9 • Chemical Equations
Equation Terms
(1 of 8)

equation	condensed statement of facts about a chemical reaction.
reactants →	substances that exist before a chemical reaction. Written on the left of the arrow.
→ products	substances that come into existence as a result of the reaction. Written to the right of the arrow.
word equation	an equation describing a chemical change using the names of the reactants and products.
coefficients	a number preceding atoms, ions, or molecules in balanced chemical equations that showing relative #'s.

9 • Chemical Equations
Types of Reactions and other Terms
(2 of 8)

synthesis	$A + B \rightarrow C$
decomposition	$AB \rightarrow A + B$
single replacement	$AB + C \rightarrow A + BC$
double replacement	$AB + CD \rightarrow AD + CB$

precipitate	solid that is formed during a reaction
spectator ions	ion that undergoes no chemical change during a reaction
molecular equation	equation with reactants and products written as whole molecules
ionic equation	equation with soluble salts written as individual ions
net ionic equation	equation with spectator ions removed

9 • Chemical Equations
Energy Changes
(3 of 8)

EXOTHERMIC
- reaction **gives off energy**
- energy is written as a product on the **right** side of arrow
- reaction mixture generally gets **warmer** or must be **cooled**

[combustion] $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$ + **energy**

[freezing] $H_2O(l) \rightarrow H_2O(s)$ + **energy**

ENDOTHERMIC
- reaction **requires** or **takes in** energy
- energy is written as a reactant on the **left** side of the arrow
- reaction mixture **takes warmth** from surroundings or **must be warmed**... for example

[electrolysis of water] $2\ H_2O$ + **energy** $\rightarrow 2\ H_2 + O_2$

9 • Chemical Equations
Showing Phases in Equations
(4 of 8)

We have seen the **phases of matter** in earlier chapters. See page 212 for atomic pictures.

(s)	solid phase	may be used to show a **ppt.**
(l)	liquid phase	
(g)	gaseous phase	

(aq)	aqueous phase -- solid or gas dissolved in water
(ppt)	precipitate -- solid **(s)** formed during a reaction use **Appendix D** or solubility rules to predict when a product is a precipitate.

(l) vs (aq)	sugar(l) would be **melted** sugar sugar(aq) would be sugar water (**dissolved**)

9 • Chemical Equations
Molecular, Ionic, Net Ionic Equations
(5 of 8)

Consider the compounds: silver nitrate + sodium chromate

Ag^+ NO_3^- Na^+ CrO_4^{2-}

molecular equation [balance at this stage]
(use double replacement pattern to predict the products)

$2\ AgNO_3 + Na_2CrO_4 \rightarrow Ag_2CrO_4(s) + 2\ NaNO_3$

ionic equation [use sol. rules to determine (aq) or (s)]

$2\ Ag^+ + 2\ NO_3^- + 2\ Na^+ + CrO_4^{2-} \rightarrow$
$Ag_2CrO_4(s) + 2\ Na^+ + 2\ NO_3^-$

net ionic equation [remove spectator ions]

$2\ Ag^+ + CrO_4^{2-} \rightarrow Ag_2CrO_4(s)$

9 • Chemical Equations
Writing Word Equations
Things To Remember
(6 of 8)

Example: Write the **word equation** of...

$SiO_2 + 4\ HF \rightarrow SiF_4 + 2\ H_2O$

silicon dioxide + hydrofluoric acid
→ silicon tetrafluoride + water

- **molecular compounds** must be named using mono-, di-, tri-, tetra-, penta-, hexa-, hepta-, octa-, nona-, deca-.
- watch for **acids** (ionic compounds ... positive ion is $\mathbf{H^+}$) acid naming rules apply (-ide = hydro---ic acid, etc.)
- **ionic compounds** do **NOT** use di-, tri-, etc. unless they are part of the ion name (e.g. **di**chromate, $Cr_2O_7^{2-}$) ionic cmpds are named as the positive and negative ion. Stock names may be used.

9 • Chemical Equations
Writing Formula Equations
Things To Remember
(7 of 8)

Example: Write the **formula equation** of...

sodium metal + water → sodium hydroxide + hydrogen gas

$Na° + H_2O \rightarrow NaOH + H_2$

- **metals** often are written with the ° symbol to emphasize that the metal is in the neutral elemental state, not an ion.
- some compounds have **common names** that you should just know... water, H_2O; ammonia, NH_3; methane, CH_4
- remember the seven **diatomic** elements so they can be written as diatomic molecules when they appear in their elemental form. Other elemental substances are written as **single atoms** (e.g. sodium metal or helium gas, He)

9 • Chemical Equations
Miscellaneous:
Law of Conservation of Mass
and Complete Combustion Reactions
(8 of 8)

The **law of conservation of mass** can be shown by comparing the **total masses** of **reactants** and **products**.:

Example: Show that the law of conservation of mass applies to the balanced equation...

$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

$44\ g + 5(32\ g) = 3(44\ g) + 4(18\ g)$

Combustion (burning) implies a **fuel** and three chemicals: $\mathbf{O_2}$, $\mathbf{CO_2}$, and $\mathbf{H_2O}$. **Example**: combustion of C_3H_8 above.

Careful when balancing: C_2H_5OH... Notice: 6H's and an O.

Use **fractions** to show **odd** #'s of O atoms, $\frac{3}{2}\ O_2$ = 3 atoms