Name _____ **Period** _____

Chapter 2: The Chemical Basis of Life

Guided Reading Activities

Big Idea: Elements, Atoms, and Compounds

Answer the following questions as you read Modules 2.1–2.4:

1. Match the following terms with their correct definitions: matter, trace element, emergent properties, element, and compound.

   a. A substance required by humans in small quantities: Trace element

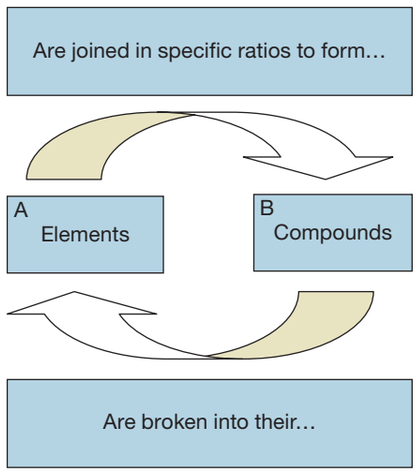
   b. A substance that cannot be chemically broken down into a simpler substance: Element

   c. Anything that takes up space and has mass: Matter

   d. Substances with two or more elements in a fixed ratio: Compound

   e. A substance with different properties than the elements that make it up: Emergent properties

2. Fill in the following diagram at right, which illustrates the relationship between compounds and elements. Provide an example of each in the space below.
   An example of a compound is NaCl (table salt).
   An example of an element is Na.



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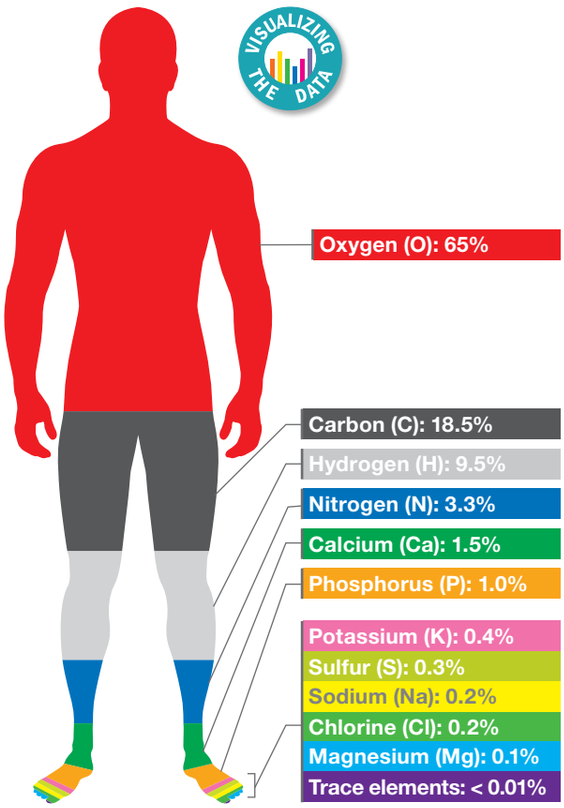
3. Neapolitan ice cream is vanilla, chocolate, and strawberry combined in a 1:1:1 ratio. Briefly explain how Neapolitan ice cream is a good analogy that helps students conceptualize the relationship between compounds and elements.
Neapolitan ice cream is an "ice cream compound" in that it is made from a combination of three different "elemental" ice cream flavors: chocolate, vanilla, and strawberry. If you wanted, you could take a knife and separate the three flavors from one another. This analogy allows you to see how elements can be combined to make new substances or broken into their elements.

4. What four elements make up the largest contribution to the human body as a percentage of body weight? Use Figure 2.1B from page 22 of your textbook to answer this question.



The four elements are: carbon, nitrogen, hydrogen, and oxygen.

5. Students tend to think that, because trace elements are required in tiny quantities, trace elements are not important. List two trace elements that the human body requires and briefly explain why each of those two trace elements is important.
Iron and iodine are two trace elements required by your body. Iron is needed for the proper transportation of oxygen in your blood; iodine is needed for hormones made in the thyroid.

