and electric current</td>
</tr>
<tr>
<td>13.</td>
<td>mixture in which particles of one substance are large enough to settle out of another substance</td>
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<tr>
<td>14.</td>
<td>brass, salt water, and air, for example</td>
</tr>
<tr>
<td>15.</td>
<td>element that is a poor conductor of thermal energy and electric current</td>
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</table>
### An ELEMENTary Word Puzzle, continued

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</table>
Complete this worksheet after you finish reading Chapter 5, Section 1. You and a friend are having a bug race. You measure the distance your pet bugs travel along a straight race track and record their time as they race. The results are plotted in the graphs below. Take a look at the two graphs. Then answer the questions that follow.

1. Look at Point A. What distance has your bug traveled so far? 
2. How long did it take your bug to travel that distance? 
3. To determine your bug’s average speed while traveling from the starting line to Point A, divide the distance traveled by the time it took to travel that distance:
   \[
   \text{average speed} = \frac{\text{distance traveled}}{\text{elapsed time}}
   \]
4. Now look at Point B. What is the distance from Point A to Point B? 
5. How long did it take your bug to travel from Point A to Point B? 
6. Calculate your bug’s average speed from Point A to Point B. 
7. Compare the graphs of your bug and your friend’s bug. Which bug was traveling at a constant speed? Explain.
Steve challenged his little sister Jenny to a problem: Use all four types of friction to get home from school as quickly and as safely as possible. He reminded her that the four types of friction are sliding, rolling, static, and fluid. Here’s what Jenny did:

Jenny hopped on her bicycle after school. What a perfect day to be cycling—the sun was shining, there was a slight breeze in the air, and the temperature was a comfortable 27°C. Jenny got on the bike path and began pedaling as fast as she could. The wheels of the bicycle were turning at a furious pace. And the faster Jenny pedaled, the stronger the breezy air blew in her face. All of a sudden, she came across a huge tree branch that had fallen on the path. Jenny slammed on her brakes and stopped just in time to avoid hitting the fallen branch. That was a close call! She got off of her bike and tried to push the branch to the side of the path so that others would not get hurt, but it was too heavy to budge. Jenny continued on her journey and got home safely in record time.

Did Jenny meet Steve’s challenge? Explain.
1. Determine whether each device measures mass or weight, and circle the correct term in each box.

2. The following list contains information that relates to either mass or weight. Write each of the bulleted items in the correct boxes above. Some information may go in more than one box.

- balance
- spring scale
- measure of gravitational force exerted on an object
- amount of matter in an object
- constant on Earth
- measured in grams
- changes when gravitational force changes
- never changes
- expressed in newtons
- remains the same when gravitational force changes
- six times less on the moon than on Earth
After you finish Chapter 5, give this puzzle a try!

Oh no! Penny Punster’s computer mixed up her physical science dictionary with her dictionary of puns. The computer paired the terms related to forces with her goofy definitions, and it paired her pun-related terms with the real definitions. Help Penny unscramble the mismatched pairs and get her dictionaries back in order. The first one has been done for you!

1. **farce**: a push or pull
   - **a. balanced**: a ringer on a stick

2. **grubby tea**: force of attraction between objects due to mass
   - **b. newton**: used to be nine

3. **freak sheen**: force opposing motion between touching surfaces
   - **c. force**: slapstick

4. **fellow’s city**: speed in a particular direction
   - **d. fluid**: influenza commercial

5. **frightening**: rate at which velocity changes
   - **e. motion**: lawn-cutting avoidance

6. **exhilaration**: rate at which an object moves
   - **f. gravity**: dirty English drink

7. **mow shun**: changing position over time
   - **g. velocity**: guy’s town

8. **spyed**: rate at which an object moves
   - **h. net force**: mesh that’s ours

9. **bell lanced**: forces producing a net force of zero
   - **i. static**: pigpen twitch

10. **net for us**: result of combined forces on an object
    - **j. mass**: spiked medieval war club

11. **wade**: measure of the force of gravity on an object
    - **k. friction**: weird shininess

12. **mace**: amount of matter in an object
    - **l. acceleration**: thrill

13. **roe link**: friction between wheels and the floor
    - **m. weight**: slowly walk into the water

14. **lib ad**: friction that slows down a swimmer
    - **n. speed**: played secret agent

15. **rolling**: fish egg connection
    - **o. sliding**: sneaky dent

16. **now ten**: unit used to express force
    - **p. lubricant**: the sign between Virgo and Scorpio won’t work

17. **sly ding**: friction that makes brakes work
    - **q. rolling**: fish egg connection
CHAPTER 6  REINFORCEMENT WORKSHEET

Falling Fast

Complete this worksheet after you finish reading Chapter 6, Section 1.

A stone rolls off a 150 m cliff. The partially completed table below shows the distance fallen and the velocity of the stone for the first few seconds of its fall.

1. Use the formula below to calculate the velocity of the stone at the end of each second. Remember that acceleration due to gravity is 9.8 m/s/s. Record the answers in the table in the column labeled “Velocity.” The first few calculations are done for you.

   Notice that the stone's initial velocity is 0 m/s. The velocity at the end of one second is the initial velocity plus the change in velocity due to gravity:

   $$velocity = initial\ velocity + change\ in\ velocity$$

   Since the initial velocity is 0 m/s, we can ignore it.

   $$velocity = change\ in\ velocity = \Delta v = (acceleration\ due\ to\ gravity) \times (time)$$

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Velocity (m/s)</th>
<th>Distance fallen during this second (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>$\Delta v = 9.8 \times 1 = 9.8$</td>
<td>4.9</td>
</tr>
<tr>
<td>2</td>
<td>$\Delta v = 9.8 \times 2 = 19.6$</td>
<td>$4.9 + 9.8 = 14.7$</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>$4.9 + 9.8 + 9.8 = 24.5$</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>$4.9 + 3(9.8) = 34.3$</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Do you see the pattern in the calculations for the third column? Calculate the distance fallen in each second, and record the two remaining values in the column labeled “Distance fallen during this second” in the table.
3. After 2 seconds, the stone will have fallen a total of 19.6 m (distance after first second + distance during second second). How far will the stone have fallen after 5 seconds? (Use the space below for your calculations.)

After 5 seconds, the stone will have fallen
________________________ m.

4. Approximately when will the stone hit the ground? Explain your reasoning.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

5. If a much heavier stone rolled off the same cliff, would it hit the ground more quickly? Explain.

________________________________________________________________________
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After you finish Chapter 6, give this puzzle a try!

Use the clues given to fill in the blanks below. Then copy the numbered letters into the corresponding squares on the next page to reveal a quotation attributed to Galileo.

1. When gravity is the only force acting on an object, the object is in

   52  47  29

2. Because of free fall, astronauts appear this way in orbit.

   40  51  2  13  44

3. The velocity at which a falling object travels when the force of air resistance exactly matches the downward force of gravity is called the

   12  46  17  25  8  19  49  30

4. The unbalanced force that causes an object to move in a circular path is called a ________ force.

   32  22  42  1

5. Sir Isaac Newton is famous for his three laws of

   11  54  38  33  26

6. Newton’s third law states that objects exert ________ and ________ forces on each other.

   34  16

7. The curved path traveled by a thrown baseball is known as

   10  45  27  35  15  37  6

8. The acceleration of a falling object is caused by the force of

   21  53  4  48

9. ________ is the tendency of an object to resist any change in its motion.

   50  24  56  3

10. A moving object’s ________ depends on the object’s mass and velocity.

    55  9  43  57
11. The fluid friction that opposes the motion of objects through air is known as
Complete this worksheet after you finish reading Chapter 7.

1. Below is a diagram of a balloon that has just been released. Identify the areas of high and low pressure, and label them on the diagram.

2. Why does air rush out of the balloon when you release it?

____________________________________________________________________________________________

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____________________________________________________________________________________________
3. Is the pressure of the stream of air exiting the balloon different from the pressure of the air around the balloon? Explain in terms of Bernoulli’s principle.

4. Add an arrow to the diagram on the previous page to show the direction of the air coming out of the balloon. Add another arrow indicating the direction the balloon is pushed by the exiting air. Label the first arrow “Air outflow,” and label the second arrow “Thrust.”

5. If you attach some weight to the balloon, it might not be able to fly. Use the terms weight, thrust, and lift to explain.
After completing Chapter 7, give this puzzle a try!
Fill in the blanks in the clues below. Then use the clues to complete
the puzzle on the next page.

Clues

1. ____________________ discovered that the buoyant force
depends on the weight of the displaced fluid.
2. ____________________ described the connection between
fluid speed and pressure.
3. A swim ____________________ controls a fish’s overall
density.
4. ____________________ force is the upward force exerted
on any object in a fluid.
5. The layer of gases surrounding the Earth is called the
__________________.
6. A ____________________ is something that flows.
7. ____________________ is the upward force due to fluid
flow around an airplane wing.
8. The amount of matter in a certain volume divided by the volume
is ____________________.
9. A fluid force that opposes motion is called
__________________.
10. One newton per square meter is a ____________________.
11. A ____________________ device uses a liquid to transmit
pressure from one point to another.
12. An irregular fluid flow is ____________________.
13. To ____________________ is to move into something else’s
location by pushing it aside.
14. ____________________ is the amount of force exerted on a
given area divided by the area.
15. The forward force from a plane’s engine is ____________________.
How many chapter concepts can you find in the block of letters below? Use the clues on the previous page to help you. Words may appear horizontally, vertically, diagonally, or backward.

T U R B U L E N C E M E Z C E E K
C A S O Q V H Y D R A U L I C D I
P R E S S U R E G Y Q A K J E X Q
O Z D Q G R T N A Y O U B S B R Z
B K D F P D E N S I T Y S S L K I
T P C H D G C T P X T E E J A Z J
A S J A W B N S G T R D R Z D F D
O T U A J A F G F P E S X M D S Z
G I M R Z Z Q I M M J C X S E U I
S E V O H T L O I B H T M C R D L
Q P L B S T C H L H B B J P G I L
X Y R W G P C I O N F T D A J S U
U R M N D R H I S F F U A S I P O
C T T I A I R E D N J J A C F L N
Q M U V Q A R J R R W H R A P A R
V L L H U Y R M W E A R R L P C E
F Q J F I M F J O U H G F S L E B
Carlita, Tom, and Jamal are having a contest to see who can build the best pulley. After they finish constructing the pulleys, they measure the input and output forces as well as the input and output work. Below is a chart with the results. Help the three students calculate the mechanical advantage and the mechanical efficiency of each of the pulleys.

1. What is the output force of Tom’s pulley? _______
2. What is the input force of Tom’s pulley? _______
3. Divide the output force by the input force. _______
4. Your answer for item 3 is the mechanical advantage for Tom’s pulley. Record this value on the chart below. Calculate the mechanical advantage of the other two pulleys in the same way, and record these values on the chart.

5. What is the output work of Carlita’s pulley? _______
6. What is the input work of Carlita’s pulley? _______
7. Divide the output work by the input work. _______
8. Multiply your answer for item 7 by 100%. _______
9. Your answer for item 8 is the mechanical efficiency for Carlita’s pulley. Record this value on the chart. Calculate the mechanical efficiency of the other two pulleys in the same way, and fill in these values in the chart.

<table>
<thead>
<tr>
<th>Force (N)</th>
<th>Work (J)</th>
<th>Mechanical Advantage</th>
<th>Mechanical Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Output</td>
<td>Input</td>
</tr>
<tr>
<td>Carlita</td>
<td>4</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Tom</td>
<td>15</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>Jamal</td>
<td>25</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

10. Based on your calculations, whose pulley won the contest? Explain your reasoning.
Complete this worksheet after you have finished reading Chapter 8, Section 3.
In Chapter 8 you learned about work and how machines can help make all kinds of work easier. You saw examples of simple machines and compound machines. In the drawing below, find as many machines as you can, and classify them as simple or compound. For each simple machine, write what type of simple machine it is.

<table>
<thead>
<tr>
<th>Simple Machines</th>
<th>Compound Machines</th>
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</thead>
<tbody>
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</tbody>
</table>
Now that you have read Chapter 8, give this word search a try!
After filling in the blanks, find the words in the puzzle on the next page.

1. The unit used to express work is the ____________________.
2. A ____________________ is an inclined plane that is wrapped in a spiral.
3. ____________________ is the rate at which work is done.
4. ____________________ occurs when a force causes an object to move in the direction of the force.
5. The work you do on a machine is called the work ____________________.
6. An ____________________ is a simple machine that is a straight, slanted surface.
7. The mechanical ____________________ of a machine compares the input force with the output force.
8. All machines are constructed from six ____________________ machines.
9. When two kinds of pulleys are used together, the system is called a ____________________.
10. A ____________________ is a simple machine consisting of a bar that pivots at a fixed point.
11. A ____________________ is a device that helps make work easier by changing the size or direction of force.
12. A ____________________ is a double inclined plane that moves.
13. Machines that are made up of two or more simple machines are called ____________________ machines.
14. A ____________________ is a simple machine consisting of two circular objects of different sizes.
15. A ____________________ consists of a grooved wheel that holds a rope or a cable.
16. The work done by a machine is called the work ____________________.
17. The fixed point at which a lever pivots is called a ____________________.
18. Two kinds of pulleys are ____________________ pulleys and ____________________ pulleys.
19. The unit used to express power is the ____________________.
20. Mechanical ____________________ is a comparison of a machine’s work output with the work input.
In the puzzle below, find the words from the blanks on the previous page. Words may appear horizontally, vertically, or diagonally.

```
F B P B W A T T N C S K R E E
F U L U Y Q O U C M I E L N R
E P L O L U E P C W V P A R W
F C S C C L F H D E M L E E W
F O A F R K E B L I P F M E E
I M X I J U A Y S D H K W H D
C P F X X F M N E J O U L E G
I O D E X T A N D O P J H Q E
E U W D W S I E M T Z O H C D
N N V E T L N D U O A L W C U
C D R U C I J S P U V C T E F
Y C P N H O U T P U T A K D R
S N I C W O R K X Q K D B L U
I Z A V A D V A N T A G E L E
D M W H E E L A N D A X L E E
```
Complete this worksheet after you finish reading Chapter 9, Section 2.

In each of the following diagrams, a boy and a girl of equal mass sit on opposite sides of a seesaw. The arrows indicate direction of movement. Take a few moments to look over the figures, and then circle the statement that correctly describes the transfer of energy for each figure.

<table>
<thead>
<tr>
<th>Figure</th>
<th>a.</th>
<th>b.</th>
<th>c.</th>
<th>d.</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>The girl’s potential energy increases as the boy’s kinetic energy increases.</td>
<td>The boy’s potential energy and the girl’s potential energy decrease.</td>
<td>The girl’s kinetic energy increases as the boy’s potential energy increases.</td>
<td>The kinetic and potential energies of the boy and the girl are equal.</td>
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<tr>
<td>2.</td>
<td>The girl’s potential energy increases as the boy’s kinetic energy increases.</td>
<td>The boy’s potential energy and the girl’s potential energy decrease.</td>
<td>The girl’s kinetic energy increases as the boy’s potential energy increases.</td>
<td>The kinetic and potential energies of the boy and the girl are equal.</td>
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<tr>
<td>3.</td>
<td>The girl’s potential energy increases as the boy’s kinetic energy increases.</td>
<td>The boy’s potential energy and the girl’s potential energy decrease.</td>
<td>The girl’s kinetic energy increases as the boy’s potential energy increases.</td>
<td>The kinetic and potential energies of the boy and the girl are equal.</td>
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</tbody>
</table>

4. Remember that mechanical energy is the sum of kinetic and potential energy. What happens to the amount of mechanical energy in the boy in Figure 3 as his potential and kinetic energies change?

________________________________________________________________________

________________________________________________________________________
Complete this worksheet after you finish reading Chapter 9, Section 2.

Jerry is busy preparing for breakfast. Little does he know that energy conversions are taking place every step of the way! Identify the energy conversion that takes place after each of Jerry’s actions, and describe the energy conversion in the space provided.

1. Jerry dusted off his solar-powered juice maker and placed it in direct sunlight so he could make freshly squeezed orange juice to go with his breakfast.

2. Jerry plugged in the electric frying pan, turned it on “high,” and waited a few minutes while the pan heated.

3. When the indicator light turned on, Jerry was ready to cook.

4. He mixed up his secret recipe, poured it into the pan, and listened as the mixture sizzled.

5. As the mixture heated, it thickened and started to change color.

6. When the mixture seemed cooked, Jerry placed it on his plate and turned off the frying pan. Next he added cold water to the frying pan, which made a giant “whooshing” noise.

**BONUS QUESTION:** What energy conversion takes place in Jerry’s body after he eats the breakfast he has prepared?
Complete the following puzzle after you finish reading Chapter 9.
Use each of the following clues to find the correct energy-related word, and write the word in the spaces provided. Then on the next page, put the numbered letters into the matching numbered squares to reveal a quotation by Nancy Newhall.

1. a force that opposes motion between surfaces that are touching

2. energy resources that formed from the buried remains of plants and animals that lived millions of years ago

3. the energy of motion

4. the process that captures the sun’s energy for food making in plants

5. energy resources that cannot be replaced after they are used

6. units used to express energy

7. a well-defined group of objects that transfer energy between one another

8. the sum of kinetic and potential energies

9. potential energy dependent upon an object’s weight and distance from the Earth’s surface

10. the ability to do work

11. resources that can be used and replaced in nature over a relatively short period of time
Exercising Your Potential, continued

12. the energy of shape or position

13. a change of one form of energy into another

14. produced when two or more nuclei join together or when the nucleus of one atom splits apart

15. a natural resource that can be converted by humans into other forms of energy in order to do useful work

16. a comparison of the amount of energy before a conversion with the amount of useful energy after a conversion

Nancy Newhall’s Quotation:

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Feel the Heat

Complete this worksheet after you have finished reading Chapter 10, Section 2. Beneath the description, write the method of heating that is taking place. (conduction, convection, or radiation)

1. One heater located in the deep end warms Carlos’s entire swimming pool.

2. The sunlight shines directly on Janet’s desk but not on Carlos’s desk. Both Janet and Carlos are near the window, yet Janet feels much warmer than Carlos.

3. Carlos places a spoon in a steaming hot bowl of soup. Minutes later, the hot handle burns his fingers.
Feel the Heat, continued

4. Carlos licks a juice pop that he has just removed from the freezer. The tip of his tongue freezes and sticks to the icy-cold treat.

5. When Janet sits near the campfire, her face feels hot even though her back feels cold.

6. When Janet wins first place in the science-fair competition, Carlos shakes her hand. Her hand feels cold to him.

7. Bubbles of liquid in Carlos’s lava lamp are heated at the lamp’s base. The bubbles then rise to the top. They fall after being cooled.
VOCABULARY REVIEW WORKSHEET

CHAPTER 10

Riddle Me This

After completing Chapter 10, give this puzzle a try!

Using each of the clues below, fill in the letters of the word or phrase being described in the blanks provided on the next page. Then read the words in the vertical box to discover the answer to the following riddle: What do you call a feline unhappy about the excessive thermal energy beneath its feet?

