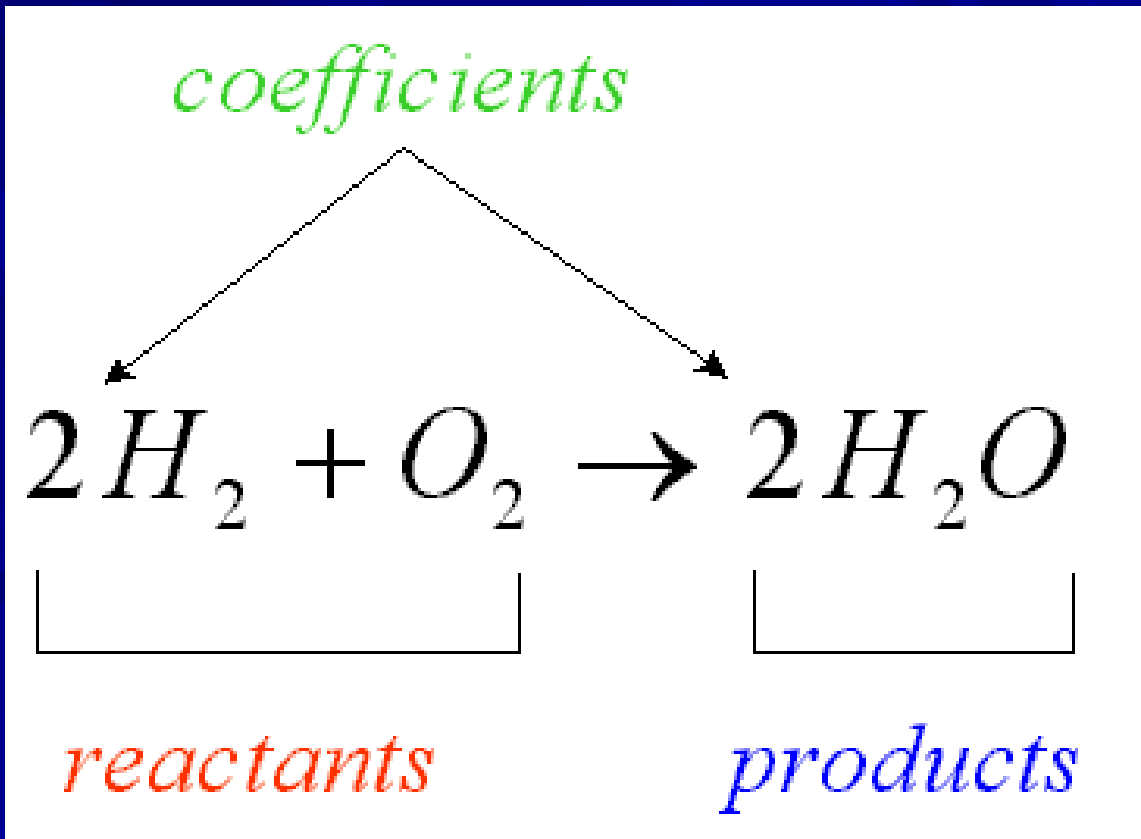
BALANCING CHEMICAL EQUATIONS

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C=1		C=1
H=4	=	H=4
O=4		O=4

- Balancing chemical equations means ***adding coefficients*** to the beginning of the chemical formulas of the reactants and the products to conform to the law of ***conservation*** of mass.



- A skeleton equation is a chemical equation that presents the reagents and products of a chemical change without taking into account the law of conservation of mass.