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6. Use the two examples that you provided in question 5 to describe how those trace elements have been introduced into our diets and/or personal hygiene habits.
Iron has been added to certain cereals as a way to get people to consume enough of it. Iodine has been added to salt for the same reason.

7. Complete the following table that lists key features about subatomic particles.

	Protons	Neutrons	Electrons
Electrical charge	Positive	Neutral	Negative
Location in an atom	Nucleus	Nucleus	In motion around the nucleus in an electron cloud
Mass	1 dalton	1 dalton	No practical mass

8. An atom of carbon has six protons. Consider that the number of protons is changed to seven. Is it still an atom of carbon? Briefly explain your answer either way.
It would no longer be carbon because you changed the number of protons. The number of protons determines the element.

9. Which of the following describes atoms of an element that vary in the number of neutrons?

   a. Electrons

   b. Isotopes

   c. Atomic number

   d. Protons

10. True or false: A radioactive isotope is unstable, which means it gives off energy and particles. If false, make it a correct statement.
True

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11. Complete the following table by filling each line with the correct value.

Element	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
Carbon-12	6	12	6	6	6
Hydrogen-1	1	1	1	0	1
Phosphorous-31	15	31	15	16	15
Fluorine-19	9	19	9	10	9
Carbon-13	6	13	6	7	6

12. Radioactive isotopes are commonly referred to as "biological spies." Briefly explain why this is an accurate description. Your explanation should include two specific examples of radioactive isotopes being used as "spies."
They are described as "radioactive spies" because the cells of an organism incorporate them the same as they would the nonradioactive isotope of that element. The use of radioactive carbon to study photosynthesis and the use of radioactive iodine to help kill thyroid cancer cells are two examples.

Big Idea: Chemical Bonds

Answer the following questions as you read Modules 2.5–2.9:

1. Electrons are found in _____shells_____ that surround the nucleus at distinct distances.

2. Any orbital can hold only how many electrons?

   a. One

   b. Zero

   c. Two

   d. Eight

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3. What are the three ways in which atoms with incomplete valence shells can interact with one another with respect to their electrons?
   Atoms can give electrons away, take them or share them.

4. Which of the following would be considered a covalent bond?

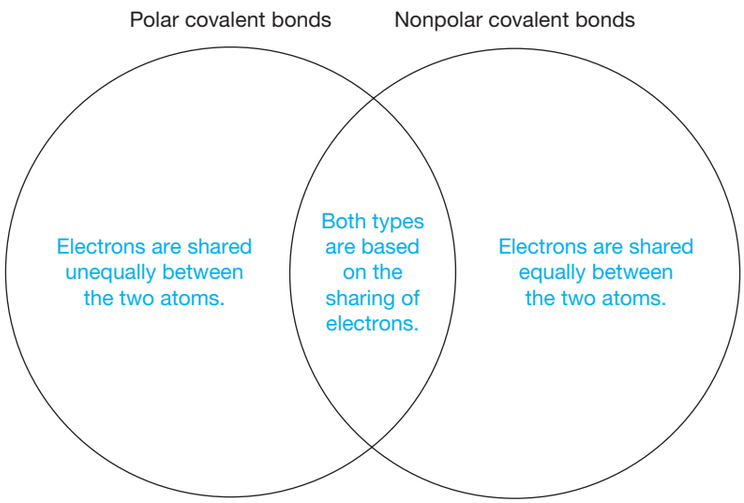
   a. Double bond

   b. Single bond

   c. Nonpolar covalent bond

   d. All of the above

5. Complete the Venn diagram that compares polar covalent bonds with nonpolar covalent bonds.



6. You are a research scientist working for an oil exploration company. A molecule is isolated from a sample taken from a new test well the company is drilling. Initial tests indicate that the molecule is nonpolar. Based on what you read in regards to nonpolar covalent bonds, what elements are likely to make up the molecule? Briefly explain your answer.
   Carbon and hydrogen are the elements likely to make up the molecule because they always form nonpolar covalent bonds with each other, which make a nonpolar molecule.

