

Nuggets: *Balance Reactions; Electrolytes; Types of Reactions; Molecular, Complete Ionic, and Net Ionic reactions; Redox Reactions, Assign Oxidation Numbers, what is Oxidized, Reduced, Oxidizing Agent, Reducing Agent*

ELECTROLYTES: A chemical that produces ions; more ions means more electrical current can flow through solution

Strong-Electrolyte: Produces large numbers of ions (soluble ionic compounds; strong acids/bases)

Weak-Electrolyte: Produces only a small quantity of ions (weak acids/bases)

Nonelectrolyte: Produces no ions, e.g., sugar (insoluble ionic compounds; molecular compounds)

Ionic Compounds: Metal + nonmetal; **Molecular Compounds:** 2 nonmetals

Acids: Produce H^+ in solution (e.g., $HCl \rightarrow H^+ + Cl^-$);

Acids can be recognized when a H is at the beginning of a formula (exceptions: H_2O and H_2O_2)

Strong acids are acids that *completely* break up (dissociate) into H^+ ; these are strong electrolytes

Strong Acids: HCl, HBr, HI, HNO_3 , H_2SO_4 , $HClO_4$, $HClO_3$ (helpful to memorize these)

Weak acids: any acid that is not a strong acid; dissociates a little; weak electrolytes

Bases: Produce OH^- in solution (e.g., $NaOH \rightarrow Na^+ + OH^-$)

Strong bases are bases that completely break up into OH^- ; these are strong electrolytes

Strong Bases: Group IA hydroxides (LiOH, NaOH, KOH, RbOH, CsOH);

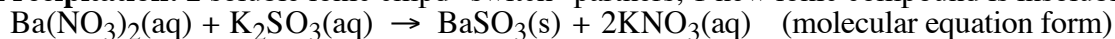
Group IIA hydroxides (only $Sr(OH)_2$, $Ba(OH)_2$) (helpful to memorize these)

Weak bases: any base that is not a strong base; produce a little OH^- ; weak electrolytes;

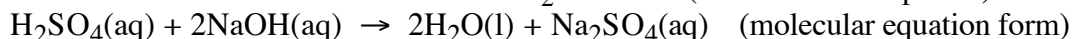
NH_3 (ammonia); better to write it as NH_4OH

TYPES OF REACTIONS

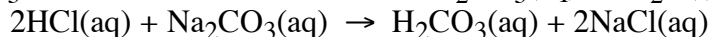
1. Precipitation: 2 soluble ionic compd "switch" partners; 1 new ionic compound is insoluble and precipitates



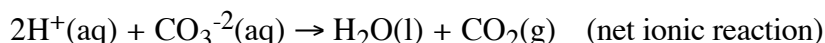
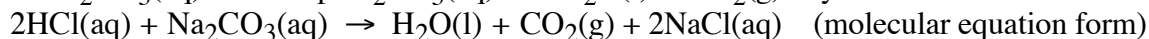
2. Acid/Base Reactions: Acid + Base $\rightarrow H_2O$ + salt (salt = ionic compound)



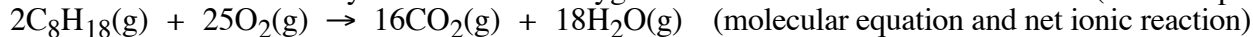
3. Gas-Forming: Reaction produces a gas; common example is acid + hydrogen carbonate (HCO_3^-) or carbonate CO_3^{-2} ; either of these reactions form $H_2CO_3(aq) \rightarrow H_2O(l)$ and $CO_2(g)$.



the $H_2CO_3(aq)$ breaks up: $H_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g)$ to yield an overall reaction:



4. Combustion: Reaction of hydrocarbon with oxygen to form water and carbon dioxide (from chapter 4)



5. Redox: Oxidation numbers change

ASSIGNING OXIDATION NUMBERS - Bookkeeping of electrons

1. Elements in elemental form 0
 2. In a compound.
 - a. Group 1A (Li, Na, ...) +1
 - b. Group 2A (Be, Mg, ...) +2
 - c. F -1
 - d. H +1 (usually)
 - e. O -2 (usually)
 3. Sum Rule: Sum of all the oxidation numbers = total charge on compound
-