1. the reason a spoon gets hot when it is in a bowl of hot soup
2. the conversion of a substance from one physical form to another
3. the energy needed to change the temperature of 1 kg of a substance by 1°C
4. the Earth’s atmosphere trapping thermal energy radiated by the sun
5. the transfer of thermal energy by the movement of a liquid or gas
6. the total kinetic energy of the particles in a substance
7. the transfer of energy between objects that are at different temperatures
8. excessive heating of a body of water
9. a material that conducts thermal energy well
10. a machine that uses heat to do work
11. the increase in the volume of a substance due to an increase in temperature
12. the transfer of thermal energy through space
13. the measure of the average kinetic energy of the particles in an object
14. a material that conducts thermal energy poorly
15. the lowest temperature on the Kelvin scale
16. solid, liquid, and gas
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</table>
**Atomic Timeline**

Complete this worksheet after you have finished reading Chapter 11, Section 1. The table below contains a number of statements connected to major discoveries in the development of atomic theory.

1. In each box, write the name of the scientist(s) associated with the statement. Choose from among the following scientists:
   - Democritus
   - Thomson
   - Bohr
   - Rutherford
   - Dalton
   - Schrödinger and Heisenberg

2. On a separate sheet of paper, construct a timeline, and label the following: 440 B.C., 1803, 1897, 1911, 1913, and the twentieth century. Cut out the boxes below along the dotted lines, and tape or glue each box of information at the correct point along your timeline.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Scientist(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are small, negatively charged particles inside an atom.</td>
<td>Electron paths cannot be predicted.</td>
</tr>
<tr>
<td>There is a small, dense, positively charged nucleus.</td>
<td>Electrons travel in definite paths.</td>
</tr>
<tr>
<td>Most of an atom's mass is in the nucleus.</td>
<td>Electrons move in empty space in the atom.</td>
</tr>
<tr>
<td>Electrons jump between levels from path to path.</td>
<td>His theory of atomic structure led to the &quot;plum-pudding&quot; model.</td>
</tr>
<tr>
<td>He conducted the cathode-ray tube experiment.</td>
<td>Electrons are found in electron clouds, not paths.</td>
</tr>
<tr>
<td>Atoms of different elements are different.</td>
<td>Atoms of the same element are exactly alike.</td>
</tr>
<tr>
<td>Atoms contain mostly empty space.</td>
<td>Atoms constantly move.</td>
</tr>
<tr>
<td>Atoms are small, hard particles.</td>
<td>All substances are made of atoms.</td>
</tr>
<tr>
<td>He conducted experiments in combining elements.</td>
<td>He conducted the gold foil experiment.</td>
</tr>
<tr>
<td>Atoms are “uncutable.”</td>
<td>Elements combine in specific proportions.</td>
</tr>
</tbody>
</table>
Atomic Anagrams

Try this anagram after you have finished Chapter 11.
Use the definitions below to unscramble the vocabulary words.

1. weighted average of the masses of all naturally occurring isotopes of the same element
   - MICTOA SAMS

2. the building blocks of matter
   - MOATS

3. unifying scientific explanation supported by testing
   - RYTHOE

4. positively charged particle in the atom
   - TORPNO

5. made up of protons and neutrons
   - UCSELUN

6. particle in the atom that has no charge
   - TRONUNE

7. atoms with the same number of protons but different numbers of neutrons
   - SOOTPIES

8. negatively charged particle in the atom
   - CLEENROT

9. number of protons in a nucleus
   - MICOTA BRUMEN

10. representation of an object or system
    - OLDEM

11. regions where electrons are likely to be found
    - RENECTOL SCUDLO

12. SI unit used to express the mass of atomic particles
    - MUA

13. sum of protons and neutrons
    - SAMS BRUNEM
1. Color the square for hydrogen yellow.
2. Color the groups with very reactive metals red.
3. Color and label the noble gases orange.
4. Color the transition metals green.
5. Using black, mark the zigzag line that shows the position of the metalloids.
6. Color the metalloids purple.
7. Use blue to color all of the nonmetals that are not noble gases.
8. Color the metals in Groups 13–16 brown.
9. Circle and label the actinides in yellow.
10. Circle and label the lanthanides in red.
11. Circle and label the alkali metals in blue.
12. Circle and label the alkaline-earth metals in purple.
13. Circle and label the halogens in green.
Answer the following questions using the periodic table on the previous page.

14. The alkaline-earth metals react similarly because they all have the same number of electrons in their outer energy level. Which group contains the alkaline-earth metals?

15. How many electrons are in the outer energy level of the atoms of alkaline-earth metals? _______

16. Hydrogen is in a different color than the rest of the elements in Group 1. Give an example of how hydrogen’s characteristics set it apart from other Group 1 elements.

17. What is the name for the group of elements that are particularly unreactive?

18. Except for the metalloids, what do all of the elements on the right side of the zigzag line have in common?
   a. They are not very reactive.    c. They are all metals.
   b. They are all nonmetals.        d. They are all very reactive.

19. Lanthanide and actinide elements are transition metals.
   True or False? (Circle one.)
   Imagine you are a scientist who has just discovered a new element. The element has an atomic number of 113, and it has three electrons in the outer energy level of each atom.

20. Where would you place this new element in the periodic table?

21. Which element would have properties most similar to the new element?
   a. hydrogen    c. boron
   b. beryllium   d. carbon

22. What name would you suggest for this new element?
Complete the following puzzle after you finish reading Chapter 12. On the next page is a partially filled-in quotation by Dmitri Mendeleev. Fill in the term described by each clue below. Then put the numbered letters into the corresponding squares on the next page to find out what Mendeleev said. The answers to questions 9–11 are chemical symbols.

1. states that the properties of elements are periodic functions of their atomic numbers

   59 16 27 40 24 41

2. column or family in the periodic table

   19 35 58

3. any element in Groups 3–12

   31 14 43 55 18 7 33 10

4. elements in Group 1

   17 22 48 8 36 11

5. having a regular, repeating pattern

   52 15 25 28 23

6. metals with two electrons in the outer energy level

   51 19 20 42 54

7. a row of elements

   61 6 26 56

8. elements that don’t react readily with other elements

   29 49 62 44 64

9. atomic number 9

   13

10. atomic number 39

    57

11. atomic number 54

    47 63
12. elements having properties of metals and nonmetals

| 39 | 46 | 37 | 5 | 12 |

13. the first row of transition metals at the bottom of the periodic table

| 1 | 9 | 34 | 4 |

14. the most abundant element in the universe

| 21 | 38 | 3 |

15. group containing iodine and chlorine

| 32 | 60 | 30 | 53 | 45 |

Mendelev's Quotation:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |

| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 |

| 58 | 59 | 60 | 61 | 62 | 63 | 64 |
Is It an Ion?

Complete this worksheet after you finish reading Chapter 13, Section 2.

Answer the following questions based on the accompanying models. Protons are shown in gray, neutrons are shown in white, and electrons are shown in black.

Answer Questions 1–6 based on Figure 1.

1. How many protons are shown? _______

2. In the periodic table, elements are ordered by atomic number, the number of protons in an atom’s nucleus. Using the periodic table in your textbook, identify the element shown.

3. How many electrons are shown? _______

4. How many electrons are in the outermost energy level? _______

5. If the number of electrons equals the number of protons, then there is no charge, and the model shows a neutral atom. If the numbers are not equal, then you have an ion. Use this reasoning to determine if Figure 1 shows an ion or a neutral atom.

6. To determine a particle’s charge, you must compare the number of protons with the number of electrons. Use the spaces to the right to subtract the number of electrons from the number of protons. (Remember, if the number of electrons is greater than the number of protons, the charge will be negative.)

<table>
<thead>
<tr>
<th>Number of protons</th>
<th>Number of electrons</th>
<th>Charge of model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answer Questions 7–11 based on Figure 2.

7. How many protons are shown? _______

8. What element is it? ______________________

9. How many electrons are shown? _______

10. How many electrons are in the outermost energy level? _______

11. Is this an ion? If it is, calculate and record the charge.

   ____________________________________________________________________
Complete this worksheet after you finish reading Chapter 13, Section 2.
The following descriptions are from the point of view of electrons that are participating in three different types of bonds—ionic, metallic, and covalent. Identify the type of bond that each electron describes. At the bottom of the page is a list of characteristics of bonds and substances containing the bonds. Match each characteristic with the corresponding bond, and write the characteristic in the space provided.

1. My buddies and I do not feel bound to the energy level of one atom in particular, so we can swim freely throughout the substance.

   **Type of bond:** ____________________________
   
   **Characteristics:** ____________________________
   ____________________________
   ____________________________

2. I might change sides at the start, but once I end up on one side or the other I stick to my decision.

   **Type of bond:** ____________________________
   
   **Characteristics:** ____________________________
   ____________________________

3. I do not feel partial to either of the atoms in my bond. To be fair, the other bonding electron and I divide our time between the bonded atoms.

   **Type of bond:** ____________________________
   
   **Characteristics:** ____________________________
   ____________________________

**Characteristics**

- Compounds have a crystal-lattice structure.
- Substances are good conductors of electric current.
- There’s a transfer of electrons.
- Two or more nonmetals are involved.
- There’s an attraction of positive ions and free-moving electrons.
- A metal reacts with a nonmetal.
After completing Chapter 13, give this puzzle a try!
Fill in the blanks in the clues below. Then use the clues to complete the puzzle on the next page.

**Clues**

1. An arrangement of ions bonded in a repeating three-dimensional pattern is a ______________________.
2. A positive particle in the nucleus that attracts electrons is a ______________________.
3. A unifying explanation for a broad range of hypotheses and observations that have been supported by testing is called a ________________.
4. The force of attraction that holds two atoms together is called a(n) ________________.
5. An electron in the outermost energy level of an atom is called a ________________.
6. The force of attraction between oppositely charged ions is a(n) ________________.
7. The ________________ is a chart that displays all elements by atomic number, and can be used to determine the number of valence electrons for some elements.
8. A ________________ is an element composed of molecules consisting of two atoms of that element.
9. The joining of atoms to form new substances is called ________________.
10. The force of attraction between the nuclei of atoms and the shared electrons is called a(n) ________________.
11. A ________________ is a neutral group of atoms held together by covalent bonds.
12. The force of attraction between a positively charged metal ion and the electrons in a metal is called a(n) ________________.
13. A(n) ________________ is a charged particle that forms when one or more valence electrons are transferred from one atom to another.
Bonding Puzzle, continued

P T E A R B I L O E O M I D C I A
T C H E M I C A L B O N D I N G T
O N R Y B O N T M L I C E D N O I
L O E Y E C M E E N T C H N E M I
C R A M S B L C B O I N D O N D G
M T T E E T U A I O N I C B O N D
C C R T Y L A S T A L L C L M O L
E E C A E N E L L A V L I A O B L
P L R L O C T C L N N T H C E T O
R E Y L O C H E I A O T Y I A N M
I E C I O C B O N M T R C M A E L
B C I C O N D V P R O T I E N L B
D N O B M E T A L E R T I H C A E
M E T O L I C I H A P L A C E V N
E L E N E N M T C E E L E E I E O C
T A R D O N S I B O O N D I D C C
M V O L E L B A T C I D O I R E P
Complete this worksheet after you finish reading Chapter 14, Section 2.

In your textbook, you read how dancers can model different chemical reactions. Another way to model chemical reactions is to use food. In the spaces provided, write the type of chemical reaction that is modeled in situations 1–4 below. The possible chemical reactions are synthesis, decomposition, single-replacement, and double-replacement. Then answer question 5.

1. One day, Oriana packed a ham-on-wheat sandwich, and her friend, Macha, packed a salami-on-rye sandwich. At lunch, they decided to trade meats. Oriana ate a salami-on-wheat sandwich, while Macha ate a ham-on-rye sandwich.

2. Yasu went to an Italian restaurant. When asked for his order he said, “I’d like the Pasta Extravaganza, but could I have meatball sauce instead of the alfredo sauce?”

3. Tara ordered a side order of mixed vegetables with her meal. But before eating them, she separated the vegetables into separate portions of peas and carrots.

4. Kevin went to a salad bar. He used lettuce and tomatoes to make his salad.

5. Hydrogen and oxygen combine to form water. How is this similar to one of the situations given above?

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
Activation Energy

Complete this worksheet after you finish reading Chapter 14, Section 3.

Activation energy is the energy a reaction needs to get started. At the bottom of the page are two energy diagrams—one for an exothermic reaction and one for an endothermic reaction. Follow the directions below to label the energy diagrams.

1. In an exothermic reaction, the chemical energy of the reactants is greater than the chemical energy of the products. Write **Exothermic reaction** under the appropriate energy diagram.

2. In an endothermic reaction, the chemical energy of the reactants is lower than the chemical energy of the products. Write **Endothermic reaction** under the appropriate energy diagram.

3. Exothermic reactions give off energy. The energy given off is the difference between the energy of the reactants and the energy of the products. Label the energy given off on the exothermic-energy diagram by writing **Energy given off** in the appropriate space.

4. Endothermic reactions absorb energy. The energy absorbed by a chemical reaction is the difference between the energy of the products and the energy of the reactants. Label the energy absorbed on the endothermic energy diagram by writing **Energy absorbed** in the appropriate space.

5. The activation energy is the energy needed to start a chemical reaction. On the diagrams below, the chemical reaction begins at the top of the peak. The activation energy is the difference between the top of the peak and the energy of the reactants. Label the activation energy of each graph by writing **Activation energy** in the appropriate space.

### Energy Diagrams for an Endothermic and an Exothermic Reaction

![Energy Diagram](attachment:energy_diagram.png)
After reading Chapter 14, give this puzzle a try!

Fill in the blanks in the clues below. Then use the clues to complete the puzzle on the next page.

1. A number written below and to the right of a chemical symbol in a formula is called a ____________________.

2. In a ____________________-replacement reaction, ions in two compounds switch places.

3. The ____________________ energy is the minimum amount of energy required for substances to react.

4. A chemical ____________________ is the process by which one or more substances undergo change to produce one or more different substances.

5. The law of ____________________ of ____________________ states that mass cannot be created or destroyed in ordinary chemical or physical changes. A similar law holds true for ____________________.

6. In a ____________________ reaction, a single compound breaks down to form two or more simpler substances.

7. In ____________________ reactions energy is released, and in ____________________ reactions energy is absorbed.

8. In a ____________________ reaction, two or more substances combine to form a single compound.

9. A chemical ____________________ describes a substance using chemical symbols and numbers.

10. A number written to the left of a chemical symbol or formula is called a ____________________.

11. In a ____________________-replacement reaction, one element replaces another that is part of a compound.

12. A chemical ____________________ is a shorthand description of a chemical reaction.

13. In a chemical reaction, each starting material is a ____________________, and each new substance formed is a ____________________.

14. A ____________________ speeds up a reaction, and an ____________________ slows down a reaction.
How many chapter concepts can you find in the block of letters below? Use the clues to help you find them. Words may appear horizontally, vertically, or diagonally.

A Reactionary Puzzle, continued

How many chapter concepts can you find in the block of letters below? Use the clues to help you find them. Words may appear horizontally, vertically, or diagonally.
Complete this worksheet after you finish reading Chapter 15, Section 2.
Libby Lidmis has been busy gathering information on acids, bases, and salts. Unfortunately, someone mixed up the information on her chart. Each of the pieces of information given below describes an acid, a base, or a salt. Help Libby straighten out her chart by matching each piece of information with the correct categories, and writing it in the appropriate box on the next page. Be careful—some of the pieces of information belong in more than one category.

- taste bitter
- may be corrosive
- used to de-ice roads
- excess hydroxide ions
- found in drain cleaner
- found in plasterboard
- react with baking soda to produce carbon dioxide gas
- change blue litmus to red
- pH less than 7
- used to make soap
- H^+
- form from a neutralization reaction
- change red litmus to blue
- sodium chloride
- found in vinegar
- taste sour
- neutralize lakes with low pH
- OH^-
- excess hydronium ions
- pH greater than 7
- slippery
- found in orange juice
- form from the reaction of a metal and a nonmetal
A Simple Solution, continued

ACIDS

BASES

SALTS
Use the clues below and on the next page to identify vocabulary terms from Chapter 15. Then find and circle each term in the word search puzzle on the next page.

1. Many fuels are made of these organic compounds.
    ___________________________

2. Atoms share electrons in __________________________ compounds.

3. __________________________ are sometimes called the “blue-prints of life.”

4. The measure of the concentration of hydronium ions in a solution is known as __________________________.

5. Plants tend to store these as oils. __________________________

6. The positive ion of a base and the negative ion of an acid combine to form this ionic compound. __________________________

7. This substance increases the number of H⁺ when dissolved in water. __________________________

8. __________________________ are organic compounds made by living things.

9. This substance is slippery and bitter. __________________________

10. These biochemicals are composed of one or more simple sugar molecules bonded together. __________________________

11. These compounds contain oppositely charged ions arranged in a crystal lattice. __________________________

12. These compounds are composed of molecules whose carbon atoms are arranged in a straight chain, a branched chain, or a ring __________________________

13. __________________________ are biochemicals that have many functions, such as regulating chemical activities.

14. This special paper is used to test for acids and bases. __________________________

15. The building blocks of proteins are __________________________.

16. This protein regulates the amount of glucose in your blood. __________________________
17. This type of carbohydrate, found in bread, cereal, and pasta, is called a __________________ carbohydrate.

18. This substance changes color in the presence of an acid or a base.

19. A carbon atom can form no more than this number of bonds.

20. This type of nucleic acid is the genetic material of the cell.

21. This type of hydrocarbon contains carbon atoms connected only by single bonds.

22. ________________ is a protein that carries oxygen to all parts of your body.

Y X B H T A R O T A C I D N I A
J C E I P N X A B R M W S O N L
A H I L O T E I O B I A E D I T
S W L N P C L P D I L S C P I L
N S R A A M H A K X A A I N Y N
O D S C G G O E S B R D I D C I
B I N K A A R C M B S L M V H B
R C I Z V U U O O I U W N U P O
A A E J O E Y H C S C Q P H G L
C O T F A E Y O N A L A E T X G
O N O V W D V I H H C I L I G O
R I R L R A I X Y F M I T S Q M
D M P A L O J K V K K T D M H E
Y A T E N G L V P B E D U Q U H
H E N I N B D E T A R U T A S S
S T C N U C L E I C A C I D S R
Complete this worksheet after you finish reading Chapter 16, Section 1.
Fill in the blanks in items 1–4, and then complete the table at the bottom of the page.

1. An alpha particle is the same as the nucleus of an atom of the element ________________. It contains ________________ neutron(s) and ________________ proton(s).

2. During alpha decay, the atomic number decreases by ________________ and the mass number ________________ by four.

3. In one type of beta decay, a neutron in a radioactive nucleus breaks down into a ________________ and a(n) ________________.

4. When a radioactive nucleus releases a beta particle, its atomic number increases by one, and the mass number ________________. (decreases, stays the same, or increases)

In the text, you learned that a uranium-238 nucleus undergoes 14 decays to become lead-206. Now you can construct a decay series by completing the table below. You will need the periodic table of the elements. The first two steps have been done for you. (Hint: All beta particles released in this series are electrons, not positrons.)

<table>
<thead>
<tr>
<th>Step</th>
<th>Type of decay</th>
<th>New atomic number</th>
<th>New mass number</th>
<th>Name of isotope formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alpha</td>
<td>90</td>
<td>234</td>
<td>Th-234</td>
</tr>
<tr>
<td>2</td>
<td>Beta</td>
<td>91</td>
<td>234</td>
<td>Pa-234</td>
</tr>
<tr>
<td>3</td>
<td>Beta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Beta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Beta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Beta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Beta</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fission or Fusion?

Complete this worksheet after you finish reading Chapter 16, Section 2.