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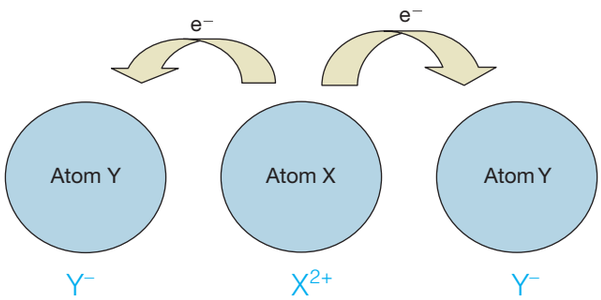
7. True or false: An ionic bond is based on the transfer of electrons between two atoms. If false, make it a correct statement.
True

8. Complete the diagram illustrating ionic bonds. Atom X gives one electron to each atom Y. What are the ions that form as a result? Put the charges under each atom.



9. Many students have difficulty understanding how giving up an electron to another atom fills the valence of the atom that gave up the electron. It seems counterintuitive to them that losing an electron actually fills their valence. Imagine you are a teacher trying to explain this particular concept to a student. Briefly describe what you would say.
By losing the electron, the atom no longer has electrons in the valence shell. If there are no longer electrons in that shell, then that shell is no longer the valence shell. The next shell closer to the nucleus becomes the valence shell and the original shell is full.

10. Match the following terms with their definitions: ionic bond, covalent bond, polar covalent bond, nonpolar covalent bond, and hydrogen bond.

a. A weak electrical attraction between a slightly positive hydrogen and a slightly negative atom: Hydrogen bond

b. Two atoms sharing electrons: Covalent bond

c. Atoms sharing electrons equally: Nonpolar covalent bond

d. A bond that forms between oppositely charged atoms: Ionic bond

e. A bond based on the unequal sharing of electrons: Polar covalent bond

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11. Chemical reactions are changes in matter that result in new substances being made by breaking existing chemical bonds, rearranging the atoms into new substances, and forming new chemical bonds.

12. In the following chemical equation, identify the products and reactants and indicate whether or not the equation is balanced. If not, balance the chemical equation.

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

This chemical equation is balanced. The CO_2 and H_2O are the reactants and the $C_6H_{12}O_6$ and the O_2 are the products.

Big Idea: Water's Life-Supporting Properties

Answer the following questions as you read Modules 2.10–2.16:

1. Which of the following is a unique property of water?

   a. Cohesion

   b. Ice floats

   c. Temperature regulation

   d. Acts as a crucial solvent

   e. All of the above are properties of water.

2. Match the following terms with their correct definitions: adhesion, temperature, surface tension, evaporative cooling, and thermal energy.

   Cooling of a surface due to a substance changing from a liquid to a gas: Evaporative cooling

   Measure of how difficult it is to break the surface of a liquid: Surface tension

   The random motion of molecules: Thermal energy

   The ability of two substances to stick together: Adhesion

   Average speed of molecules moving within matter: Temperature

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3. Because water is _____polar_____, it is able to dissolve many of life's important substances.

4. You observe a substance dissolving in water. What is likely to be true about that substance?
The substance dissolving is likely to be polar.

5. As the pH increases the $[H^+]$ _____, and as the pH decreases the $[H^+]$ _____.

   a. decreases; increases

   b. increases; decreases

   c. increases; stays the same

   d. decreases; stays the same

6. Complete the following table regarding acids and bases.

	Acids	Bases
Effect on H^+ when dissolved in a solution	Increases	Decreases
pH range	0 up to 7	From after 7 to 14
Example	HCl	NaOH

