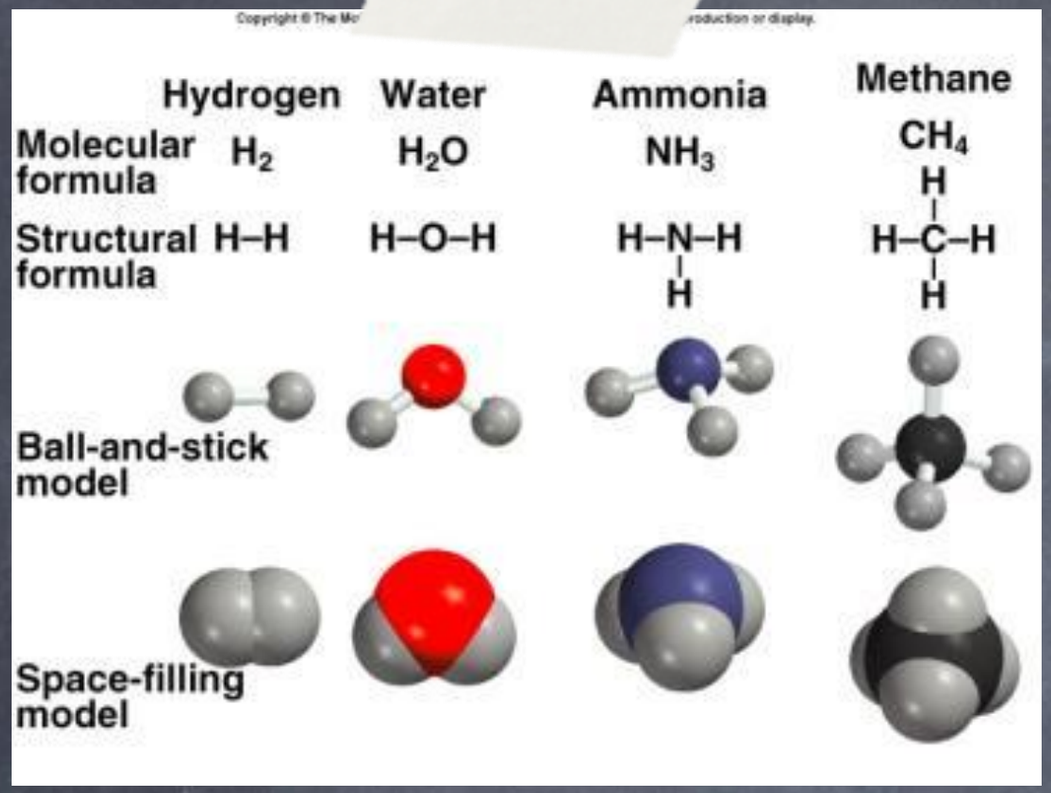
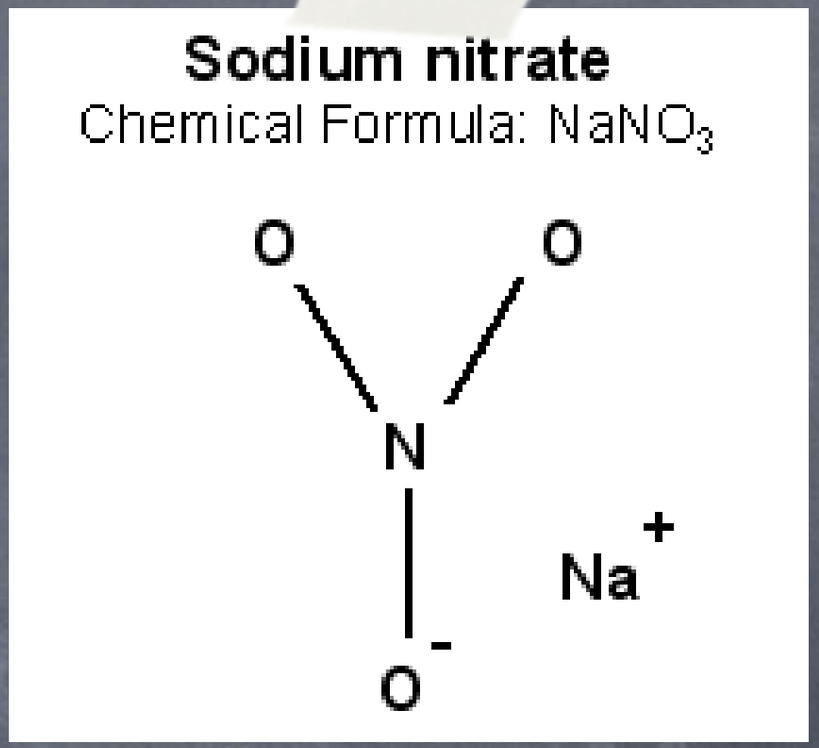
