Acids and Bases Atoms-first

- Links to Sections 6.3 and 8.1 of the atoms-first version of An Introduction to Chemistry by Mark Bishop.

https://preparatorychemistry.com/Bishop_Book_atoms_6.pdf

https://preparatorychemistry.com/Bishop_audiobook_atoms_Section_6_3.html

https://preparatorychemistry.com/Bishop_Lecture_Acids.html

https://preparatorychemistry.com/Bishop_Book_atoms_8.pdf

https://preparatorychemistry.com/Bishop_audiobook_atoms_Section_8_1.html

https://preparatorychemistry.com/Bishop_Lecture_Strong_and_Weak_Acids_and_Bases.html

Acids and Bases Chemisty-first

- Links to Sections 5.1 and 5.4 of the chemistry-first version of An Introduction to Chemistry by Mark Bishop.

https://preparatorychemistry.com/Bishop_Book_5_eBook.pdf

https://preparatorychemistry.com/Bishop_audiobook_CF_Section_5_1.html

https://preparatorychemistry.com/Bishop_audiobook_CF_Section_5_4.html

https://preparatorychemistry.com/Bishop_Lecture_Acids.html

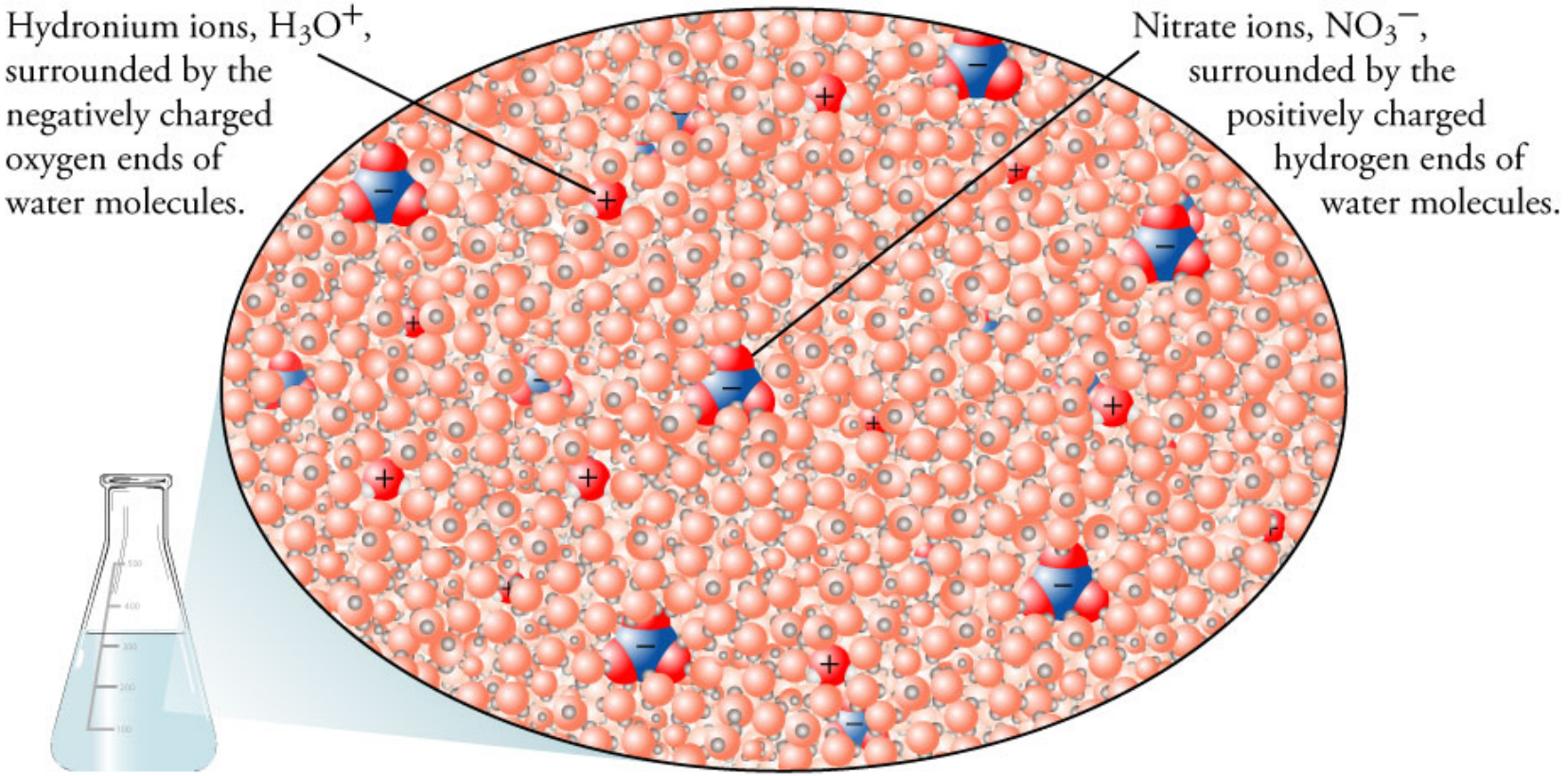
https://preparatorychemistry.com/Bishop_Lecture_Strong_and_Weak_Acids_and_Bases.html

