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Measuring Matter

I. Counting Particles

1. **Define the term mole.**

# of carbon atoms in 12g of pure carbon-12

Mole – (mol) - the base unit used to measure the amount of a substance

2. **How many particles are in one mole?** 6.02×10^{23} (602,213,670,000,000,000,000,000) particles

This value is also known as : Avogadro's Number (4) *(use 3 significant figures).*

3. **The mole is convenient to use to count** large **quantities of particles.**

II. Converting Between Moles & Particles

1. **Using Dimensional Analysis, determine how much soda you need for a party if you need four-and-one-half cases of Mt. Dew.**

Step #1 : Determine the Relationship : (1) case = 24 cans of soda

Step #2 : Conversion Factors : $\frac{24 \text{ cans}}{1 \text{ case}}$ and $\frac{1 \text{ case}}{24 \text{ cans}}$

Step #3 : Conversion : $4.5 \text{ cases} \times \frac{24 \text{ cans}}{1 \text{ case}} = 108 \text{ cans}$

2. **Determine how many particles are in 3.5 mol of sucrose.**

Step #1 : Determine the Relationship : (1) mol = 6.02×10^{23} particles

Step #2 : Conversion Factors : $\frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}}$ and $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}}$

Step #3 : Conversion : $3.5 \text{ mol sucrose} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol sucrose}} = 2.11 \times 10^{24} \text{ atoms (sucrose)}$

3. **Determine how many moles are in 2.11 x 10^{24} molecules of sucrose.**

Step #1 : Determine the Relationship : (1) mol = 6.02×10^{23} particles

Step #2 : Conversion Factors : $\frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}}$ and $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}}$

Step #3 : Conversion : $2.11 \times 10^{24} \text{ molecules (sucrose)} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms (sucrose)}} = 3.5 \text{ mol (sucrose)}$

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III. Mass & The Mole

1. **All atoms have similar masses.**

   (Circle One) : True (False)

2. **What are the atomic-mass values of each of the following elements?**

   Weighted isotope averages

   Carbon : 12.011 amu Hydrogen : 1.008 amu Helium : 4.003 amu

3. **If one mole is defined as the number of Carbon-12 atoms in exactly 12 grams of pure Carbon-12, then one mole of Carbon-12 atoms is equal to** 12 **grams.**

4. **The molar mass of any element is equal to its atomic mass.**

   (Circle One) : (True) False

   Iron = 55.845 amu = 55.845 g (55.845 g/mol)

5. **The units for measuring molar mass are :** g/mol .

IV. Using Molar Mass

1. **Instead of counting out five dozen jelly beans, determine how many grams of jelly beans would need weighed to get 5 dozen jelly beans (*assume one-dozen equals 35 grams*).**

   1. $\frac{35\text{ g jelly beans}}{1\text{ dozen}}$ and $\frac{1\text{ dozen}}{35\text{ g jelly beans}}$ 2. $5\text{ dozen} \times \frac{35\text{ g beans}}{1\text{ dozen}} = 175\text{ g jelly beans}$

2. **Determine how much copper (Cu) is needed if 3.00 mol is required for a lab.**
   (Use the Periodic Table to find the mass of Cu / Round to significant figures provided)

   Cu = 63.546 amu

   $3.00\text{ mol Cu} \times \frac{63.546\text{ g Cu}}{1\text{ mol Cu}} = 191\text{ g Cu}$

3. **How would you determine how many jelly beans are remaining if you have 550 g of jelly beans (*assume one-dozen equals 35 grams*).**

   See #1

   $550\text{ g jelly beans} \times \frac{1\text{ dozen}}{35\text{ g jelly beans}} = 16\text{ doz} \times \frac{12\text{ beans}}{1\text{ doz}} = 192\text{ jelly beans}$

4. **How many atoms of oxygen are in 1.00 g of oxygen?**
   (Use the Periodic Table to find the mass of O_2 / Round to significant figures provided)

   $O_2 = 31.998$ amu

   $O = 15.999$

   $1.00\text{ g } O_2 \times \frac{1\text{ mol } O_2}{31.998\text{ g } O_2} \times \frac{6.02 \times 10^{23}\text{ atom}}{1\text{ mol } O_2} = 1.88 \times 10^{22}\text{ atoms } O_2$

