1. You have a 26.98 g piece of aluminum.
   a) How many moles are in 26.98 g of Al?

Ans. $\#\ mol\ of\ Al\ = \left(\frac{26.98\ g\ Al}{1}\right)\left(\frac{1\ mol\ Al}{26.98\ g\ Al}\right) = 1.000\ mol\ Al$

   b) How many atoms are in 26.98 g of Al?

Ans. $\#\ atoms\ of\ Al\ = \left(\frac{1.000\ mol\ Al}{1}\right)\left(\frac{6.022x10^{23}\ atoms}{1\ mol}\right) = 6.022x10^{23}\ atoms\ Al$

   c) How many moles are in 5.00 g of Al?

Ans. $\#\ mol\ of\ Al\ = \left(\frac{5.00\ g\ Al}{1}\right)\left(\frac{1\ mol\ Al}{26.98\ g\ Al}\right) = 0.185\ mol\ Al$

   d) How many atoms are in 5.00 g of Al?

Ans. $\#\ atoms\ of\ Al\ = \left(\frac{0.185\ mol\ Al}{1}\right)\left(\frac{6.022x10^{23}\ atoms}{1\ mol}\right) = 1.11x10^{23}\ atoms\ Al$

2. You have a 20.00 g sample of chlorine gas.
   a) How many moles of $Cl_2$ are in the 20.00 g sample?

Ans. $\#\ mol\ of\ Cl_2\ = \left(\frac{20.00\ g\ Cl_2}{1}\right)\left(\frac{1\ mol\ Cl_2}{70.90\ g\ Cl_2}\right) = 0.2821\ mol\ Cl_2$

   b) How many molecules are in 20.00 g of $Cl_2$?

Ans. $\#\ molecules\ of\ Cl_2\ = \left(\frac{0.2821\ mol\ Cl_2}{1}\right)\left(\frac{6.022x10^{23}\ molecules}{1\ mol}\right) = 1.699x10^{23}\ molecules\ Cl_2$

   c) How many Cl atoms are in 20.00 g of $Cl_2$?

Ans. $\#\ atoms\ of\ Cl\ = \left(\frac{1.699x10^{23}\ molecules\ Cl_2}{1}\right)\left(\frac{2\ atoms\ Cl}{1\ molecule\ Cl_2}\right) = 3.398x10^{23}\ atoms\ Cl$

   d) How many moles of $Cl_2$ are in a 5.00 g sample?

Ans. $\#\ mol\ of\ Cl_2\ = \left(\frac{5.00\ g\ Cl_2}{1}\right)\left(\frac{1\ mol\ Cl_2}{70.90\ g\ Cl_2}\right) = 0.0705\ mol\ Cl_2$

   e) How many molecules of $Cl_2$ are in 5.00 g?

Ans. $\#\ molecules\ of\ Cl_2\ = \left(\frac{0.0705\ mol\ Cl_2}{1}\right)\left(\frac{6.022x10^{23}\ molecules}{1\ mol}\right) = 4.25x10^{22}\ molecules\ Cl_2$

3. You have a sample containing 10.00 g of $AlCl_3$?
   a) What is the molecular mass of $AlCl_3$?

Ans.

| Element | Atomic Mass | # of Atoms | Net Molar Mass |
|---|---|---|---|
| Al | 26.98 | 1 | 26.98 |
| Cl | 35.45 | 3 | 106.35 |
| | | **Molar Mass →** | 133.33 |

   b) How many moles of $AlCl_3$ are in the sample?

Ans. $$\#\ mol\ of\ AlCl_3 = \left(\frac{10.00\ g\ AlCl_3}{1}\right)\left(\frac{1\ mol\ AlCl_3}{133.33\ g\ AlCl_3}\right) = 7.500x10^{-2}\ mol\ AlCl_3$$

   c) How many moles of $Al^{3+}$ are in the sample?

Ans. $$\#\ mol\ of\ Al^{3+} = \left(\frac{7.500x10^{-2}\ mol\ AlCl_3}{1}\right)\left(\frac{1\ Al^{3+}}{1\ AlCl_3}\right) = 7.500x10^{-2}\ mol\ Al^{3+}$$

   d) How many moles of $Cl^-$ are in the sample?

Ans. $$\#\ mol\ of\ Cl^- = \left(\frac{7.500x10^{-2}\ mol\ AlCl_3}{1}\right)\left(\frac{3\ Cl^-}{1\ AlCl_3}\right) = 2.250x10^{-1}\ mol\ Cl^-$$

   e) How many grams of $Al^{3+}$ are in the sample?

Ans. $$\#\ grams\ of\ Al^{3+} = \left(\frac{7.500x10^{-2}\ mol\ AlCl_3}{1}\right)\left(\frac{26.98\ g\ Al^{3+}}{1\ mol\ Al^{3+}}\right) = 2.024\ g\ Al^{3+}$$

   f) How many grams of $Cl^-$ are in the sample?

