

Chemical Reactions #1



Equations

- _____ **equations** – show the complete chemical formulas. Does not indicate ionic character
- _____ **equation** – shows all ions. Actually how the particles exist in the solution

Steps for Writing Ionic Equations

1. Write the balanced molecular equation (balanced chemical equation)
2. Break every thing down into its ions **EXCEPT** the _____, _____, _____, or _____ (complete ionic equation)
3. Cross out everything that is the same on both sides (_____ ions)
4. Write what is left (net ionic equation)

Rules

- When writing ionic equations, you must keep together the solid, gas, water, or weak electrolyte
- **Spectator ions** – ions that appear on both sides of the equation. They have very little to do with the chemical reaction

A few more things that you must know...

- When writing ionic reactions...you must be able to identify the solid, gas or weak electrolyte
- In order to know what is solid...you MUST memorize the solubility rules
- You must also be able to identify strong electrolytes...
- They are all strong acids & bases
 - Strong acids...HCl, HBr, HI, HClO₃, HClO₄, HNO₃, HIO₄, H₂SO₄
 - Strong bases...all group 1A & 2A hydroxides

Solubility Rules

SOLUBILITY RULES

Always soluble:

alkali metal ions (Li⁺, Na⁺, K⁺, Rb⁺, Cs⁺), NH₄⁺,
NO₃⁻, ClO₃⁻, ClO₄⁻, C₂H₃O₂⁻

Generally soluble:

(mnemonics)

Cl⁻, Br⁻, I⁻ Soluble except Ag⁺, Pb²⁺, Hg₂²⁺ (AP/H)

F⁻ Soluble except Ca²⁺, Sr²⁺, Ba²⁺, Pb²⁺, Mg²⁺

(CBS-PM)

SO₄²⁻ Soluble except Ca²⁺, Sr²⁺, Ba²⁺, Pb²⁺ (CBS/PBS)

Generally insoluble:

O²⁻, OH⁻ Insoluble except and alkali metals, and NH₄⁺

Ca²⁺, Sr²⁺, Ba²⁺ (CBS) somewhat soluble

CO₃²⁻, PO₄³⁻, S²⁻, SO₃²⁻, C₂O₄²⁻, CrO₄²⁻

Insoluble except alkali metals and NH₄⁺

Classification of Reactions

- There are 5 major classifications of reactions:
 - _____(Combination)
 - _____
 - _____
 - _____
 - _____(Metathesis)

Synthesis # 1

1. Metal oxide + nonmetal oxide → salt (Not Redox)
- Sulfur dioxide gas is passed over solid calcium oxide

Synthesis # 2

2. Metal oxide + water \rightarrow base (Not Redox)

- Solid sodium oxide is added to water

Synthesis #3

3. Non metal oxide + water \rightarrow acid

- Sulfur dioxide gas is placed in water

Synthesis # 4

4. Metal + nonmetal \rightarrow salt (Redox...NO IONS)

- A salt is just an ionic compound (a positive charge & a negative charge)
- Magnesium metal is combusted in nitrogen gas

Synthesis #5

5. Metal chloride + O₂ \rightarrow Metal chlorate

- Magnesium chloride reacts with oxygen gas

More Decomposition

- $(\text{NH}_4)_2\text{CO}_3 \rightarrow 2\text{NH}_3 + \text{H}_2\text{O} + \text{CO}_2$
- $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
- If you get any of these products...they decompose...
 - $\text{NH}_4\text{OH} \rightarrow \text{NH}_3 + \text{H}_2\text{O}$
 - $\text{H}_2\text{CO}_3 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
 - $\text{H}_2\text{SO}_3 \rightarrow \text{SO}_2 + \text{H}_2\text{O}$
 - $\text{HNO}_2 \rightarrow \text{NO} + \text{NO}_2 + \text{H}_2\text{O}$

