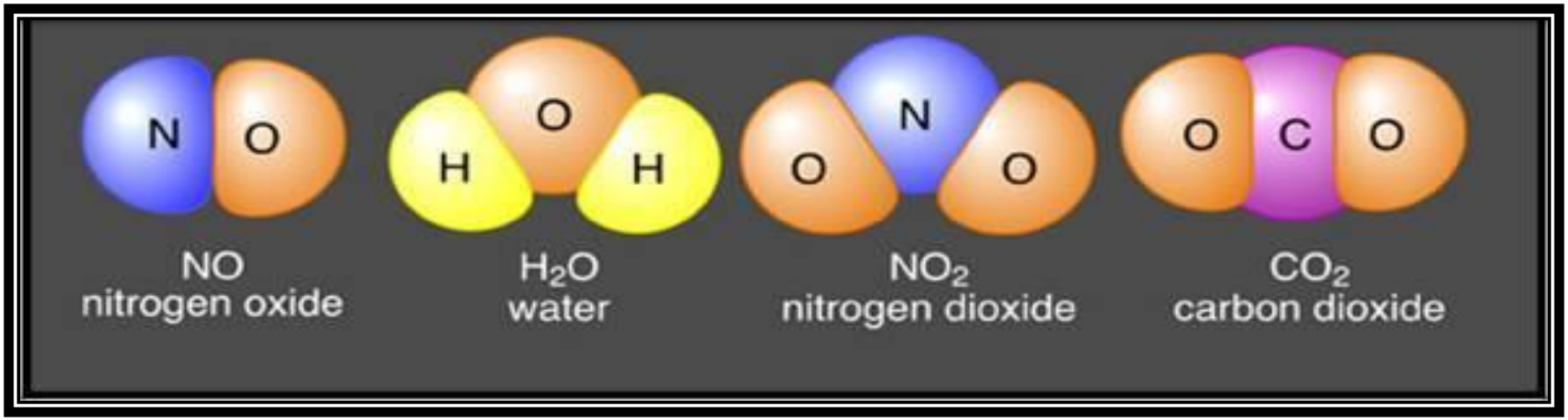
Laws of Chemical Combination

What makes compounds different?

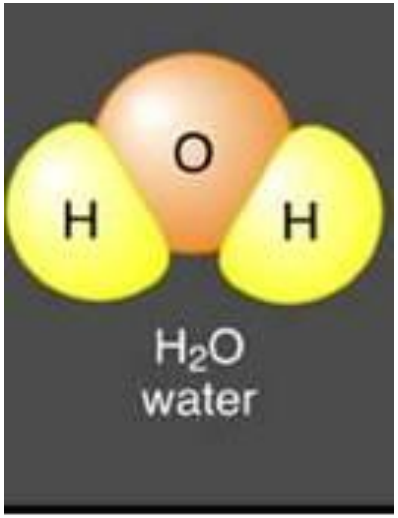
Law of Constant Composition

- 1799 Joseph Proust

- a chemical compound contains the same elements in exactly the same proportions (ratios) by mass regardless of the size of the sample or source of the compound



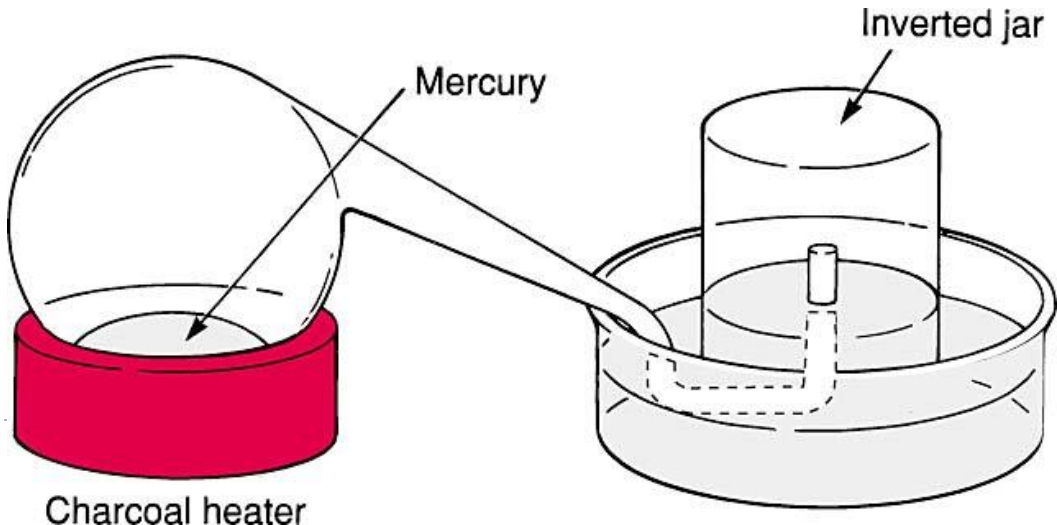
- For example, water always consists of oxygen and hydrogen atoms, and it is always 89 percent oxygen by mass and 11 percent hydrogen by mass



Does mass change during a chemical reaction?

Law of Conservation of Mass

- Lavoisier heated a measured amount of mercury to form the red oxide of mercury. He measured the amount of oxygen removed from the jar and the amount of red oxide formed. When the reaction was reversed, he found the original amounts of mercury and oxygen.



Law of Conservation of Mass

- 1744 Antoine Lavoisier
- matter can not be created or destroyed in ordinary chemical or physical changes.
- the mass of the reactants (starting materials) equals the mass of the products

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

48.6 g 32.0 g 80.6 g

Example

- 10 grams of $CaCO_3$ on heating gave 4.4g of CO_2 and 5.6 of CaO. Show that these observations are in agreement with the law of conservation

Law of Multiple Proportions

- 1803 John Dalton

- States that when two elements combine to form more than one compound, the masses of one element which combine with a fixed mass of the other element are in ratios of small whole numbers

Example:

- Carbon monoxide (CO): 12 parts by mass of carbon combines with 16 parts by mass of oxygen.

- Carbon dioxide (CO_2): 12 parts by mass of carbon combines with 32 parts by mass of oxygen.

- Ratio of the masses of oxygen that combines with a fixed mass of carbon (12 parts) 16: 32 or 1: 2

- Water has an oxygen-to-hydrogen mass ratio of 7.9:1.
- Hydrogen peroxide, another compound consisting of oxygen and hydrogen, has an oxygen-to-hydrogen mass ratio of 15.8:1.
- Ratio of the masses of oxygen that combines with a fixed mass of hydrogen is 7.9: 15.8 or 1: 2