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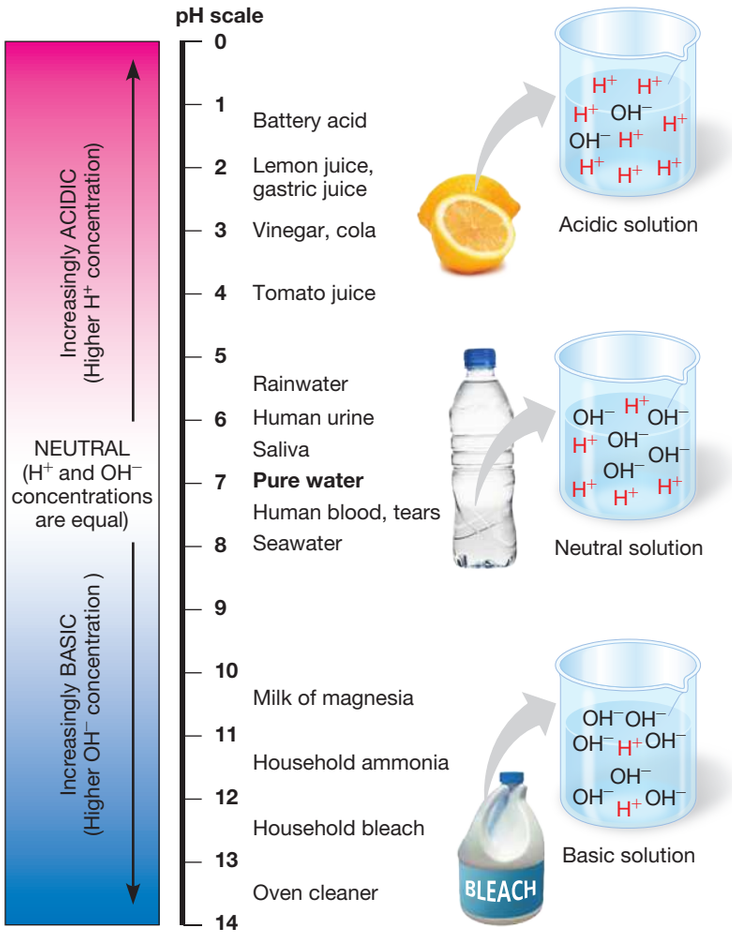
7. How much more $[H^+]$ does lemon juice have compared with pure water? Use Figure 2.14 on page 32 of your textbook.



Lemon juice has 100,000 times more $[H^+]$ when compared to pure water.

8. True or false: Ocean acidification is when CO_2 dissolves in ocean water and lowers the pH. If false, make it a correct statement.
True

9. The authors describe an experiment where scientists examined the effects of carbonate ion concentration on coral reef calcification. In that study, what variable did they manipulate or test? What variable did they measure to see if the manipulated variable had an effect?
They manipulated the carbonate ion concentration. They measured the rate of calcification by the reef-building organisms.

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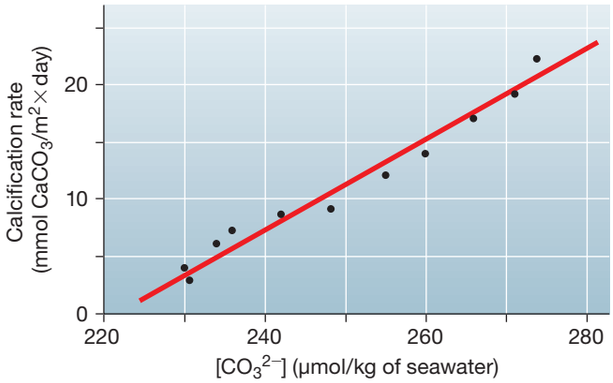
10. What is the correlation between carbonate ion concentration and the rate of calcification by reef organisms? Use Figure 2.15a on page 33 in your textbook.



Source: Adaptation of figure 5 from "Effect of Calcium Carbonate Saturation State on the Calcification Rate of an Experimental Coral Reef" by C. Langdon, et al., from *Global Biogeochemical Cycles*, June 2000, Volume 14(2). American Geophysical Union.

The rate of calcification increased as the concentration of the carbonate ion increased.

11. The search for life on other planets hinges on finding ___water___.

CONNECTING THE BIG IDEAS

Use your knowledge of the information contained within this chapter's "Big Ideas" to answer this question.

Oils are nonpolar substances (molecules formed by nonpolar covalent bonds) that do not readily interact with water. Propose an explanation for why oils are not readily attracted to water, whereas a substance like NaCl (table salt) is attracted to H_2O.

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