Neutralization Reactions

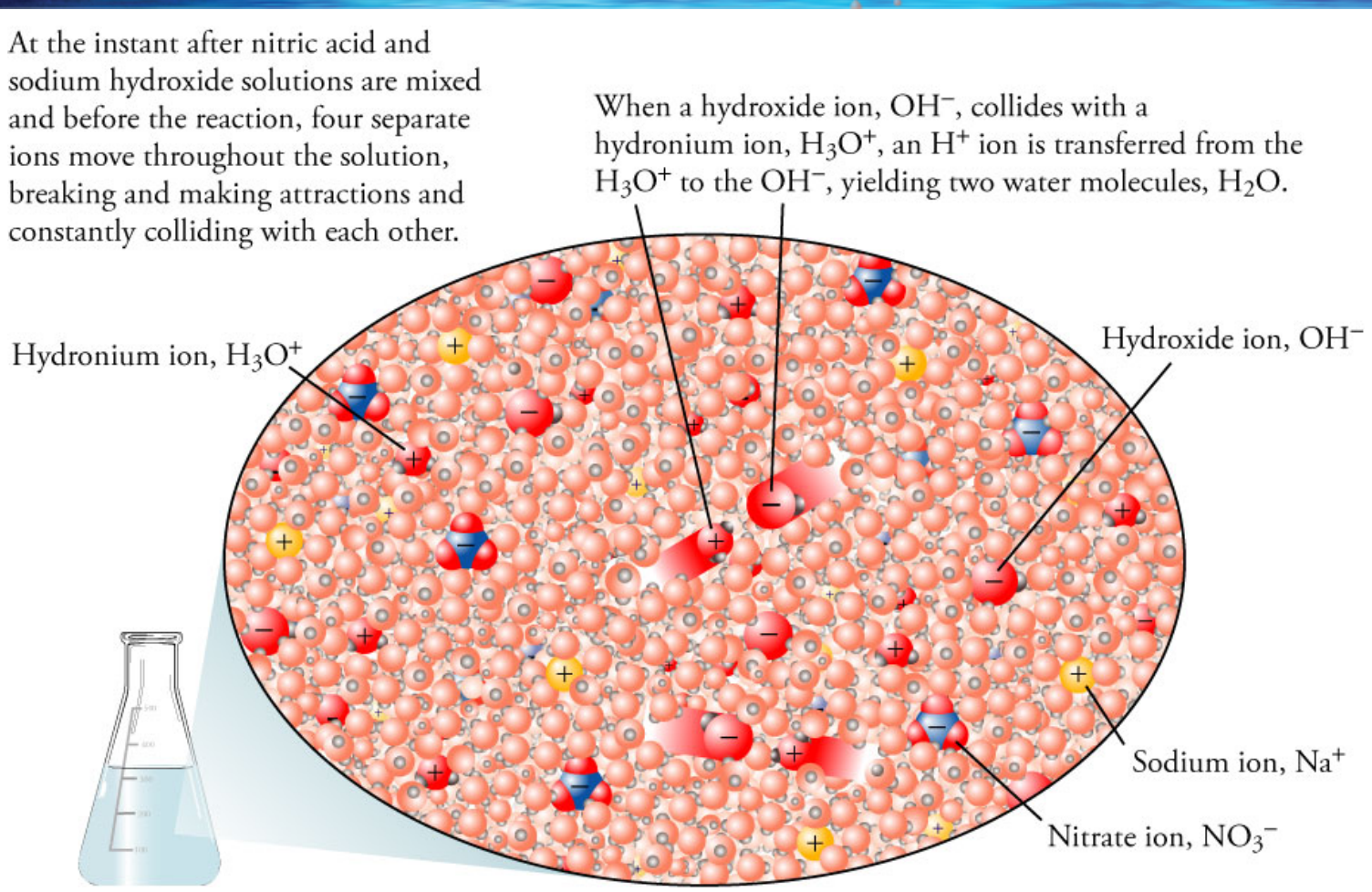
- Reactions between Arrhenius acids and Arrhenius bases are called ***neutralization reactions***.

