Bonds in a Droplet

Use periodic-table position to predict chemical bonds.

FB.2.3 "Relate chemical reactivity to an element's position on the periodic table. Use this information to determine what type of bond will form between elements (ionic, covalent, hydrogen)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentences that locate element groups on the periodic table, and circle words about losing, gaining, or sharing electrons. Write 1 beside the ionic-bond rule, 2 beside the covalent-bond rule, and 3 beside the conditions for hydrogen bonding.

What Holds a Droplet Together?

(1) At a coastal lab, a student watches crystals form as a drop of seawater dries. To predict what holds the particles together, the student checks the periodic table. Metals occupy the left and center; most nonmetals cluster on the right. Lithium and sodium sit in group 1, while magnesium and calcium sit in group 2. Oxygen and sulfur are in group 16; fluorine and chlorine are in group 17. Carbon is in group 14, and nitrogen is in group 15. Hydrogen sits at the top left but behaves as a nonmetal. Elements in the same group often react in similar ways.

(2) Position offers a clue to electron behavior. Group 1 metals tend to lose one outer electron, and group 2 metals tend to lose two. Group 16 nonmetals tend to gain two electrons, while group 17 nonmetals tend to gain one. When a metal transfers electrons to a nonmetal, the resulting positive and negative ions attract through an ionic bond. Two nonmetals usually share electrons instead, forming a covalent bond. Carbon, nitrogen, sulfur, and hydrogen can form covalent bonds with other nonmetals. The periodic table predicts a likely bond type, not the exact shape or properties of a substance.

(3) Hydrogen bonding adds another layer to a damp surface. It is not a third way for isolated atoms to join. First, hydrogen must be covalently bonded to nitrogen, oxygen, or fluorine. That hydrogen can then be attracted to a nitrogen, oxygen, or fluorine atom on a nearby molecule. This attraction is called a hydrogen bond and is usually weaker than an ionic or covalent bond. For example, hydrogen attached to nitrogen in one molecule can attract oxygen in another molecule. In a liquid, many such attractions can link neighboring molecules, even while covalent bonds hold the atoms inside each molecule together.

2 ANSWER WITH EVIDENCE

Use the passage

1. Lithium reacts with fluorine. Use their groups to predict how electrons move and what type of bond forms.

2. Calcium reacts with sulfur. How do their positions help you predict the bond type?

3. Carbon bonds with chlorine. Predict the bond type and explain how their positions support your answer.

4. In a droplet of water, what type of attraction can link one water molecule to another? How is it different from the bonds within a water molecule?

3 YOUR TURN

Your own words

Write a short guide to an imagined sample containing sodium with sulfur, sulfur with hydrogen, and separate hydrogen fluoride molecules. Predict the bond type for each element pair and the attraction possible between hydrogen fluoride molecules, explaining the periodic-table clue or bonding condition for each.

ANSWER KEY

Bonds in a Droplet

PART 1 · READ AND MARK

Underline the sentences that locate element groups on the periodic table, and circle words about losing, gaining, or sharing electrons. Write 1 beside the ionic-bond rule, 2 beside the covalent-bond rule, and 3 beside the conditions for hydrogen bonding. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Lithium reacts with fluorine. Use their groups to predict how electrons move and what type of bond forms.	**Group 1 lithium tends to lose one electron, and group 17 fluorine tends to gain one. Electron transfer produces ions that form an ionic bond.**
2	Calcium reacts with sulfur. How do their positions help you predict the bond type?	**Calcium is a group 2 metal that tends to lose two electrons; sulfur is a group 16 nonmetal that tends to gain two. They form an ionic bond.**
3	Carbon bonds with chlorine. Predict the bond type and explain how their positions support your answer.	**Carbon and chlorine are both nonmetals, so they usually share electrons in a covalent bond.**
4	In a droplet of water, what type of attraction can link one water molecule to another? How is it different from the bonds within a water molecule?	**A hydrogen bond can form between hydrogen bonded to oxygen in one molecule and oxygen in another. Within each water molecule, oxygen and hydrogen share electrons in covalent bonds.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Sodium is a group 1 metal, and sulfur is a group 16 nonmetal, so electron transfer can produce ions that form ionic bonds. Sulfur and hydrogen are both nonmetals, so they can share electrons in covalent bonds. Within each hydrogen fluoride molecule, hydrogen is covalently bonded to fluorine; hydrogen on one molecule can attract fluorine on another, forming a hydrogen bond between molecules.

Accept explanations based on metal versus nonmetal position even if students do not name group numbers. For hydrogen bonding, require an attraction between molecules, not a replacement for the covalent bond within a molecule.