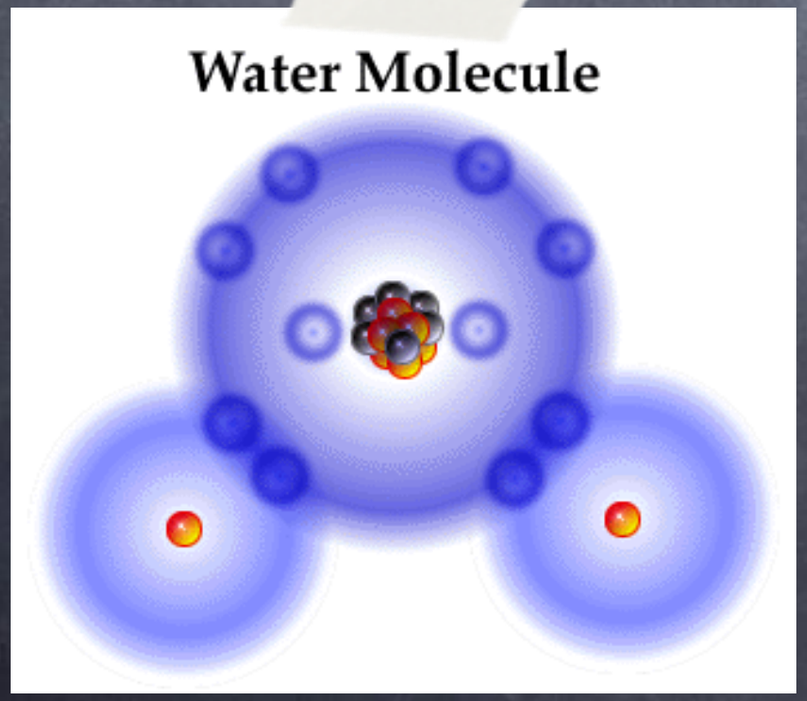
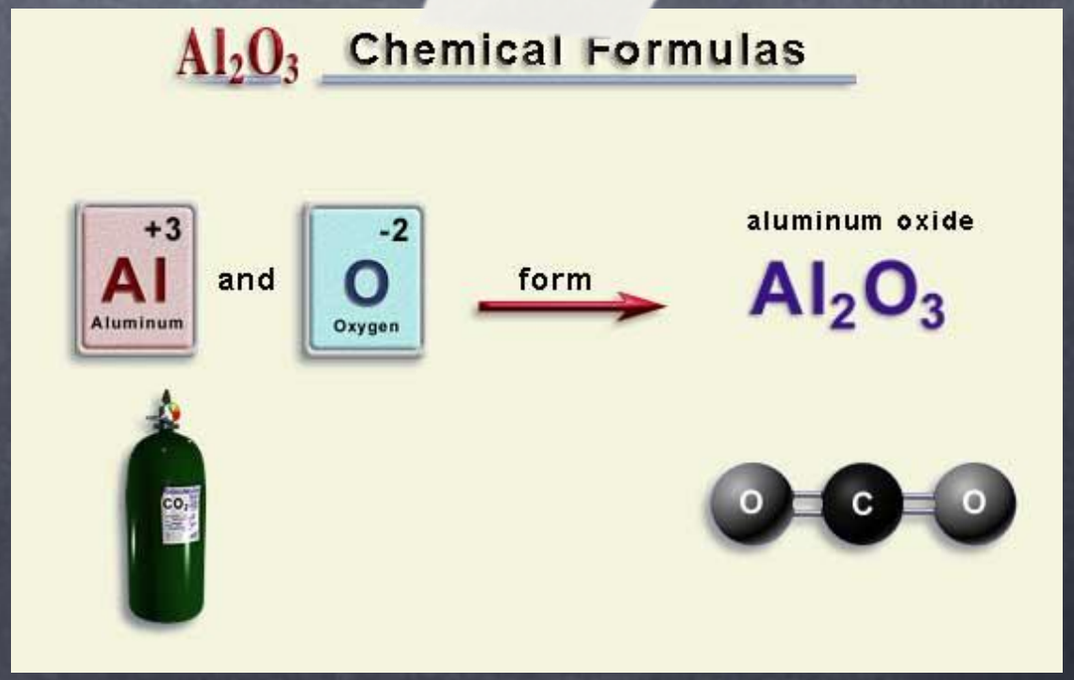
Writing Chemical Formulas