$$HNO_3(aq) + NaOH(aq) \rightarrow H_2O(l) + NaNO_3(aq)$$

Aqueous Nitric Acid

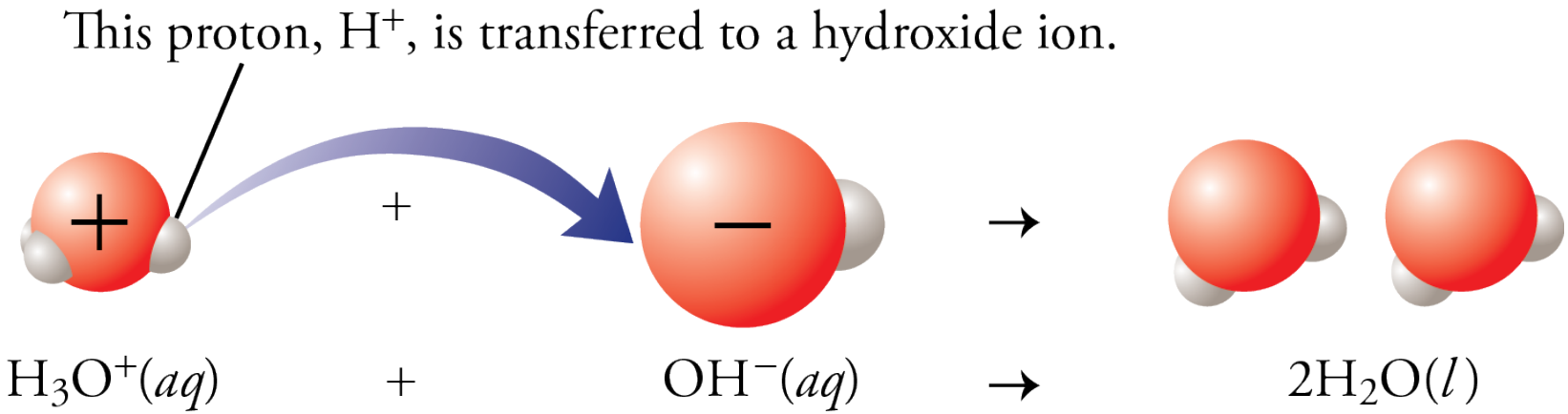


Mixture of HNO_3 and NaOH Before Reaction

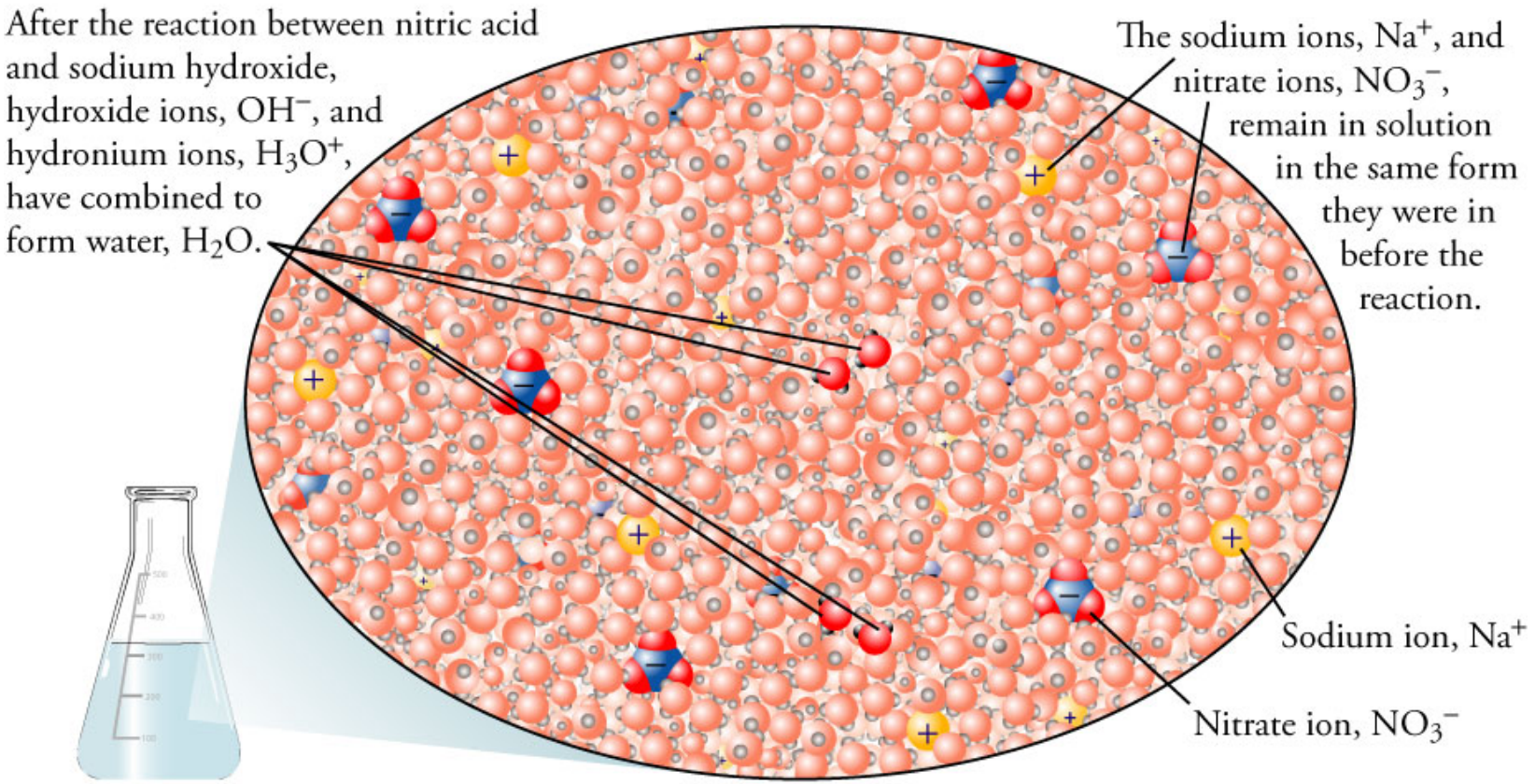


Strong Acid and Strong Base Reaction

The hydronium ion, H_3O^+, from the strong acid reacts with the hydroxide ion, OH^-, from the strong base to form water, H_2O.



Mixture of HNO_3 and NaOH After the Reaction



https://preparatorychemistry.com/neutralization_Canvas.html

Reaction between an Acid and a Hydroxide Base.

- If you have an Arrhenius acid combined with an Arrhenius base, they will react in an acid-base reaction.
- The reactions we will see have the double displacement form.

$$AB + CD \rightarrow AD + CB$$

- The positive part of the acid is H^+.
- For a hydroxide base, the base can be soluble or insoluble.
- For a hydroxide base, the products are water and a water-soluble ionic compound.

Reaction between an Acid and a Carbonate Base

- The reaction of an acid with a base containing the carbonate ion or the hydrogen carbonate ion has the following form.

$$AB(aq) + CD(aq \text{ or } s) \rightarrow H_2O(l) + CO_2(g) + CB(aq)$$

- The positive part of the AB acid is H^+.