Skeleton equation for octane (C_8H_{18}) combustion

$$C_8H_{18\,(g)} + O_{2\,(g)} \rightarrow CO_{2\,(g)} + H_2O_{\,(g)}$$

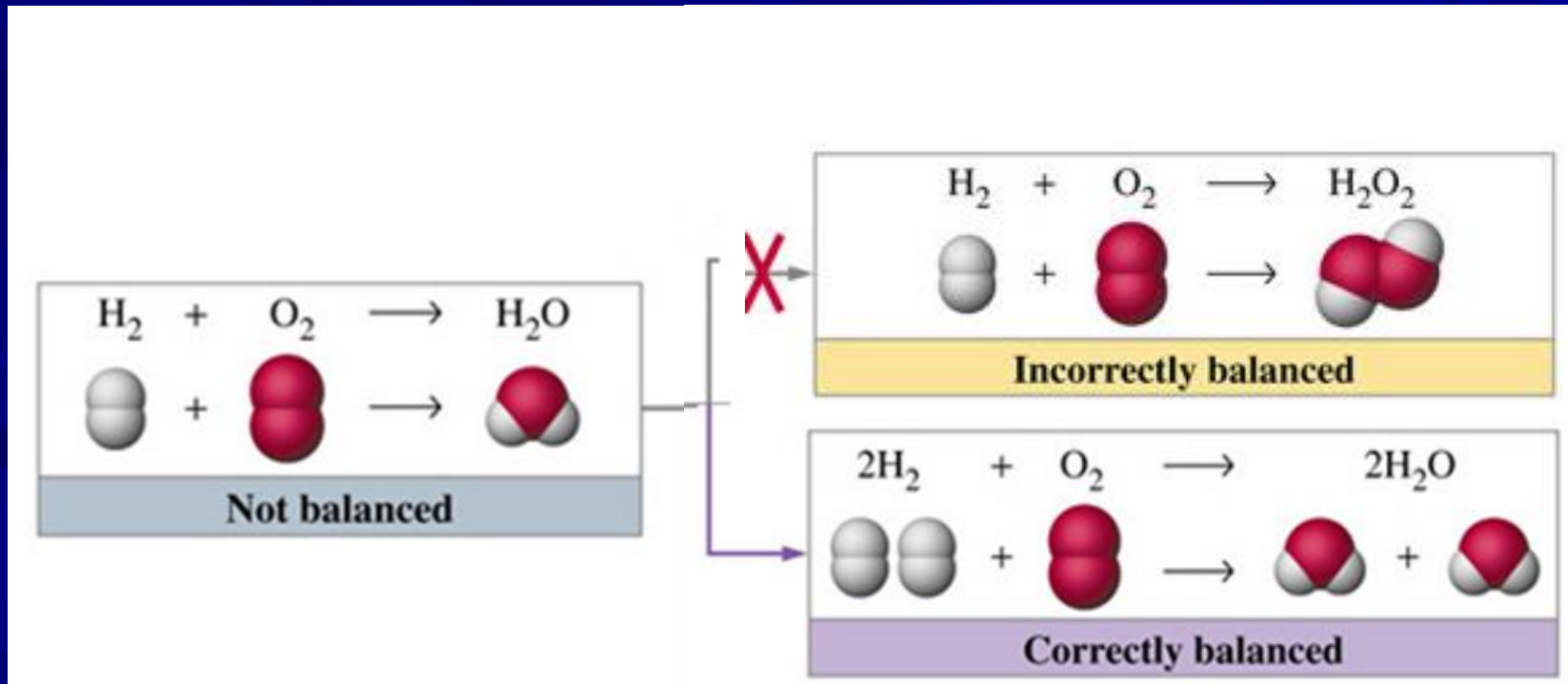
- To observe ***the law of conservation of mass***, a skeleton equation must be balanced to ensure equal ***numbers of atoms*** in the ***reactants*** and the ***products***.