Chemical Formulas represent compounds.

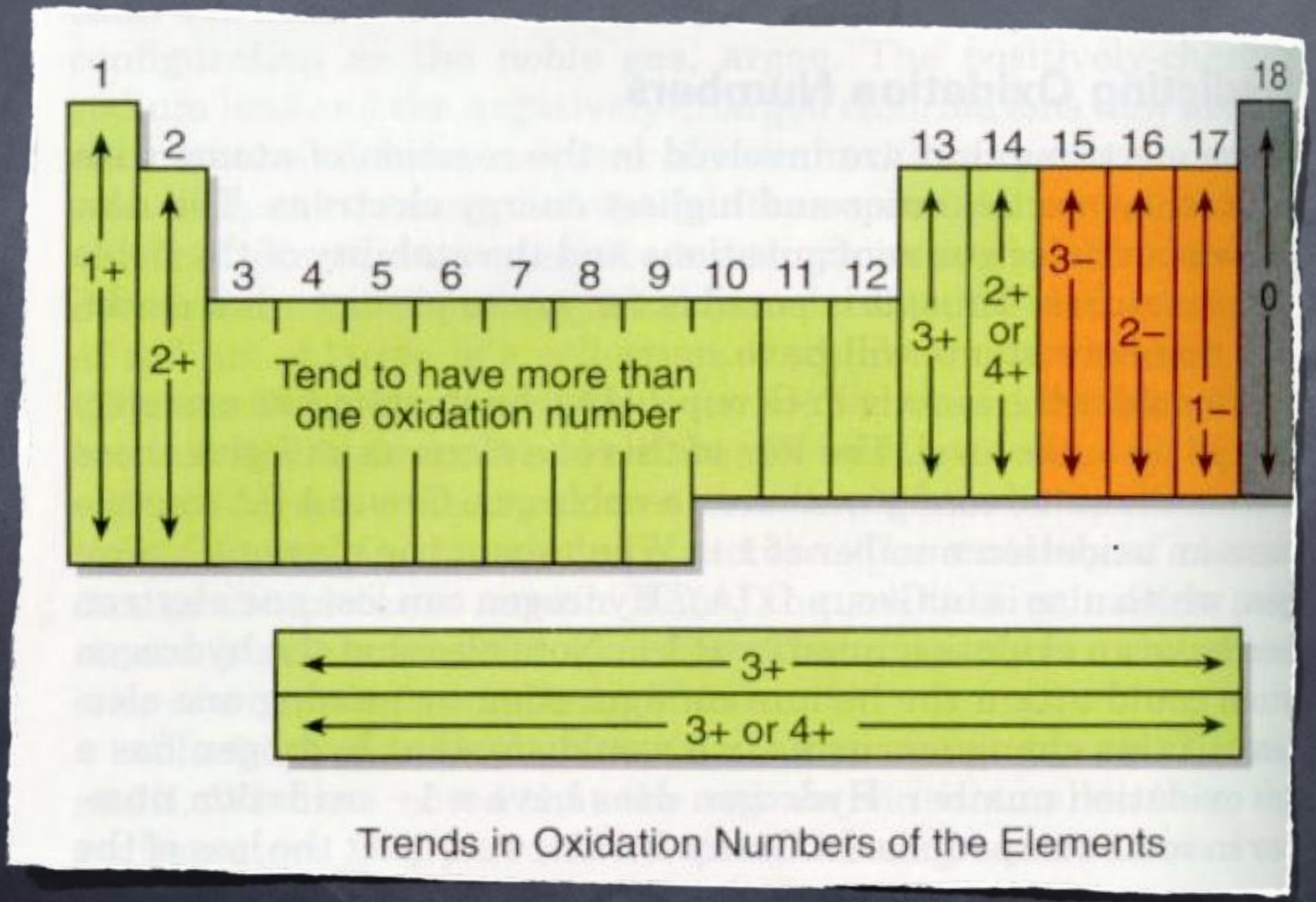








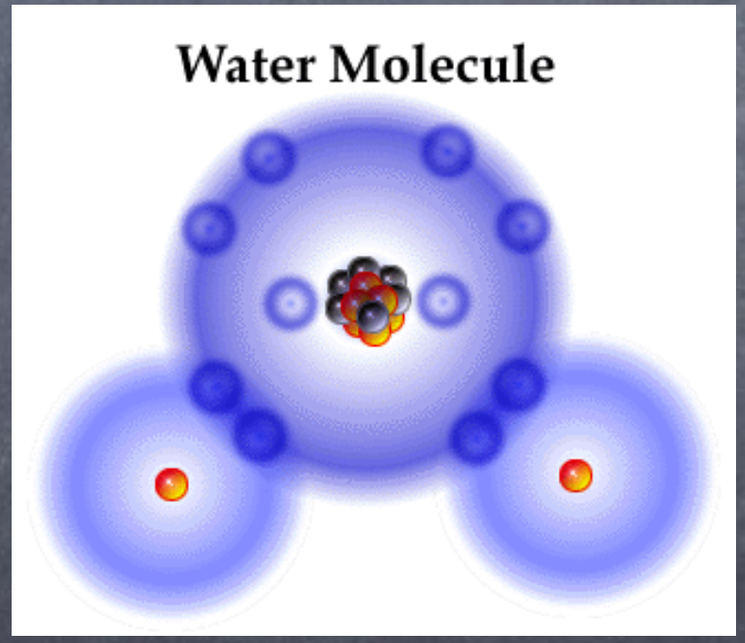
Oxidation Numbers are used to determine the ratio in which elements combine to form compounds.



