Balancing Equations

Conservation of Mass

Conservation of Mass

- In 1789, Antoine Lavoisier demonstrated the chemical principle known as the law of conservation of mass.
- According to the law of conservation of mass, during a chemical reaction matter is neither created nor destroyed.
- As a consequence, during a chemical reaction the mass does not change.

Chemical Equations and Conservation

- Chemical equations should show conservation of mass.
- Example:

$$AgNO_3(aq) \quad + \quad NaCl(aq) \quad \rightarrow \quad NaNO_3(aq) \quad + \quad AgCl(s)$$

$AgNO_3$

Ag = 108 × 1 = 108
N = 14 × 1 = 14
O = 16 × 3 = 48
170

NaCl

Na = 23 × 1 = 23
Cl = 35 × 1 = 35
58

$NaNO_3$

Na = 23 × 1 = 23
N = 14 × 1 = 14
O = 16 × 3 = 48
85

AgCl

Ag = 108 × 1 = 108
Cl = 35 × 1 = 35
143

228 (170 + 58)

228 (85 + 143)

Checking for Conservation

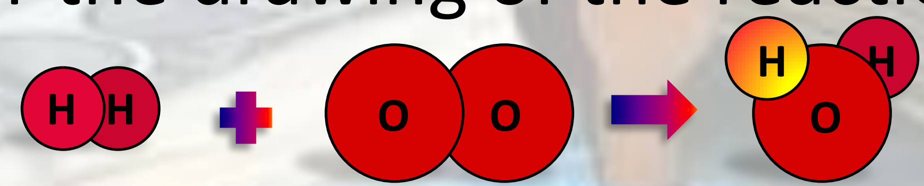
- Consider the equation for the formation of water: $H_2 + O_2 \rightarrow H_2O$
- Does it show conservation?

$H_2 + O_2 \rightarrow H_2O$

2 + 32 ≠ 18

NO!!

- Why doesn’t it show conservation?
- Consider the drawing of the reaction below:

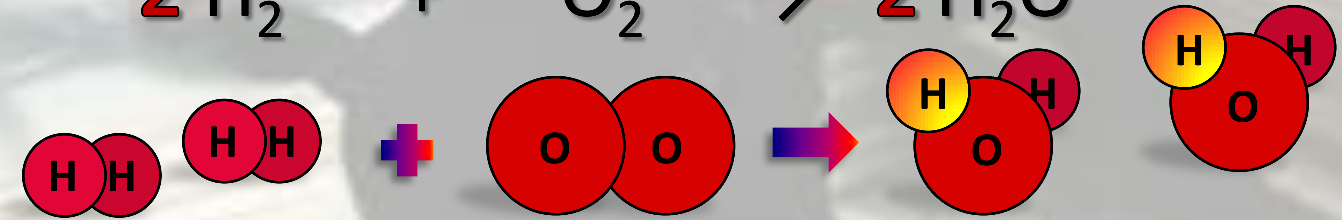


- An oxygen atom is missing!

Balancing the Equation

- Since there is an oxygen missing on one side of the equation, the equation is not balanced.

$$2\,H_2 \quad + \quad O_2 \quad \rightarrow \quad 2\,H_2O$$



- The only way to get an additional oxygen on the product side is to add another water molecule.
- Adding another water molecule puts two extra hydrogen atoms on the product side.
- The only way to even things out is to put another hydrogen molecule on the reactant side.
- This result can be shown in the equation with coefficients. This makes the equation balanced.

Balancing for Conservation

- The unbalanced equation does not show conservation of mass.

$$H_2 + O_2 \rightarrow H_2O$$

$$2 + 32 \neq 18$$

- The balanced equation does show conservation of mass.

$$2H_2 + O_2 \rightarrow 2H_2O$$

$$2(2) + 32 = 2(18)$$

$$36 = 36$$

Balancing is Counting

- If an equation is balanced, it shows conservation of mass. Checking the masses is unnecessary.
- Balancing is just a matter of counting the number of each type of atom, and making sure it is the same on both the reactant side and product side of the equation.
- If the equation is unbalanced, balance it by using coefficients.

(*NOTE:* Think of coefficients as multipliers.)

Examples

State whether each of the following is *balanced* or *unbalanced*. If it is unbalanced, balance it.

- __C + __O_2 → __CO_2 **Balanced**
- __N_2 + **3** H_2 → **2** NH_3
- **2** Al + **6** HCl → **2** $AlCl_3$ + **3** H_2
- __$BaCl_2$ + **2** $AgNO_3$ → __$Ba(NO_3)_2$ + **2** $AgCl$
- __C_3H_8 + **5** O_2 → **3** CO_2 + **4** H_2O