CHEM 145 Lecture
Problems
Molecular Weight

Molecular Weight Calculations:

NaCl

$MW_{Na} := 22.989768 \cdot gm \cdot mole^{-1}$

$MW_{Cl} := 35.4527 \cdot gm \cdot mole^{-1}$

$MW_{NaCl} := MW_{Na} + MW_{Cl}$ $\quad MW_{NaCl} = 58.442468 \cdot gm \cdot mole^{-1}$

H_2O

$MW_{H} := 1.00794 \cdot gm \cdot mole^{-1}$

$MW_{O} := 15.9994 \cdot gm \cdot mole^{-1}$

$MW_{H2O} := 2 \cdot MW_{H} + MW_{O}$

$MW_{H2O} = 18.01528 \cdot gm \cdot mole^{-1}$

$CFCl_3$

$MW_{C} := 12.011 \cdot gm \cdot mole^{-1}$

$MW_{F} := 18.9984032 \cdot gm \cdot mole^{-1}$

$MW_{Cl} = 35.4527 \cdot gm \cdot mole^{-1}$

$MW_{CFCl3} := MW_{C} + MW_{F} + 3 \cdot MW_{Cl}$

$MW_{CFCl3} = 137.3675032\ mole^{-2} \cdot gm \cdot mole$

C_2H_6O

$MW_{C} = 12.011 \cdot gm \cdot mole^{-1}$

$MW_{H} = 1.00794 \cdot gm \cdot mole^{-1}$

$MW_{O} = 15.9994 \cdot gm \cdot mole^{-1}$

$MW_{C2H6O} := 2 \cdot MW_{C} + 6 \cdot MW_{H} + MW_{O}$

$MW_{C2H6O} = 46.06904 \cdot gm \cdot mole^{-1}$

Calculate the number of moles of a compound

Beer has about 10. gm of ethanol (C2H6O), how many moles of ethanol? How many ethanol molecules? How many carbon atoms? How many hydrogen atoms? How many oxygen atoms?

$\text{Mass}_{C2H6O} := 10.0 \cdot gm$

$\text{MW}_{C2H6O} = 46.06904 \cdot gm \cdot mole^{-1}$

$\text{Mole}_{C2H6O} := \frac{\text{Mass}_{C2H6O}}{\text{MW}_{C2H6O}}$ $\quad \text{Mole}_{C2H6O} = 0.21706552 \cdot mole$

$N := 6.022136736 \cdot 10^{23} \cdot mole^{-1}$

$\text{Molecule}_{C2H6O} := \text{Mole}_{C2H6O} \cdot N$ $\quad \text{Molecule}_{C2H6O} = 1.30719823 \cdot 10^{23}$

$\text{Atom}_{C} := 2 \cdot \text{Molecule}_{C2H6O}$ $\quad \text{Atom}_{C} = 2.61439645 \cdot 10^{23}$

$\text{Atom}_{H} := 6 \cdot \text{Molecule}_{C2H6O}$ $\quad \text{Atom}_{H} = 7.84318936 \cdot 10^{23}$

$\text{Atom}_{O} := \text{Molecule}_{C2H6O}$ $\quad \text{Atom}_{O} = 1.30719823 \cdot 10^{23}$

One cup of Coffe has about 50 mg of caffeine ($C_8N_4O_2H_{10}$). How many moles of caffeine? How many Moles of carbon? How many moles of nitrogen? How many Moles of oxygen? How many moles of hydrogen?

$\text{Mass}_{caffeine} := 50 \cdot mg$

$mg = 1 \cdot 10^{-3} \cdot gm$

$\text{Mass}_{caffeine} = 0.05 \cdot gm$

$\text{MW}_{C} = 12.011 \cdot gm \cdot mole^{-1}$

$\text{MW}_{N} := 14.00674 \cdot gm \cdot mole^{-1}$

$\text{MW}_{O} = 15.9994 \cdot gm \cdot mole^{-1}$

$\text{MW}_{H} = 1.00794 \cdot gm \cdot mole^{-1}$

$\text{MW}_{caffeine} := 8 \cdot \text{MW}_{C} + 4 \cdot \text{MW}_{N} + 2 \cdot \text{MW}_{O} + 10 \cdot \text{MW}_{H}$

