Chem 151 Help Session I

Mole and Molarity *(Answer Key)*

Mole

To count a bottle of glass beads by its mass *(demonstration)*

1 dozen = 12

To count atoms and molecules by their masses

1 mole = 6.0221 x 10^{23} **Knowing the molar mass of atoms/molecules enable us to count the number of atoms/ molecules.**

1. How many sucrose molecules ($C_{12}H_{22}O_{11}$) in 5.00 lbs of cane sugar?

   Molar mass of sucrose = 342.3 g/mol

   Number of sucrose molecules = $(5.00\,lbs)(\frac{454\,g}{1\,lb})(\frac{1\,mol}{342.3\,g}) = 6.63\,mol$

2. How many carbon atoms in 5.00 lbs of cane sugar?

   One mole of sucrose contains 12 moles of C atoms.

   Number of C atoms = $(6.63\,mol\ sucrose)(\frac{12\,mol\ C\ atoms}{1\,mol\ sucrose}) = 79.6\,mol\ C\ atoms$

3. If 5.00 lbs of cane sugar is burned in air and all the carbon turns into carbon dioxide gas, how many grams of carbon dioxide can be produced from the reaction?

   It is not necessary to know the balanced reaction equation to solve this problem. Since air will provide the oxygen needed for the reaction, all the carbon atoms in sucrose will turn into carbon dioxide. Therefore, the moles of CO_2 produced should be equal to the moles of C atoms in sucrose; (that is, 79.6 moles CO_2 gas).

   Grams of CO_2 produced = $(79.6\,mol\ CO_2)(\frac{44.01\,g}{1\,mol\ CO_2}) = 3.50\times10^{3}\ g$

4. When bromine is added to sodium hydroxide solution at elevated temperature, the following reaction takes place.

   $3\ Br_2\ +\ 6\ NaOH\ \rightarrow 5\ NaBr\ +\ NaBrO_3\ +\ 3\ H_2O$

   Calculate the number of grams of sodium bromide and sodium bromate that can be produced by the reaction of 3.00 g bromine and an excess amount of sodium hydroxide.

   From the reaction equation, we know that 3 Br_2 react to produce 5 NaBr and one $NaBrO_3$. Therefore, to solve this problem, first we must find out how many Br_2 in 3.00 g.

   Moles of Br_2 = $(3.00\,g)(\frac{1\,mol\ Br_2}{159.8\,g}) = 0.0188\,mol\ Br_2$

   Grams of NaBr produced = $(0.0188\,mol\ Br_2)(\frac{5\,mol\ NaBr}{3\,mol\ Br_2})(\frac{102.9\,g}{1\,mol\ NaBr}) = 3.22\,g$

   Grams of $NaBrO_3$ produced = $(0.0188\,mol\ Br_2)(\frac{1\,mol\ NaBrO_3}{3\,mol\ Br_2})(\frac{150.9\,g}{1\,mol\ NaBrO_3}) = 0.946\,g$

Molarity

$$\textbf{Molarity of } x = \frac{\text{moles of } x}{\text{Volume of solution in } L}$$

$$\textbf{Moles of } x = M_x V_x$$

5. 5.00 g of $MgCl_2$ (MM = 95.25 g/mol) dissolves in water to make 80.0 mL of solution.

   a) What is the molarity of $MgCl_2$ in solution?

   Moles of $MgCl_2$ in 5.00 g = $(5.00\,g)(\frac{1\,mol}{95.25\,g}) = 0.0525\,mol$

   Molarity of $MgCl_2$ in solution = $\frac{0.0525\,mol}{0.0800\,L}) = 0.656\,mol/L = 0.656\,M$

   b) What is the molartiy of Cl^- ions in solution?

   Since every mole of $MgCl_2$ produces 2 moles of Cl^- ions, there are 2 x 0.0525 mol Cl^- = 0.105 mol Cl^- in solution.

   Molarity of Cl^- ions = $\frac{0.105\,mol}{0.0800\,L} = 1.31\,mol/L = 1.31\,M$

   c) What is the molarity of Mg^{2+} ions in solution?

   Since one mole of $MgCl_2$ produces one mole of Mg^{2+} in solution, the molarity of Mg^{2+} ions should be the same as the molarity of $MgCl_2$, which is 0.656 M.

6. 5.00 g of $MgCl_2$ and 4.00 g of NaCl (MM = 58.44 g/mol) dissolves in water to make 80.0 mL of solution. What is the molarity of Cl^- in solution?

   First, one must obtain the total number of moles of Cl^- in solution.

   Moles of Cl^- from $MgCl_2$ = $(5.00\,g)(\frac{1\,mol\ MgCl_2}{95.25\,g})(\frac{2\,mol\ Cl^-}{1\,mol\ MgCl_2}) = 0.105\,mol\ Cl^-$

   Moles of Cl^- from NaCl = $(4.00\,g)(\frac{1\,mol}{58.44\,g}) = 0.0684\,mol\ Cl^-$

   Molarity of Cl^- in 80.0 mL solution = $\frac{(0.105 + 0.0684)\,mol\ Cl^-}{0.0800\,L} = 2.17\,mol/L = 2.17\,M$

7. How many grams of NaCl are needed for preparing 600. mL of a 0.250 M solution?

   Moles of NaCl in solution = (0.250 mol/L)(0.600 L) = 0.150 mol NaCl

   Grams of NaCl in 0.150 mol = (0.150 mol NaCl)(58.44 g/mol) = 8.77 g

8. Calculate the mass of AgCl precipitate (MM = 143.32 g/mol) formed from the reaction of 150 mL of 0.300 M $AgNO_3$ solution and an excess amount of $BaCl_2$.

   Moles of AgCl produced = moles of $AgNO_3$ = (0.300 mol/L)(0.150 L) = 0.0450 mol

   Mass of AgCl produced = $(0.0450\,mol)(\frac{143.3\,g}{1\,mol}) = 6.45\,g$

9. Calculate the volume of a 0.200M barium chloride solution required in order to precipitate all the silver ions from 150 mL of 0.300 M $AgNO_3$ solution.

   Moles of Cl^- ions needed = moles of Ag^+ ions = (0.300 mol/L)(0.150 L) = 0.0450 mol

   Moles of $BaCl_2$ needed = $(0.0450\ mol\ Cl^-)(\frac{1\,mol\ BaCl_2}{2\ mol\ Cl^-}) = 0.0225\ mol\ BaCl_2$

   Volume of $BaCl_2$ solution needed = $(0.0225\ mol\ BaCl_2)(\frac{1\ L\ solution}{0.200\ mol\ BaCl_2}) = 0.112\ L$