While it’s true that fusion and fission are both types of nuclear reactions, the similarity ends there. Follow the steps below to sort out the facts and eliminate any con-fusion!

1. Take a look at the illustrations in the table below. In the first column, label each illustration either “fusion” or “fission.”

2. Read over the following list of information. Then write each piece of information next to the appropriate type of nuclear reaction. Answers may be used more than once.

- Chernobyl
- not currently used to provide electrical energy
- hydrogen is a plasma
- fuels 20 percent of the electrical energy used in the United States
- requires temperatures over 100,000,000°C
- radioactive waste products
- occurs in the sun’s core
- no radioactive waste products
- energy is released
- large nucleus splits into two smaller nuclei
- uranium
- two or more nuclei join together to form a more-massive nucleus
CHAPTER 16 VOCABULARY REVIEW WORKSHEET

Atomic Energy Acrostic

After you finish Chapter 16, give this puzzle a try!
Fill in the blanks below. Then put letters into the matching numbered squares to reveal a quote by Marie Curie.

1. occurs when two or more small nuclei join together to form a larger, more-massive nucleus

   ___ ___ ___ ___ ___ __20__ __38__ ___ __9__

2. decay that occurs when a nucleus releases a positron or an electron

   ___ ___ __13__ ___ ___

3. the ability of the nuclei of some atoms to give off high-energy particles and rays

   ___ ___ ___ ___ __23__ __8__ __45__ ___ __5__ __27__

4. the collective name of high-energy particles and rays given off by the nuclei of atoms

   ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ __42__ __40__ ___ __3__ __30__

5. the process by which high-energy particles and rays are released

   ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
10. the length of time it takes for one-half of the nuclei of a radioactive isotope to decay

11. occurs when a nucleus releases a particle consisting of two protons and two neutrons

12. the isotope often used to determine the age of once-living things

13. a continuous series of nuclear fission reactions

What Marie Curie said:
Charge!

Complete this worksheet after you have finished reading Chapter 17, Section 1. There are three ways for an object to gain a charge: friction, conduction, and induction. When it loses its charge it experiences electric discharge. Label the following pictures as examples of conduction, induction, friction, or electric discharge.

1. 

2. 

3. 

4. 

5. 

6.
Complete this worksheet after you have finished reading Chapter 17, Section 4.

Two electric circuits powered by cells are shown below. Answer the following questions based on the information given in the diagrams. Questions 1–6 refer to Figure 1, and Questions 8–12 refer to Figure 2.

Label the parts of the circuit and the cell by writing the letter that corresponds to the appropriate part in the space provided.

1. _____ load
2. _____ electrode
3. _____ wire
4. _____ electrolyte
5. _____ energy source
6. Is this circuit connected in series or in parallel?
   ________________________________________

7. A cell that contains liquid electrolytes is called a __________________________ cell.

8. What is the power in this circuit? __________________________

9. What is the voltage in this circuit? __________________________

10. Recall that \( I = \frac{P}{V} \). If you divide the power of the circuit by its voltage, you’ll get the circuit’s current. What is the current of this circuit?
   ________________________________________

11. Remember that Ohm’s law can be rearranged to say: \( R = \frac{V}{I} \). If you divide the circuit’s voltage by its current, you’ll get the resistance of the circuit. What is the resistance caused by the light bulb?
   ________________________________________

12. This cell contains a solid electrolyte, so it is a __________________________ cell.
VOCABULARY REVIEW WORKSHEET

An Electrifying Puzzle

Now that you have read Chapter 17, give this crossword puzzle a try!

ACROSS
3. type of circuit in which different loads are on separate branches
4. a material in which charges cannot easily move
5. the rate at which charge passes a given point
6. The energy per unit charge is called the ________ difference.
7. The law of electric ________s states that like charges repel and opposite charges attract.
11. a device in a circuit that uses electrical energy to do work
15. converts thermal energy into electrical energy
17. consists of several cells
18. a complete, closed path through which electric charges flow
19. the opposition to the flow of electric charge
20. used to open and close a circuit

DOWN
1. a device that produces an electric current by converting chemical energy into electrical energy
2. Electric ________ is the loss of static electricity as charges move off an object.
3. the part of a solar panel that absorbs light and converts it into electrical energy
5. transfer of electrons from one object to another by direct contact
8. rearrangement of electrons on an uncharged object without direct contact with a charged object
9. A charged object exerts an electric ________ on other charged objects.
10. Electric ________ is the rate at which electrical energy does work.
12. a material in which charges can move easily
13. The buildup of electric charges on an object is called ________ electricity.
14. the difference in energy per unit charge as a charge moves between two points in the path of a circuit
16. type of circuit in which all parts are connected in a single loop
An Electrifying Puzzle, continued

[Crossword puzzle image]
Complete this worksheet after reading Chapter 18, Section 1.

After months in space, Captain Iva Braveheart and her crew are approaching their destination—the planet Lodestone. Read the following entries in Captain Braveheart’s personal spacelog, and answer the questions.

**Earth date July 21, 2313**

Finally, we are drawing near to the planet Lodestone. Tomorrow we should be close enough to perform some tests on the planet. I am most curious to know what the planet’s core is like—and whether compasses are likely to work on this planet.

**1. What properties of planet Lodestone’s core would indicate that the planet probably has magnetic properties?**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

**Earth date July 22, 2313**

Our tests indicate that the planet should have magnetic poles, just like Earth. A small team will visit the planet’s surface tomorrow. I’m going to take along a bar magnet and string to find magnetic north and south on Lodestone.

**2. How will the captain find magnetic north and south on this planet using a bar magnet and string?**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

**3. Captain Braveheart plans to name geographic North on planet Lodestone after magnetic north and geographic South after magnetic south. If she does, will North and South be the same on Lodestone as they are on Earth? Explain.**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
A Magnetic Time

Complete this worksheet after reading Chapter 18, Section 3.

1. Draw a line from the person or group of people in Column A to their contribution to the study of electromagnetism in Column B. Be careful; two scientists match with one contribution.

2. Draw a line from the contribution in Column B to the year or time period when it occurred in Column C.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
<th>Column C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hans Christian Oersted</td>
<td>proposed that the Earth is one giant magnet</td>
<td>2,000 years ago</td>
</tr>
<tr>
<td>Michael Faraday</td>
<td>found a mineral called magnetite, which attracts iron-containing objects</td>
<td>1831</td>
</tr>
<tr>
<td>Greeks</td>
<td>found that a changing magnetic field could induce an electric current</td>
<td>1600</td>
</tr>
<tr>
<td>William Gilbert</td>
<td>after many experiments, concluded that an electric current produces a magnetic field</td>
<td>1820</td>
</tr>
<tr>
<td>Joseph Henry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Use the information above to create a timeline in the space below.
After you finish Chapter 18, try this puzzle!

Using each of the clues below, fill in the letters of the word or phrase being described on the blanks provided on the next page.

1. Force between two magnets
2. Parts of a magnet where the magnetic effects are strongest
3. Device used to measure current
4. Device that changes electrical energy into kinetic energy
5. Produced by a coil of current-carrying wire wrapped around an iron core
6. Scientist who discovered the relationship between electricity and magnetism
7. During electromagnetic _______, a changing magnetic field produces an electric current.
8. Magnet made with iron, nickel, or cobalt
9. British scientist who discovered that a changing magnetic field can produce an electric current
10. Abbreviation for magnetic levitation
11. A tiny region in a magnet where all the atoms are grouped together and their poles are aligned
12. Region around a magnet in which magnetic force can act
13. Device that uses electromagnetic induction to convert kinetic energy into electrical energy
14. Coil of wire that, when carrying an electric current, produces a magnetic field
15. Device that increases or decreases the voltage of an alternating current
16. Material that attracts iron or materials containing iron
A Puzzling Transformation, continued

1. __ __ __ __ E __ __ __ __ __ __ __ __ __

2. __ __ L __ __

3. __ __ __ __ __ __ __ __ __ __ E __ __ __

4. __ __ __ __ __ __ __ __ C __ __ __ __ __

5. __ __ __ __ T __ __ __ __ __ __ __ __ __

6. __ __ R __ __ __ __ __

7. __ __ __ __ __ __ __ __ O __

8. __ __ __ __ __ __ __ M __ __ __ __ __

9. __ __ A __ __ __ __ __

10. __ __ G __ __ __

11. __ __ __ __ __ N

12. __ __ __ __ __ E __ __ __ __ __ __ __ __

13. __ __ __ __ __ __ __ __ __ __ T __ __

14. __ __ __ __ __ __ I __

15. __ __ __ __ __ __ __ __ __ __ S __ __ __

16. __ __ __ __ M
Semiconductors’ Conductivity

Complete this worksheet after reading Chapter 19, Section 1.

A semiconductor is a material that conducts electrical energy better than an insulator but not as well as a conductor. Silicon may be the most well-known semiconductor, but it’s not the only one. Another semiconductor is germanium (Ge). Use the periodic table in your textbook to help you answer the following questions.

1. Like silicon, germanium has _______ electrons in the outermost energy level of each atom.

Doping a semiconductor means replacing a few atoms of the semiconductor with a few atoms of another substance that has a different number of valence electrons.

2. Germanium can be doped with antimony (Sb), a group _______ element, which has _______ electrons in the outermost energy level of each atom.

3. Germanium can be doped with indium (In), a group _______ element, which has _______ electrons in the outermost energy level of each atom.

4. In the space below, sketch the arrangement of electrons in pure germanium, in germanium doped with antimony, and in germanium doped with indium. Draw only the electrons in the outermost energy levels. The outermost energy level of each atom is represented by a gray circle.

   ![Electron Arrangement Diagram]

An n-type semiconductor is a doped semiconductor with an “extra” electron. A p-type semiconductor is a doped semiconductor with a “hole” where an electron could be.

5. Doping germanium with __________________________ results in an n-type semiconductor.

6. Doping germanium with __________________________ results in a p-type semiconductor.
The Ins and Outs of Computing

Complete this worksheet after you finish Chapter 19, Section 3. Fill in the blanks in the paragraph below with the terms input device, microprocessor, memory, and output device.

1. Information is entered into a computer using a(n) _________________. The information is processed by the central processing unit, which is a(n) ________________, or the information is stored in the computer’s ________________ until it is needed. When a computer finishes a task, it shows the results on a(n) ________________.

2. Below is an illustration of a desktop computer setup. Label the parts of the computer with the following terms: speaker, monitor, keyboard, mouse, floppy disk, printer.

3. Using colored pencils or crayons, color input devices yellow, output devices red, and storage and processing devices blue.

4. The computer shown above does not have a modem. If it did, what color would you shade the modem? Explain.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
CHAPTER 19 VOCABULARY REVIEW WORKSHEET

**A Circuit-ous Crossword**

After you finish Chapter 19, try this crossword puzzle!

**ACROSS**

1. something that represents information
2. a huge computer network consisting of millions of computers that can share information with each other
6. an entire circuit formed on a single silicon chip
13. conducts electric current better than an insulator but not as well as a conductor
14. an electronic device that performs tasks by processing and storing information
15. integrated circuit that contains many of a computer’s capabilities on a single chip
16. _______ tubes can perform the same functions as transistors, but they are larger, give off more thermal energy, and don’t last as long.

**DOWN**

1. set of instructions or commands that tells a computer what to do
3. type of wave that consists of changing electric and magnetic waves
4. an electronic component that allows current in only one direction
5. a collection of tiny circuits that supply electric current to the parts of an electronic device
7. type of signal whose properties can change continuously according to changes in the original information
8. type of signal that consists of a series of electric pulses represented by the digits of binary numbers
9. an electronic component composed of three layers of semiconductors
10. the sending of information across long distances by electronic means
11. the parts or equipment that make up a computer
12. process that modifies the conductivity of a semiconductor
A Circuit-ous Crossword, continued

Across:
1. Central chip of an electronic device (11)
2. Circuits that allow current to flow in one direction only (10)
4. Device that stores and processes data (8)
5. Short, straight line in a circuit (13)
6. Component that allows current to flow in any direction (9)
8. Combination of two or more circuits (8)
10. Component that stores and retrieves data (10)
11. Component that converts energy into another form (12)
12. Device that stores small amounts of data (6)
13. Component that conducts electricity (14)
14. Component that stores small amounts of data (14)
15. Component that conduct electricity (14)
16. Component that stores and retrieves data (12)

Down:
3. Component that stores and retrieves data (10)
7. Component that provides power to the circuit (9)
9. Component that conducts electricity (10)
11. Component that stores and retrieves data (8)
12. Component that stores and retrieves data (10)
13. Component that stores and retrieves data (10)
14. Component that stores and retrieves data (10)
15. Component that stores and retrieves data (10)
16. Component that stores and retrieves data (10)
1. What is the amplitude of the wave?

2. What is the wavelength?

Remember, frequency, expressed in hertz (Hz), is the number of waves produced in a given amount of time.

3. If you were watching this wave go by and counted five crests passing a certain point in 5 seconds, what would be the frequency of the wave? Use the formula and the space below to calculate your answer.

\[
\text{Frequency} = \frac{\text{number of waves}}{\text{time}} =
\]

4. What would the frequency of the wave be if you counted 10 crests in five seconds? Use the space below to calculate the answer.

5. If the wavelength became 12 m but the wave speed remained the same, would the frequency increase, decrease, or stay the same?
Complete this worksheet after you finish reading Chapter 20, Section 3.
Diagram and label the interaction described below, and then answer the questions that follow.
Wave A, with an amplitude of 3 m, meets wave B, with an amplitude of 3 m. When A and B overlap, the wave produced (C) has an amplitude of 6 m.

1. What type of wave interaction is described? Explain.

2. If wave A were to overlap with a different wave to produce a new wave that had an amplitude of 0 m instead of 6 m, would this be the same type of interaction described above? Explain.
CHAPTER 20
VOCABULARY REVIEW WORKSHEET

Let's Do the Wave!

After you finish Chapter 20, give this puzzle a try!

Figure out the words described by the clues below, and write each word in the appropriate space. Then find and circle the words in the puzzle on the next page.

1. ____________________________  a substance through which a wave can travel
2. ____________________________  the bending of a wave as it passes at an angle from one medium to another
3. ____________________________  a disturbance that transmits energy through matter and space
4. ____________________________  when one vibrating object causes similar vibrations in another object that is nearby
5. ____________________________  the lowest point of a transverse wave
6. ____________________________  the number of waves produced in a given amount of time
7. ____________________________  when two or more waves overlap
8. ____________________________  describes lines that meet at right angles
9. ____________________________  an echo, for example (wave interaction)
10. ____________________________  a wave that occurs at the boundary between two media when transverse and longitudinal waves combine
11. ____________________________  wave in which particles in the medium vibrate back and forth along the path the wave travels
12. ____________________________  waves in which particles of the medium vibrate in an up-and-down motion
13. ____________________________  the distance between two adjacent compressions
14. ____________________________  the maximum distance a wave vibrates from its rest position
15. ____________________________  kind of wave that looks like it is stationary
16. ____________________________  the highest point of a transverse wave
17. ____________________________  measurement equal to one wave per second
18. ____________________________  the bending of waves around a barrier or through an opening
In the puzzle below, find the words from the blanks on the previous page. Words may appear horizontally, vertically, or diagonally.

| S | W | V | O | M | Y | O | Y | S | F | S | U | M | V | J | Z | X |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| U | B | H | C | P | I | C | E | X | T | S | V | G | T | G | C | R |
| R | A | L | U | C | I | D | N | E | P | R | E | P | M | N | Z | C |
| F | G | O | V | W | D | S | R | E | F | L | E | C | T | I | O | N |
| A | T | N | T | R | W | O | L | F | U | L | O | O | K | D | A | T |
| C | R | G | E | E | N | O | E | W | M | Q | O | M | I | N | M | L |
| E | A | I | A | F | R | N | S | I | N | G | E | R | A | A | B | O |
| I | N | T | E | R | F | E | R | E | N | C | E | R | U | T | T | W |
| W | S | U | V | A | E | S | E | P | R | S | E | T | F | S | T | A |
| Y | V | D | O | C | O | L | B | N | O | O | U | L | D | N | M | V |
| T | E | I | O | T | U | S | N | N | A | Y | A | I | C | P | E | E |
| T | R | N | O | I | T | C | A | R | F | F | I | D | L | M | D | L |
| R | S | A | M | O | I | N | R | Y | O | E | L | I | P | N | I | E |
| O | E | L | J | N | C | A | T | N | D | W | T | O | W | H | U | N |
| U | E | F | H | E | R | T | Z | L | E | U | R | V | E | B | M | G |
| G | G | I | L | F | U | N | S | L | D | O | U | C | R | E | S | T |
| H | C | O | D | I | W | A | V | E | A | T | I | Q | U | O | R | H |
Doppler Dan’s Dump Truck

Complete this worksheet after you finish reading Chapter 21, Section 2.

Doppler Dan the Garbage Man is moving a truckload of glass from one end of the recycling plant to the other. Elinor has just helped him load up all of the broken bottles at the front of the plant on the east side of the lot. As Dan drives away, he honks his horn in thanks to Elinor. He speeds off in a hurry, because his buddy Otis is waiting impatiently on the west side to help him unload the glass from the dump truck.

“Howdy Otis,” says Dan, as he drives up.

“Hey,” grumbles Otis, chewing on his pen. “Your horn sounds funny.”

“Sounds fine to me,” says Dan as cheerfully as possible. He thought Otis was just making trouble, as he is not a morning person. Still it seemed like a strange thing to say. Why would the horn sound different to Otis than it did to him?

At the end of the day, Dan was still wondering about Otis’s mysterious comment. He decided to ask Elinor about it.

Elinor reminded Dan that he honked the horn as he drove away from her. Then she drew him the diagram below. Points 0–3 represent Dan’s positions as he drove from east to west. The compressions of the sound waves made by the honking horn are shown as circles A–D. A is the compression that came from the horn when Dan was at Point 0, B is from Point 1, C is from Point 2, and D is from Point 3.

Next Elinor told Dan that by studying the diagram and doing some minor calculations, he could find out the answer. On the next page, follow the steps Dan used to find out why the horn sounded different to Otis. The formulas below will help you.

**Formulas**

- **For the speed of a wave:** wave speed = wavelength × frequency
- **For wavelength:** wavelength = wave speed ÷ frequency
- **For frequency:** frequency = wave speed ÷ wavelength
1. Use your textbook to find the speed of sound in air at 20°C.
   wave speed = ______________________

2. Doppler Dan bought his horn from Honk, Inc. They guaranteed that the horn will honk at a frequency of 350 Hz. Use the equation on the previous page to calculate the wavelength of sound made by Dan’s horn and show your work here.

3. Find the wavelength of the sound by measuring the distance from one compression to the next. From where Otis is standing, what is the wavelength of the sound? ________________

4. The frequency of sound that you hear is the speed of the sound divided by the wavelength. What frequency did Otis hear?

5. What is the wavelength of the sound on the side of the dump truck where Elinor is standing,? ________________

6. What frequency did Elinor hear?

7. Complete the chart below.

<table>
<thead>
<tr>
<th>Listener</th>
<th>Sound wavelength</th>
<th>Sound frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Otis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elinor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Now use the information that you have just gathered and your understanding of the Doppler effect to explain why Otis heard the sound differently than Dan.
After you finish reading Chapter 21, give this puzzle a try!
Fill in each blank with the correct term. Then use the vocabulary words to find the words in the puzzle on the next page.

