Friday worksheet 2a – concentrations in solutions with ionic substances.

Keep in mind - Square brackets [] denotes concentration (mol/L)
eg [NaCl] = concentration of NaCl in mol/L
eg [NaCl] = 0.12M = the concentration of NaCl in the solution is 0.12 mol/L

Exaple 1- What is the concentration of Lead(II) and nitrate ions in a 1.00M $Pb(NO_3)_2$ solution.
Since there is 1.00 mol of $Pb(NO_3)_2$ in every litre we also conclude that there is also 1.00 mol of Pb^{2+} and 2.0 mol of NO_3^- ions in every litre. We can see from the formula that the ratio of ions.

Valency of Some Simple and Polyatomic Ions

Valency	Simple (+ve) ions	Simple (-ve) ions	Polyatomic ions
1	Copper(I), Cu^+ Hydrogen, H^+ Potassium, K^+ Silver, Ag^+ Sodium, Na^+	Hydride, H^- Chloride, Cl^- Bromide, Br^- Iodide, I^-	Ammonium, NH_4^+ Hydrogencarbonate, HCO_3^- Hydroxide, OH^- Nitrate, NO_3^-
2	Calcium, Ca^{2+} Copper(II), Cu^{2+} Iron(II), Fe^{2+} Lead(II), Pb^{2+} Magnesium, Mg^{2+} Zinc, Zn^{2+}	Oxide, O^{2-} Sulfide, S^{2-}	Carbonate, CO_3^{2-} Sulfate, SO_4^{2-}
3	Aluminium, Al^{3+} Iron(III), Fe^{3+}	Nitride, N^{3-}	Phosphate, PO_4^{3-}

Example 2 - Find the $[NH_4^+]$ and $[PO_4^{-3}]$ in a 0.40M solution of ammonium phosphate.
Step 1 – write the formula of ammonium phosphate
=> $(NH_4)_3PO_4$
Step 2 – From the formula we see that for every mol of $(NH_4)_3PO_4$ we have one mol of PO_4^{-3} and three mol of NH_4^+ ions.
=> $[NH_4^+] = 3 \times 0.40 = 1.2M$, $[PO_4^{-3}] = 1 \times 0.40 = 0.40M$

1) Calculate the $[Fe^{3+}]$ and $[OH^-]$ in a 1.21 M Iron(III) hydroxide solution.

   Step 1 Write the formula
   => $Fe(OH)_3$
   Step 2
   => Calculate the concentration of each ion.
   => $[Fe^{3+}] = 1.21$ M
   => $[OH^-] = 3.63$ M

2) Calculate the concentration, in mol/L, of aluminium and nitrate ions in a 3.2 M solution of aluminium nitrate.
   Step 1 Write the formula
   => $Al(NO_3)_3$
   Step 2
   => Calculate the concentration of each ion.
   => $[Al^{3+}] = 3.2$ M
   => $[NO_3^-] = 9.6$ M

3) Calculate the concentration of ions, in mol/L, in a 0.500 M ammonium nitride solution.
   Step 1 Write the formula
   => $(NH_4)_3N$
   Step 2
   => Calculate the concentration of ions.
   For every mol of $(NH_4)_3N$ there are 4 ions.
   => 4 X 0.500 = 2.00 M

4) A solution of aluminium nitrate is formed by dissolving 8.90 g of the substance in 300.0 mL of distilled water.

a. Calculate the concentration of the aluminium nitrate solution.

Step 1 Write the formula of aluminium nitrate $Al(NO_3)_3$
Step 2 Calculate the mol of aluminium nitrate
=> 8.90 / 213 = 0.0418
Step 3 Calculate the concentration in mol/L
=> 0.0418 / 0.300 = 0.139 M

b. Calculate the:

i. $[Al^{3+}]$ = *0.139 M*
ii. $[NO_3^-]$ *= 0.139 X 3 = 0.417 M*

5) A 1.00 L sample of 0.100 M NaCl was mixed with a 500.0 mL 0.200 M NH_4Cl . Given that no reaction takes place and assuming that both NaCl and ammonium chloride are soluble in water, find the concentration in mol/L of chloride ions in the final solution.

Step 1 Calculate the mol of Cl^- ions in the 1.00 L of 0.100 M NaCl
=> mol of Cl^- ions = 0.100 mol
Step 2 Calculate the mol of Cl^- ions in the 500 mL of 0.200M NH_4Cl
=> mol of Cl^- ions = 0.100 mol (if there are 0.200 mol per litre Cl^- then 0.100 will be present in 0.5 litres)
Step 3 Add the mol of Cl^- ions present
=> 0.200 mol
Step 4 Divide the mol by the final volume.
=> 0.200mol/1.5L = 1.33 M

6) 4.52 grams of ammonium phosphate is dissolved in 2.00 L of pure water.

a. calculate the :

i. Concentration of ammonium phosphate in ppm

ppm =mg/L
Step 1 – Find the mg of $(NH_4)_3PO_4$
=> 4520
Step 2 Divide by the number of litres
=> 4520/2.00 = 2260ppm

ii. Concentration of ammonium phosphate in mol/L

Step 1 write the formula
=> $(NH_4)_3PO_4$
step 2 find the mol of $(NH_4)_3PO_4$
=> 4.52 / 149.1 = 0.0303
Step 3 Find the concentration in mol/L
=> 0.0303/ 2.00 = 0.0152 M

iii. $[NH_4^+]$ *= 0.0152 X 3 = 0.0456 M*
iv. $[PO_4^{-3}]$ *= 0.0152 M*

7) 52.0 grams of aluminium nitrate is dissolved in 4.00 L of pure water and then mixed with 2.00 L of a 1.00 M sodium nitrate solution.

a. calculate the :

i. Concentration of aluminium in ppm in the final solution

ppm = mg/L

Since all the aluminium ions come from aluminium nitrate the following steps 1-3 will determine the mass of aluminium in the aluminium nitrate solution.

Step 1 Find the percentage composition of aluminium in aluminium nitrate

=> formula of aluminium nitrate - $Al(NO_3)_3$

=> % mass due to aluminium is (27.0 / 213) X 100 = 12.7%

Step 2 find the mass due to aluminium

=> 52.0 X (12.7 / 100) = 6.60 g

Step 3 convert the mass of aluminium to mg.

=> 6600 mg

Step 4 Divide by the number of litres in the final solution.

=> 6600 mg / 6 L = 1100 ppm.

ii. Concentration of nitrate ions, in mol/L, in the final solution.

Nitrate ions will come from both solutions. Determine the mol of nitrate ions that come from each solution

Step 1 calculate the mol of nitrate ions that come from 52.0 g of aluminium nitrate.

=> mol of aluminium nitrate = 52.0 / 213 = 0.244 mol

=> mol of nitrate ions = 0.24413 X 3 = 0.7324 mol

Step 3 Calculate the mol of nitrate ions that are in the 2.00 litres of the 1.00 M $NaNO_3$.

=> 2 X 1.00 = 2.00 mol.

Step 4 Total mol of nitrate ions.

=> 0.244 + 2.00 = 2.244 mol.

Step 5 Calculate the $[NO_3^-]$ in the final solution.

=> 2.244 mol / 6.00L = 0.374 M