What's in Solution?

Use particle and conductivity models to compare acids and bases.

CHE.6.c "Use multiple models to predict the relative properties of strong, weak, concentrated, and dilute acids and bases."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline clues about particles, circle clues about conductivity, and write a 1 beside each sentence that separates strength from concentration.

Two Ways to Look at a Solution

1. At a pool supply shop, two bottles can both be acids without behaving alike in water. A strong acid, such as hydrochloric acid, transfers a proton to water from nearly every acid particle, producing hydronium ions and negative ions. A weak acid, such as the acetic acid in vinegar, transfers protons from only some particles; many remain neutral. A particle model would show nearly all strong-acid particles as ions but a mixture of ions and neutral particles for the weak acid. The same strength idea applies to bases: sodium hydroxide separates fully into ions, while ammonia reacts with water only partly to make hydroxide ions.

2. Concentration is a different label: it tells how much solute is dissolved in a given volume, not what fraction becomes ions. A concentrated sample has more dissolved solute per volume than a dilute sample of the same solute. Diluting hydrochloric acid does not turn its acid particles into weak-acid particles; they still react nearly completely with water. A concentrated weak acid may have more ions per volume than a very dilute strong acid, despite its smaller fraction of ionized particles. Likewise, a dilute solution of a strong base remains strong, even though it contains fewer dissolved base units per volume.

3. A second model uses a conductivity tester: ions carry charge through the liquid, so more mobile ions generally mean greater conductivity. For equal starting numbers of dissolved acid particles per volume, a strong acid usually gives more ions and higher conductivity than a weak acid, if the ions move at similar speeds. For the same acid, a more concentrated solution generally conducts better than a more dilute one. Higher hydroxide ion concentration also means higher pH for basic solutions at the same temperature. When strength and concentration change together, do not rank conductivity from either label alone; compare the numbers and mobility of ions.

2 ANSWER WITH EVIDENCE

Use the passage

1. Acid X and acid Y start with equal numbers of dissolved acid particles per volume. Nearly all X particles form ions, but only a small fraction of Y particles do. Which acid is stronger? Assuming similar ion mobility, which solution should conduct better? Explain with a particle model.

2. Two solutions contain the same strong base. Solution A has more dissolved base units per volume than solution B. Predict which has more hydroxide ions per volume and a higher pH. Explain why the base in B is still strong.

3. Acid C is weak and concentrated. Acid D is strong and very dilute. Which acid is stronger? Can you rank their conductivity from these labels alone? Use both models to explain.

4. Two basic solutions have equal numbers of dissolved base units per volume. Each unit can yield one hydroxide ion. In one solution, nearly every unit yields an ion; in the other, only some do. Which should have the higher pH, and what would a particle model show?

3 YOUR TURN

Your own words

Invent two acid samples: one strong and dilute, the other weak and concentrated. In four sentences, describe what a particle model would show for each, then explain which sample is stronger and why a conductivity test cannot be predicted from the labels alone.

ANSWER KEY

What's in Solution?

PART 1 · READ AND MARK

Underline clues about particles, circle clues about conductivity, and write a 1 beside each sentence that separates strength from concentration. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Acid X and acid Y start with equal numbers of dissolved acid particles per volume. Nearly all X particles form ions, but only a small fraction of Y particles do. Which acid is stronger? Assuming similar ion mobility, which solution should conduct better? Explain with a particle model.	**X is stronger. Its particle model shows more ions per volume, so X should conduct better if ion mobility is similar.**
2	Two solutions contain the same strong base. Solution A has more dissolved base units per volume than solution B. Predict which has more hydroxide ions per volume and a higher pH. Explain why the base in B is still strong.	**A has more hydroxide ions per volume and a higher pH. The base in B is still strong because its dissolved units still separate fully into ions.**
3	Acid C is weak and concentrated. Acid D is strong and very dilute. Which acid is stronger? Can you rank their conductivity from these labels alone? Use both models to explain.	**D is stronger because a greater fraction of its acid particles form ions. Conductivity cannot be ranked from the labels alone; C could have more ions per volume despite its smaller ionized fraction, and ion mobility also matters.**
4	Two basic solutions have equal numbers of dissolved base units per volume. Each unit can yield one hydroxide ion. In one solution, nearly every unit yields an ion; in the other, only some do. Which should have the higher pH, and what would a particle model show?	**The solution in which nearly every unit yields an ion should have the higher pH. Its particle model would show more hydroxide ions and fewer neutral base particles.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Sample S is a dilute strong acid, and sample W is a concentrated weak acid. A particle model of S would show relatively few dissolved acid units per volume, with nearly all represented as ions. A model of W would show many dissolved acid units per volume, but only a small fraction represented as ions. S is stronger, yet I cannot predict which sample conducts better without knowing the number and mobility of ions in each.

Accept particle descriptions that distinguish the fraction forming ions from the amount of solute per volume. Conductivity comparisons should account for ion count and, when relevant, ion mobility.