Which Way Water?

Model how water interacts with two kinds of solutes

CHE.5.b "Develop and use models to illustrate solute-solvent interactions."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline descriptions of attractions between particles, circle the particles involved, and number the changes from a solid to separated particles. Use your marks to plan a particle model.

Inside Two Beakers

1. A student adds potassium bromide (KBr) to a beaker of water. Before mixing, the solid contains a repeating arrangement of K^+ and Br^- ions. Attractions between opposite charges hold the ions together. A water molecule is not an ion, but its oxygen end has a partial negative charge and its hydrogen ends have partial positive charges. Scientists write these as δ^- and δ^+. In a particle model, water should appear as a bent molecule, not a straight line or a single charged dot. That shape helps show which end of each water molecule faces an ion.

2. When potassium bromide dissolves, water molecules at the solid's surface pull on its ions. The oxygen ends of nearby water molecules face K^+ ions, while the hydrogen ends face Br^- ions. The ions separate from the crystal and move through the liquid, each surrounded by water molecules. One unit of potassium bromide contributes one K^+ and one Br^-, so a model of dissolved particles should keep their numbers equal. Dissolving does not turn the ions into neutral atoms. A sketch with a little crystal still at the bottom can represent a mixture in which some solid has not dissolved.

3. A second beaker contains sugar dissolved in water. Unlike potassium bromide, sugar consists of neutral molecules, not positive and negative ions. Water molecules attract parts of the sugar molecules and help pull the molecules apart from one another. Each sugar molecule remains a molecule as it spreads through the water. A useful model should therefore show separate, intact sugar molecules among water molecules, not a cloud of sugar ions. Models leave out some details to make interactions clear. For either beaker, labels can identify the solute particles and show how nearby water molecules are arranged.

2 ANSWER WITH EVIDENCE

Use the passage

1. Describe how you would show potassium bromide particles before they dissolve. What holds those particles together?

2. In a model of dissolved potassium bromide, which end of water should face each ion? Explain using partial charges.

3. A student draws three K^+ ions and one Br^- ion to model fully dissolved potassium bromide. How should the student change the model, and why?

4. How should the solute particles in a model of dissolved sugar differ from those in a model of dissolved potassium bromide?

3 YOUR TURN

Your own words

Calcium chloride ($CaCl_2$) is an ionic solid made of Ca^{2+} and Cl^- ions. In two panels, model one formula unit before and after it dissolves in water: show the correct numbers of ions, draw and label nearby bent water molecules, and write one sentence explaining which water ends face the separated ions.

Which Way Water?

PART 1 · READ AND MARK

Underline descriptions of attractions between particles, circle the particles involved, and number the changes from a solid to separated particles. Use your marks to plan a particle model. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Describe how you would show potassium bromide particles before they dissolve. What holds those particles together?	**Show a repeating arrangement of K^+ and Br^- ions held together by attraction between opposite charges.**
2	In a model of dissolved potassium bromide, which end of water should face each ion? Explain using partial charges.	**Water's partially negative oxygen end faces K^+. Its partially positive hydrogen ends face Br^- because opposite charges attract.**
3	A student draws three K^+ ions and one Br^- ion to model fully dissolved potassium bromide. How should the student change the model, and why?	**The student should show equal numbers of K^+ and Br^- ions because each unit of potassium bromide contributes one of each.**
4	How should the solute particles in a model of dissolved sugar differ from those in a model of dissolved potassium bromide?	**Show intact, neutral sugar molecules spread among water molecules, rather than separated positive and negative ions.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Before panel: one Ca^{2+} ion beside two Cl^- ions, labeled as part of the solid. After panel: one separated Ca^{2+} ion and two separated Cl^- ions, each with nearby bent water molecules labeled O and H. Water's partially negative oxygen ends face Ca^{2+}, while its partially positive hydrogen ends face Cl^-.

Accept any clear particle arrangement that preserves the one-to-two ratio of calcium to chloride ions after dissolving. Water molecules need not be drawn to scale, but their orientation and labels should be consistent with the partial charges.