Trends in Oxidation Numbers of the Elements

Understanding Chemical Formulas

Chemical formulas are composed of a positive half and a negative half.



Ex. - Water is a compound you know to have a formula of H_2O.

The element with the positive oxidation number is always written first.

H O

The element with the negative oxidation number is always written second.

The total of the oxidation numbers in a compound must equal <u>zero</u>.

$$\overset{+1}{H}\ \overset{-2}{O}$$

Hydrogen's oxidation number is +1 and oxygen's is -2. With one H and one O, the total is not 0, it is -1!!!

* Subscripts, small numbers to the lower right of the chemical symbol, represent the number of that element present in the compound.

★ The subscript of 1 is never written in a chemical formula. It is understood since the chemical symbol is there.

* Add subscripts after a chemical symbol, when needed, to make the oxidation numbers total zero.

$$H_2O$$

How to check if the formula is correct:

Multiply subscript by oxidation number for the total oxidation number of each element in a formula.

For Hydrogen:

(oxidation number +1)(subscript 2) = +2 total

For Oxygen:

(oxidation number -2)(subscript 1) = -2 total

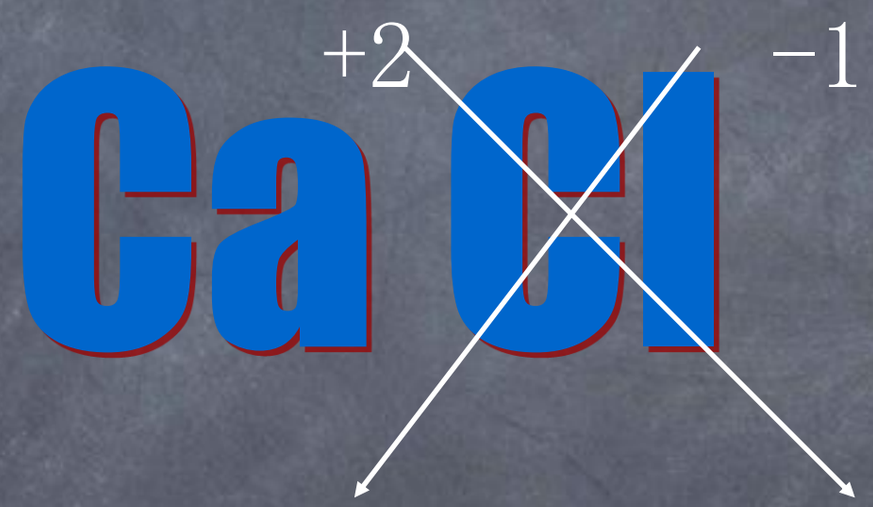
The formula H_2O is the correct formula!!!

There MUST be an easier way....and there is!!

The easiest way to think of writing chemical formulas is to use the oxidation number (without the + or -) of one element as the subscript of the other element.

$$Ca^{+2}Cl^{-1}$$

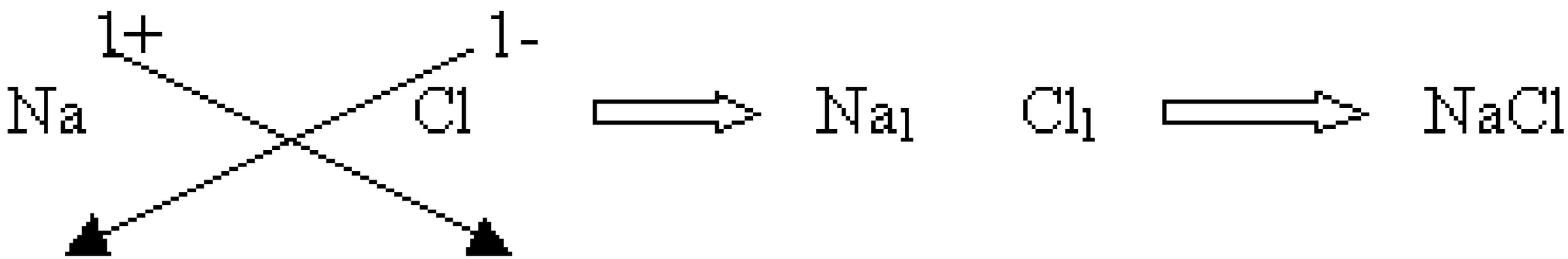
Cross over the oxidation numbers without the charges!!!



