Name Mr. Shank Period AP 1, 2, 3

Introduction to the Mole

1. What is the value of Avogadro's number? $N_A = 6.022 \times 10^{23}$

2. How many eggs are in one mole of eggs? Eggs = 6.022×10^{23}

3. Give the molar masses of each of the following compounds. Show all **work** AND all **units**.

   a) NO_2

   molar mass (NO_2) = 1 × molar mass (N) + 2 × molar mass (O)

   = 1 (14.007 g/mol) + 2 (16.00 g/mol)

   = **46.007 g/mol**

   b) $CuSO_4$

   molar mass $(CuSO_4)$ = 1 × Molar mass (Cu) + 1 × molar mass (S) + 4 × molar mass (O)

   = 1 (63.55 g/mol) + 1 (32.06 g/mol) + 4 (16.00 g/mol)

   = **159.61 g/mol**

   c) $Mg(NO_3)_2$

   molar mass $(Mg(NO_3)_2)$ = 1 × molar mass (Mg) + 2 × [1 × molar mass (N) + 3 × molar mass (O)]

   = 1 (24.30 g/mol) + 2 [1 (14.007 g/mol) + 3 (16.00 g/mol)]

   = **148.314 g/mol**

4. Give the number of moles in

   a) 100 g of NO_2

   $$100 \text{ g } NO_2 \times \frac{\text{mol } NO_2}{46.007 \text{ g } NO_2} = \textbf{2.17 mol } NO_2$$

   b) 26 g of $CuSO_4$

   $$26 \text{ g } CuSO_4 \times \frac{1 \text{ mol } CuSO_4}{159.61 \text{ g } CuSO_4} = \textbf{0.16 mol } CuSO_4$$

   c) 8.64 mg of $Mg(NO_3)_2$

   $$8.64 \text{ mg } Mg(NO_3)_2 \left| \frac{1 \text{ g}}{1000 \text{ mg}} \right| \frac{1 \text{ mol } Mg(NO_3)_2}{148.314 \text{ g } Mg(NO_3)_2} = 0.0000583 = \textbf{5.83} \times 10^{-5} \textbf{ mol } Mg(NO_3)_2$$

5. Give the number of molecules in [redacted]

a) 100 g of NO_2

Method 1: Convert from moles (found in last problem) to molecules

$$2.17 \text{ mol } NO_2 \times \frac{6.022 \times 10^{23} \text{ molecules } NO_2}{1 \text{ mol } NO_2} = \boxed{1.31 \times 10^{24} \text{ molecules } NO_2}$$

Method 2: Convert directly from mass to molecules

$$\frac{100 \text{ g } NO_2}{46.007 \text{ g } NO_2} \left| \frac{1 \text{ mol } NO_2}{1 \text{ mol } NO_2} \right| \frac{6.022 \times 10^{23} \text{ molecules } NO_2}{1 \text{ mol } NO_2} = \boxed{1.31 \times 10^{24} \text{ molecules } NO_2}$$

b) 31 mol of $CuSO_4$

$$\frac{31 \text{ mol } CuSO_4}{1 \text{ mol } CuSO_4} \left| \frac{6.022 \times 10^{23} \text{ molecules } CuSO_4}{1 \text{ mol } CuSO_4} \right| = \boxed{1.87 \times 10^{25} \text{ molecules } CuSO_4}$$

c) 92 millimole of $Mg(NO_3)_2$

$$\frac{92 \text{ millimole } Mg(NO_3)_2}{1000 \text{ millimole } Mg(NO_3)_2} \left| \frac{1 \text{ mol } Mg(NO_3)_2}{1 \text{ mol } Mg(NO_3)_2} \right| \frac{6.022 \times 10^{23} \text{ molecules } Mg(NO_3)_2}{1 \text{ mol } Mg(NO_3)_2} = \boxed{5.54 \times 10^{22} \text{ molecules } Mg(NO_3)_2}$$

6. Balance the following chemical equations:

a) $\underline{2}\ C_8H_{18} + \underline{25}\ O_2 \rightarrow \underline{16}\ CO_2 + \underline{18}\ H_2O$

b) $\underline{2}\ Ca_3(PO_4)_2 + \underline{6}\ SiO_2 + \underline{10}\ C \rightarrow \underline{1}\ P_4 + \underline{6}\ CaSiO_3 + \underline{10}\ CO$

7. Vanadium (V) oxide, V_2O_5, can be reduced by zinc to form vanadium (II) oxide, V_2O_2, and zinc oxide, ZnO.

$$\underline{1}\ V_2O_5 + \underline{3}\ Zn \rightarrow \underline{1}\ V_2O_2 + \underline{3}\ ZnO$$

a) Balance the above reaction by putting the correct coefficients in the blanks.

b) Assuming an unlimited amount of zinc metal, what mass of V_2O_5 is needed to produce 100 g of V_2O_2?

$$100 \text{ g } V_2O_2 \times \frac{1 \text{ mol } V_2O_2}{133.88 \text{ g } V_2O_2} \times \frac{1 \text{ mol } V_2O_5}{1 \text{ mol } V_2O_2} \times \frac{181.88 \text{ g } V_2O_5}{1 \text{ mol } V_2O_5} = \boxed{135.85 \text{ g } V_2O_5}$$