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. $\#\ \text{mol of } AlCl_3 = \left(\frac{10.00\ \text{g } AlCl_3}{1}\right)\left(\frac{1\ \text{mol } AlCl_3}{133.33\ \text{g } AlCl_3}\right) = 7.500\text{x}10^{-2}\ \text{mol } AlCl_3$

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

Ans. $\#\ \text{mol of } Al^{3+} = \left(\frac{7.500\text{x}10^{-2}\ \text{mol } AlCl_3}{1}\right)\left(\frac{1\ Al^{3+}}{1\ AlCl_3}\right) = 7.500\text{x}10^{-2}\ \text{mol } Al^{3+}$

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

Ans. $\#\ \text{mol of } Cl^- = \left(\frac{7.500\text{x}10^{-2}\ \text{mol } AlCl_3}{1}\right)\left(\frac{3\ Cl^-}{1\ AlCl_3}\right) = 2.250\text{x}10^{-1}\ \text{mol } Cl^-$

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

Ans. $\#\ \textit{grams of } Al^{3+} = \left(\frac{7.500\text{x}10^{-2}\ \textit{mol } AlCl_3}{1}\right)\left(\frac{26.98\ \textit{g } Al^{3+}}{1\ \textit{mol } Al^{3+}}\right) = 2.024\ \textit{g } Al^{3+}$

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

Ans. $\#\ \text{grams of } Cl^- = \left(\frac{2.250\text{x}10^{-1}\ \text{mol } AlCl_3}{1}\right)\left(\frac{35.45\ \text{g } Cl^-}{1\ \text{mol } Cl^-}\right) = 7.976\ \text{g } Cl^-$

4. You dissolve 25.00 g of $AlCl_3$ in 1.0 kg of de-ionized H_2O.
   a) What is the mass percent of Al^{3+} and Cl^- in $AlCl_3$?

Ans. From above, the net molar mass of Al is 26.98 g per 1 mole (or 133.3 g) of $AlCl_3$, therefore

$$\%\ Al = \left(\frac{26.98\ \text{g Al}}{1\ \text{mol}}\right)\left(\frac{1\ \text{mol}}{133.33\ \text{g } AlCl_3}\right)\times 100\% = 20.24\%$$ {or 20.24 g Al^{3+} per 100 g $AlCl_3$}

The net molar mass of Cl in $AlCl_3$ is 106.35 g per 1 mole (or 133.3 g) of $AlCl_3$, therefore

$$\%\ Cl = \left(\frac{106.35\ \text{g Al}}{1\ \text{mol}}\right)\left(\frac{1\ \text{mol}}{133.33\ \text{g } AlCl_3}\right)\times 100\% = 79.76\%$$

b) What is the mass percent of $AlCl_3$ in the whole aqueous solution (including the water)?

Ans. The mass % of $AlCl_3$ in the solution is just the mass of $AlCl_3$ divided by the total mass of the solution (1.0kg = 1.0×10^3g).

$$\%\ AlCl_3 = \left(\frac{25.00\ g\ AlCl_3}{1.0 \times 10^3\ g\ solution}\right) \times 100\% = 2.5\%$$

Note there are only 2 sig figs in this calculation.

c) How many grams of Al^{3+} and Cl^-, respectively, are dissolved in solution?

Ans. First we need the mass of Al^{3+} and Cl^-, respectively, in the solution:

$$\text{mass of } Al^{3+} = \left(\frac{25.00\ g\ AlCl_3}{1}\right)\left(\frac{0.2024\ g\ Al^{3+}}{1.000\ g\ AlCl_3}\right) = 5.060\ g\ Al^{3+}$$

$$\text{mass of } Cl^- = \left(\frac{25.00\ g\ AlCl_3}{1}\right)\left(\frac{106.35\ g\ Cl^-}{133.33\ g\ AlCl_3}\right) = 19.94\ g\ Cl^-$$

d) What is the mass percent of the Al^{3+} and Cl^- ions in the whole aqueous solution (including the water)?

Ans. The mass % of each of the ions in the solution is:

$$\%\ Al^{3+} = \left(\frac{5.060\ g\ Al^{3+}}{1.0 \times 10^3\ g\ solution}\right) \times 100\% = 0.51\%$$

$$\%\ Cl^- = \left(\frac{19.94\ g\ Cl^-}{1.0 \times 10^3\ g\ solution}\right) \times 100\% = 2.0\%$$

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

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

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

Ans. $$\#\text{ molecules of } H_2O = \left(\frac{8.32\text{ mol } H_2O}{1}\right)\left(\frac{6.022\times10^{23}\text{ molecules}}{1\text{ mol}}\right) = 5.01\times10^{24}\text{ molecules } H_2O$$

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

Ans. The % H in H_2O is: $$\%\text{ H} = \left(\frac{\text{net molar mass H}}{\text{molar mass } H_2O}\right)\times100\% = \left(\frac{2.016}{18.02}\right)\times100\% = 11.19\%$$

The % O in H_2O is: $$\%\text{ O} = \left(\frac{\text{net molar mass O}}{\text{molar mass } H_2O}\right)\times100\% = \left(\frac{16.00}{18.02}\right)\times100\% = 88.79\%$$

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

Ans. $$\text{Mass of } H_2O = \left(\frac{10.0\text{ g O}}{1}\right)\left(\frac{100\text{ g } H_2O}{88.79\text{ g O}}\right) = 11.3\text{ g}$$