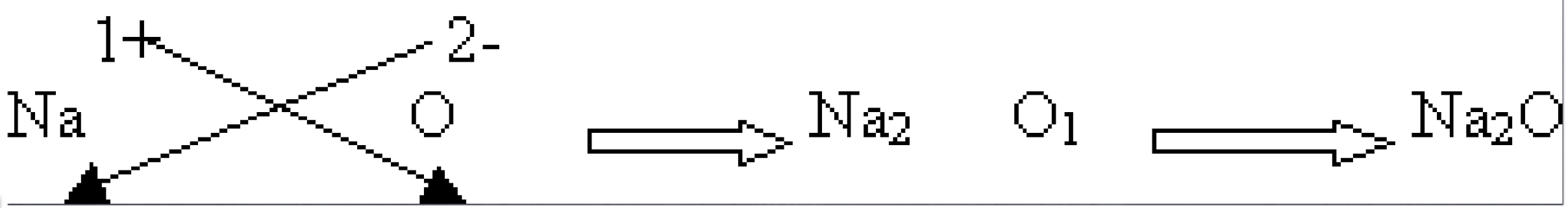
$CaCl_2$

REMINDER: DO NOT write a subscript of 1.
Reduce the subscripts if needed.

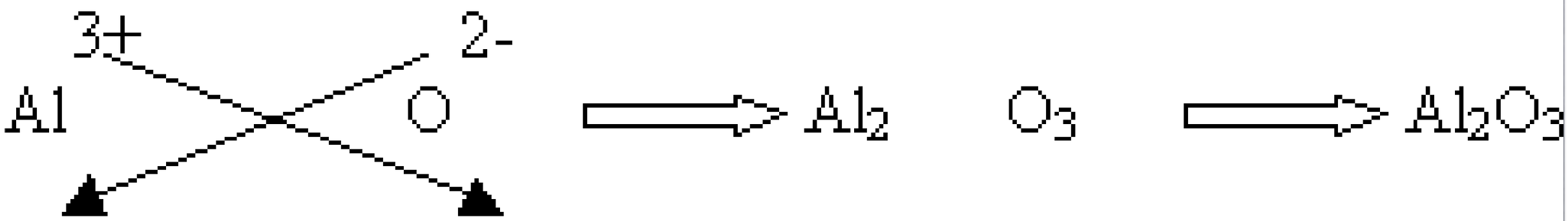
Example 1 – Sodium chloride (common salt)



