

# Patterns of Chemical Reactions

Reaction Types

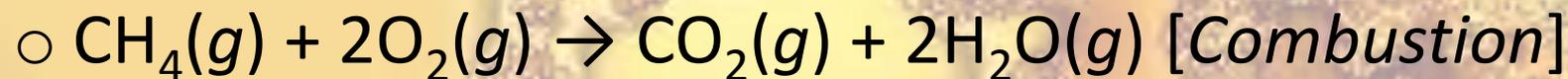
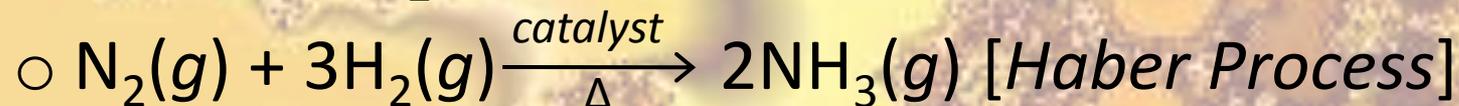
© Evan P. Silberstein, 2007

# Synthesis

- During a ***synthesis*** or ***direct combination*** reaction, substances combine.

- General pattern:  **$A + B \rightarrow AB$**  or  **$AB + D \rightarrow AD + BD$**  [*Combustion*]

- Examples:



## KEY

Metal = A or C

Nonmetal = B

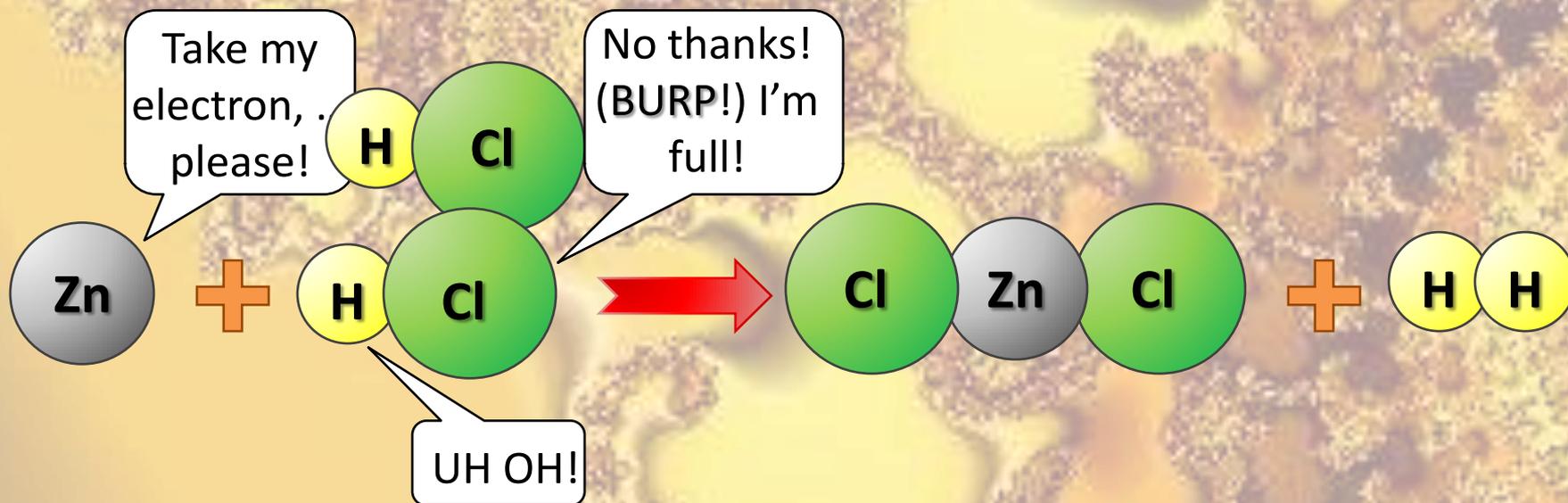
or D

# Decomposition

- During a ***decomposition*** or ***analysis*** reaction, a compound breaks down.
- General pattern:  **$AB \rightarrow A + B$**
- Examples:
  - $2\text{H}_2\text{O}_2(aq) \rightarrow 2\text{H}_2\text{O}(\ell) + 2\text{O}_2(g)$
  - $2\text{HgO}(s) \rightarrow 2\text{Hg}(\ell) + \text{O}_2(g)$
  - $\text{H}_2\text{CO}_3(aq) \rightarrow \text{H}_2\text{O}(\ell) + \text{CO}_2(g)$

# Single Replacement

- During a **single replacement** or **substitution** reaction, a metal replaces another metal in a compound or a nonmetal replaces another nonmetal in a compound.

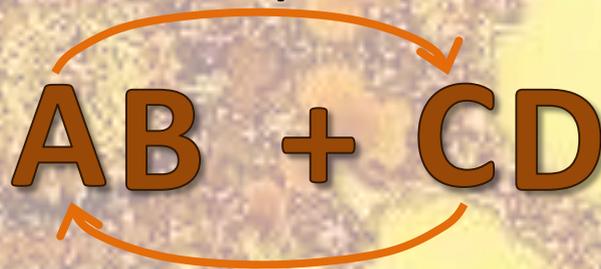


# Single Replacement (Continued)

- General Pattern:  $AB + C \rightarrow CB + A$  or  $AB + D \rightarrow AD + B$
- Examples
  - Replacement of a metal by a more active metal
    - ✓ **Molecular equation:**  $CuSO_4(aq) + Mg(s) \rightarrow MgSO_4(aq) + Cu(s)$
    - ✓ **Ionic equation:**  $Cu^{+2} + SO_4^{-2} + Mg \rightarrow Mg^{+2} + SO_4^{-2} + Cu$
    - ✓ **...omitting spectator ions:**  $Cu^{+2} + Mg \rightarrow Mg^{+2} + Cu$
  - Replacement of a nonmetal by a more active nonmetal
    - ✓  $2NaI(aq) + Cl_2(g) \rightarrow 2NaCl(aq) + I_2(s)$

# Double Replacement

- During a ***double replacement*** or ***exchange of ions*** reaction, the metals in two aqueous compounds switch places.



- General Pattern:  $AB + CD \rightarrow CB + AD$
- Example:
  - $AgNO_3(aq) + NaCl(aq) \rightarrow NaNO_3(aq) + AgCl(s)$

# Reversible and End Reactions

- End reaction - reaction in which the products are not available to react to form the initial reactants because:
  - A precipitate forms.
  - A gas forms.
  - A liquid forms.
  - A product is removed.
- Reversible reaction - reaction in which the products remain available to react to form the initial reactants.