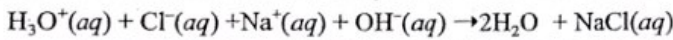
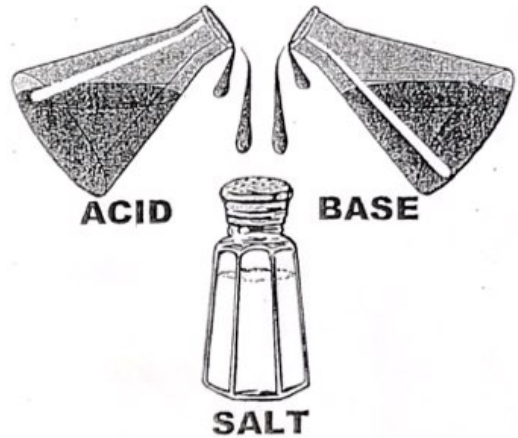


## Neutralization Reactions

Acids and bases are opposites, so it makes sense that when they react together, the result is neutral. What happens during the chemical reaction that makes everything neutral? Technically, every acid base reaction is a double replacement reaction  $[HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)]$ . Actually, it is a little more involved. Recall that acids ionize in water to produce hydronium ions  $[HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)]$ . Bases, on the other hand, dissociate in water to release hydroxide ions  $[NaOH(s) + H_2O(l) \rightarrow Na^+(aq) + OH^-(aq) + H_2O(l)]$ . This means the double replacement reaction between  $HCl(aq)$  and  $NaOH(aq)$  really looks as follows:



Salt ( $NaCl$ ) is an ionic compound. When it is placed in water, it dissociates  $[NaCl(s) + H_2O(l) \rightarrow Na^+(aq) + Cl^-(aq)]$ . This means, the complete reaction is  $H_3O^+(aq) + Cl^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow 2H_2O(l) + Na^+(aq) + Cl^-(aq)$ . The **highlighted** ions are exactly the same on both the product and reactant side of the equation. Because these ions did not actually participate in the reaction, they are called *spectator ions*. What is left,  $H_3O^+(aq) + OH^-(aq) \rightarrow 2H_2O(l)$ , is the net reaction. Since the final product is water, the result is neutral.



Answer the questions below based on the reading above, and on your knowledge of chemistry.

Complete and balance each of the acid base neutralizations below. Identify the spectator ions.

- a.  $1 H_2SO_4 + 1 Mg(OH)_2 \rightarrow 2 H_2O + MgSO_4$  spectators  $Mg^{+2}, SO_4^{-2}$
- b.  $3 HNO_3 + 1 Al(OH)_3 \rightarrow 3 H_2O + Al(NO_3)_3$  spectators  $Al^{+3}, NO_3^-$
- c.  $2 H_3PO_4 + 3 Ca(OH)_2 \rightarrow 6 H_2O + Ca_3(PO_4)_2$  spectators  $Ca^{+2}, PO_4^{-3}$
- d.  $1 HI + 1 KOH \rightarrow H_2O + KI$  spectators  $K^+, I^-$
- e.  $2 HBr + 1 Ba(OH)_2 \rightarrow 2 H_2O + BaBr_2$  spectators  $Ba^{+2}, Br^-$

2. How are the net reactions for each of the examples above similar?

All produce water and a salt

3. The definition of neutralization is a reaction between an acid and a base to produce a salt and water. Where does the salt come from in the neutralization reaction? The leftover spectator ions

4. Where does the water come from in a neutralization reaction?

The  $H^+$  from the acid and the  $OH^-$  ion from the base

5. What occurs during a neutralization reaction that causes the end product to be neutral?

The final pH is 7.