- The products are water, carbon dioxide, and a water-soluble ionic compound. The H_2O and the CO_2 come from the decomposition of the initial product H_2CO_3.

Steps for Writing Acid-Base Equations

- Write the formulas for the given reactants separated by a “+” and followed by a single arrow. The acid formula will be followed by an (aq), and the base formula will followed by (aq) if it is water soluble or (s) if it is insoluble.

  $AB(aq) + CD(aq \text{ or } s) \rightarrow$

Steps for Writing Acid-Base Equations

- Follow these steps to determine the formulas for the products.
  - Divide the acid formula into H^+ and whatever is left after all of the H^+ ions are removed. For example, HNO_3 is divided into H^+ and NO_3^-, and H_2SO_4 is divided into H^+ and SO_4^{2-}.
  - Divide the base into its cation and whatever is left when the cations are removed. For example, NaOH is divided into Na^+ and OH^-, and K_2CO_3 is divided into K^+ and CO_3^{2-}.

Steps for Writing Acid-Base Equations (cont.)

- Follow these steps to determine the formulas for the products. (cont.)
  - If the base includes the hydroxide ion, the first product will be water.

    $AB(aq) + CD(aq \text{ or } s) \rightarrow H_2O(l) + CB(aq)$
  - If the base includes either the carbonate ion or the hydrogen carbonate ion, the first products will be water and carbon dioxide.