1. Balance the following equations.

- | | |
|---|--|
| a. $\text{Mg} + \text{SiO}_2 \rightarrow \text{MgO} + \text{Si}$ | b. $\text{Ca(s)} + \text{N}_2(\text{g}) \rightarrow \text{Ca}_3\text{N}_2(\text{s})$ |
| c. $\text{CH}_3\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ | d. $\text{CaCl}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CaCO}_3 + \text{NaCl}$ |
| e. $\text{P}_4\text{O}_{10} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4$ | f. $\text{C}_6\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ |
| g. $\text{C}_3\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ | |

2. Which of the following are soluble in water?

- | | | | | | | |
|------------------------|----------------------|----------------------|--|---------|-------|--------|
| a. NaCl | b. Na ₂ S | c. FeS | d. sucrose | e. AgCl | f. HF | g. KOH |
| h. Fe(OH) ₃ | i. FeCl ₃ | j. CrPO ₄ | k. (NH ₄) ₂ CO ₃ | | | |

3. Write balanced molecular reactions for each of the following (recall that combustion refers to the reaction of a hydrocarbon with oxygen gas, O₂, to produce water, H₂O, and carbon dioxide, CO₂). Include phases [(aq), (s), (l), (g)].

- | | |
|---|---|
| a. gaseous pentane (C ₅ H ₁₂) is combusted | b. gaseous ethylene (C ₂ H ₄) is combusted |
| c. aqueous HCl and Ba(OH) ₂ react | d. aqueous AgNO ₃ and NaBr reacting |

4. Identify the following chemicals when they are dissolved into water as a strong, weak, or nonelectrolytes. (Recall: strong acid/strong base/soluble ionic: strong electrolyte; weak acid/weak base: weak electrolyte; insoluble ionic/molecular: nonelectrolyte)

- | | | | | |
|--------------------|-----------------------------------|--|----------|----------------------|
| a. NaCl | b. HCl | c. HC ₂ H ₃ O ₂ | d. sugar | e. BaSO ₄ |
| f. NH ₃ | g. H ₂ SO ₄ | h. NaOH | i. HF | |

5. Which of the following compounds will form a solution that is a poor conductor of electricity? If they all do, select "e."

- | | | | | |
|---------|--------|---|----------------------|-------------------------------|
| a. NaCl | b. KOH | c. NH ₄ C ₂ H ₃ O ₂ | d. HClO ₄ | e. None form a poor conductor |
|---------|--------|---|----------------------|-------------------------------|

6. a. Write the molecular reaction of sodium oxide with water.

b. Write the molecular reaction of P₄O₁₀ with water.

7. a. What are the seven common strong acids and seven strong bases (give name and chemical formula)? b. Identify (name and chemical formula) one common weak acid and one common weak base.

8. For each reaction identify whether the reaction would be product-favored or reactant-favored.

- | | |
|---|--|
| a. $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{Cl}^- + \text{H}_3\text{O}^+$ | b. $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ |
| c. $\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^-$ | d. $\text{NaF} \rightarrow \text{Na}^+ + \text{F}^-$ |

9. Write the balanced molecular and net ionic reaction for each of the following. If no reaction occurs, write no reaction. (Hint: Start by writing a molecular reaction, then a complete ionic, and then a net ionic.) Include phases [(aq), (s), (l), (g)].

- An aqueous solution of KCl is combined with an aqueous solution of AgNO₃ to yield a precipitate.
- Aqueous Pb(NO₃)₂ and aqueous NaI are combined.
- A solution of HCl and a solution of KOH are combined.
- A solution of sodium hydrogen carbonate is mixed with nitric acid.
- A balloon containing oxygen gas and hydrogen gas is combusted.
- Aqueous BaCl₂ and aqueous K₂SO₄ are mixed together to yield an insoluble precipitate.
- The addition of aqueous Mn(NO₃)₂ to an aqueous solution of Na₃PO₄.

10. Identify the type of reaction [gas-forming, acid-base, or precipitation] that is occurring below. (Note: use only one label for each reaction.)