$\text{MW}_{caffeine} = 194.19316 \cdot gm \cdot mole^{-1}$

$$\text{Mole}_{\text{caffeine}} := \frac{\text{Mass}_{\text{caffeine}}}{\text{MW}_{\text{caffeine}}} \qquad \text{Mole}_{\text{caffeine}} = 2.57475598 \cdot 10^{-4} \cdot \text{mole}$$

$$\text{Mole}_{C} := 8 \cdot \text{Mole}_{\text{caffeine}} \qquad \text{Mole}_{C} = 2.05980478 \cdot 10^{-3} \cdot \text{mole}$$

$$\text{Mole}_{N} := 4 \cdot \text{Mole}_{\text{caffeine}} \qquad \text{Mole}_{N} = 1.02990239 \cdot 10^{-3} \cdot \text{mole}$$

$$\text{Mole}_{O} := 2 \cdot \text{Mole}_{\text{caffeine}} \qquad \text{Mole}_{O} = 5.14951196 \cdot 10^{-4} \cdot \text{mole}$$

$$\text{Mole}_{H} := 10 \cdot \text{Mole}_{\text{caffeine}} \qquad \text{Mole}_{H} = 2.57475598 \cdot 10^{-3} \cdot \text{mole}$$

Calculate the mass (in grams) of the following:

It is possible to measure a pico mole of CCl_4. How many grams is this?

$$\text{Mole}_{CCl4} := 10^{-12} \cdot \text{mole}$$

$$\text{MW}_{CCl4} := \text{MW}_{C} + 4 \cdot \text{MW}_{Cl}$$

$$\text{MW}_{CCl4} = 153.8218 \cdot \text{gm} \cdot \text{mole}^{-1}$$

$$\text{Mass}_{CCl4} := \text{MW}_{CCl4} \cdot \text{Mole}_{CCl4}$$

$$\text{Mass}_{CCl4} = 1.538218 \cdot 10^{-10} \cdot \text{gm}$$

It is possible to measure an attomole of sodium. How many grams is this? How many atoms?

$$\text{Mole}_{Na} := 10^{-18} \cdot \text{mole} \qquad \text{MW}_{Na} = 22.989768 \cdot \text{gm} \cdot \text{mole}^{-1}$$

$$\text{Mass}_{Na} := \text{MW}_{Na} \cdot \text{Mole}_{Na} \qquad \text{Mass}_{Na} = 2.2989768 \cdot 10^{-17} \cdot \text{gm}$$

$$\text{Atom}_{Na} := \text{Mole}_{Na} \cdot N \qquad \text{Atom}_{Na} = 6.02213674 \cdot 10^{5}$$

A friend of mine from graduate school worked on a laser fluorescence experiment that measured special dye compounds at a concentration of 10 yocto moles. If the dye has a molecualar weight of 300 g/mole, how many grams is this? How many atoms?

$Mole_{dye} := 10 \cdot 10^{-24} \cdot mole$

$MW_{dye} := 300 \cdot gm \cdot mole^{-1}$

$Mass_{dye} := Mole_{dye} \cdot MW_{dye}$ $\quad Mass_{dye} = 3 \cdot 10^{-21} \circ gm$

$Molecule_{dye} := Mole_{dye} \cdot N$ $\quad Molecule_{dye} = 6.02213674$

In a laboratory experiment, it is routine to measure out 0.0154 mole of sodium chloride. How many grams is this?

$Mole_{NaCl} := 0.0154 \cdot mole$

$MW_{NaCl} = 58.442468 \circ gm \cdot mole^{-1}$

$Mass_{NaCl} := Mole_{NaCl} \cdot MW_{NaCl}$

$Mass_{NaCl} = 0.90001401 \circ gm$

Calculate the percent mass of each element for the given chemical formula.

NaCl

$MW_{NaCl} = 58.442468 \circ gm \cdot mole^{-1}$

$MW_{Na} = 22.989768 \circ gm \cdot mole^{-1}$

$MW_{Cl} = 35.4527 \circ gm \cdot mole^{-1}$

$Fraction_{Na} := \frac{MW_{Na}}{MW_{NaCl}}$ $\quad Fraction_{Na} = 0.39337435$ $\quad Fraction_{Na} = 39.33743524 \circ \%$

$Fraction_{Cl} := \frac{MW_{Cl}}{MW_{NaCl}}$ $\quad Fraction_{Cl} = 0.60662565$ $\quad Fraction_{Cl} = 60.66256476 \circ \%$