    $AB(aq) + CD(aq \text{ or } s) \rightarrow H_2O(l) + CO_2(g) + CB(aq)$

Steps for Writing Acid-Base Equations (cont.)

- Follow these steps to determine the formulas for the products. (cont.)
  - The formula for the second product is formed by combining the cation from the base and the anion from the acid. For example, Na^+ combines with NO_3^- to form the CB formula, $NaNO_3(aq)$. (Remember that even though the ions in ionic compounds dissolved in water are separated from each other, we describe them as together in the complete equation.)

$$AB(aq) + CD(aq \text{ or } s) \rightarrow H_2O(l) + CB(aq)$$

$$\text{or } AB(aq) + CD(aq \text{ or } s) \rightarrow H_2O(l) + CO_2(g) + CB(aq)$$

Example 1

- Write the complete equation for the neutralization reaction that takes place when aqueous solutions of sulfuric acid, H_2SO_4, and sodium hydroxide, NaOH, are mixed. (If an acid has more than one acidic hydrogen, assume that there is enough base to remove all of them. Assume that there is enough acid to neutralize all of the basic anions.)

Example 1 Steps

- The acid-base reactions we will see are double displacement reactions.

  $AB + CD \rightarrow AD + CB$

- Write the formulas for the given reactants separated by a "+" and followed by a single arrow. The acid formula will be followed by an (aq), and the base formula will followed by (aq) if it is water soluble or (s) if it is insoluble.

  $H_2SO_4(aq) + NaOH(aq) \rightarrow$

Example 1 Steps

$$H_2SO_4(aq) + NaOH(aq) \rightarrow$$

- Identify A, B, C, and D, and write the formulas for the AD and CB products on the right side of the arrow.
  - For the acid H_2SO_4, A is H^+ and B is SO_4^{2-}.
  - For NaOH, C is Na^+ and D is OH^-.
  - Therefore, AD is HOH or water, H_2O, and CB is Na_2SO_4. Remember to balance the charges when writing the formulas.
- H_2O will be followed by (l), and the ionic product will be followed by (aq).

$$H_2SO_4(aq) + NaOH(aq) \rightarrow H_2O(l) + Na_2SO_4(aq)$$

Example 1 Steps

$$H_2SO_4(aq) + NaOH(aq) \rightarrow H_2O(l) + Na_2SO_4(aq)$$

- If one of your products is H_2CO_3, eliminate it and write $H_2O(l)$ and $CO_2(g)$ in its place.
- Balance the equation.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow 2H_2O(l) + Na_2SO_4(aq)$$

Example 2

- Write the complete equation for the neutralization reaction that takes place when aqueous solutions of hydrochloric acid, HCl(aq), and potassium carbonate, K_2CO_3, are mixed. (If an acid has more than one acidic hydrogen, assume that there is enough base to remove all of them. Assume that there is enough acid to neutralize all of the basic anions.)

Example 2 Steps

- The acid-base reactions we will see are double displacement reactions.

  $AB + CD \rightarrow AD + CB$

- Write the formulas for the given reactants separate by a “+” and followed by a single arrow. The acid formula will be followed by an (aq), and the base formula will followed by (aq) if it is water soluble or (s) if it is insoluble.

  $HCl(aq) + K_2CO_3(aq) \rightarrow$

Example 2 Steps

$HCl(aq) + K_2CO_3(aq) \rightarrow$

- Identify A, B, C, and D, and write the formulas for the AD and CB products on the right side of the arrow.
  - For the acid HCl, A is H^+ and B is Cl^-.
  - For K_2CO_3, C is K^+ and D is CO_3^{2-}.
  - Therefore, AD is H_2CO_3, and CB is KCl. Again, remember to balance the charges when writing the formulas.
- The products will be followed by (aq).

$HCl(aq) + K_2CO_3(aq) \rightarrow H_2CO_3(aq) + KCl(aq)$

Example 2 Steps

$HCl(aq) + K_2CO_3(aq) \rightarrow H_2CO_3(aq) + KCl(aq)$

- If one of your products is H_2CO_3, eliminate it and write $H_2O(l)$ and $CO_2(g)$ in its place.

  $HCl(aq) + K_2CO_3(aq)$

  $\rightarrow H_2O(l) + CO_2(g) + KCl(aq)$

- Balance the equation.

  $2HCl(aq) + K_2CO_3(aq)$

  $\rightarrow H_2O(l) + CO_2(g) + 2KCl(aq)$