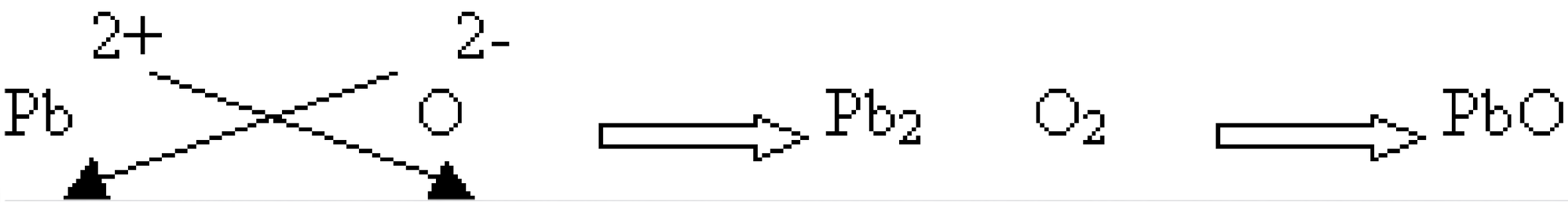
Example 2 – Sodium oxide



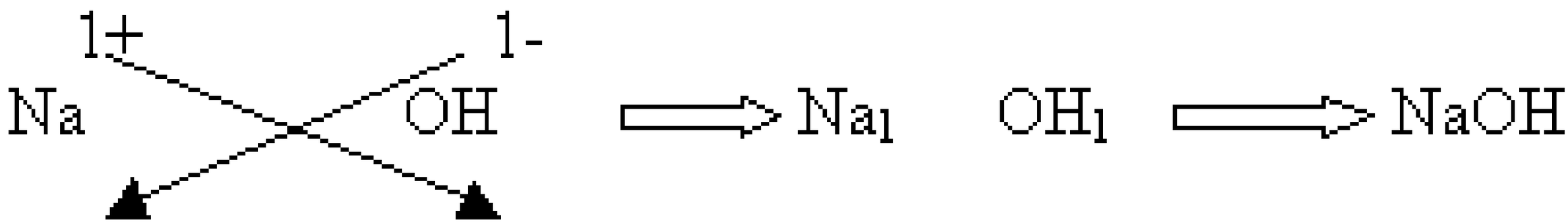
Example 3 – Aluminium oxide



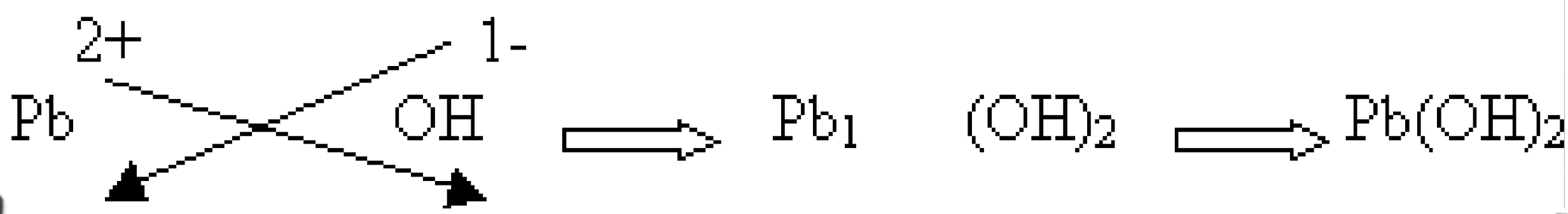
Example 4 – Lead oxide



Example 5 – Sodium hydroxide (caustic soda)



Example 6 – Lead hydroxide



Background

- Thousands of known chemical reactions occur in various systems. Memorizing the equations for so many chemical reactions would be difficult. It is more useful and realistic to classify reactions according to various similarities and regularities.

THE 5 TYPES OF REACTIONS

Combustion

Decomposition

Double Replacement

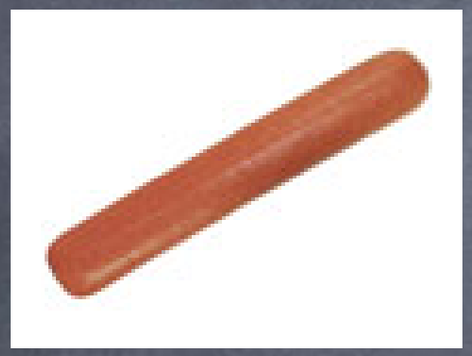
Synthesis

Single Replacement

Synthesis Reaction

Synthesis reaction – 2 substances combine to form a single product

A + B → AB



$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

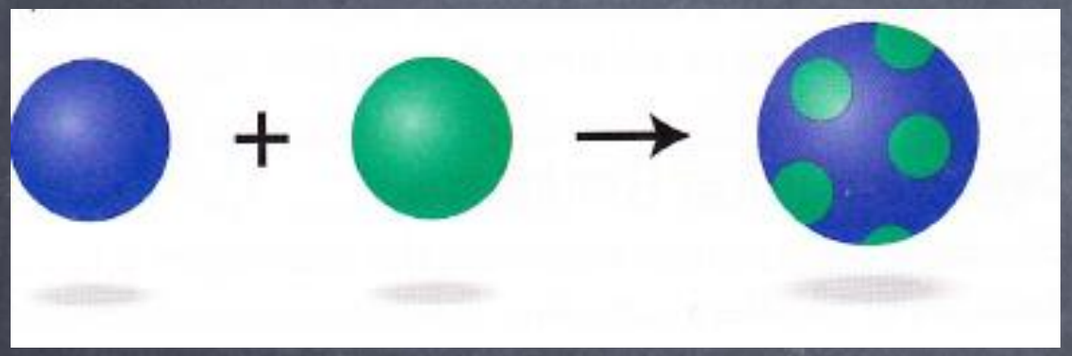
Magnesium and oxygen combine to form magnesium oxide.

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

Hydrogen and oxygen combine to form dihydrogen monoxide

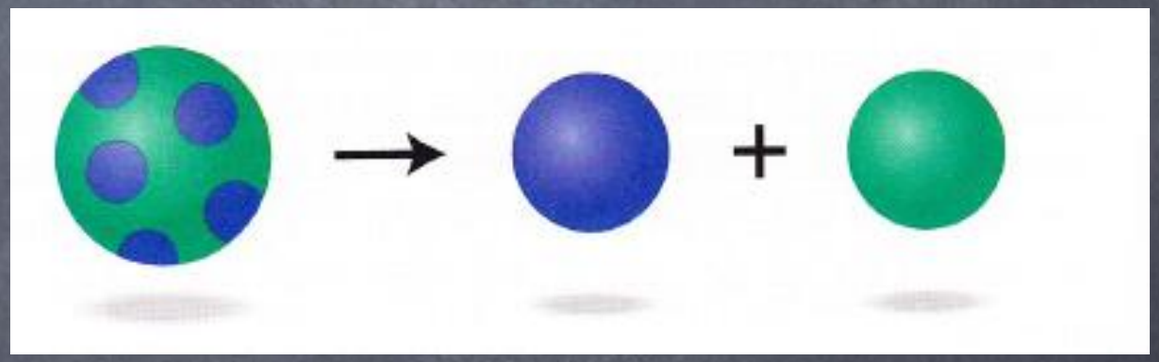
Look at the reactants represented below, which reaction involves elements as reactants? Which reaction involves compounds as reactants?