$$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$$

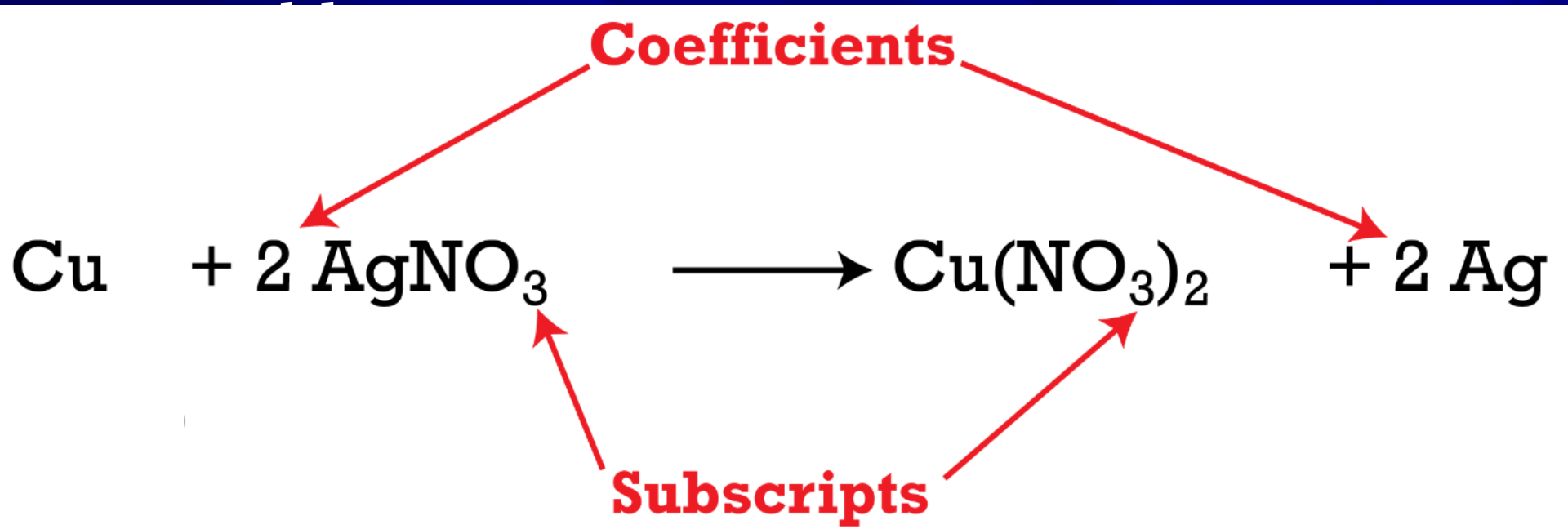
Reactants	
C	3
H	8
O	2

Products	
C	1
H	2
O	3

- These rules must be followed to balance a chemical equation:
  - only ***coefficients*** may be added;
  - the ***indexes*** in the chemical formulas of compounds cannot be changed.



- Do not write the coefficient 1; it is ***understood***.
- When the ***equation*** is balanced, coefficients that are used must ***be whole numbers*** reduced to the ***lowest term***.



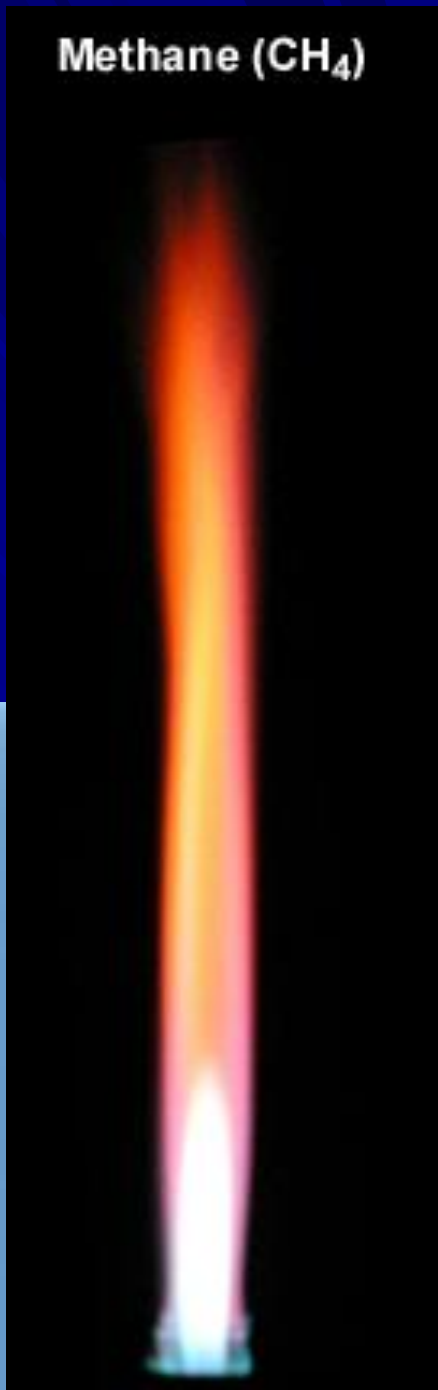
- When the equation is balanced, the number of atoms of each element must be the same in the ***reactants***(reagents) and the ***products***.