1. The apparent change in the pitch of a car’s horn as it moves past you is a result of the ________________ effect.

2. When any kind of wave bounces off a barrier, the bouncing back of the wave is called ________________. A bounced sound wave is called an ________________. This kind of sound wave is the basis for ________________, a method whales and bats use to find food.

3. The bending of waves around barriers or through openings is called ________________.

4. Each instrument has a unique ________________ that is the result of several pitches blending together through interference.

5. The ________________ of the note depends on whether it is played softly or loudly, and the ________________ is how low or high the note sounds.

6. Due to ________________, the vibration of a tuning fork can cause a guitar string to vibrate when the fork is held near the string.

7. The hammer, anvil, and stirrup bones are in the ________________ ear. The ________________ ear changes vibrations into electrical signals. The ________________ ear acts as a funnel for sound waves.

8. Constructive or destructive ________________ occurs when sound waves overlap and combine.

9. The ________________ is a unit used to express how loud or soft a sound is.

10. A ________________ is an undesirable, nonmusical sound that includes a random mix of pitches.
11. An extremely fast airplane can cause an explosive sound called a ________________ boom.

12. __________________ sounds have a frequency lower than 20 Hz, while __________________ sounds have a frequency higher than 20,000 Hz.

13. In a __________________ wave, some portions of the wave are at rest while other portions have a large amplitude.

Search the puzzle below to find each of the words you wrote in the blanks above, and circle these words in the puzzle. Words may appear horizontally, vertically, or diagonally.
Light Interactions

Complete this worksheet after you finish reading Chapter 22, Section 3. Light waves can interact with objects or with other light waves in a variety of ways. Complete the table by writing a description or explanation and an example of each kind of light interaction. The first example is provided.

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Description or explanation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflection</td>
<td>A green sweater looks green because green light is reflected off it.</td>
<td></td>
</tr>
<tr>
<td>Absorption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scattering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Complete this worksheet after you finish reading Chapter 22, Section 3.

Fiona wants to be a detective. In order to pass the entrance exam to Private Eye University, she is practicing her spy skills on her friends Jorge, Charles, and Tamika. Reflection is one of the hardest sections on the exam. Use what you have discussed in class to help Fiona learn about the law of reflection.

**Figure 1**

1. Figure 1 in Fiona’s notes shows a beam of light hitting and reflecting off a mirror. Label the normal, incident beam, reflected beam, angle of incidence, and angle of reflection on the diagram.

Fiona knows from the law of reflection that the angle of incidence always equals the angle of reflection. She uses this law to plan a system of mirrors that will allow her to spy on her friends. With her special arrangement of mirrors, Fiona can watch her friends walk by as she hides behind a brick wall.

2. Figure 2 shows the arrangement of mirrors. Using the law of reflection, draw the path of light as it would reflect off each of the mirrors. The normals have been drawn on the reflecting surfaces for you. (Hint: Not all of the mirrors will be used.)

**Figure 2**

3. Which of her friends is Fiona able to see with her mirrors in their current arrangement?
After you finish reading Chapter 22, give this puzzle a try!
Fill in the blanks below. Then put the letters in the matching numbered squares on the next page to reveal a quote by Albert Einstein.

1. the bending of waves as they pass into a different medium

2. energy emitted in the form of EM waves

3. the release of energy by particles of matter that have absorbed extra energy

4. the material that gives paint its color by absorbing some colors of light and reflecting others

5. occurs when waves overlap and combine

6. the entire range of EM waves, such as light, radio waves, microwaves, and X rays

7. the bending of waves around a barrier or through an opening

8. the passing of light through matter

9. materials that transmit light easily, without scattering

10. waves that are used in radar

11. can be created by combining red, green, and blue light
12. the transfer of energy from light waves to particles of matter

13. when a wave bounces off an object

14. materials that do not transmit any light

15. materials that transmit and scatter light

What Albert Einstein said:

---
Mirror, Mirror

Complete this worksheet after reading Chapter 23, Section 2.

You will need a straightedge for this activity. Each of the following four illustrations features an object, an image, and a mirror. The optical axis and the focal point are also shown where appropriate.

1. Identify the mirror as plane, convex, or concave. (Circle your answer.)

2. Identify the image as a real or virtual image. (Circle your answer.)

3. For concave and convex mirrors, if the rays are not drawn, draw them into the ray diagram.

---

Object  

Plane or convex or concave  
Real image or virtual image

Object  

Plane or convex or concave  
Real image or virtual image

Object  

Plane or convex or concave  
Real image or virtual image

Object  

Plane or convex or concave  
Real image or virtual image
Each illustration below features an object, an image, and a lens. The optical axis and the focal point are also shown.

1. Identify the lens as convex or concave. (Circle your answer.)
2. Identify the image as a real or virtual image. (Circle your answer.)
After finishing Chapter 23, give this puzzle a try!
Use the clues given below to complete the crossword puzzle on the next page.

**ACROSS**

2. the opening that lets light into the eye
4. a piece of film on which an interference pattern produces a 3-D image
7. Visible light sources are ________ objects.
8. ________ light is produced when electrons combine with gaseous metal atoms.
11. the back surface of the eye
12. ________ light is light produced by hot objects.
15. The ________ length is the distance between a mirror and its focal point.
17. A(n) ________ is a curved, transparent object that forms an image by refracting light.
18. ________ mirrors produce virtual, upright images that are smaller than the original object.
19. ________ light is produced when certain gases absorb and then release energy.
20. An image formed by a mirror with a flat surface is called a(n) ________ image.

**DOWN**

1. ________ light is visible light emitted by a phosphor particle when it absorbs energy.
2. ________ mirrors have a flat surface.
3. A visible object that is not a light source is being ________.
5. the opening that lets light into a camera
6. In ________ light, all of the light waves vibrate in the same plane.
9. A straight line drawn outward from the center of a lens or mirror is the ________ axis.
10. Unlike 20 across, light passes through ________ images.
13. ________ lenses are used to correct nearsightedness.
14. the transparent membrane that protects the eye
16. controls the size of the pupil
An Enlightening Puzzle, continued
Complete this worksheet after you finish reading Chapter 1, Section 2.
You plan to enter a paper airplane contest sponsored by *Talkin’ Physical Science* magazine. The person whose airplane flies the farthest wins a lifetime subscription to the magazine! The week before the contest, you watch an airplane landing at a nearby airport. You notice that the wings of the airplane have flaps, as shown in the illustration at right. The paper airplanes you’ve been testing do not have wing flaps.

What question would you ask yourself based on these observations? Write your question in the space below for “State the problem.” Then tell how you could use the other steps in the scientific method to investigate the problem.

1. **State the problem.**
   
   *Accept all reasonable answers. Sample answer:* Will a paper airplane with wing flaps fly farther than one without wing flaps?

2. **Form a hypothesis.**
   
   *Accept all reasonable answers. Sample answer:* A paper airplane with wing flaps will fly farther than one without wing flaps.

3. **Test the hypothesis.**
   
   *Accept all reasonable answers. Sample answer:* I would make two airplanes, identical except one has wing flaps, and the other doesn’t. I would then launch both from the same spot several times and measure the length of each flight.

4. **Analyze the results.**
   
   *Accept all reasonable answers. Sample answer:* I would find the average distance for flights of airplanes with and without wing flaps.

5. **Draw conclusions.**
   
   *Accept all reasonable answers. Sample answer:* If the plane with wing flaps had a longer average flight, I would assume that paper airplanes with wing flaps fly farther; if not, I would assume paper airplanes without flaps fly farther.
After finishing Chapter 1, give this puzzle a try!

**VOCABULARY REVIEW WORKSHEET**

**The Wide World of Physical Science**

**ACROSS**

1. the ratio of an object’s mass to its volume
2. the amount of space something occupies
3. any use of the senses to gather information
4. the application of knowledge, tools, and materials to accomplish tasks
5. measure of the amount of matter in an object
6. Scientists use the _____ System of Units so they can share and compare results.
10. Scientists use the _____ System of Units so they can share and compare results.
13. measure of how much surface an object has
15. measure of how hot or cold something is
16. The study of matter and energy is called _____ science.

**DOWN**

1. a possible explanation or answer to a question
5. a possible explanation or answer to a question
6. A representation of a salt crystal made out of table-tennis balls is a _____ of the crystal.
7. Scientists use the _____ method to solve problems and answer questions.
8. an experimental boat that imitates the way a penguin swims
9. in science, a summary of many experimental results and observations
11. a scientific explanation for a range of hypotheses and observations supported by testing
12. pieces of information acquired through experimentation
14. the basic SI unit of length

---

**Clues:**

1. DENSITY
2. VOLUME
3. OBSERVATION
4. TECHNOLOGY
5. DAY
6. MASS
7. OP
10. INTERNATIONAL
11. D
12. E
13. AREA
14. TEMPERATURE
15. I
16. PHYSICAL

---

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Imagine that you work at a chemical plant. This morning, four different liquid chemicals accidentally spilled into the same tank. Luckily, none of the liquids reacted with each other! Also, you know the liquids do not dissolve in one another, so they must have settled in the tank in four separate layers. The sides of the tank are made of steel, so you can only see the surface of what’s inside. But you need to remove the red chemical to use in a reaction later this afternoon. How will you find and remove the red chemical? By finding the chemicals’ different densities, of course!

The following liquids were spilled into the tank:
- a green liquid that has a volume of 48 L and a mass of 36 kg
- a blue liquid that has a volume of 144 L and a mass of 129.6 kg
- a red liquid that has a volume of 96 L and a mass of 115.2 kg
- a black liquid that has a volume of 120 L and a mass of 96 kg

1. Calculate the density of each liquid.
   Green liquid: _______ 0.75 kg/L
   Blue liquid: _______ 0.9 kg/L
   Red liquid: _______ 1.2 kg/L
   Black liquid: _______ 0.8 kg/L

2. Determine the order in which the liquids have settled in the tank.
   First (bottom): _______ red
   Second: _______ blue
   Third: _______ black
   Fourth (top): _______ green

3. Use colored pencils to sketch the liquid layers in the container in the diagram on the next page.

4. What kind of property did you use to distinguish between these four chemicals?
   a. a chemical property
   b. a physical property
   c. a liquid property
   d. None of the above
5. Now that you know where the red chemical is inside the tank, how can you remove it?

Accept all reasonable answers. Sample answer: I could open the spigot at the bottom of the tank and let the red liquid out.
Complete the puzzle after you finish reading Chapter 2.

Fill in each blank with the correct word. Then find the words in the puzzle. Words in the puzzle can be spelled forward or backward and can be vertical, horizontal, or diagonal.

1. The tendency of an object to resist any change in motion is called __________ inertia.
2. When water is in a container, the surface of the water is curved. This curve is called the __________ meniscus.
3. The amount of space occupied by an object is its __________ volume.
4. Iron __________ pyrite is also known as fool's gold.
5. The __________ mass of an object is the amount of matter in the object. The SI unit for expressing this quantity is the __________ kilogram.
6. The force that causes an object to feel a "pull" toward Earth is called __________ gravity. The measure of this force is the object's __________ weight. The SI unit for expressing this force is the __________ newton.
7. __________ Matter is anything that has volume and mass.
8. __________ Density is mass divided by unit volume.
9. A __________ chemical change occurs when one or more substances are changed into entirely new substances with different properties.
10. Examples of __________ physical properties are color and odor.
11. A __________ characteristic property is always the same, whether the sample observed is large or small.
Complete this worksheet after you finish reading Chapter 3, Section 2. Each figure below shows a container that is meant to hold one state of matter. Identify the state of matter, and write the state on the line below the corresponding figure. Then write each of the descriptions listed below in the correct boxes. Some descriptions may go in more than one box.

Particles are close together.
Particles are held tightly in place by other particles.
Particles break away completely from one another.
changes volume to fill its container.
changes shape when placed in a different container.

- can be used in hydraulic systems
- obeys Boyle’s law
- amount of empty space can change
- has definite shape
- particles vibrate in place
- does not change in volume
- has surface tension

<table>
<thead>
<tr>
<th>State of matter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid</td>
<td>has surface tension</td>
</tr>
<tr>
<td></td>
<td>can be used in hydraulic systems</td>
</tr>
<tr>
<td></td>
<td>changes shape when placed in a different container</td>
</tr>
<tr>
<td></td>
<td>does not change in volume</td>
</tr>
<tr>
<td></td>
<td>Particles are close together.</td>
</tr>
<tr>
<td>Gas</td>
<td>Particles break away completely from one another.</td>
</tr>
<tr>
<td></td>
<td>changes shape when placed in a different container</td>
</tr>
<tr>
<td></td>
<td>changes volume to fill its container</td>
</tr>
<tr>
<td></td>
<td>obeys Boyle’s law</td>
</tr>
<tr>
<td></td>
<td>amount of empty space can change</td>
</tr>
<tr>
<td>Solid</td>
<td>Particles are close together.</td>
</tr>
<tr>
<td></td>
<td>Particles vibrate in place.</td>
</tr>
<tr>
<td></td>
<td>Particles are held tightly in place by other particles.</td>
</tr>
<tr>
<td></td>
<td>does not change in volume</td>
</tr>
<tr>
<td></td>
<td>has definite shape</td>
</tr>
</tbody>
</table>
VOCABULARY REVIEW WORKSHEET

Know Your States

After you finish Chapter 3, give this puzzle a try! Use the clues below to complete the crossword puzzle.

ACROSS
3. to change state from a gas to a liquid
6. change of state from a solid to a gas
7. Particles have an orderly arrangement in this type of solid.
10. physical form in which a substance can exist
11. how your body is cooled when you perspire
14. changes shape but doesn’t change volume
15. He said that as the volume of a gas increases, its pressure decreases.
16. how molten metal changes into a solid
18. does not change shape when placed in a different container

DOWN
1. measure of the average speed of the particles of a substance
2. to change state from a solid to a liquid
4. Because of surface tension liquids form spherical _________.
5. has no definite shape or volume; conducts electric current
8. Particles are arranged in no particular order in this type of solid.
9. A change of state where energy is given off is called a(n) ________ change.
12. If a substance pours very slowly, it has a high ________.
13. A change of state reaction that ________ energy is endothermic.
15. how hot water changes to steam
17. changes shape and volume to fit container
Complete this worksheet after you finish reading Chapter 4, Section 3. Label each figure below with the type of substance it BEST models: colloid, compound, element, solution, or suspension.

1. colloids
2. compound
3. element
4. suspension
5. solution
6. Why did you label the figures on the previous page as you did?

Accept all reasonable answers. Sample answer: In Figure 3, the particles were identical and part of the same substance, so it had to be an element.

Figure 2 was a compound because the particles were identical but made of two different substances. The other three figures were mixtures because each contained two different types of particles. Figure 4 had the largest clumps of the solute, so it was a suspension. Figure 1 had the next-largest clumps of the second substance, making it a colloid. Figure 5 had the most homogeneous mix of the two substances, making it a solution.

Professor Jumble’s Confusion

In her lab, Professor Jumble has four shelves labeled “Suspensions,” “Solutions,” “Compounds,” and “Colloids,” respectively. Last night, the professor set one beaker of clear liquid on each of the four shelves. When the professor walked into her lab this morning, all four beakers were on the same shelf, and she didn’t know which was which. She tested each beaker, and the results are below.

Use the test results to help Professor Jumble unjumble the beakers, and write the identity of each liquid in the blanks.

<table>
<thead>
<tr>
<th>Beaker A: solution</th>
<th>Beaker B: compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Light passes right through.</td>
<td>• Light passes right through.</td>
</tr>
<tr>
<td>• Particles do not separate in a centrifuge or a filter.</td>
<td>• Particles do not separate in a centrifuge or a filter.</td>
</tr>
<tr>
<td>• Upon heating, the liquid evaporates, and a crystal powder remains.</td>
<td>• Upon heating, the liquid evaporates, but no residue remains.</td>
</tr>
<tr>
<td>• The particles could not be separated by any other physical changes.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Beaker C: suspension</th>
<th>Beaker D: colloid</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Liquid scatters light.</td>
<td>• Liquid scatters light.</td>
</tr>
<tr>
<td>• Liquid centrifuged into two different-colored layers.</td>
<td>• Liquid passes through a filter without leaving a residue.</td>
</tr>
<tr>
<td>• Particles were left behind in the filter.</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER

4 VOCABULARY REVIEW WORKSHEET

An ELEMENTary Word Puzzle

Give this puzzle a try after you read Chapter 4.

Identify each term described by the clues. Then find and circle each term in the puzzle on the next page. Words may appear forward or backward, horizontally, vertically, or diagonally.

1. solubility
   amount of solute needed to make a saturated solution using a given amount of solvent at a certain temperature

2. colloid
   mixture in which dispersed particles are too light to settle out

3. solvent
   substance in which another is dissolved

4. concentration
   can be expressed as grams of solute per milliliter of solvent

5. element
   pure substance that cannot be separated into simpler substances by physical or chemical means

6. mixture
   two or more substances that are combined physically, not chemically

7. compound
   pure substance made up of at least two elements that are chemically combined

8. density
   characteristic property measured in grams per cubic centimeter that tells a substance’s mass per unit volume

9. metalloid
   element that has properties of both metals and nonmetals

10. alloy
    solid solution of a metal or a nonmetal dissolved in a metal

11. solute
    dissolved substance

12. metal
    shiny element; good conductor of thermal energy and electric current

13. suspension
    mixture in which particles of one substance are large enough to settle out of another substance

14. solution
    brass, salt water, and air, for example

15. nonmetal
    element that is a poor conductor of thermal energy and electric current
An ELEMENTary Word Puzzle, continued

```
S O L U B I L I T Y
S H O E C U F L A M T Y E C
O K I L T N E M E L E B I H O
D O P R U N E T R O J I N S N
E I M L T Z R N I O P M O C
N M O N A C E O P C S J D A E
S S O L V E N T G O N U N R N
I D N E L P S W L L P S U C T
T X R S Y A V U A L M T O A R
Y E U K C S T T A O X D P R A
O T P U R I E E P I A E M B T
L A M X O M S N M D V J O A I
L W K K N K C R E D E M C T O
A L O O L S U S P E N S I O N
E N N A R A H C B O Z L T U Q
```
Bug Race

Complete this worksheet after you finish reading Chapter 5, Section 1.
You and a friend are having a bug race. You measure the distance your pet bugs travel
along a straight race track and record their time as they race. The results are plotted in the
graphs below. Take a look at the two graphs. Then answer the questions that follow.

1. Look at Point A. What distance has your bug traveled so far? ___________ 20 cm
2. How long did it take your bug to travel that distance? ___________ 3.5 s
3. To determine your bug's average speed while traveling from the starting line to Point A, divide the distance traveled by the time it took to travel that distance:
   \[ \text{average speed} = \frac{\text{distance traveled}}{\text{elapsed time}} = \frac{20 \text{ cm}}{3.5 \text{ s}} = 5.7 \text{ cm/s} \]
4. Now look at Point B. What is the distance from Point A to Point B? ___________ 20 cm
5. How long did it take your bug to travel from Point A to Point B? ___________ 3.5 s
6. Calculate your bug's average speed from Point A to Point B.
   \[ \frac{20 \text{ cm}}{3.5 \text{ s}} = 5.7 \text{ cm/s} \]
7. Compare the graphs of your bug and your friend's bug. Which bug was traveling at a constant speed? Explain.
   My bug was traveling at a constant speed. For my bug, average speed did not change over time, so the graph of distance traveled over time is a straight line.
Complete this worksheet after you finish reading Chapter 5, Section 3.