Synthesis reaction



A synthesis reaction involves the combination smaller molecules

Decomposition reaction



A decomposition reaction involves the breaking apart of larger molecules

Synthesis Reactions

- Involve the combination of smaller atoms and /or molecules into larger molecules.
- They are also called *combination reactions*

- General formula
- $A + B \longrightarrow AB$
- If you see two elements as reactants, you know the reaction has to be a sysnthesis reaction

- Synthesis reactions can also involve combinations of small molecules.

- For example, when ammonia and hydrogen chloride vapours combine they form a white smoke as solid particles of ammonium chloride are formed.

Hydrogen chloride + ammonia $\longrightarrow$ ammonium chloride

$HCl + NH_3 \longrightarrow NH_4Cl$

Decomposition Reactions

- In a decomposition reaction, a single compound undergoes a reaction the produces two or more products.
  - General equation $AX \longrightarrow A + X$

Decomposition Reactions

- It involve the splitting of a large molecule into elements or smaller molecules.

- General formula

$$AB \longrightarrow A + B$$

- Example, electrolysis of water uses electricity to split water molecules into their elements

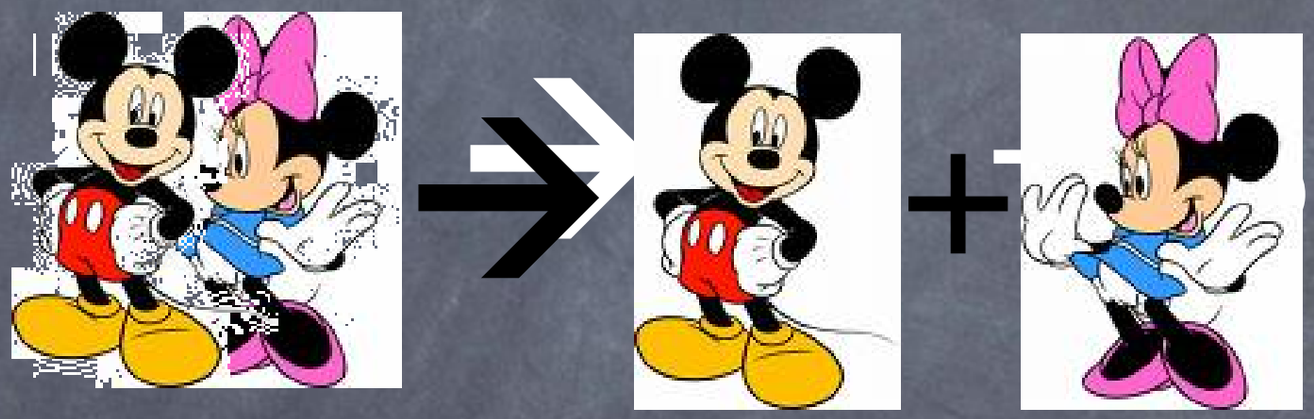
water → hydrogen + oxygen

$$H_2O \longrightarrow H_2 + O_2$$

$$2H_2O \longrightarrow 2H_2 + O_2$$

Decomposition Reaction

Decomposition reaction - A single compound breaks down into 2 or more products.



$2H_2O_2(aq) \rightarrow O_2(g) + 2H_2O(l)$

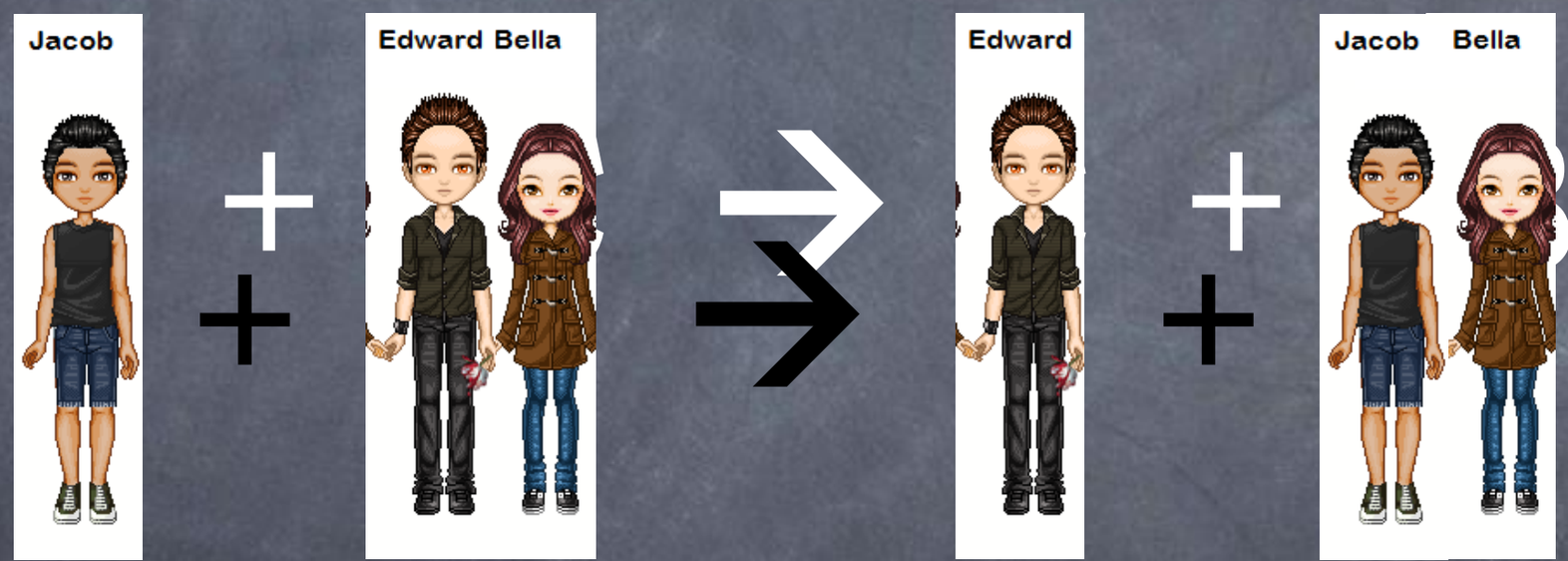
Hydrogen peroxide decomposes into oxygen gas and dihydrogen monoxide.