- $2\text{KI}(\text{aq}) + \text{Pb}(\text{NO}_3)_2(\text{aq}) \rightarrow 2\text{KNO}_3(\text{aq}) + \text{PbI}_2(\text{s})$
- $\text{NaOH}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{NaCl}(\text{aq})$
- $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$
- $\text{Cd}(\text{NO}_3)_2(\text{aq}) + \text{H}_2\text{S}(\text{g}) \rightarrow \text{CdS}(\text{s}) + \text{HNO}_3(\text{aq})$
- $\text{FeCO}_3(\text{aq}) + \text{HC}_2\text{H}_3\text{O}_2(\text{aq}) \rightarrow \text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$

- Write the molecular reaction to prepare a solution of zinc(II) bromide using a redox reaction.
- Write the molecular reaction to prepare a solution of zinc(II) bromide using an acid/base reaction.
- Write the molecular reaction to prepare a solution of zinc(II) bromide using a gas-forming reaction.
- Write the molecular reaction to prepare a solution of zinc(II) bromide using a precipitation reaction.

12. Assign the oxidation numbers for each element present.

- Na
- Fe
- Cl₂
- Li⁺
- Br⁻
- NO
- NO₂
- NaCl
- NaNO₃
- NO₃⁻
- PO₄⁻³
- H₂O
- H₂SO₄
- Ca(NO₃)₂
- S₂O₃⁻²
- CO₃⁻²
- MnSO₄
- Cr₃(PO₄)₂
- CuNO₃
- NH₄NO₃

13. Identify what is being oxidized, reduced, what the oxidizing agent is, and what the reducing agent is. (The reaction don't need to be balanced to do this - **don't** try to balance these reactions.)

- $\text{S}^{2-} + \text{NO}_3^- \rightarrow \text{NO}_2 + \text{S}_8$
- $\text{NO}_3^- + \text{Cu} \rightarrow \text{NO} + \text{Cu}^{2+}$
- $\text{MnO}_4^- + \text{SO}_2 \rightarrow \text{SO}_4^{2-} + \text{Mn}^{2+}$
- $\text{Hg}_2^{2+} + \text{H}_2\text{S} \rightarrow \text{Hg} + \text{S}_8$

ANSWERS

- $2\text{Mg} + \text{SiO}_2 \rightarrow 2\text{MgO} + \text{Si}$
 - $3\text{Ca}(\text{s}) + \text{N}_2(\text{g}) \rightarrow \text{Ca}_3\text{N}_2(\text{s})$
 - $2\text{CH}_3\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 4\text{H}_2\text{O}$
 - $\text{CaCl}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CaCO}_3 + 2\text{NaCl}$
 - $\text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_4$
 - $2\text{C}_6\text{H}_6 + 15\text{O}_2 \rightarrow 12\text{CO}_2 + 6\text{H}_2\text{O}$
 - $2\text{C}_3\text{H}_6 + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$
- a, b, d, f, g, i, k
- $\text{C}_5\text{H}_{12}(\text{g}) + 8\text{O}_2(\text{g}) \rightarrow 5\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
 - $\text{C}_2\text{H}_4(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
- $2\text{HCl}(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{BaCl}_2(\text{aq})$
 - $\text{AgNO}_3(\text{aq}) + \text{NaBr}(\text{aq}) \rightarrow \text{AgBr}(\text{s}) + \text{NaNO}_3(\text{aq})$
- strong (soluble/ionic)
 - strong (strong acid)
 - weak (weak acid)
 - non (molecular)
 - non (insoluble/ionic)
 - weak (weak base)
 - strong (strong acid)
 - strong (strong base)
- weak (weak acid)
- $\text{Na}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq})$
 - $\text{P}_4\text{O}_{10}(\text{s}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}_3\text{PO}_4(\text{aq})$
- Strong acids:* HCl/hydrochloric acid, HBr/hydrobromic acid, HI/hydroiodic acid, H₂SO₄/sulfuric acid, HNO₃/nitric acid, HClO₄/perchloric acid, HClO₃/chloric acid; *Strong bases:* LiOH/lithium hydroxide, NaOH/sodium hydroxide, KOH/potassium hydroxide, RbOH/rubidium hydroxide, CsOH/cesium hydroxide, Sr(OH)₂/strontium hydroxide, Ba(OH)₂/barium hydroxide;
- Weak acid:* HC₂H₃O₂/acetic acid (also CH₃COOH, HAc, or HOAc); *Weak Base:* NH₃/ammonia (also NH₄OH)