Mole, Mass & Particles Conversion *Teacher’s Notes*

**GOAL** – We need to be able to convert between number of particles, grams and moles of a substance.

**Counting Particles (atoms & molecules)**

- 1 water molecule = H₂O = 2 hydrogen atoms, 1 oxygen atom
- 1 sugar molecule = C₆H₁₂O₆ = 6 C atoms, 12 H atoms, 6 O atoms
- 1 calcium nitrate molecule = Ca(NO₃)₂ = 1 Ca atoms, 2 N atoms, 6 O atoms

If one drop of water = 1.67 x 10²¹ molecules of water, then what is the number of H & O atoms in an Olympic sized pool???

**Too many to count!**

**** Need something more manageable!

**A Mole …**

- measures the *amount* of something
- is the SI Unit for counting the *quantity* of *particles (aka atoms & molecules)*
- defined as the number of particles in exactly 12 grams of *carbon-12*.
- 1 mole = 602 200 000 000 000 000 000 particles
- Using scientific notation, 1 mole = 6.022 x 10²³ particles = *Avogadro’s number*.

**Particles-to-Moles & Moles-to-Particles Conversions**

1. How many atoms are in 2.4 moles of potassium?

   \[2.4 \text{ mol} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 1.4 \times 10^{24} \text{ atoms}\]

2. 4.5 x 10¹⁵ molecules of carbon dioxide = how many moles of CO₂?

   \[4.5 \times 10^{15} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} = 7.5 \times 10^{-9} \text{ mol}\]

**Using Mass to Count Particles**

**Molar Mass is …**

- the mass of 6.022 x 10²³ *particles*.
- it is measured in *grams* or *kilograms*.
- the same # as the atomic mass on the periodic table, but the units are *grams* instead of *amus’s*.
Molar Mass Calculations
3. Mass of 1 mole (6.022 x 10^{23} particles) of nitrogen (N_2)
   \[14.0 \text{ g} \times 2 \text{ N atoms in N}_2 = 28.0 \text{ g}\]

4. Mass of 1 mole (6.022 x 10^{23} particles) of nitrogen oxide (NO)
   \[14.0 \text{ g of } N \times 16.0 \text{ g of } O = 30.0 \text{ g}\]

5. Mass of 1 mole (6.022 x 10^{23} particles) of lithium oxide (Li_2O)
   \[(6.9 \text{ g of } Li \times 2 \text{ Li atoms}) + 16.0 \text{ g of } O = 29.8 \text{ g}\]

Moles-to-Mass Conversion Calculations
6. What is the mass of 1.5 moles of nickel
   \[1.5 \text{ mol} \times \frac{58.7 \text{ g}}{1 \text{ mol}} = 88.1 \text{ g}\]

7. What is the mass of 6.4 moles of carbon monoxide (NO)
   \[6.4 \text{ mol} \times \frac{30.0 \text{ g}}{1 \text{ mol}} = 192 \text{ g}\]

Mass-to-Mole Conversion Calculations
8. How many moles are in 54.5 g of water (H_2O)?
   \[54.5 \text{ g} \times \frac{1 \text{ mol}}{18.0 \text{ g}} = 3.03 \text{ mol}\]

9. How many moles are in 1.95 kg of carbon dioxide (CO_2)?
   \[1.95 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol}}{44.0 \text{ g}} = 44.3 \text{ mol}\]

In Summary
- Individual **particles** (atoms and molecules) are measured in **atomic mass units (amu's)**
- **Moles** of particles (atoms and molecules) are measured in **grams**.
- We need to convert between the number of particles, the number of moles, and the mass of a substance.
  
  # of Particles \[\leftrightarrow\] Moles \[\leftrightarrow\] Mass

- Use the factor label method and the following conversion factors:

  \[
  \begin{array}{cccc}
  \text{Particles} & \rightarrow & \text{Moles} & \text{Moles} & \rightarrow & \text{Particles} & \text{Moles} & \rightarrow & \text{Mass} & \text{Mass} & \rightarrow & \text{Moles} \\
  \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ particles}} & \times & \frac{6.022 \times 10^{23} \text{ particles}}{1 \text{ mol}} & \times & \frac{\text{molar mass from PT}}{1 \text{ mol}} & \times & \frac{1 \text{ mol}}{\text{molar mass from PT}}
  \end{array}
  \]