

When you're trying to complete a precipitation reaction:

 $\bigcirc$  Write the IONS that form when the reactants are dissolved.

Description Make NEW compounds by pairing up cations with anions. Don't forget that the positive and negative charges must balance each other out!

 $(\mathbf{3})$  Use the solubility rules to determine the PHASE of each new compound - solid or aqueous.

(4) Balance the overall equation.

$$M_{g}(I_{2}(a_{q}) + N_{a}(_{2}H_{3}O_{2}(a_{q})) \rightarrow NO \text{ REACTION!}^{*})$$
ions:  $M_{g}^{2+} C_{1}^{-} N_{a}^{+} (_{2}H_{3}O_{2}^{-})$ 

$$M_{g}((_{2}H_{3}O_{2})_{2} \dots \text{ dissolves in water})$$

$$N_{a}(I_{a} \dots \text{ dissolves in water})$$

So, no solid forms here. All possible combinations of these four ions result in compounds that dissolve readily in water.

$$\frac{m_g^{2+}Cl^{-}}{\log^2 Cl^{-}} + \frac{N_0^{+}C_2H_3U_2^{-}}{N_0^{+}} \rightarrow \frac{N_0^{+}m_g^{2+}}{\log^2 Cl^{-}}$$

$$\frac{N_0^{+}M_g^{2+}C_2H_3U_2^{-}}{\log^2 Cl^{-}}$$

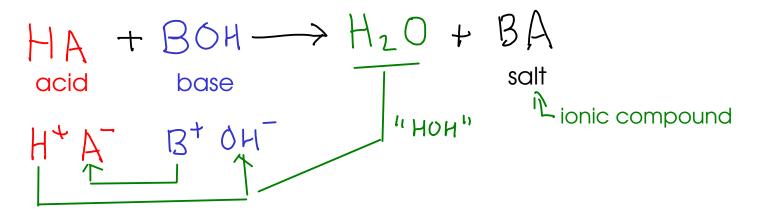
NO CHANGE, therefore NO DRIVING FORCE, and NO REACTION

★ We will learn about other driving forces than the formation of solid, but these driving forces do not apply to this reaction

# ACID/BASE REACTIONS (also called NEUTRALIZATION REACTIONS)

- There are several stable molecules that may be formed in double replacement reactions, but the most common is <u>WATER</u>!

- Double replacement reactions that form water are also called "neutralizations"



\* To make water (  $H_2O$  ), you need a source of hydrogen ion (  $H^4$  ) and hydroxide ion (  $GH^-$  )

$$H^{+}(aq) + OH^{-}(aq) \longrightarrow H_{2}O(\ell)$$

$$\begin{array}{c} \text{This is the} \\ \text{NET IONIC} \\ \text{EQUATION} \\ \text{for many} \\ \text{neutralizations} \\ \\ \text{STRONG base!} \end{array}$$

## ACIDS

- compounds that release hydrogen ion (H<sup>+</sup>), when dissolved in water. Properties of acids:
  - Corrosive: React with most metals to give off hydrogen gas
  - Cause chemical burns on contact
  - Taste sour (like citrus citric acid!)
  - Changes litmus indicator to RED

## BASES

- Substances that release hydroxide ion (OH~) when dissolved in water

## Properties of bases:

- Caustic: Attack and dissolve organic matter (think lye, which is NaOH)
- Cause skin/eye damage on contact
- Taste bitter
- changes litmus indicator to BLUE

Due to the dissolving action of base on your skin, bases will feel "slippery". The base ITSELF is not particularly slippery, but what's left of your skin IS! <sup>122</sup> ACID/BASE or NEUTRALIZATION reactions continued

- the driving force of these reactions is the formation of water molecules.

$$\begin{array}{c} \underbrace{H^{+}(\iota_{q})}_{\text{From the acid}} + \underbrace{OH^{-}(\iota_{q})}_{\text{From the base}} \rightarrow H_{2}O(\ell) \end{array} \text{ Net ionic equation} \\ H_{2}SO_{4}(\iota_{q}) + \underbrace{N_{a}OH(\iota_{q})}_{\text{H}} \rightarrow \underbrace{H_{2}O(\ell)}_{\text{H}} + \underbrace{N_{a}SO_{4}(\iota_{q})}_{\text{H}} \\ \text{ions:} \quad \underbrace{H^{+}SO_{4}}_{\text{H}} \xrightarrow{N_{a}^{+}OH^{-}}_{\text{H}} \\ \text{-How can this reaction be detected?} \\ \text{-pH detector (indicator paper, etc.)} \\ \text{-do the products have similar chemical properties to the reactants?} \end{array}$$

- release of heat!