Single Replacement

- Element + Compound \rightarrow Element + Compound
- $\text{A} + \text{BX} \rightarrow \text{AX} + \text{B}$
- Can have metal & metal replacement, halogen & halogen replacement, or metal & hydrogen replacement

Single Replacement

- Need to know your activity series!
- Just look at your Standard Reduction Potential Table

Weakest

Strongest

STANDARD REDUCTION POTENTIALS IN AQUEOUS SOLUTION AT 25°C	
Reduction Half-Reaction	Standard Reduction Potential, E° (V)
$\text{Li}^+ + \text{e}^- \rightarrow \text{Li}$	-3.04
$\text{K}^+ + \text{e}^- \rightarrow \text{K}$	-2.93
$\text{Ba}^{2+} + 2\text{e}^- \rightarrow \text{Ba}$	-2.91
$\text{Ca}^{2+} + 2\text{e}^- \rightarrow \text{Ca}$	-2.87
$\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$	-2.71
$\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$	-2.37
$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	-1.66
$\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$	-0.76
$\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe}$	-0.44
$\text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni}$	-0.25
$\text{Sn}^{2+} + 2\text{e}^- \rightarrow \text{Sn}$	-0.14
$\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$	-0.13
$\text{H}^+ + \text{e}^- \rightarrow \text{H}_2$	0.00
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	0.34
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	0.80
$\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}$	1.50

Single Replacement

- Magnesium turnings are added to a solution of ferric chloride

Single Replacement

- Sodium is added to water
- Whenever water is added to an element visualize it as HOH (make sure you re write it as H₂O)

Single Replacement

- Chlorine gas is bubbled into a solution of potassium fluoride

Double Replacement

- **Double Replacement** – a reaction involving the exchange of ions between 2 compounds
- Of the form: $AX + BY \rightarrow BX + AY$

Double Replacement

- In order for a double replacement reaction to take place, one of 3 things must be formed:
- Precipitate (solid)
- Gas
- Weak electrolyte

Solubility Rules!!!

SOLUBILITY RULES

Always soluble:

alkali metal ions (Li^+ , Na^+ , K^+ , Rb^+ , Cs^+), NH_4^+ ,
 NO_3^- , ClO_3^- , ClO_4^- , $\text{C}_2\text{H}_3\text{O}_2^-$

Generally soluble:

Cl^- , Br^- , I^- Soluble except Ag^+ , Pb^{2+} , Hg_2^{2+} (AP/H)

F^- Soluble except Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+} , Mg^{2+}

SO_4^{2-} Soluble except Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+} (CBS-PM)

Generally insoluble:

O^{2-} , OH^- Insoluble except alkali metals, and NH_4^+

Ca^{2+} , Sr^{2+} , Ba^{2+} (CBS) somewhat soluble

CO_3^{2-} , PO_4^{3-} , S^{2-} , SO_3^{2-} , $\text{C}_2\text{O}_4^{2-}$, CrO_4^{2-}
Insoluble except alkali metals and NH_4^+

Double Replacement # 1 (Precipitate)

1. Precipitate (must know solubility rules)...the precipitate will stay together
- A saturated solution of barium hydroxide is mixed with a solution of iron (III) sulfate

Double Replacement # 2 (Formation of a gas)

2. Formation of a gas (acid + sulfide, sulfite, carbonate, or bicarbonate... or ammonium salt + a strong base \rightarrow $\text{NH}_3(\text{g})$, H_2O , and a salt)
- Hydrobromic acid is added to a solution of potassium bicarbonate

Double Replacement # 3

3. Metal hydride + water \rightarrow H_2 + strong base (IONS)
- Sodium hydride is placed into water

Double Replacement #4 (Acid Base neutralization)

- Acid + base \rightarrow salt + water
- Hydrogen sulfide gas is bubbled through excess potassium hydroxide solution

Combustion

1. Hydrocarbon + $O_2 \rightarrow CO_2 + H_2O$ (No ions)
- Combustion of methane

 - Combustion of 2-ethyl – 3 methylhexane