Steve challenged his little sister Jenny to a problem: Use all four types of friction to get home from school as quickly and as safely as possible. He reminded her that the four types of friction are sliding, rolling, static, and fluid. Here’s what Jenny did:

Jenny hopped on her bicycle after school. What a perfect day to be cycling—the sun was shining, there was a slight breeze in the air, and the temperature was a comfortable 27°C. Jenny got on the bike path and began pedaling as fast as she could. The wheels of the bicycle were turning at a furious pace. And the faster Jenny pedaled, the stronger the breezy air blew in her face. All of a sudden, she came across a huge tree branch that had fallen on the path. Jenny slammed on her brakes and stopped just in time to avoid hitting the fallen branch. That was a close call! She got off of her bike and tried to push the branch to the side of the path so that others would not get hurt, but it was too heavy to budge. Jenny continued on her journey and got home safely in record time.

Did Jenny meet Steve’s challenge? Explain.

Sample answer: Yes; Jenny met Steve’s challenge. The friction between the turning wheels of her bike and the ground was rolling friction. The air blowing against Jenny’s face as she pedaled faster caused fluid friction. The sliding of the brakes on the wheels of the bicycle was an example of sliding friction. And the friction that prevented her from moving the heavy branch was static friction.
Complete this worksheet after you finish reading Chapter 5, Section 4. Pictured below are two measurement devices, A and B.

<table>
<thead>
<tr>
<th>Weight or Mass?</th>
<th>Weight or Mass?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• spring scale</td>
<td>• balance</td>
</tr>
<tr>
<td>• measure of gravitational force exerted</td>
<td>• amount of matter in an object</td>
</tr>
<tr>
<td>on an object</td>
<td>• constant on Earth</td>
</tr>
<tr>
<td>• constant on Earth</td>
<td>• never changes</td>
</tr>
<tr>
<td>• changes when gravitational force</td>
<td>• measured in grams</td>
</tr>
<tr>
<td>changes</td>
<td>• remains the same when gravitational</td>
</tr>
<tr>
<td>• expressed in newtons</td>
<td>force changes</td>
</tr>
<tr>
<td>• six times less on the moon than on</td>
<td>• six times less on the moon than on</td>
</tr>
<tr>
<td>the Earth</td>
<td>Earth</td>
</tr>
</tbody>
</table>

1. Determine whether each device measures mass or weight, and circle the correct term in each box.

2. The following list contains information that relates to either mass or weight. Write each of the bulleted items in the correct boxes above. Some information may go in more than one box.

- balance
- spring scale
- measure of gravitational force exerted on an object
- amount of matter in an object
- constant on Earth
- measured in grams
- changes when gravitational force changes
- never changes
- expressed in newtons
- remains the same when gravitational force changes
- six times less on the moon than on Earth
After you finish Chapter 5, give this puzzle a try!
Oh no! Penny Punster’s computer mixed up her physical science dictionary with her
dictionary of puns. The computer paired the terms related to forces with her goofy
definitions, and it paired her pun-related terms with the real definitions. Help Penny
unscramble the mismatched pairs and get her dictionaries back in order. The first one
has been done for you!

1. farce: a push or pull  a. balanced: a ringer on a stick
2. grubby tea: force of attraction b. newton: used to be nine
   between objects due to mass c. force: slapstick
c. freak sheen: force opposing d. fluid: influenza commercial
   motion between touching e. motion: lawn-cutting avoidance
   surfaces f. gravity: dirty English drink
g. fellow’s city: speed in a particu- g. velocity: guy’s town
lar direction h. net force: mesh that’s ours
i. sty tic: friction that disappears i. static: pigpen twitch
   when an object starts moving j. mass: spiked medieval war club
   l. exhilaration: rate at which j. rolling: fish egg connection
   velocity changes k. friction: weird shininess
   m. mow shun: changing position k. fluid: influenza commercial
   over time l. acceleration: thrill
n. spyed: rate at which an object m. weight: slowly walk into the water
   moves n. speed: played secret agent
   o. bell lanced: forces producing a o. sliding: sneaky dent
   net force of zero p. lubricant: the sign between Virgo and
   h. net force: result of combined Scorpio won’t work
   forces on an object q. rolling: fish egg connection
   m. wade: measure of the force of r. sliding: sneaky dent
   gravity on an object q. rolling: fish egg connection
   j. mace: amount of matter in an r. rolling: fish egg connection
   object s. roe link: friction between s. roe link: friction between
   wheels and the floor t. ringleader
   t. Libra can’t: reduces friction u. lubricant: the sign between Virgo and
   u. flu ad: friction that slows down Scorpio won’t work
   a swimmer v. lubricant: the sign between Virgo and
   b. now ten: unit used to express Scorpio won’t work
   force w. lubricant: the sign between Virgo and
   o. sly ding: friction that makes Scorpio won’t work
   brakes work

Name ____________________________ Date ________________ Class ____________

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**Falling Fast**

Complete this worksheet after you finish reading Chapter 6, Section 1.

A stone rolls off a 150 m cliff. The partially completed table below shows the distance fallen and the velocity of the stone for the first few seconds of its fall.

1. Use the formula below to calculate the velocity of the stone at the end of each second. Remember that acceleration due to gravity is 9.8 m/s/s. Record the answers in the table in the column labeled “Velocity.” The first few calculations are done for you.

   Notice that the stone's initial velocity is 0 m/s. The velocity at the end of one second is the initial velocity plus the change in velocity due to gravity:

   \[
   \text{velocity} = \text{initial velocity} + \text{change in velocity}
   \]

   Since the initial velocity is 0 m/s, we can ignore it.

   \[
   \text{velocity} = \Delta v = (\text{acceleration due to gravity}) \times (\text{time})
   \]

   

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Velocity (m/s)</th>
<th>Distance fallen during this second (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>(\Delta v = 9.8 \times 1 = 9.8)</td>
<td>4.9</td>
</tr>
<tr>
<td>2</td>
<td>(\Delta v = 9.8 \times 2 = 19.6)</td>
<td>4.9 + 9.8 = 14.7</td>
</tr>
<tr>
<td>3</td>
<td>29.4</td>
<td>4.9 + 9.8 + 9.8 = 24.5</td>
</tr>
<tr>
<td>4</td>
<td>39.2</td>
<td>4.9 + 3(9.8) = 34.3</td>
</tr>
<tr>
<td>5</td>
<td>49.0</td>
<td>4.9 + 4(9.8) = 44.1</td>
</tr>
<tr>
<td>6</td>
<td>58.8</td>
<td>4.9 + 5(9.8) = 53.9</td>
</tr>
</tbody>
</table>

2. Do you see the pattern in the calculations for the third column? Calculate the distance fallen in each second, and record the two remaining values in the column labeled “Distance fallen during this second” in the table.
3. After 2 seconds, the stone will have fallen a total of 19.6 m (distance after first second + distance during second second). How far will the stone have fallen after 5 seconds? (Use the space below for your calculations.)

$4.9\ m + 14.7\ m + 24.5\ m + 34.3\ m + 44.1\ m = 122.5\ m$

After 5 seconds, the stone will have fallen

$\frac{122.5}{m}$.

4. Approximately when will the stone hit the ground? Explain your reasoning.

It will take between 5 and 6 seconds to hit the ground. At the end of 5 seconds, the stone will have fallen 122.5 m. It takes 6 seconds for the stone to fall 176.4 m, but the cliff is only 150 m high. Therefore, the stone will hit the ground some time between 5 and 6 seconds after rolling off the cliff.

5. If a much heavier stone rolled off the same cliff, would it hit the ground more quickly? Explain.

No; a heavier stone would hit the ground in the same amount of time. Objects fall to the ground at the same rate because the acceleration due to gravity is the same for all objects.
After you finish Chapter 6, give this puzzle a try!

Use the clues given to fill in the blanks below. Then copy the numbered letters into the corresponding squares on the next page to reveal a quotation attributed to Galileo.

1. When gravity is the only force acting on an object, the object is in
   
   \[
   \begin{array}{cccc}
   F & R & E & E \\
   52 & 47 & 29 & \quad L \\
   \end{array}
   \]

2. Because of free fall, astronauts appear this way in orbit.
   
   \[
   \begin{array}{cccccccc}
   W & E & I & G & H & T & L & E & S & S \\
   40 & 51 & 2 & 13 & 44 & \quad T & E & S & T & R & I & O & N
   \end{array}
   \]

3. The velocity at which a falling object travels when the force of air resistance exactly matches the downward force of gravity is called the
   
   \[
   \begin{array}{cccccccc}
   T & E & R & M & I & N & A & L & V & E & L & O & C & I & T & Y
   \end{array}
   \]

4. The unbalanced force that causes an object to move in a circular path is called a ________ force.
   
   \[
   \begin{array}{cccc}
   C & E & N & T & R & I & P & E & T & A & L
   \end{array}
   \]

5. Sir Isaac Newton is famous for his three laws of
   
   \[
   \begin{array}{cccc}
   M & O & T & I & O & N
   \end{array}
   \]

6. Newton’s third law states that objects exert ________ and ________ forces on each other.
   
   \[
   \begin{array}{cccc}
   E & Q & U & A & L & O & P & P & O & S & I & T & E
   \end{array}
   \]

7. The curved path traveled by a thrown baseball is known as
   
   \[
   \begin{array}{cccc}
   P & R & O & J & E & C & T & I & L & E & M & O & T & I & O & N
   \end{array}
   \]

8. The acceleration of a falling object is caused by the force of
   
   \[
   \begin{array}{cccc}
   G & R & A & V & I & T & Y
   \end{array}
   \]

9. ________ is the tendency of an object to resist any change in its motion.
   
   \[
   \begin{array}{cccc}
   I & N & E & R & T & I & A
   \end{array}
   \]

10. A moving object’s ________ depends on the object’s mass and velocity.
    
    \[
    \begin{array}{cccc}
    M & O & M & E & N & T & U & M
    \end{array}
    \]
11. The fluid friction that opposes the motion of objects through air is known as **air resistance**.

12. I have never met a man so ignorant that I could not learn something from him.

13. Man so ignorable that I could not learn.
Complete this worksheet after you finish reading Chapter 7.

1. Below is a diagram of a balloon that has just been released. Identify the areas of high and low pressure, and label them on the diagram.

2. Why does air rush out of the balloon when you release it?

Sample answer: The air inside the balloon is under a higher pressure than the air outside of the balloon. Fluids flow from regions of high pressure to regions of low pressure. The air under high pressure will rush out of the balloon until the pressure inside the balloon equals the pressure outside the balloon.
3. Is the pressure of the stream of air exiting the balloon different from the pressure of the air around the balloon? Explain in terms of Bernoulli’s principle.

Yes; Bernoulli’s principle says that as the speed of a moving fluid increases, its pressure decreases. The air exiting the balloon is moving faster than the air around the balloon. That means the pressure of the air exiting the balloon is lower than the pressure of the air around the balloon.

4. Add an arrow to the diagram on the previous page to show the direction of the air coming out of the balloon. Add another arrow indicating the direction the balloon is pushed by the exiting air. Label the first arrow “Air outflow,” and label the second arrow “Thrust.”

5. If you attach some weight to the balloon, it might not be able to fly. Use the terms weight, thrust, and lift to explain.

Sample answer: The added weight would mean a greater downward pull of gravity on the balloon. For the balloon to fly, there must be enough thrust to create enough lift to counter the downward pull of gravity. If the pull of gravity is greater than the lift, the balloon won’t fly.
After completing Chapter 7, give this puzzle a try!

Fill in the blanks in the clues below. Then use the clues to complete the puzzle on the next page.

Clues

1. _______ Archimedes _______ discovered that the buoyant force depends on the weight of the displaced fluid.

2. _______ Bernoulli _______ described the connection between fluid speed and pressure.

3. A swim _______ bladder _______ controls a fish’s overall density.

4. _______ Buoyant _______ force is the upward force exerted on any object in a fluid.

5. The layer of gases surrounding the Earth is called the _______ atmosphere _______.

6. A _______ fluid _______ is something that flows.

7. _______ Lift _______ is the upward force due to fluid flow around an airplane wing.

8. The amount of matter in a certain volume divided by the volume is _______ density _______.

9. A fluid force that opposes motion is called _______ drag _______.

10. One newton per square meter is a _______ pascal _______.

11. A _______ hydraulic _______ device uses a liquid to transmit pressure from one point to another.

12. An irregular fluid flow is _______ turbulence _______.

13. To _______ displace _______ is to move into something else’s location by pushing it aside.

14. _______ Pressure _______ is the amount of force exerted on a given area divided by the area.

15. The forward force from a plane’s engine is _______ thrust _______.
How many chapter concepts can you find in the block of letters below? Use the clues on the previous page to help you. Words may appear horizontally, vertically, diagonally, or backward.
Complete this worksheet after you have finished reading Chapter 8, Section 3.

Carlita, Tom, and Jamal are having a contest to see who can build the best pulley. After they finish constructing the pulleys, they measure the input and output forces as well as the input and output work. Below is a chart with the results. Help the three students calculate the mechanical advantage and the mechanical efficiency of each of the pulleys.

1. What is the output force of Tom’s pulley? ___ 60 N ___
2. What is the input force of Tom’s pulley? ___ 15 N ___
3. Divide the output force by the input force. ___ 4 ___
4. Your answer for item 3 is the mechanical advantage for Tom’s pulley. Record this value on the chart below. Calculate the mechanical advantage of the other two pulleys in the same way, and record these values on the chart.

5. What is the output work of Carlita’s pulley? ___ 3 N ___
6. What is the input work of Carlita’s pulley? ___ 4 N ___
7. Divide the output work by the input work. ___ 0.75 ___
8. Multiply your answer for item 7 by 100%. ___ 75% ___
9. Your answer for item 8 is the mechanical efficiency for Carlita’s pulley. Record this value on the chart. Calculate the mechanical efficiency of the other two pulleys in the same way, and fill in these values in the chart.

<table>
<thead>
<tr>
<th>Force (N)</th>
<th>Work (J)</th>
<th>Mechanical advantage</th>
<th>Mechanical efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Output</td>
<td>Input</td>
</tr>
<tr>
<td>Carlita</td>
<td>4</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Tom</td>
<td>15</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>Jamal</td>
<td>25</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

10. Based on your calculations, whose pulley won the contest? Explain your reasoning.

Jamal’s pulley is the best because his has the highest values for both mechanical advantage and mechanical efficiency. This means that he will get more output work for the effort he puts in and that his pulley has relatively little friction.
Complete this worksheet after you have finished reading Chapter 8, Section 3. In Chapter 8 you learned about work and how machines can help make all kinds of work easier. You saw examples of simple machines and compound machines. In the drawing below, find as many machines as you can, and classify them as simple or compound. For each simple machine, write what type of simple machine it is.

### Simple Machines
- door knob, wheel and axle
- window blind cord, pulley
- knife, wedge
- faucet, screwdriver, wheel and axle
- bottle opener, lever
- jar lid, screw
- screw, screw
- ramp, inclined plane

### Compound Machines
- can opener
- scissors
- stand mixer
- coffee maker
- toaster
- refrigerator
- dishwasher
- stove
Now that you have read Chapter 8, give this word search a try!
After filling in the blanks, find the words in the puzzle on the next page.

1. The unit used to express work is the __________ joule __________.
2. A __________ screw __________ is an inclined plane that is wrapped in a spiral.
3. __________ Power __________ is the rate at which work is done.
4. __________ Work __________ occurs when a force causes an object to move in the direction of the force.
5. The work you do on a machine is called the work __________ input __________.
6. An __________ inclined plane __________ is a simple machine that is a straight, slanted surface.
7. The mechanical __________ advantage __________ of a machine compares the input force with the output force.
8. All machines are constructed from six __________ simple __________ machines.
9. When two kinds of pulleys are used together, the system is called a __________ block and tackle __________.
10. A __________ lever __________ is a simple machine consisting of a bar that pivots at a fixed point.
11. A __________ machine __________ is a device that helps make work easier by changing the size or direction of force.
12. A __________ wedge __________ is a double inclined plane that moves.
13. Machines that are made up of two or more simple machines are called __________ compound __________ machines.
14. A __________ wheel and axle __________ is a simple machine consisting of two circular objects of different sizes.
15. A __________ pulley __________ consists of a grooved wheel that holds a rope or a cable.
16. The work done by a machine is called the work __________ output __________.
17. The fixed point at which a lever pivots is called a __________ fulcrum __________.
18. Two kinds of pulleys are __________ fixed __________ pulleys and __________ movable __________ pulleys.
19. The unit used to express power is the __________ watt __________.
20. Mechanical __________ efficiency __________ is a comparison of a machine’s work output with the work input.
In the puzzle below, find the words from the blanks on the previous page. Words may appear horizontally, vertically, or diagonally.
See What I Saw

Complete this worksheet after you finish reading Chapter 9, Section 2.

In each of the following diagrams, a boy and a girl of equal mass sit on opposite sides of a seesaw. The arrows indicate direction of movement. Take a few moments to look over the figures, and then circle the statement that correctly describes the transfer of energy for each figure.

1.  
   ![Diagram 1]  
   a. The girl's potential energy increases as the boy's kinetic energy increases.  
   b. The boy's potential energy and the girl's potential energy decrease.  
   c. The girl's kinetic energy increases as the boy's potential energy increases.  
   d. The kinetic and potential energies of the boy and the girl are equal.

2.  
   ![Diagram 2]  
   a. The girl's potential energy increases as the boy's kinetic energy increases.  
   b. The boy's potential energy and the girl's potential energy decrease.  
   c. The girl's kinetic energy increases as the boy's potential energy increases.  
   d. The kinetic and potential energies of the boy and the girl are equal.

3.  
   ![Diagram 3]  
   a. The girl's potential energy increases as the boy's kinetic energy increases.  
   b. The boy's potential energy and the girl's potential energy decrease.  
   c. The girl's kinetic energy increases as the boy's potential energy increases.  
   d. The kinetic and potential energies of the boy and the girl are equal.

4. Remember that mechanical energy is the sum of kinetic and potential energy. What happens to the amount of mechanical energy in the boy in Figure 3 as his potential and kinetic energies change?

   The mechanical energy of the boy stays the same.
Complete this worksheet after you finish reading Chapter 9, Section 2.

Jerry is busy preparing for breakfast. Little does he know that energy conversions are taking place every step of the way! Identify the energy conversion that takes place after each of Jerry’s actions, and describe the energy conversion in the space provided.

1. Jerry dusted off his solar-powered juice maker and placed it in direct sunlight so he could make freshly squeezed orange juice to go with his breakfast.
   
   Light energy is converted to electrical energy in the solar panel, and electrical energy is converted to mechanical energy in the juicer.

2. Jerry plugged in the electric frying pan, turned it on “high,” and waited a few minutes while the pan heated.

   Electrical energy from the outlet is converted into thermal energy in the frying pan.

3. When the indicator light turned on, Jerry was ready to cook.

   Electrical energy from the outlet is converted into light energy.

4. He mixed up his secret recipe, poured it into the pan, and listened as the mixture sizzled.

   Thermal energy from the frying pan is converted into sound.

5. As the mixture heated, it thickened and started to change color.

   Thermal energy in the frying pan is converted into chemical energy.

6. When the mixture seemed cooked, Jerry placed it on his plate and turned off the frying pan. Next he added cold water to the frying pan, which made a giant “whooshing” noise.

