Atomic Mass and Molar Mass Conversions and Stoichiometry

1. Calculate the molecular mass of ibuprofen **$C_{13}H_{18}O_2$**

Number of atoms C 13 H 18 O 2
Atomic mass of C 12.011 amu H 1.00794 amu O 15.9994 amu

13 x 12.011 amu + 18 x 1.00794 amu + 2 x 15.9994 amu = **206.28 amu**

2. Calculate the formula weight of $Al_2(SO_4)_3$.

Number of atoms Al 2 S 3 O 12
Atomic mass of Al 26.98 amu S 32.07 amu O 15.9994 amu
2 × 26.98 amu + 3 × 32.07 amu + 12 × 15.9994 amu = **342.16 amu**

3. How many molecules of oxygen (O_2) are present in a 0.250 mol sample of the gas?
Given: mole Desired: molecules

Equivalences:
1 mol = 6.02 x 10^{23} molecules
Conversion factors

$$\frac{1\ mol}{6.02\times10^{23} molecules}\ or\ \frac{6.02\times10^{23} molecules}{1\ mol}$$

Setup:

$$0.250\ mol \times \frac{6.02\times10^{23} molecules}{1\ mol} = \mathbf{1.50\times10^{23}\ molecules}$$

4. I have 2.61 x 10^{23} C atoms. How many moles is this? How many grams?

Given units: atoms desired units: moles and grams

Equivalences: 1 mol = 6.02 × 10^{23} atoms; 1 mol C = 12.011 g

Roadmap: atoms → mol → grams

Conversion factors

$$\frac{1\ mol}{6.02\times10^{23}\ atoms}\ or\ \frac{6.02\times10^{23}\ atoms}{1\ mol};\quad \frac{1\ mol\ C}{12.011\ g}\ or\ \frac{12.011\ g}{1\ mol\ C}$$

Setup: $2.61\times10^{23} C\ atoms \times \frac{1\ mol\ C}{6.02\times10^{23}\ atoms} = \mathbf{0.434\ mol}$

$$0.434\ mol \times \frac{12.011\ g}{1\ mol} = \mathbf{5.21\ g}$$

5. Calculate the molar mass of NH_3.

14.0067 g/mol + 3 x 1.00794 g = **17.03 g/mol**

What is the mass in grams of 0.25 mol NH_3?

Given: mol Desired: grams Equivalence: 1 mol NH_3 = 17.03 g NH_3

Conversion Factors

$$\frac{1\ mol\ NH_3}{17.03\ g} \qquad \frac{17.03\ g}{1\ mol\ NH_3}$$

Setup:

$$0.25\ mol\ NH_3 \times \frac{17.03\ g}{1\ mol\ NH_3} = \mathbf{4.26\ g}$$

How many moles NH_3 are in 25.0 g?

Given: g Desired: mol Equivalence: 1 mol NH_3 = 17.03 g NH_3

Setup:

$$25.0\ g \times \frac{1\ mol\ NH_3}{17.03\ g} = \mathbf{1.47\ mol}$$

6. How many moles of aspirin ($C_9H_8O_4$) are in a 350 mg tablet?

350 mg = 0.350 g

1 mole $C_9H_8O_4$ = 9 x 12.011 g/mol + 8 x 1.00794 g/mol + 4 x 15.9994 g/mol = 180.16 g/mol

$$0.350\ g \times \frac{1\ mol}{180.16\ g} = \mathbf{0.00194\ mol}$$

7. How many moles of sodium hydrogen phosphate are in 2.8 g? How many moles of Na^+ ions? How many moles of HPO_4^{2-} ions?

M_m Na_2HPO_4 = 2 x 22.99 g/mol + 1.00794 g/mol + 30.97 g/mol + 4 x 15.9994 g/mol = 141.96 g/mol

$$2.8\ g\ Na_2HPO_4 \times \frac{1\ mol}{141.96\ g} = \mathbf{0.020\ mol\ Na_2HPO_4}$$

$$\mathbf{0.020\ mol\ Na_2HPO_4} \times \frac{\mathbf{2\ mol\ Na^+}}{\mathbf{1\ mol\ Na_2HPO_4}} = \mathbf{0.040\ mol\ Na^+\ ions}$$

$$\mathbf{0.020\ mol\ Na_2HPO_4} \times \frac{\mathbf{1\ mol\ HPO_4^{2-}}}{\mathbf{1\ mol\ Na_2HPO_4}} = \mathbf{0.020\ mol\ HPO_4^{2-}\ ions}$$

8. Consider the following reaction:

$$Ni\ (s) + 2\ HCl\ (aq) \longrightarrow NiCl_2\ (aq) + H_2(g)$$

ALWAYS make sure equation is balanced!!!!!!!!!!

a) How many moles of nickel will react with 2.40 moles HCl?

Mole ratios: $\frac{1\ mol\ Ni}{2\ mol\ HCl}$ and $\frac{2\ mol\ HCl}{1\ mol\ Ni}$

Setup: 2.40 mol HCl x $\frac{1 \text{ mol Ni}}{2 \text{ mol HCl}}$ = **1.20 mol Ni**

b) How many moles of $NiCl_2$ are formed if 3.2 moles of HCl are reacted?

Mole ratios: $\frac{1 \text{ mol } NiCl_2}{2 \text{ mol HCl}}$ and $\frac{2 \text{ mol HCl}}{1 \text{ mol } NiCl_2}$

Setup: 3.2 mol HCl x $\frac{1 \text{ mol } NiCl_2}{2 \text{ mol HCl}}$ = **1.6 mol Ni Cl_2**

c) How many grams of $NiCl_2$ are produced for every 2.60 mol of Ni reacted?

Mole ratios: $\frac{1 \text{ mol } NiCl_2}{1 \text{ mol Ni}}$ and $\frac{1 \text{ mol Ni}}{1 \text{ mol } NiCl_2}$

Equivalence: 1 mol $NiCl_2$ = 126.9 g

Additional Conversion factors $\frac{1 \text{ mol } NiCl_2}{126.9 \text{ g}}$ and $\frac{126.9 \text{ g}}{1 \text{ mol } NiCl_2}$

Setup: 2.60 mol Ni x $\frac{1 \text{ mol } NiCl_2}{1 \text{ mol Ni}}$ x $\frac{126.9 \text{ g}}{1 \text{ mol } NiCl_2}$ = 330 g $NiCl_2$

d) How many grams of HCl is needed to produce 0.6678 g H_2 gas?

Mole ratios: $\frac{2 \text{ mol HCl}}{1 \text{ mol } H_2}$ and $\frac{1 \text{ mol } H_2}{2 \text{ mol HCl}}$

Equivalences: 1 mol HCl = 36.460 g and 1 mole H_2 = 2.016 g

Additional Conversion Factors:

Setup: 0.6778 g H_2 x $\frac{1 \text{ mol } H_2}{2.016 \text{ g}}$ x $\frac{2 \text{ mol HCl}}{1 \text{ mol } H_2}$ x $\frac{36.460 \text{ g}}{1 \text{ mol HCl}}$ = **24.52 g HCl**

e) Using the information obtained from part c, what is the percent yield if in an experiment 322 g of $NiCl_2$ was recovered?

% yield = $\frac{\text{actual yield, g}}{\text{theoretical yield , g}} \times 100$

theoretical yield 330 g actual yield 322 g

calculation: $\frac{322\ g}{330\ g} \times 100 = \mathbf{97.6\%}$