$2NaCl(s) \rightarrow 2Na(s) + Cl_2(g)$

Sodium chloride decomposes into sodium and chlorine gas.

Single Replacement Reaction

<u>Single Replacement reaction</u> - A single element takes the place of another element in a compound.



$AgNO_3(aq) + Cu(s) \rightarrow Ag(s) + CuNO_3(aq)$

Copper replaces silver in silver nitrate to copper (I) nitrate and silver.

$Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$

Zinc replaces hydrogen in hydrogen chloride to yield hydrogen gas and zinc chloride

Double Replacement Reaction

<u>Double Replacement reaction</u> - Elements in 2 compounds switch places to form 2 new compounds.

$HCl(aq) + NaOH(aq) \rightarrow HOH(l) + NaCl(aq)$

Hydroxide and chlorine switch places to hydrogen hydroxide (water) and sodium chloride

$Na_2S(aq) + Zn(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + ZnS\ (s)$

Sulfur and nitrate switch places to form sodium nitrate and zinc sulfide.

Combustion Reactions

- In a combustion reaction, a substance combines with oxygen, releasing a large amount of energy in the form of light and heat.
- $2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$

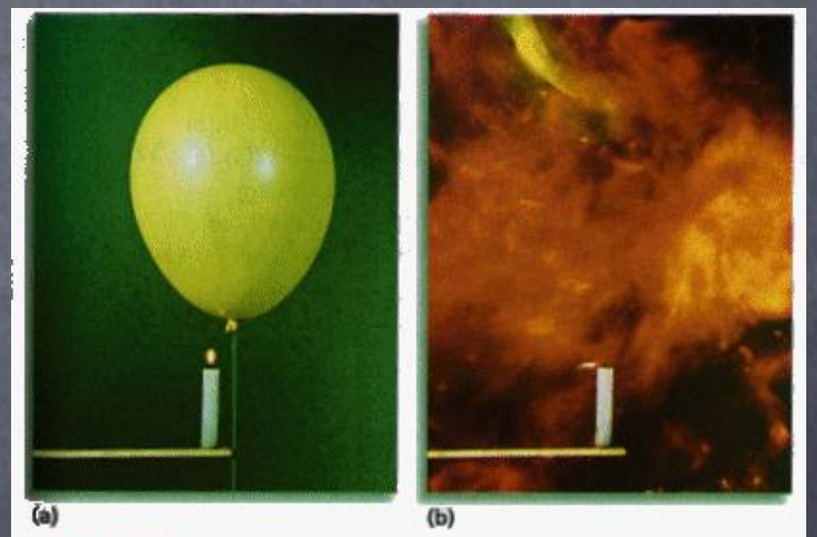


FIGURE 8-13 (a) The candle supplies heat to the hydrogen and oxygen in the balloon, triggering the explosive combustion reaction shown in (b).

- $C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g)$

Combustion Reaction

Combustion reaction - A hydrocarbon (H and C) burn in oxygen to produce water and carbon dioxide. Heat is given off as energy.

$$C_xH_x + O_2 \rightarrow H_2O + CO_2 + \text{heat}$$

$$CH_4(g) + 2O_2(g) \rightarrow 2H_2O\ (l) + CO_2(g)$$

Methane burns in oxygen to produce water and carbon dioxide.

$$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 11H_2O(l) + 12CO_2(g)$$

Sucrose burns in oxygen to produce water and carbon dioxide.