   Thermal energy in the frying pan is converted into sound energy.

**BONUS QUESTION:** What energy conversion takes place in Jerry’s body after he eats the breakfast he has prepared?

Chemical energy is converted into thermal energy and kinetic energy.
Complete the following puzzle after you finish reading Chapter 9. Use each of the following clues to find the correct energy-related word, and write the word in the spaces provided. Then on the next page, put the numbered letters into the matching numbered squares to reveal a quotation by Nancy Newhall.

1. a force that opposes motion between surfaces that are touching
   - F R I C T I O N

2. energy resources that formed from the buried remains of plants and animals that lived millions of years ago
   - F O S S I L S

3. the energy of motion
   - K N E T I C

4. the process that captures the sun’s energy for food making in plants
   - P H O T O S Y N T H E S I S

5. energy resources that cannot be replaced after they are used
   - N O N R E N E W A B L E

6. units used to express energy
   - J O U L E S

7. a well-defined group of objects that transfer energy between one another
   - C L O S E D S Y S T E M

8. the sum of kinetic and potential energies
   - M E C H A N I C A L E N E R G Y

9. potential energy dependent upon an object’s weight and distance from the Earth’s surface
   - G R A V I T A T I O N A L

10. the ability to do work
    - E N E R G Y

11. resources that can be used and replaced in nature over a relatively short period of time
    - R E N E W A B L E

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12. the energy of shape or position

13. a change of one form of energy into another

14. produced when two or more nuclei join together or when the nucleus of one atom splits apart

15. a natural resource that can be converted by humans into other forms of energy in order to do useful work

16. a comparison of the amount of energy before a conversion with the amount of useful energy after a conversion

Nancy Newhall’s Quotation:

Conservation is humanity caring for the future...
Complete this worksheet after you have finished reading Chapter 10, Section 2. Beneath the description, write the method of heating that is taking place. (conduction, convection, or radiation)

1. One heater located in the deep end warms Carlos’s entire swimming pool.
   - convection

2. The sunlight shines directly on Janet’s desk but not on Carlos’s desk. Both Janet and Carlos are near the window, yet Janet feels much warmer than Carlos.
   - radiation

3. Carlos places a spoon in a steaming hot bowl of soup. Minutes later, the hot handle burns his fingers.
   - conduction
Feel the Heat, continued

4. Carlos licks a juice pop that he has just removed from the freezer. The tip of his tongue freezes and sticks to the icy-cold treat.

   conduction

5. When Janet sits near the campfire, her face feels hot even though her back feels cold.

   radiation

6. When Janet wins first place in the science-fair competition, Carlos shakes her hand. Her hand feels cold to him.

   conduction

7. Bubbles of liquid in Carlos’s lava lamp are heated at the lamp’s base. The bubbles then rise to the top. They fall after being cooled.

   convection
CHAPTER 10
VOCABULARY REVIEW WORKSHEET

Riddle Me This

After completing Chapter 10, give this puzzle a try!

Using each of the clues below, fill in the letters of the word or phrase being described in the blanks provided on the next page. Then read the words in the vertical box to discover the answer to the following riddle: What do you call a feline unhappy about the excessive thermal energy beneath its feet?

1. the reason a spoon gets hot when it is in a bowl of hot soup
2. the conversion of a substance from one physical form to another
3. the energy needed to change the temperature of 1 kg of a substance by 1°C
4. the Earth’s atmosphere trapping thermal energy radiated by the sun
5. the transfer of thermal energy by the movement of a liquid or gas
6. the total kinetic energy of the particles in a substance
7. the transfer of energy between objects that are at different temperatures
8. excessive heating of a body of water
9. a material that conducts thermal energy well
10. a machine that uses heat to do work
11. the increase in the volume of a substance due to an increase in temperature
12. the transfer of thermal energy through space
13. the measure of the average kinetic energy of the particles in an object
14. a material that conducts thermal energy poorly
15. the lowest temperature on the Kelvin scale
16. solid, liquid, and gas
Riddle Me This, continued

1. **Conduction**
2. **Change of State**
3. **Specific Heat Capacity**
4. **Greenhouse Effect**
5. **Convection**
6. **Thermal Energy**
7. **Heat**
8. **Thermal Pollution**
9. **Conductor**
10. **Heat Engine**
11. **Thermal Expansion**
12. **Radiation**
13. **Temperature**
14. **Insulator**
15. **Absolute Zero**
16. **States of Matter**
Complete this worksheet after you have finished reading Chapter 11, Section 1. The table below contains a number of statements connected to major discoveries in the development of atomic theory.

1. In each box, write the name of the scientist(s) associated with the statement. Choose from among the following scientists:

- Democritus 440 B.C.
- Thomson 1897
- Bohr 1913
- Rutherford 1911
- Dalton 1803
- Schrödinger and Heisenberg twentieth century

2. On a separate sheet of paper, construct a timeline, and label the following: 440 B.C., 1803, 1897, 1911, 1913, and the twentieth century. Cut out the boxes below along the dotted lines, and tape or glue each box of information at the correct point along your timeline.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Scientist(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1803</td>
<td>Atoms of different elements are different. 1803 (Dalton)</td>
<td></td>
</tr>
<tr>
<td>1897</td>
<td>There are small, negatively charged particles inside an atom. 1897 (Thomson)</td>
<td></td>
</tr>
<tr>
<td>1911</td>
<td>Most of an atom’s mass is in the nucleus. 1911 (Rutherford)</td>
<td></td>
</tr>
<tr>
<td>1913</td>
<td>Electrons jump between levels from path to path. 1913 (Bohr)</td>
<td></td>
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<tr>
<td>1897</td>
<td>He conducted the cathode-ray tube experiment. 1897 (Thomson)</td>
<td></td>
</tr>
<tr>
<td>1803</td>
<td>Atoms contain mostly empty space. 1911 (Rutherford)</td>
<td></td>
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<tr>
<td>440 B.C.</td>
<td>Atoms are “uncuttable.” 440 B.C. (Democritus)</td>
<td></td>
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<tr>
<td>1911</td>
<td>Atoms are small, hard particles. 440 B.C. (Democritus)</td>
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<tr>
<td>1803</td>
<td>All substances are made of atoms. 1803 (Dalton)</td>
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<tr>
<td>1911</td>
<td>He conducted experiments in combining elements. 1803 (Dalton)</td>
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<tr>
<td>1803</td>
<td>He conducted the gold foil experiment. 1911 (Rutherford)</td>
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<tr>
<td>1913</td>
<td>Electrons move in empty space in the atom. 1911 (Rutherford)</td>
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<tr>
<td>20th century</td>
<td>Electrons travel in definite paths. 1913 (Bohr)</td>
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<tr>
<td>1911</td>
<td>His theory of atomic structure led to the “plum-pudding” model. 1897 (Thomson)</td>
<td></td>
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<tr>
<td>20th century</td>
<td>Electron paths cannot be predicted. 20th century (Schrödinger and Heisenberg)</td>
<td></td>
</tr>
<tr>
<td>1897</td>
<td>Electrons are found in electron clouds, not paths. 20th century (Schrödinger and Heisenberg)</td>
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<tr>
<td>1803</td>
<td>Atoms of the same element are exactly alike. 1803 (Dalton)</td>
<td></td>
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<tr>
<td>440 B.C.</td>
<td>Atoms constantly move. 440 B.C. (Democritus)</td>
<td></td>
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<tr>
<td>1803</td>
<td>Elements combine in specific proportions. 1803 (Dalton)</td>
<td></td>
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CHAPTER 11

VOCABULARY REVIEW WORKSHEET

Atomic Anagrams

Try this anagram after you have finished Chapter 11. Use the definitions below to unscramble the vocabulary words.

1. weighted average of the masses of all naturally occurring isotopes of the same element
   MICTOA SAMS ____________ atomic mass

2. the building blocks of matter
   MOATS ____________ atoms

3. unifying scientific explanation supported by testing
   RYTHOE ____________ theory

4. positively charged particle in the atom
   TORPNO ____________ proton

5. made up of protons and neutrons
   UCSELUN ____________ nucleus

6. particle in the atom that has no charge
   TRONUNE ____________ neutron

7. atoms with the same number of protons but different numbers of neutrons
   SOOTPIES ____________ isotopes

8. negatively charged particle in the atom
   CLEENROT ____________ electron

9. number of protons in a nucleus
   MICOTA BRUMEN ____________ atomic number

10. representation of an object or system
    OLDEM ____________ model

11. regions where electrons are likely to be found
    RENECTOL SCUDLO ____________ electron clouds

12. SI unit used to express the mass of atomic particles
    MUA ____________ amu

13. sum of protons and neutrons
    SAMS BRUNEM ____________ mass number
Complete this worksheet after you have finished reading Chapter 12, Section 2.
You can tell a lot about the properties of an element just by looking at the element’s location on the periodic table. This worksheet will help you better understand the connection between the periodic table and the properties of the elements. Follow the directions below, and use crayons or colored pencils to color the periodic table at the bottom of the page.

1. Color the square for hydrogen yellow.
2. Color the groups with very reactive metals red.
3. Color and label the noble gases orange.
4. Color the transition metals green.
5. Using black, mark the zigzag line that shows the position of the metalloids.
6. Color the metalloids purple.
7. Use blue to color all of the nonmetals that are not noble gases.
8. Color the metals in Groups 13–16 brown.
9. Circle and label the actinides in yellow.
10. Circle and label the lanthanides in red.
11. Circle and label the alkali metals in blue.
12. Circle and label the alkaline-earth metals in purple.
13. Circle and label the halogens in green.
Answer the following questions using the periodic table on the previous page.

14. The alkaline-earth metals react similarly because they all have the same number of electrons in their outer energy level. Which group contains the alkaline-earth metals?

They are in Group 2.

15. How many electrons are in the outer energy level of the atoms of alkaline-earth metals?

2

16. Hydrogen is in a different color than the rest of the elements in Group 1. Give an example of how hydrogen’s characteristics set it apart from other Group 1 elements.

Sample answer: The alkali metals are solids, while hydrogen is a gas at room temperature.

17. What is the name for the group of elements that are particularly unreactive?

They are called the noble gases.

18. Except for the metalloids, what do all of the elements on the right side of the zigzag line have in common?

a. They are not very reactive.
   b. They are all nonmetals.
   c. They are all metals.
   d. They are all very reactive.

19. Lanthanide and actinide elements are transition metals.

True or False? (Circle one.)

Imagine you are a scientist who has just discovered a new element. The element has an atomic number of 113, and it has three electrons in the outer energy level of each atom.

20. Where would you place this new element in the periodic table?

I would place it in Group 13.

21. Which element would have properties most similar to the new element?

a. hydrogen
   b. beryllium
   c. boron
   d. carbon

22. What name would you suggest for this new element?

Accept all answers.
VOCABULARY REVIEW WORKSHEET

Bringing It to the Periodic Table

Complete the following puzzle after you finish reading Chapter 12.

On the next page is a partially filled-in quotation by Dmitri Mendeleev. Fill in the term described by each clue below. Then put the numbered letters into the corresponding squares on the next page to find out what Mendeleev said. The answers to questions 9–11 are chemical symbols.

1. states that the properties of elements are periodic functions of their atomic numbers

2. column or family in the periodic table

3. any element in Groups 3–12

4. elements in Group 1

5. having a regular, repeating pattern

6. metals with two electrons in the outer energy level

7. a row of elements

8. elements that don’t react readily with other elements

9. atomic number 9

10. atomic number 39

11. atomic number 54

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12. elements having properties of metals and nonmetals

13. the first row of transition metals at the bottom of the periodic table

14. the most abundant element in the universe

15. group containing iodine and chlorine

Mendeleev's Quotation:

*Note to the Teacher:
You may want to inform your students that the term “atomic weight” was used interchangeably with “atomic mass” in the past. “Atomic mass” is the currently accepted term, and is therefore used in this book.
Complete this worksheet after you finish reading Chapter 13, Section 2.

Answer the following questions based on the accompanying models. Protons are shown in gray, neutrons are shown in white, and electrons are shown in black.

Answer Questions 1–6 based on Figure 1.

1. How many protons are shown? 17
2. In the periodic table, elements are ordered by atomic number, the number of protons in an atom’s nucleus. Using the periodic table in your textbook, identify the element shown.  chlorine
3. How many electrons are shown? 18
4. How many electrons are in the outermost energy level? 8
5. If the number of electrons equals the number of protons, then there is no charge, and the model shows a neutral atom. If the numbers are not equal, then you have an ion. Use this reasoning to determine if Figure 1 shows an ion or a neutral atom.

Figure 1 shows an ion.

6. To determine a particle’s charge, you must compare the number of protons with the number of electrons. Use the spaces to the right to subtract the number of electrons from the number of protons. (Remember, if the number of electrons is greater than the number of protons, the charge will be negative.)

<table>
<thead>
<tr>
<th>Number of protons</th>
<th>Number of electrons</th>
<th>Charge of model</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>18</td>
<td>−1</td>
</tr>
</tbody>
</table>

Answer Questions 7–11 based on Figure 2.

7. How many protons are shown? 10
8. What element is it? neon
9. How many electrons are shown? 10
10. How many electrons are in the outermost energy level? 8
11. Is this an ion? If it is, calculate and record the charge.

No, this is not an ion because it has equal numbers of electrons and protons. It has no charge.
Interview with an Electron

Complete this worksheet after you finish reading Chapter 13, Section 2.
The following descriptions are from the point of view of electrons that are participating in three different types of bonds—ionic, metallic, and covalent. Identify the type of bond that each electron describes. At the bottom of the page is a list of characteristics of bonds and substances containing the bonds. Match each characteristic with the corresponding bond, and write the characteristic in the space provided.

1. My buddies and I do not feel bound to the energy level of one atom in particular, so we can swim freely throughout the substance.

   Type of bond: This electron describes a metallic bond.

   Characteristics: Substances are good conductors of electricity.

   There’s an attraction of positive ions and free-moving electrons.

2. I might change sides at the start, but once I end up on one side or the other I stick to my decision.

   Type of bond: This electron describes an ionic bond.

   Characteristics: Compounds have a crystal-lattice structure. A metal reacts with a nonmetal. There is a transfer of electrons.

3. I do not feel partial to either of the atoms in my bond. To be fair, the other bonding electron and I divide our time between the bonded atoms.

   Type of bond: This electron describes a covalent bond.

   Characteristics: There’s an attraction between nuclei and shared electrons. Two or more nonmetals are involved.

**Characteristics**

- Compounds have a crystal-lattice structure.
- Substances are good conductors of electric current.
- There’s an attraction between nuclei and shared electrons.
- There’s a transfer of electrons.
- Two or more nonmetals are involved.
- There’s an attraction of positive ions and free-moving electrons.
- A metal reacts with a nonmetal.
After completing Chapter 13, give this puzzle a try!

Fill in the blanks in the clues below. Then use the clues to complete the puzzle on the next page.

Clues
1. An arrangement of ions bonded in a repeating three-dimensional pattern is a ______ crystal lattice ______.
2. A positive particle in the nucleus that attracts electrons is a ______ proton ______.
3. A unifying explanation for a broad range of hypotheses and observations that have been supported by testing is called a ______ theory ______.
4. The force of attraction that holds two atoms together is called a(n) ______ chemical bond ______.
5. An electron in the outermost energy level of an atom is called a ______ valence electron ______.
6. The force of attraction between oppositely charged ions is a(n) ______ ionic bond ______.
7. The ______ periodic table ______ is a chart that displays all elements by atomic number, and can be used to determine the number of valence electrons for some elements.
8. A ______ diatomic element ______ is an element composed of molecules consisting of two atoms of that element.
9. The joining of atoms to form new substances is called ______ chemical bonding ______.
10. The force of attraction between the nuclei of atoms and the shared electrons is called a(n) ______ covalent bond ______.
11. A ______ molecule ______ is a neutral group of atoms held together by covalent bonds.
12. The force of attraction between a positively charged metal ion and the electrons in a metal is called a(n) ______ metallic bond ______.
13. A(n) ______ ion ______ is a charged particle that forms when one or more valence electrons are transferred from one atom to another.
Bonding Puzzle, continued

PTEARBILOEOMIDCIA
TCHEMICALBONDINGT
ONRYBONTMLICEDNOI
LOEYECMEENTECHNEMI
CRAMSBLCBINDONDG
MTTEETUAIONICBOND
CCRTYLASTALLCLMOL
EECAENELLAVLIAOBLS
PRLRLOCCTCLNNTHCETO
REYLOCHE_IAOTYIAMM
IECIOCBONMTRCMAEL
BCICONDVPROTELNB
DNOMBETALERTIHCAM
METOLICIHAPLACEVN
ELENEMTCEEIELIEOC
TARDONSIBOONDIDCC
MVOLELBBATCIDIOIREP
Complete this worksheet after you finish reading Chapter 14, Section 2. In your textbook, you read how dancers can model different chemical reactions. Another way to model chemical reactions is to use food. In the spaces provided, write the type of chemical reaction that is modeled in situations 1–4 below. The possible chemical reactions are synthesis, decomposition, single-replacement, and double-replacement. Then answer question 5.

1. One day, Oriana packed a ham-on-wheat sandwich, and her friend, Macha, packed a salami-on-rye sandwich. At lunch, they decided to trade meats. Oriana ate a salami-on-wheat sandwich, while Macha ate a ham-on-rye sandwich.
   **double-replacement reaction**

2. Yasu went to an Italian restaurant. When asked for his order he said, “I’d like the Pasta Extravaganza, but could I have meatball sauce instead of the alfredo sauce?”
   **single-replacement reaction**

3. Tara ordered a side order of mixed vegetables with her meal. But before eating them, she separated the vegetables into separate portions of peas and carrots.
   **decomposition reaction**

4. Kevin went to a salad bar. He used lettuce and tomatoes to make his salad.
   **synthesis reaction**

5. Hydrogen and oxygen combine to form water. How is this similar to one of the situations given above?
   **When hydrogen and oxygen combine to form water, it is a synthesis reaction—two substances combine to form a new substance. This is like the salad bar situation above, in which two foods are combined to form a new food—a salad.**
Complete this worksheet after you finish reading Chapter 14, Section 3.

Activation energy is the energy a reaction needs to get started. At the bottom of the page are two energy diagrams—one for an exothermic reaction and one for an endothermic reaction. Follow the directions below to label the energy diagrams.

1. In an exothermic reaction, the chemical energy of the reactants is greater than the chemical energy of the products. Write Exothermic reaction under the appropriate energy diagram.

2. In an endothermic reaction, the chemical energy of the reactants is lower than the chemical energy of the products. Write Endothermic reaction under the appropriate energy diagram.

3. Exothermic reactions give off energy. The energy given off is the difference between the energy of the reactants and the energy of the products. Label the energy given off on the exothermic-energy diagram by writing Energy given off in the appropriate space.

4. Endothermic reactions absorb energy. The energy absorbed by a chemical reaction is the difference between the energy of the products and the energy of the reactants. Label the energy absorbed on the endothermic energy diagram by writing Energy absorbed in the appropriate space.

5. The activation energy is the energy needed to start a chemical reaction. On the diagrams below, the chemical reaction begins at the top of the peak. The activation energy is the difference between the top of the peak and the energy of the reactants. Label the activation energy of each graph by writing Activation energy in the appropriate space.

Energy Diagrams for an Endothermic and an Exothermic Reaction
After reading Chapter 14, give this puzzle a try!