... formation of water is usually accompanied by a release of heat

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## GAS FORMATION / OTHER MOLECULES

- There are a few other molecules that can be made with exchange-type chemistry.
- Most of these molecules are unstable and can break apart to form gases.
- Formation of a weak acid:
  - The formation of ANY weak acid in an exchange-type reaction can be a driving force.
  - Some weak acids are unstable and can break apart into gas molecules.

$$H_2(O_3Lag) \longrightarrow H_2O(l) + (CO_2C_g)$$
 Gas bubbles can leave solution!

... but how would you form carbonic acid in an exchange-type reaction?

acid + carbonate 
$$(0_3^{2-1})^{OR}$$
  
acid + bicarbonate  $H(0_3^{-1})^{OR}$   
 $H_2SO_4(a_4)+2N_4H(0_3(a_4)) \rightarrow 2H_2CO_3(a_4)+Na_2SO_4(a_4)$   
 $H^+SO_4^{1-1}N_a^+H(0_3^{-1})^{OR}$   
Formation of carbonic acid  
drives the reaction ... BUT ...

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... but when we mix sulfuric acid and sodium bicarbonate, we observe BUBBLES. We need to write an equation that agrees with our observations. We know that carbonic acid decomposes, so we go ahead and put that into our equation.

$$H_2(O_3Lag) \longrightarrow H_2O(l) + CO_2(g)$$

$$H_2O_3Lag) \rightarrow Na_2SO_4(ag) + 2H_2O(l) + 2(O_2(g))$$

Other molecules of interest:

$$\begin{array}{l} H_2 SO_3 : \text{ sulfurous acid } - \text{React an ACID with a SULFITE} \\ H_2 SO_3(n_q) \rightarrow H_2 O(l) + SO_2(g) \\ H_2 S : \text{ hydrogen sulfide (gas) - React an ACID with a SULFIDE} \\ H_2 SO_4(n_q) + N_{a_2} S(n_q) \rightarrow N_{a_2} So_4(n_q) + H_2 S(g) \end{array}$$

<sup>123</sup> few more exchange examples: \*  
Ca(l<sub>1</sub>(a<sub>1</sub>) + 2 A<sub>2</sub> NO<sub>3</sub>(a<sub>1</sub>) 
$$\rightarrow$$
 (a(NO<sub>3</sub>)<sub>2</sub>u<sub>1</sub>) + 2 A<sub>2</sub> C)(s)  
Ca<sup>1+</sup>Cl<sup>-</sup> A<sub>3</sub> + NO<sub>3</sub>  
Ca<sup>1+</sup>Cl<sup>-</sup> A<sub>3</sub> + NO<sub>3</sub>  
H + PO<sub>4</sub> + 3N<sub>0</sub>OH(a<sub>1</sub>)  $\rightarrow$  3 H<sub>2</sub>O(l) + Na<sub>3</sub> PO<sub>4</sub>(a<sub>2</sub>)  
H + PO<sub>4</sub> + Na<sub>4</sub> OH<sup>-</sup> Formation of liquid water drives  
this NEUTRALIZATION reaction. Detect  
by release of heat.  
KCI (a<sub>4</sub>) + Na<sub>1</sub>NO<sub>3</sub> (a<sub>1</sub>)  $\rightarrow$  KNO<sub>3</sub> (a<sub>1</sub>) NO  
K<sup>+</sup>Cl<sup>-</sup> Na<sup>+</sup> NO<sub>3</sub>  
both "products" are water-soluble ionic compounds - meaning  
that they would exist in water as free ions. This is the same  
state they were in before being mixed. There's no driving force  
for reaction, and therefore - no reaction.  
H<sub>2</sub>So<sub>4</sub>(a<sub>1</sub>) + Na<sub>2</sub>(O<sub>3</sub>(a<sub>1</sub>)  $\rightarrow$  H<sub>2</sub>O(l) + Na<sub>2</sub>So<sub>4</sub>(a<sub>3</sub>)  
H<sup>+</sup>So<sub>4</sub> Na<sup>+</sup> CO<sub>3</sub><sup>2-</sup> H<sub>2</sub>O(l) + Co<sub>2</sub>(g) Na<sub>2</sub>So<sub>4</sub>(a<sub>4</sub>)

Formation of carbonic acid and its decomposition to water and carbon dioxide gas drives this reaction. We will observe gas bubbles being released.