Bonds Under Test

Use electron patterns and conductivity evidence to investigate compounds.

PHS.3.2 "Using the periodic table and scientific methods, investigate the formation of compounds through ionic and covalent bonding."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline where electrons are transferred or shared, circle each compound formula, and number the observations used to test the bonding models.

What Holds the Particles Together?

1. On a winter sidewalk, a scatter of sodium chloride can help melt ice. Why does this white solid behave differently from a bottle of distilled water? The periodic table offers a starting prediction. Sodium sits in group 1, so an atom has one outer electron. Chlorine sits in group 17, so an atom has seven outer electrons. A sodium atom can transfer its outer electron to a chlorine atom. The resulting Na^+ and Cl^- ions attract each other. Their charges balance in a one-to-one ratio, giving the compound NaCl.

2. Water offers a different way to build a compound. Each hydrogen atom has one electron and can hold two in its outer level. Oxygen, in group 16, has six outer electrons and can hold eight in its outer level. One oxygen atom shares a pair of electrons with each of two hydrogen atoms. The shared pairs form covalent bonds in H_2O. Each hydrogen counts its shared pair, while oxygen counts both shared pairs along with its other outer electrons. Water consists of molecules rather than a repeating array of positive and negative ions. Pure water therefore carries electric current very poorly.

3. How could a class test these bonding predictions? A low-voltage conductivity probe can compare dry, solid sodium chloride, a solution made by dissolving sodium chloride in distilled water, and distilled water alone. Keep the probe, temperature, and liquid volume the same for both liquids. Record whether each sample allows a measurable current. Solid sodium chloride conducts poorly because its ions cannot move freely. In solution, its separated ions move and carry charge, so the solution conducts well. Distilled water conducts very poorly. These results support the ion model, but a conductivity test alone cannot show where every electron is.

2 ANSWER WITH EVIDENCE

Use the passage

1. How do sodium's and chlorine's periodic-table groups help predict an ionic bond? Give the charge of each resulting ion.

2. Why does one oxygen atom form covalent bonds with two hydrogen atoms in H_2O?

3. Which would carry more current, solid sodium chloride or sodium chloride dissolved in water? Use the bonding model to explain.

4. How does comparing salt solution with distilled water help test whether mobile ions carry the current?

3 YOUR TURN

Your own words

A methane molecule has one carbon atom bonded to four hydrogen atoms. Use the periodic table to write its formula, explain how shared electrons fill the atoms' outer levels, and describe what you would look for in an electron-density model to test your bonding claim.

ANSWER KEY

Bonds Under Test

HIGH SCHOOL · PHS.3.2

PART 1 · READ AND MARK

Underline where electrons are transferred or shared, circle each compound formula, and number the observations used to test the bonding models. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How do sodium's and chlorine's periodic-table groups help predict an ionic bond? Give the charge of each resulting ion.	**Group 1 sodium has one outer electron to transfer; group 17 chlorine has seven and can gain one. They form Na^+ and Cl^-, which attract.**
2	Why does one oxygen atom form covalent bonds with two hydrogen atoms in H_2O?	**Oxygen has six outer electrons and needs two more for a full outer level. It shares one pair with each of two hydrogen atoms, also filling each hydrogen's outer level.**
3	Which would carry more current, solid sodium chloride or sodium chloride dissolved in water? Use the bonding model to explain.	**The solution would carry more current because its separated ions can move and carry charge. Ions in the solid cannot move freely.**
4	How does comparing salt solution with distilled water help test whether mobile ions carry the current?	**Salt solution conducts well, while distilled water conducts very poorly. The difference supports the claim that mobile ions from dissolved salt carry the current, rather than water alone.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Methane is CH_4. Carbon has four outer electrons, so it shares one pair with each of four hydrogen atoms. Each hydrogen then counts two electrons in its outer level, and carbon counts eight. An electron-density model would support covalent bonding if it showed electron density between carbon and each hydrogen, rather than showing that electrons had transferred completely from one atom to another.

Accept explanations that connect periodic-table outer electrons to transfer or sharing. For the open task, look for CH_4, four shared pairs, and a testable prediction of electron density between bonded atoms.