Fill in the blanks in the clues below. Then use the clues to complete the puzzle on the next page.

1. A number written below and to the right of a chemical symbol in a formula is called a _____________________.

2. In a ________ double _______ -replacement reaction, ions in two compounds switch places.

3. The ________ activation energy is the minimum amount of energy required for substances to react.

4. A chemical ________ reaction _______ is the process by which one or more substances undergo change to produce one or more different substances.

5. The law of ________ conservation of ________ mass _______ states that mass cannot be created or destroyed in ordinary chemical or physical changes. A similar law holds true for ________ energy _______.

6. In a _______ decomposition _______ reaction, a single compound breaks down to form two or more simpler substances.

7. In _______ exothermic _______ reactions energy is released, and in _______ endothermic _______ reactions energy is absorbed.

8. In a _______ synthesis _______ reaction, two or more substances combine to form a single compound.

9. A chemical _______ formula _______ describes a substance using chemical symbols and numbers.

10. A number written to the left of a chemical symbol or formula is called a ________ coefficient _______.

11. In a _______ single _______ -replacement reaction, one element replaces another that is part of a compound.

12. A chemical _______ equation _______ is a shorthand description of a chemical reaction.

13. In a chemical reaction, each starting material is a ______ reactant _______, and each new substance formed is a ______ product _______.

14. A ______ catalyst _______ speeds up a reaction, and an ______ inhibitor _______ slows down a reaction.
How many chapter concepts can you find in the block of letters below? Use the clues to help you find them. Words may appear horizontally, vertically, or diagonally.

<table>
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<td>T</td>
<td>N</td>
</tr>
<tr>
<td>P</td>
<td>A</td>
<td>I</td>
<td>S</td>
<td>A</td>
<td>C</td>
<td>I</td>
<td>F</td>
<td>O</td>
<td>I</td>
<td>I</td>
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<tr>
<td>T</td>
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<td>A</td>
<td>I</td>
<td>K</td>
<td>T</td>
<td>A</td>
<td>U</td>
<td>R</td>
<td>D</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>G</td>
</tr>
<tr>
<td>F</td>
<td>M</td>
<td>H</td>
<td>S</td>
<td>D</td>
<td>O</td>
<td>U</td>
<td>B</td>
<td>L</td>
<td>E</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td>E</td>
<td>N</td>
<td>D</td>
<td>O</td>
<td>T</td>
<td>H</td>
<td>E</td>
<td>R</td>
<td>M</td>
<td>I</td>
<td>C</td>
<td>Q</td>
<td>N</td>
<td>K</td>
</tr>
</tbody>
</table>

A Reactionary Puzzle, continued
Complete this worksheet after you finish reading Chapter 15, Section 2. Libby Lidmis has been busy gathering information on acids, bases, and salts. Unfortunately, someone mixed up the information on her chart. Each of the pieces of information given below describes an acid, a base, or a salt. Help Libby straighten out her chart by matching each piece of information with the correct categories, and writing it in the appropriate box on the next page. Be careful—some of the pieces of information belong in more than one category.

- taste bitter
- may be corrosive
- used to de-ice roads
- excess hydroxide ions
- found in drain cleaner
- found in plasterboard
- react with baking soda to produce carbon dioxide gas
- change blue litmus to red
- pH less than 7
- used to make soap
- H⁺

- form from a neutralization reaction
- change red litmus to blue
- sodium chloride
- found in vinegar
- taste sour
- neutralize lakes with low pH
- OH⁻
- excess hydronium ions
- pH greater than 7
- slippery
- found in orange juice
- form from the reaction of a metal and a nonmetal
ACIDS

- taste sour
- may be corrosive
- react with baking soda to produce carbon dioxide gas
- change blue litmus to red
- pH less than 7
- found in vinegar
- excess hydronium ions
- found in orange juice
  \[ H^+ \]

BASES

- taste bitter
- may be corrosive
- excess hydroxide ions
- found in drain cleaner
- pH greater than 7
- used to make soap
- slippery
  \[ OH^- \]
- change red litmus to blue
- neutralize lakes with low pH

SALTS

- form from the reaction of a metal and a nonmetal
- sodium chloride
- formed from a neutralization reaction
- used in plasterboard
- used to de-ice roads
VOCABULARY REVIEW WORKSHEET

Compounding the Problem

Use the clues below and on the next page to identify vocabulary terms from Chapter 15. Then find and circle each term in the word search puzzle on the next page.

1. Many fuels are made of these organic compounds.  
   ________________ hydrocarbons

2. Atoms share electrons in ________________ covalent compounds.

3. ________________ Nucleic acids are sometimes called the “blue-prints of life.”

4. The measure of the concentration of hydronium ions in a solution is known as ________________ pH.

5. Plants tend to store these as oils. ________________ lipids

6. The positive ion of a base and the negative ion of an acid combine to form this ionic compound. ________________ salt

7. This substance increases the number of H⁺ when dissolved in water. ________________ acid

8. ________________ Biochemicals are organic compounds made by living things.

9. This substance is slippery and bitter. ________________ base

10. These biochemicals are composed of one or more simple sugar molecules bonded together. ________________ carbohydrates

11. These compounds contain oppositely charged ions arranged in a crystal lattice. ________________ ionic

12. These compounds are composed of molecules whose carbon atoms are arranged in a straight chain, a branched chain, or a ring ________________ organic

13. ________________ Proteins are biochemicals that have many functions, such as regulating chemical activities.

14. This special paper is used to test for acids and bases. ________________ litmus

15. The building blocks of proteins are ________________ amino acids.

16. This protein regulates the amount of glucose in your blood. ________________ insulin
17. This type of carbohydrate, found in bread, cereal, and pasta, is called a ___________ carbohydrate.

18. This substance changes color in the presence of an acid or a base. __________ indicator

19. A carbon atom can form no more than this number of bonds. __________ four

20. This type of nucleic acid is the genetic material of the cell. __________ DNA

21. This type of hydrocarbon contains carbon atoms connected only by single bonds. __________ saturated

22. __________ Hemoglobin is a protein that carries oxygen to all parts of your body.
The Decay of a Nucleus

Complete this worksheet after you finish reading Chapter 16, Section 1.

Fill in the blanks in items 1–4, and then complete the table at the bottom of the page.

1. An alpha particle is the same as the nucleus of an atom of the element ____________ helium___________. It contains ____________ two neutron(s) and ____________ two proton(s).

2. During alpha decay, the atomic number decreases by ____________ two and the mass number ____________ decreases by four.

3. In one type of beta decay, a neutron in a radioactive nucleus breaks down into a ____________ proton__________ and a(n) ____________ electron ____________.

4. When a radioactive nucleus releases a beta particle, its atomic number increases by one, and the mass number ____________ stays the same__________.

(decreases, stays the same, or increases)

In the text, you learned that a uranium-238 nucleus undergoes 14 decays to become lead-206. Now you can construct a decay series by completing the table below. You will need the periodic table of the elements. The first two steps have been done for you. (Hint: All beta particles released in this series are electrons, not positrons.)

<table>
<thead>
<tr>
<th>Step</th>
<th>Type of decay</th>
<th>New atomic number</th>
<th>New mass number</th>
<th>Name of isotope formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alpha</td>
<td>90</td>
<td>234</td>
<td>Th-234</td>
</tr>
<tr>
<td>2</td>
<td>Beta</td>
<td>91</td>
<td>234</td>
<td>Pa-234</td>
</tr>
<tr>
<td>3</td>
<td>Beta</td>
<td>92</td>
<td>234</td>
<td>U-234</td>
</tr>
<tr>
<td>4</td>
<td>Alpha</td>
<td>90</td>
<td>230</td>
<td>Th-230</td>
</tr>
<tr>
<td>5</td>
<td>Alpha</td>
<td>88</td>
<td>226</td>
<td>Ra-226</td>
</tr>
<tr>
<td>6</td>
<td>Alpha</td>
<td>86</td>
<td>222</td>
<td>Rn-222</td>
</tr>
<tr>
<td>7</td>
<td>Alpha</td>
<td>84</td>
<td>218</td>
<td>Po-218</td>
</tr>
<tr>
<td>8</td>
<td>Alpha</td>
<td>82</td>
<td>214</td>
<td>Pb-214</td>
</tr>
<tr>
<td>9</td>
<td>Beta</td>
<td>83</td>
<td>214</td>
<td>Bi-214</td>
</tr>
<tr>
<td>10</td>
<td>Beta</td>
<td>84</td>
<td>214</td>
<td>Po-214</td>
</tr>
<tr>
<td>11</td>
<td>Alpha</td>
<td>82</td>
<td>210</td>
<td>Pb-210</td>
</tr>
<tr>
<td>12</td>
<td>Beta</td>
<td>83</td>
<td>210</td>
<td>Bi-210</td>
</tr>
<tr>
<td>13</td>
<td>Beta</td>
<td>84</td>
<td>210</td>
<td>Po-210</td>
</tr>
<tr>
<td>14</td>
<td>Alpha</td>
<td>82</td>
<td>206</td>
<td>Pb-206</td>
</tr>
</tbody>
</table>
Fission or Fusion?

Complete this worksheet after you finish reading Chapter 16, Section 2.

While it’s true that fusion and fission are both types of nuclear reactions, the similarity ends there. Follow the steps below to sort out the facts and eliminate any con-fusion!

1. Take a look at the illustrations in the table below. In the first column, label each illustration either “fusion” or “fission.”

2. Read over the following list of information. Then write each piece of information next to the appropriate type of nuclear reaction. Answers may be used more than once.

- Chernobyl
- not currently used to provide electrical energy
- hydrogen is a plasma
- fuels 20 percent of the electrical energy used in the United States
- requires temperatures over 100,000,000°C
- radioactive waste products

- occurs in the sun’s core
- no radioactive waste products
- energy is released
- large nucleus splits into two smaller nuclei
- uranium
- two or more nuclei join together to form a more-massive nucleus

Nuclear Reaction Chart

<table>
<thead>
<tr>
<th>Chernobyl</th>
<th>fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>fuels 20 percent of the electrical energy used in the United States</td>
<td>not currently used to provide electrical energy</td>
</tr>
<tr>
<td>radioactive waste products</td>
<td>hydrogen is a plasma</td>
</tr>
<tr>
<td>energy is released</td>
<td>requires temperatures over 100,000,000°C</td>
</tr>
<tr>
<td>large nucleus splits into two smaller nuclei</td>
<td>occurs in the sun’s core</td>
</tr>
<tr>
<td>uranium</td>
<td>no radioactive waste products</td>
</tr>
</tbody>
</table>

Name __________________________________________ Date _________________ Class ____________
After you finish Chapter 16, give this puzzle a try!

Fill in the blanks below. Then put letters into the matching numbered squares to reveal a quote by Marie Curie.

1. occurs when two or more small nuclei join together to form a larger, more-massive nucleus

   \[
   \begin{array}{cccc}
   N & U & C & L & E & A & R \\
   F & U & S & I & O & N \\
   20 & 38 & 9
   \end{array}
   \]

2. decay that occurs when a nucleus releases a positron or an electron

   \[
   B & E & T & A \\
   13
   \]

3. the ability of the nuclei of some atoms to give off high-energy particles and rays

   \[
   R & A & D & I & O & A & C & T & I & V & I & T & Y \\
   23 & 8 & 45 & 5 & 27
   \]

4. the collective name of high-energy particles and rays given off by the nuclei of atoms

   \[
   N & U & C & L & E & A & R & I & A & T & I & O & N \\
   42 & 40 & 3 & 30
   \]

5. the process by which high-energy particles and rays are released

   \[
   R & A & D & I & O & A & C & T & I & V & E & D & E & C & A & Y \\
   25 & 46 & 34 & 19 & 47 & 37 & 33
   \]

6. atoms with the same number of protons but different numbers of neutrons

   \[
   I & S & O & T & O & P & E & S \\
   15 & 2 & 16 & 41
   \]

7. occurs when a large nucleus splits, releasing energy and two smaller nuclei

   \[
   N & U & C & L & E & A & R & I & O & N \\
   F & I & S & S & I & O & N \\
   11 & 43 & 35 & 6
   \]

8. the sum of protons and neutrons in an atom

   \[
   M & A & S & S & N & U & M & B & E & R \\
   22 & 29 & 1 & 36
   \]

9. high-energy light waves that are released from a radioactive nucleus during alpha decay and beta decay

   \[
   G & A & M & M & A & R & A & Y & S \\
   7
   \]
10. the length of time it takes for one-half of the nuclei of a radioactive isotope to decay

   H A L F
   32  28  12  24

11. occurs when a nucleus releases a particle consisting of two protons and two neutrons

   A L P H A D E C A Y
   10  4

12. the isotope often used to determine the age of once-living things

   C A R B O N
   18  17

13. a continuous series of nuclear fission reactions

   N U C L E A R C H A I N R E A C T I O N
   26  39

      21  44  14  31

What Marie Curie said:

   N O T H I N G
   1  2  3  4  5  6  7  8  9

   I S T O
   14  15  16  17

   B E F E A R E D
   18  19  20  21  22  23  24  25

   I T I S O N L Y
   26  27  28  29  30  31  32  33

   T O B E
   34  35  36  37

   U N D E R S T O O D
   38  39  40  41  42  43  44  45  46  47
Complete this worksheet after you have finished reading Chapter 17, Section 1. There are three ways for an object to gain a charge: friction, conduction, and induction. When it loses its charge it experiences electric discharge. Label the following pictures as examples of conduction, induction, friction, or electric discharge.

1. induction
2. conduction
3. conduction
4. induction or friction
5. friction
6. induction
Complete this worksheet after you have finished reading Chapter 17, Section 4.

Two electric circuits powered by cells are shown below. Answer the following questions based on the information given in the diagrams. Questions 1–6 refer to Figure 1, and Questions 8–12 refer to Figure 2.

Label the parts of the circuit and the cell by writing the letter that corresponds to the appropriate part in the space provided.

1. ______ A load
2. ______ D electrode
3. ______ B wire
4. ______ E electrolyte
5. ______ C energy source

6. Is this circuit connected in series or in parallel?
   _________________________ series _________________________

7. A cell that contains liquid electrolytes is called a ______ wet _______ cell.

8. What is the power in this circuit? ______ 100 W _______

9. What is the voltage in this circuit? ______ 12 V _______

10. Recall that $I = P/V$. If you divide the power of the circuit by its voltage, you’ll get the circuit’s current. What is the current of this circuit?
    
    The current is 8.33 amperes.

11. Remember that Ohm’s law can be rearranged to say: $R = V/I$. If you divide the circuit’s voltage by its current, you’ll get the resistance of the circuit. What is the resistance caused by the light bulb?

    The resistance is 1.44 ohms.

12. This cell contains a solid electrolyte, so it is a ______ dry _______ cell.
CHAPTER 17

VOCABULARY REVIEW WORKSHEET

An Electrifying Puzzle

Now that you have read Chapter 17, give this crossword puzzle a try!

ACROSS
3. type of circuit in which different loads are on separate branches
4. a material in which charges cannot easily move
5. the rate at which charge passes a given point
6. The energy per unit charge is called the ________ difference.
7. The law of electric __________ states that like charges repel and opposite charges attract.
11. a device in a circuit that uses electrical energy to do work
15. converts thermal energy into electrical energy
17. consists of several cells
18. a complete, closed path through which electric charges flow
19. the opposition to the flow of electric charge
20. used to open and close a circuit

DOWN
1. a device that produces an electric current by converting chemical energy into electrical energy
2. Electric __________ is the loss of static electricity as charges move off an object.
3. the part of a solar panel that absorbs light and converts it into electrical energy
5. transfer of electrons from one object to another by direct contact
8. rearrangement of electrons on an uncharged object without direct contact with a charged object
9. A charged object exerts an electric __________ on other charged objects.
10. Electric __________ is the rate at which electrical energy does work.
12. a material in which charges can move easily
13. The buildup of electric charges on an object is called ________ electricity.
14. the difference in energy per unit charge as a charge moves between two points in the path of a circuit
16. type of circuit in which all parts are connected in a single loop
An Electrifying Puzzle, continued

1. C
2. D  E  PARALLEL
3. I  L  H
4. INSULATOR
5. CURRENT
6. POTENTIAL
7. CHARGE
8. C  D
9. I
10. R  F
11. U  N
12. C  S  W
13. V  I
14. C  C
15. THERMOCOUPLE
16. T  S
17. BATTERY
18. CIRCUIT
19. RESISTANCE
20. SWITCH
CHAPTER

18 REINFORCEMENT WORKSHEET

Planet Lodestone

Complete this worksheet after reading Chapter 18, Section 1.

After months in space, Captain Iva Braveheart and her crew are approaching their destination—the planet Lodestone. Read the following entries in Captain Braveheart’s personal spacelog, and answer the questions.

Earth date July 21, 2313

Finally, we are drawing near to the planet Lodestone. Tomorrow we should be close enough to perform some tests on the planet. I am most curious to know what the planet’s core is like—and whether compasses are likely to work on this planet.

1. What properties of planet Lodestone’s core would indicate that the planet probably has magnetic properties?

   Sample answer: If the planet had a liquid core that contained mostly iron and nickel, like Earth’s, then the planet would probably have magnetic properties.

Earth date July 22, 2313

Our tests indicate that the planet should have magnetic poles, just like Earth. A small team will visit the planet’s surface tomorrow. I’m going to take along a bar magnet and string to find magnetic north and south on Lodestone.

2. How will the captain find magnetic north and south on this planet using a bar magnet and string?

   Sample answer: When a bar magnet is suspended on a string in a magnetic field, the magnet will always point in the same direction. The north pole of the magnet will point to the south magnetic pole of the planet.

3. Captain Braveheart plans to name geographic North on planet Lodestone after magnetic north and geographic South after magnetic south. If she does, will North and South be the same on Lodestone as they are on Earth? Explain.

   Sample answer: No; on Earth, geographic North is really a magnetic south pole and geographic South is really a magnetic north pole. So a magnet that points north on Lodestone would point south on Earth.
### A Magnetic Time

Complete this worksheet after reading Chapter 18, Section 3.

1. Draw a line from the person or group of people in Column A to their contribution to the study of electromagnetism in Column B. Be careful; two scientists match with one contribution.

2. Draw a line from the contribution in Column B to the year or time period when it occurred in Column C.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
<th>Column C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hans Christian Oersted</td>
<td>proposed that the Earth is one giant magnet</td>
<td>2,000 years ago</td>
</tr>
<tr>
<td>Michael Faraday</td>
<td>found a mineral called magnetite, which attracts iron-containing objects</td>
<td>1831</td>
</tr>
<tr>
<td>Greeks</td>
<td>found that a changing magnetic field could induce an electric current</td>
<td>1600</td>
</tr>
<tr>
<td>William Gilbert</td>
<td>after many experiments, concluded that an electric current produces a magnetic field</td>
<td>1820</td>
</tr>
<tr>
<td>Joseph Henry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Use the information above to create a timeline in the space below.

Sample answer: The Development of Electromagnetism

```
AD 0

Greeks find magnetite.

Gilbert proposes Earth is a giant magnet.

Oersted finds that an electric current produces a magnetic field.

Faraday and Henry find that a changing magnetic field induces an electric current.
```

---

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After you finish Chapter 18, try this puzzle!

Using each of the clues below, fill in the letters of the word or phrase being described on the blanks provided on the next page.