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V. Moles Of Compounds

1. **The formula for Freon (CCl_2F_2) represents a 1:2:2 ratio of C-Cl-F, which also represents a mole of the compound.**

   (Circle One) : (True) False

2. **Determine how many moles of fluorine are in 5.50 mol of Freon (CCl_2F_2).**

   Step #1 : Determine the Relationship : CCl_2F_2 = 1 C, 2 Cl_2, 2 F_2

   Step #2 : Conversion Factors :

   $\frac{1\ mol\ C}{1\ mol\ CCl_2F_2}$ $\frac{2\ mol\ Cl}{1\ mol\ CCl_2F_2}$ $\frac{2\ mol\ F}{1\ mol\ CCl_2F_2}$

   Step #3 : Conversion :

   $5.50\ mol\ CCl_2F_2 \times \frac{2\ mol\ Cl}{1\ mol\ CCl_2F_2} =$ 11.0 mol F atoms

VI. Molar Mass Of Compounds

1. **The mass of the mole of a compound equals the sum of the masses of all of the particles in the compound.**

   (Circle One) : (True) False

2. **Determine the molar mass of potassium chromate, K_2CrO_4.**

   K = 39.10 amu
   Cr = 52.00 amu
   O = 16.00 amu

   1. $2\ mol\ K \times \frac{39.10\ g}{1\ mol\ K} = 78.20\ g$
   2. $1\ mol\ Cr \times \frac{52.00\ g}{1\ mol\ Cr} = 52.00\ g$
   3. $4\ mol\ O \times \frac{16.00\ g\ O}{1\ mol\ O} = 64.00\ g$

   $78.20\ g + 52.00\ g + 64.00\ g = 194.20\ g$

3. **Determine the mass of 2.50 mol of allyl sulfide, $(C_3H_5)_2S$.** ← garlic odor

   S = 32.07 amu
   C = 12.01 amu
   H = 1.008 amu

   1. $1\ mol\ S \times \frac{32.07\ g}{1\ mol\ S} = 32.07\ g$
   2. $6\ mol\ C \times \frac{12.01\ g}{1\ mol\ C} = 72.06\ g$
   3. $10\ mol\ H \times \frac{1.008\ g}{1\ mol\ H} = 10.08\ g$

   $114.21\ g/mol$ $(C_3H_5)_2S$

   $2.50\ mol\ (C_3H_5)_2S \times \frac{114.21\ g}{1\ mol} = 286\ g$

4. **Determine the number of moles of calcium hydroxide, $Ca(OH)_2$, in 325 g of the compound.**

   Ca = 40.08 amu
   O = 16.00 amu
   H = 1.008 amu

   1. $1\ mol\ Ca \times \frac{40.08\ g}{1\ mol\ Ca} = 40.08\ g$
   2. $2\ mol\ O \times \frac{16.00\ g}{1\ mol\ O} = 32.00\ g$
   3. $2\ mol\ H \times \frac{1.008\ g}{1\ mol\ H} = 2.016\ g$

   $74.10\ g/mol$ $Ca(OH)_2$

   ← Rust removes

   $325\ g\ Ca(OH)_2 \times \frac{1\ mol\ Ca(OH)_2}{74.10\ g} = 4.39\ mol\ Ca(OH)_2$

   ← Refine petroleum

5. **Determine the mass (per formula unit) of 35.6 g of aluminum chloride, $AlCl_3$.**

   Al = 26.98 amu
   Cl = 35.45 amu

   1. $1\ mol\ Al \times \frac{26.98\ g}{1\ mol} = 26.98\ g$
   2. $3\ mol\ Cl \times \frac{35.45\ g}{1\ mol} = 106.35\ g$

   $133.33\ g/mol$ $AlCl_3$

   $\frac{133.33\ g\ AlCl_3}{mol} \times \frac{1\ mol}{6.02 \times 10^{23}\ units} = 2.21 \times 10^{-22}\ AlCl_3/unit$