Balanced equation for octane (C_8H_{18}) combustion

$$2\,C_8H_{18\,(g)} + 25\,O_{2\,(g)} \rightarrow 16\,CO_{2\,(g)} + 18\,H_2O_{\,(g)}$$

	# of atoms of reactants	*# of atoms of products*
C	$2 \times 8 = 16$	16
H	$2 \times 18 = 36$	$18 \times 2 = 36$
O	$25 \times 2 = 50$	$16 \times 2 + 18 = 50$

- The following example shows the balancing of a skeleton equation that presents the reagents and products in the ***combustion*** of methane(CH_4)



EXAMPLE: Balance the equation:

C: 1 atom

$$CH_4 + O_2 \longrightarrow CO_2 + H_2O$$

A. First check carbon *(C)* in methane *(CH_4)* and carbon dioxide *(CO_2)*.

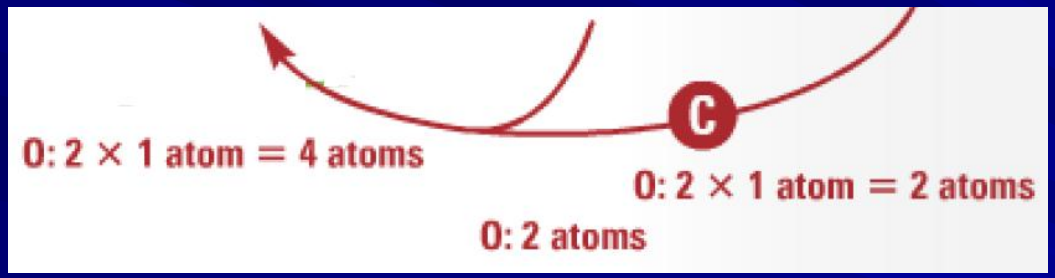
Since there is one atom of carbon on either side of the equation, it is possible to conclude that the carbon is balanced.

B. Write the coefficient 2 in front of water (H_2O) to balance the 4 hydrogen (H) atoms in the methane.

$$CH_4 + O_2 \longrightarrow CO_2 + 2H_2O$$

C. This coefficient 2 in front of water *(H_2O)* brings total number of oxygen *(O)* atoms in the products of 2 in *CO_2 and 2 in H_2O*

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$



Balance by adding a coefficient 2 in front of the oxygen *(O_2)* the least complex reactant.

The equation is now balanced.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Elements	Reactants	Products
C	1	1
H	4	$2 \times 2 = 4$
O	$2 \times 2 = 4$	$2 + 2 = 4$

Balance the following chemical equations:

a) $2\,NO_2 \rightarrow N_2O_4$

Elements	Reactants	Products
N	2	2
O	$2 \times 2 = 4$	4

b) $2\,CO + O_2 \rightarrow 2\,CO_2$

Elements	Reactants	Products
C	2	2
O	$2+2=4$	$2\times2=4$

c) $FeCl_3 + 3\ NaOH \rightarrow Fe(OH)_3 + 3\ NaCl$

Elements	Reactants	Products
Fe	1	1
OH	3	3
Na	3	3
Cl	3	3

d) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Elements	Reactants	Products
Fe	2	2
C	3	3
O	$3+3=6$	$3\times2=6$