1. Force between two magnets
2. Parts of a magnet where the magnetic effects are strongest
3. Device used to measure current
4. Device that changes electrical energy into kinetic energy
5. Produced by a coil of current-carrying wire wrapped around an iron core
6. Scientist who discovered the relationship between electricity and magnetism
7. During electromagnetic ________, a changing magnetic field produces an electric current.
8. Magnet made with iron, nickel, or cobalt
9. British scientist who discovered that a changing magnetic field can produce an electric current
10. Abbreviation for magnetic levitation
11. A tiny region in a magnet where all the atoms are grouped together and their poles are aligned
12. Region around a magnet in which magnetic force can act
13. Device that uses electromagnetic induction to convert kinetic energy into electrical energy
14. Coil of wire that, when carrying an electric current, produces a magnetic field
15. Device that increases or decreases the voltage of an alternating current
16. Material that attracts iron or materials containing iron
A Puzzling Transformation, continued

1. MAGNETIC FORCE

2. POLES

3. GALVANOMETER

4. ELECTRIC MOTOR

5. ELECTROMAGNET

6. OERSTED

7. INDUCTION

8. FERROMAGNET

9. FARADAY

10. MAGLEV

11. DOMAIN

12. MAGNETIC FIELD

13. GENERATOR

14. SOLENOID

15. TRANSFORMER

16. MAGNET
Complete this worksheet after reading Chapter 19, Section 1.

A semiconductor is a material that conducts electrical energy better than an insulator but not as well as a conductor. Silicon may be the most well-known semiconductor, but it’s not the only one. Another semiconductor is germanium (Ge). Use the periodic table in your textbook to help you answer the following questions.

1. Like silicon, germanium has 4 electrons in the outermost energy level of each atom.

Doping a semiconductor means replacing a few atoms of the semiconductor with a few atoms of another substance that has a different number of valence electrons.

2. Germanium can be doped with antimony (Sb), a group 15 element, which has 5 electrons in the outermost energy level of each atom.

3. Germanium can be doped with indium (In), a group 13 element, which has 3 electrons in the outermost energy level of each atom.

4. In the space below, sketch the arrangement of electrons in pure germanium, in germanium doped with antimony, and in germanium doped with indium. Draw only the electrons in the outermost energy levels. The outermost energy level of each atom is represented by a gray circle.

An n-type semiconductor is a doped semiconductor with an “extra” electron. A p-type semiconductor is a doped semiconductor with a “hole” where an electron could be.

5. Doping germanium with antimony results in an n-type semiconductor.

6. Doping germanium with indium results in a p-type semiconductor.
The Ins and Outs of Computing

Complete this worksheet after you finish Chapter 19, Section 3.
Fill in the blanks in the paragraph below with the terms *input device*, *microprocessor*, *memory*, and *output device*.

1. Information is entered into a computer using a(n) ______ input device ______. The information is processed by the central processing unit, which is a(n) ______ microprocessor ______, or the information is stored in the computer’s ______ memory ______ until it is needed. When a computer finishes a task, it shows the results on a(n) ______ output device ______.

2. Below is an illustration of a desktop computer setup. Label the parts of the computer with the following terms: *speaker, monitor, keyboard, mouse, floppy disk, printer*.

3. Using colored pencils or crayons, color input devices yellow, output devices red, and storage and processing devices blue.

4. The computer shown above does not have a modem. If it did, what color would you shade the modem? Explain.

   Sample answer: A modem can be an input device (yellow) and an output device (red), so I would shade the modem orange.
CHAPTER
19 VOCABULARY REVIEW WORKSHEET

A Circuit-ous Crossword

After you finish Chapter 19, try this crossword puzzle!

ACROSS
1. something that represents information
2. a huge computer network consisting of millions of computers that can share information with each other
6. an entire circuit formed on a single silicon chip
13. conducts electric current better than an insulator but not as well as a conductor
14. an electronic device that performs tasks by processing and storing information
15. integrated circuit that contains many of a computer’s capabilities on a single chip
16. ________ tubes can perform the same functions as transistors, but they are larger, give off more thermal energy, and don’t last as long.

DOWN
1. set of instructions or commands that tells a computer what to do
3. type of wave that consists of changing electric and magnetic waves
4. an electronic component that allows current in only one direction
5. a collection of tiny circuits that supply electric current to the parts of an electronic device
7. type of signal whose properties can change continuously according to changes in the original information
8. type of signal that consists of a series of electric pulses represented by the digits of binary numbers
9. an electronic component composed of three layers of semiconductors
10. the sending of information across long distances by electronic means
11. the parts or equipment that make up a computer
12. process that modifies the conductivity of a semiconductor
Complete this worksheet after you finish reading Chapter 20, Section 2.
Examine the diagram below, and then answer the questions that follow.

1. What is the amplitude of the wave?
   The amplitude of the wave is 5 m.

2. What is the wavelength?
   The wavelength is 10 m.

Remember, frequency, expressed in hertz (Hz), is the number of waves produced in a given amount of time.

3. If you were watching this wave go by and counted five crests passing a certain point in 5 seconds, what would be the frequency of the wave? Use the formula and the space below to calculate your answer.

   \[
   \text{Frequency} = \frac{\text{number of waves}}{\text{time}} = \frac{5}{5 \text{ s}} = \frac{1}{1} = 1 \text{ Hz}
   \]

4. What would the frequency of the wave be if you counted 10 crests in five seconds? Use the space below to calculate the answer.

   \[
   \text{Frequency} = \frac{10}{5 \text{ s}} = 2 \text{ Hz}
   \]

5. If the wavelength became 12 m but the wave speed remained the same, would the frequency increase, decrease, or stay the same?
   If the wavelength became 12 m, the frequency would decrease.
Diagram and label the interaction described below, and then answer the questions that follow.

Wave A, with an amplitude of 3 m, meets wave B, with an amplitude of 3 m. When A and B overlap, the wave produced (C) has an amplitude of 6 m.

1. What type of wave interaction is described? Explain.
   
   Sample answer: The wave interaction is **constructive interference** because when the waves overlapped, the amplitude of the resulting wave (C) was greater than the amplitude of the individual waves.

2. If wave A were to overlap with a different wave to produce a new wave that had an amplitude of 0 m instead of 6 m, would this be the same type of interaction described above? Explain.
   
   Sample answer: No; if the amplitude of the resulting wave were 0 m, the amplitude of the resulting wave would be less than the amplitude of the original waves. This would be an example of **total destructive interference**.
CHAPTER 20

VOCABULARY REVIEW WORKSHEET

Let’s Do the Wave!

After you finish Chapter 20, give this puzzle a try!

Figure out the words described by the clues below, and write each word in the appropriate space. Then find and circle the words in the puzzle on the next page.

1. medium — a substance through which a wave can travel
2. refraction — the bending of a wave as it passes at an angle from one medium to another
3. wave — a disturbance that transmits energy through matter and space
4. resonance — when one vibrating object causes similar vibrations in another object that is nearby
5. trough — the lowest point of a transverse wave
6. frequency — the number of waves produced in a given amount of time
7. interference — when two or more waves overlap
8. perpendicular — describes lines that meet at right angles
9. reflection — an echo, for example (wave interaction)
10. surface — a wave that occurs at the boundary between two media when transverse and longitudinal waves combine
11. longitudinal — wave in which particles in the medium vibrate back and forth along the path the wave travels
12. transverse — waves in which particles of the medium vibrate in an up-and-down motion
13. wavelength — the distance between two adjacent compressions
14. amplitude — the maximum distance a wave vibrates from its rest position
15. standing — kind of wave that looks like it is stationary
16. crest — the highest point of a transverse wave
17. hertz — measurement equal to one wave per second
18. diffraction — the bending of waves around a barrier or through an opening
In the puzzle below, find the words from the blanks on the previous page. Words may appear horizontally, vertically, or diagonally.
Doppler Dan’s Dump Truck

Complete this worksheet after you finish reading Chapter 21, Section 2.

Doppler Dan the Garbage Man is moving a truckload of glass from one end of the recycling plant to the other. Elinor has just helped him load up all of the broken bottles at the front of the plant on the east side of the lot. As Dan drives away, he honks his horn in thanks to Elinor. He speeds off in a hurry, because his buddy Otis is waiting impatiently on the west side to help him unload the glass from the dump truck.

“Howdy Otis,” says Dan, as he drives up.

“Hey,” grumbles Otis, chewing on his pen. “Your horn sounds funny.”

“Sounds fine to me,” says Dan as cheerfully as possible. He thought Otis was just making trouble, as he is not a morning person. Still it seemed like a strange thing to say. Why would the horn sound different to Otis than it did to him?

At the end of the day, Dan was still wondering about Otis’s mysterious comment. He decided to ask Elinor about it.

Elinor reminded Dan that he honked the horn as he drove away from her. Then she drew him the diagram below. Points 0–3 represent Dan’s positions as he drove from east to west. The compressions of the sound waves made by the honking horn are shown as circles A–D. A is the compression that came from the horn when Dan was at Point 0, B is from Point 1, C is from Point 2, and D is from Point 3.

Next Elinor told Dan that by studying the diagram and doing some minor calculations, he could find out the answer. On the next page, follow the steps Dan used to find out why the horn sounded different to Otis. The formulas below will help you.

**Formulas**

For the speed of a wave: \[ \text{wave speed} = \text{wavelength} \times \text{frequency} \]

For wavelength: \[ \text{wavelength} = \text{wave speed} \div \text{frequency} \]

For frequency: \[ \text{frequency} = \text{wave speed} \div \text{wavelength} \]
1. Use your textbook to find the speed of sound in air at 20˚C. 
   \[
   \text{wave speed} = \frac{343 \text{ m/s}}{343 \text{ m/s}}
   \]

2. Doppler Dan bought his horn from Honk, Inc. They guaranteed that the horn will honk at a frequency of 350 Hz. Use the equation on the previous page to calculate the wavelength of sound made by Dan's horn and show your work here.
   \[
   (343 \text{ m/s}) \div 350 \text{ Hz} = 0.98 \text{ m}
   \]

3. Find the wavelength of the sound by measuring the distance from one compression to the next. From where Otis is standing, what is the wavelength of the sound? 
   \[
   0.90 \text{ m}
   \]

4. The frequency of sound that you hear is the speed of the sound divided by the wavelength. What frequency did Otis hear?
   \[
   (343 \text{ m/s}) \div 0.90 \text{ m} = 381 \text{ Hz}
   \]

5. What is the wavelength of the sound on the side of the dump truck where Elinor is standing? 
   \[
   1.06 \text{ m}
   \]

6. What frequency did Elinor hear?
   \[
   (343 \text{ m/s}) \div 1.06 \text{ m} = 324 \text{ Hz}
   \]

7. Complete the chart below.

<table>
<thead>
<tr>
<th>Listener</th>
<th>Sound wavelength</th>
<th>Sound frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan</td>
<td>0.98 m</td>
<td>350 Hz</td>
</tr>
<tr>
<td>Otis</td>
<td>0.90 m</td>
<td>381 Hz</td>
</tr>
<tr>
<td>Elinor</td>
<td>1.06 m</td>
<td>324 Hz</td>
</tr>
</tbody>
</table>

8. Now use the information that you have just gathered and your understanding of the Doppler effect to explain why Otis heard the sound differently than Dan.

   As the dump truck moved toward Otis, he heard a higher frequency (higher pitched) sound than Dan. Dan was moving with the sound source, so he heard the actual frequency of the horn.
After you finish reading Chapter 21, give this puzzle a try!

Fill in each blank with the correct term. Then use the vocabulary words to find the words in the puzzle on the next page.

1. The apparent change in the pitch of a car's horn as it moves past you is a result of the _________________ effect.

2. When any kind of wave bounces off a barrier, the bouncing back of the wave is called _________________. A bounced sound wave is called an _________________. This kind of sound wave is the basis for _________________, a method whales and bats use to find food.

3. The bending of waves around barriers or through openings is called _________________.

4. Each instrument has a unique _________________ that is the result of several pitches blending together through interference.

5. The _________________ of the note depends on whether it is played softly or loudly, and the _________________ is how low or high the note sounds.

6. Due to _________________, the vibration of a tuning fork can cause a guitar string to vibrate when the fork is held near the string.

7. The hammer, anvil, and stirrup bones are in the _________________ ear. The _________________ ear changes vibrations into electrical signals. The _________________ ear acts as a funnel for sound waves.

8. Constructive or destructive _________________ occurs when sound waves overlap and combine.

9. The _________________ is a unit used to express how loud or soft a sound is.

10. A _________________ is an undesirable, nonmusical sound that includes a random mix of pitches.
11. An extremely fast airplane can cause an explosive sound called a __________ sonic ______ boom.

12. ___________ infrasonic sounds have a frequency lower than 20 Hz, while ___________ ultrasonic sounds have a frequency higher than 20,000 Hz.

13. In a ___________ standing wave, some portions of the wave are at rest while other portions have a large amplitude.

Search the puzzle below to find each of the words you wrote in the blanks above, and circle these words in the puzzle. Words may appear horizontally, vertically, or diagonally.
# Light Interactions

Complete this worksheet after you finish reading Chapter 22, Section 3.

Light waves can interact with objects or with other light waves in a variety of ways. Complete the table by writing a description or explanation and an example of each kind of light interaction. The first example is provided.

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Description or explanation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflection</td>
<td>A wave bounces off an object.</td>
<td>A green sweater looks green because green light is reflected off it.</td>
</tr>
<tr>
<td>Absorption</td>
<td>Energy carried by light waves is transferred to particles of matter.</td>
<td>Sample answer: Due to absorption (and scattering), the beam of a flashlight appears dimmer the further it is from the flashlight.</td>
</tr>
<tr>
<td>Scattering</td>
<td>Light energy is released by particles of matter that have absorbed energy.</td>
<td>Sample answer: Scattering of blue light makes the sky look blue.</td>
</tr>
<tr>
<td>Refraction</td>
<td>The path of a wave bends as it passes at an angle from one medium to another.</td>
<td>Sample answer: A straw placed in a glass of water appears bent.</td>
</tr>
<tr>
<td>Diffraction</td>
<td>Diffraction is the bending of waves around barriers and through openings.</td>
<td>Sample answer: Shadows appear slightly blurry at the edges.</td>
</tr>
<tr>
<td>Interference</td>
<td>Waves overlap and combine.</td>
<td>Sample answer: When light of one wavelength shines through two slits onto a screen a series of bright and dark bands will appear.</td>
</tr>
</tbody>
</table>
Complete this worksheet after you finish reading Chapter 22, Section 3.

Fiona wants to be a detective. In order to pass the entrance exam to Private Eye University, she is practicing her spy skills on her friends Jorge, Charles, and Tamika. Reflection is one of the hardest sections on the exam. Use what you have discussed in class to help Fiona learn about the law of reflection.

**Figure 1**

![Diagram of a light source, incident beam, reflected beam, angle of incidence, and angle of reflection.]

1. Figure 1 in Fiona's notes shows a beam of light hitting and reflecting off a mirror. Label the normal, incident beam, reflected beam, angle of incidence, and angle of reflection on the diagram.

Fiona knows from the law of reflection that the angle of incidence always equals the angle of reflection. She uses this law to plan a system of mirrors that will allow her to spy on her friends. With her special arrangement of mirrors, Fiona can watch her friends walk by as she hides behind a brick wall.

2. Figure 2 shows the arrangement of mirrors. Using the law of reflection, draw the path of light as it would reflect off each of the mirrors. The normals have been drawn on the reflecting surfaces for you. (Hint: Not all of the mirrors will be used.)

3. Which of her friends is Fiona able to see with her mirrors in their current arrangement?

   **Fiona can see Jorge.**
After you finish reading Chapter 22, give this puzzle a try!
Fill in the blanks below. Then put the letters in the matching numbered squares on the next page to reveal a quote by Albert Einstein.

1. the bending of waves as they pass into a different medium

   REFRACTION

   8 12 38

2. energy emitted in the form of EM waves

   RADIATION

   37 7 20

3. the release of energy by particles of matter that have absorbed extra energy

   SCATTERING

   32 11 39

4. the material that gives paint its color by absorbing some colors of light and reflecting others

   PIGMENT

   6 22

5. occurs when waves overlap and combine

   INTERFERENCE

   34 16 16

6. the entire range of EM waves, such as light, radio waves, microwaves, and X rays

   ELECTROMAGNETIC

   35 17 1

   SPECTRUM

   31 9

7. the bending of waves around a barrier or through an opening

   DIFFRACTION

   15 26

8. the passing of light through matter

   TRANSMISSION

   13 5 27

9. materials that transmit light easily, without scattering

   TRANSPARENT

   19 28 33

10. waves that are used in radar

    MICROWAVES

    18 10

11. can be created by combining red, green, and blue light

    WHITE LIGHT

    2 23 14

---

Tom H. [Author's Name]
12. the transfer of energy from light waves to particles of matter
   \[\text{ABSORPTION}\]

13. when a wave bounces off an object
   \[\text{REFLECTION}\]

14. materials that do not transmit any light
   \[\text{OPAQUE}\]

15. materials that transmit and scatter light
   \[\text{TRANSLUCENT}\]

What Albert Einstein said:

\[\text{T H E I M P O R T A N T T H I N G}\]

\[\text{I S N O T T O S T O P}\]

\[\text{Q U E S T I O N I N G}\]
Mirror, Mirror

Complete this worksheet after reading Chapter 23, Section 2. You will need a straightedge for this activity. Each of the following four illustrations features an object, an image, and a mirror. The optical axis and the focal point are also shown where appropriate.

1. Identify the mirror as plane, convex, or concave. (Circle your answer.)

2. Identify the image as a real or virtual image. (Circle your answer.)

3. For concave and convex mirrors, if the rays are not drawn, draw them into the ray diagram.

<table>
<thead>
<tr>
<th>Object</th>
<th>Mirror</th>
<th>Image</th>
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</table>

plane or convex or concave

real image or virtual image

plane or convex or concave

real image or virtual image

plane or convex or concave

real image or virtual image
Each illustration below features an object, an image, and a lens. The optical axis and the focal point are also shown.

1. Identify the lens as convex or concave. (Circle your answer.)
2. Identify the image as a real or virtual image. (Circle your answer.)
After finishing Chapter 23, give this puzzle a try!

Use the clues given below to complete the crossword puzzle on the next page.

ACROSS
2. the opening that lets light into the eye
4. a piece of film on which an interference pattern produces a 3-D image
7. Visible light sources are _______ objects.
8. _______ light is produced when electrons combine with gaseous metal atoms.
11. the back surface of the eye
12. _______ light is light produced by hot objects.
15. The _______ length is the distance between a mirror and its focal point.
17. A(n) _______ is a curved, transparent object that forms an image by refracting light.
18. _______ mirrors produce virtual, upright images that are smaller than the original object.
19. _______ light is produced when certain gases absorb and then release energy.
20. An image formed by a mirror with a flat surface is called a(n) _______ image.
21. A(n) _______ produces intense light of a single color.

DOWN
1. _______ light is visible light emitted by a phosphor particle when it absorbs energy.
2. _______ mirrors have a flat surface.
3. A visible object that is not a light source is being _______.
5. the opening that lets light into a camera
6. In _______ light, all of the light waves vibrate in the same plane.
9. A straight line drawn outward from the center of a lens or mirror is the _______ axis.
10. Unlike 20 across, light passes through _______ images.
13. _______ lenses are used to correct nearsightedness.
14. the transparent membrane that protects the eye
16. controls the size of the pupil
An Enlightening Puzzle, continued

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