Bond Detectives

Use valence electrons to predict bonds and formulas.

8.5 "Obtain, evaluate, and communicate information from the periodic table to make predictions about the reactivity of the main group elements. a. Use valence electron configuration to model ionic and covalent bonds."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each group number and its valence-electron count in the passage. Circle words that tell you whether electrons transfer or are shared.

What the Periodic Table Predicts

1 Imagine choosing materials for a flashlight battery. The periodic table can help you predict which main group elements will react and how they will bond. Elements in the same group, or column, have the same number of valence electrons, the electrons in their outer shell. Group 1 has one, Group 2 has two, Group 14 has four, Group 16 has six, and Group 17 has seven. Hydrogen has one valence electron. Atoms with nearly empty or nearly full outer shells often react to reach a more stable arrangement.

2 In an ionic bond, a metal transfers valence electrons to a nonmetal. Lithium, in Group 1, gives its one outer electron to fluorine, in Group 17. Lithium becomes Li^+, and fluorine becomes F^-. Their opposite charges attract. The simplest ratio is one lithium ion to one fluoride ion, written LiF. In a solid, many ions form a repeating pattern, so LiF does not mean the solid contains only two ions. A Group 2 metal can lose two electrons; a Group 16 nonmetal can gain two.

3 In a covalent bond, nonmetal atoms share valence electrons rather than transfer them. Oxygen, in Group 16, has six valence electrons and needs two more for a full outer shell. Each hydrogen atom needs one more electron to fill its first shell, which holds only two. Oxygen shares one pair of electrons with each of two hydrogen atoms, forming H_2O. Here the formula tells how many atoms are in one molecule. To predict a bond, use group numbers to count outer electrons, then check whether atoms will transfer or share electrons.

2 ANSWER WITH EVIDENCE

Use the passage

1. Sodium (Na), a Group 1 metal, reacts with chlorine (Cl), a Group 17 nonmetal. Which atom gives up an electron? Give both ion charges and the simplest ionic formula.

2. Magnesium (Mg), a Group 2 metal, reacts with oxygen (O), a Group 16 nonmetal. How many electrons transfer per atom? Give the simplest ion ratio and formula.

3. Carbon (C) is a Group 14 nonmetal, and hydrogen (H) has one valence electron. How many hydrogen atoms can share electrons with one carbon atom so carbon fills its outer shell? Give the molecular formula.

4. Potassium (K), a Group 1 metal, reacts with sulfur (S), a Group 16 nonmetal. How many potassium atoms are needed for each sulfur atom? Explain with electron counts and give the simplest ionic formula.

3 YOUR TURN

Your own words

Predict two compounds: one made from calcium (Ca), a Group 2 metal, and bromine (Br), a Group 17 nonmetal, and one made from calcium and selenium (Se), a Group 16 nonmetal. For each, explain the electron transfer, give the ion charges, simplest ion ratio, and formula. Which compound uses more nonmetal ions per metal ion?

Bond Detectives

PART 1 · READ AND MARK

Underline each group number and its valence-electron count in the passage. Circle words that tell you whether electrons transfer or are shared. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Sodium (Na), a Group 1 metal, reacts with chlorine (Cl), a Group 17 nonmetal. Which atom gives up an electron? Give both ion charges and the simplest ionic formula.	**Sodium gives one electron to chlorine. The ions are Na^+ and Cl^-, and the simplest ionic formula is NaCl.**
2	Magnesium (Mg), a Group 2 metal, reacts with oxygen (O), a Group 16 nonmetal. How many electrons transfer per atom? Give the simplest ion ratio and formula.	**One magnesium atom gives two electrons to one oxygen atom. The Mg^{2+} to O^{2-} ratio is 1:1, so the formula is MgO.**
3	Carbon (C) is a Group 14 nonmetal, and hydrogen (H) has one valence electron. How many hydrogen atoms can share electrons with one carbon atom so carbon fills its outer shell? Give the molecular formula.	**Four hydrogen atoms can each share one pair of electrons with carbon. The formula is CH_4.**
4	Potassium (K), a Group 1 metal, reacts with sulfur (S), a Group 16 nonmetal. How many potassium atoms are needed for each sulfur atom? Explain with electron counts and give the simplest ionic formula.	**Two potassium atoms each give one electron to sulfur, which needs two. The simplest ionic formula is K_2S.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Calcium has two valence electrons. For calcium bromide, one calcium atom gives one electron to each of two bromine atoms. The ions are Ca^{2+} and Br^-, so the simplest ion ratio is 1:2 and the formula is $CaBr_2$. For calcium selenide, calcium gives both electrons to one selenium atom. The ions are Ca^{2+} and Se^{2-}, giving a 1:1 ratio and CaSe. Calcium bromide uses more nonmetal ions per metal ion.

Accept clear descriptions of electron transfer in place of drawings. Ionic formulas represent the simplest ratios of ions, not the number of ions in an entire solid.