Ans. $$\#\ grams\ of\ Cl^- = \left(\frac{2.250x10^{-1}\ mol\ AlCl_3}{1}\right)\left(\frac{35.45\ g\ Cl^-}{1\ mol\ Cl^-}\right) = 7.976\ g\ Cl^-$$

4. You dissolve 25.00 g of $AlCl_3$ in 1.0 L of de-ionized $H_2O$.
   a) How many moles of $AlCl_3$ are dissolved?

Ans. $$\#\ mol\ of\ AlCl_3 = \left(\frac{25.00\ g\ AlCl_3}{1}\right)\left(\frac{1\ mol\ AlCl_3}{133.33\ g\ AlCl_3}\right) = 0.1875\ mol\ AlCl_3$$

   b) How many molecules of $AlCl_3$ are dissolved?

Ans. $$\#\ molecules\ of\ AlCl_3 = \left(\frac{1.875\ mol\ AlCl_3}{1}\right)\left(\frac{6.022x10^{23}\ molecules}{1\ mol}\right) = 1.129x10^{23}\ molecules\ AlCl_3$$

   c) Using the information above, calculate how much volume of this solution you would need to get 5.00 g of $AlCl_3$.

Ans. volume of solution= $\left(\frac{5.00\ g\ AlCl_3}{1}\right)\left(\frac{1.0\ L\ solution}{25.00\ g\ AlCl_3}\right)$=0.20 L solution

5. You have a flask containing 150. g of $H_2O$ (volume is 150. mL).

a) How many moles of $H_2O$ are in 150. g?

Ans. First, calculate the molar mass for $H_2O$:

| Element | Atomic Mass | # of Atoms | Net Molar Mass |
|---|---|---|---|
| H | 1.008 | 2 | 2.016 |
| O | 16.00 | 1 | 16.00 |
| | | **Molar Mass →** | 18.02 |

$$\#\ mol\ of\ H_2O\ =\ \left(\frac{150.\ g\ H_2O}{1}\right)\left(\frac{1\ mol\ H_2O}{18.02\ g\ H_2O}\right)=8.32\ mol\ H_2O$$

b) How many molecules of $H_2O$ are 150. g?

Ans. $$\#\ molecules\ of\ H_2O\ =\ \left(\frac{8.32\ mol\ H_2O}{1}\right)\left(\frac{6.022x10^{23}\ molecules}{1\ mol}\right)=5.01x10^{24}\ molecules\ H_2O$$

c) What is the mass percent of H and O, respectively, in $H_2O$?

Ans. The % H in $H_2O$ is: $$\%\ H\ =\ \left(\frac{net\ molar\ mass\ H}{molar\ mass\ H_2O}\right)\times 100\%=\left(\frac{2.016}{18.02}\right)\times 100\%=11.19\%$$

The % O in $H_2O$ is: $$\%\ O\ =\ \left(\frac{net\ molar\ mass\ O}{molar\ mass\ H_2O}\right)\times 100\%=\left(\frac{16.00}{18.02}\right)\times 100\%=88.79\%$$

d) How much water (in grams) is needed if you need to obtain 10.0 grams of oxygen?

Ans. mass of $H_2O$ = (10.0 g O)/(0.8879) = 11.3 g of $H_2O$

6. In the chemistry lab, you produce 10.0 grams of hydrogen gas from the following chemical reaction:

**$2HCl\ (aq) + Zn\ (s) \rightarrow H_2\ (g) + ZnCl_2\ (aq)$**

a) What is the molar mass of $H_2$?

Ans.

| Element | Atomic Mass | # of Atoms | Net Molar Mass |
|---|---|---|---|
| H | 1.008 | 2 | 2.016 |
| | | **Molar Mass →** | 2.016 |

b) How many moles of $H_2$ are in 10.0 g?

Ans. $$\#\ mol\ of\ H_2\ =\ \left(\frac{10.0\ g\ H_2}{1}\right)\left(\frac{1\ mol\ H_2}{2.016\ g\ H_2}\right)=4.96\ mol\ H_2$$

c) How many moles of Zn are needed to produce 10.0 g of $H_2$?

Ans. The molar ratio of Zn to $H_2$ in this reaction is: 1 Zn:1 $H_2$

Thus, the amount of Zn needed to produce 10.0 g $H_2$, or 4.96 moles of $H_2$ is:

$$\#\ mol\ of\ Zn\ =\ \left(\frac{4.96\ mol\ H_2}{1}\right)\left(\frac{1\ Zn}{1\ H_2}\right)=4.96\ mol\ Zn$$

d) How many grams of Zn are needed to produce the 10.0 g of $H_2$?

Ans. $$\#\ grams\ of\ Zn\ =\ \left(\frac{4.96\ mol\ Zn}{1}\right)\left(\frac{65.41\ g\ Zn}{1\ mol\ Zn}\right)=324.\ g\ Zn$$