Exercise 1:

1) A numerical indications can be applied in the three positions A, Z and q to the X symbol of an element ($^{A}_{z}X^{q}$). Give the significance of each one ?

2) Find the number of neutrons, protons and electrons in each of the following atoms and ions:

$^{19}_{9}F$, $^{238}_{92}U$, $^{52}_{24}Cr^{3+}$, $^{24}_{12}Se^{2-}$

Exercice 2 : Atom, molecule, mole and Avogadro number

We have 60 g of alum $Al_2(SO_4)_3$. How many is there:

a- $Al_2(SO_4)_3$ molecules.

b- atoms of Aluminum (Al), Sulfur (S) and oxygen (O)

c- grams of Al, S and O.

M(Al)=27g/mol, M(O) 16g/mol, M(S)=32g/mol

Exercice 3 :

1- How many grams of NaCl must be dissolved to obtain 100mL of 0.1M NaCl solution? M_{NaCl}=58.5g.mol^{-1}
2- How many grams of $Ca(OH)_2$ are there in 0.25 L of 0.01N solution of this body?
3- Mix 50 mL of 1.0 M H_2SO_4 with 200mL of 0.5M H_2SO_4. Calculate the concentration of the solution obtained?
4- We take V_0=20mL from a $CuSO_4$ solution with a concentration C_0=5.10^{-2} mol.L^{-1}. This volume is introduced into a 500mL volumetric flask, filled with distilled water, then homogenized. Calculate the molarity, the normality of this solution?.

Exercice 4 : Calculate molarity and normality:

1- a solution of hydrochloric acid HCl knowing that on the label we find the following information: 37% by mass; 1.19kg/L and M =36.5g/mol.

2- of a concentrated solution of H_2SO_4, that it is 96% by mass and that its density is 1.84. We give M (H_2SO_4) =98g/mol

3- an aqueous solution of aluminum chloride ($AlCl_3$) by dissolving 0.55 g of this salt in 50 mL water.

Exercice 5 :

Commercial sulfuric acid is a liquid with density d = 1.84 contains 98% (by mass) of pure H_2SO_4.

1- Write down the equation for its chemical reaction in water

2- Calculate the molarity and normality of this acid.

3 - What respective volumes of this solution and water must be mixed to obtain 2 liters of 2 N H_2SO_4 solution? $\rho_{water} = 1000\ g\ l^{-1}$

Exercice 1 :

1- Significance of each one : A, Z and q

The mass number A of an atom is the sum of protons (p) and neutrons (n).

Atomic number Z is the number of protons.

Electric charge (symbol q) Electric charge is the smallest electric charge that can be carried by a particle in nature. q= n.e

2- Number of neutrons, protons and electrons

Elements	Number of protons	Number of electrons	Number of neutrons
$^{19}_{9}F$	9	9	19 – 9 = 10
$^{238}_{92}U$	92	92	238 – 92 = 146
$^{52}_{24}Cr^{3+}$	24	24 – 3 = 21	52 – 24 = 28
$^{24}_{12}Se^{2-}$	12	12 + 2 = 14	24 – 12 = 12

Exercice 2 :

Number of Al molecules $Al_2(SO_4)_3$ $N_{Al_2(SO_4)_3} = \frac{m}{M}\mathcal{N}_A = n\mathcal{N}_A$

$$N_{Al_2(SO_4)_3} = \frac{m}{M}\mathcal{N}_A = n\mathcal{N}_A = \frac{60}{342} \times 6{,}023\ 10^{23}$$

$$n = 0{,}175 mol \Rightarrow N_{Al_2(SO_4)_3} = 0{,}175 \times 6{,}023\ 10^{23} = 1{,}05\ 10^{\mathbf{23}}$$ molecules

b- Number of atoms (Al, S and O)

$$Al_2(SO_4)_3 \longrightarrow 2\,Al + 3\,S + 12\,O$$

$N_{Al} = \frac{m}{M}2\mathcal{N}_A = 2n\mathcal{N}_A$ A.N: $N_{Al} = 2 \times 1{,}05.\,10^{23} = 2{,}10\ 10^{23}$ atoms

$N_S = \frac{m}{M}3\mathcal{N}_A = 3n\mathcal{N}_A$ A.N: $N_S = 3 \times 1{,}05.\,10^{23} = 3{,}15\ 10^{23}$ atoms

$N_O = \frac{m}{M}12\mathcal{N}_A = 12n\mathcal{N}_A$ A.N : $N_O = 12 \times 1{,}05.\,10^{23} = 12{,}6\ 10^{23}$ atoms

c- The mass of (Al, S and O) in 60g of $Al_2(SO_4)_3$

$$m_{Al} = \frac{m}{M}2M_{Al} = n2M_{Al} = 0{,}175 \times 2 \times 27 = 9{,}45g$$

$$m_S = n3M_S = 0{,}175 \times 3 \times 32 = 16{,}8g$$

$$m_O = n12M_O = 0{,}175 \times 12 \times 16 = 33{,}6g$$

Exercice 3 :

1- The mass m of NaCl

$$C = \frac{m_{solute}}{MV_{solution}} \Rightarrow m_{solute} = CMV_{solution} = 0{,}1 \times 58{,}5 \times 0{,}1 = 0{,}585g$$

2- The mass m of $Ca(OH)_2$

$$C_N = \frac{EG}{V_{solution}} = \frac{m_{solute}}{MV_{solution}} Z \Rightarrow m_{solute} = CMV_{solution} /Z = (0{,}01 \times 74 \times 0{,}25)/2 = 0{,}092g$$

3- The concentration of the solution obtained

$$C = \frac{C_1V_1 + C_2V_2}{V_1 + V_2} = \frac{1 \times 0{,}05 + 0{,}5 \times 0{,}2}{0{,}05 + 0{,}2} = 0{,}6mol/L$$

4- Calculate the molarity, the normality of this solution.

$$C = \frac{m_{solute}}{MV_{solution}}$$

$$C_0V_0 = C_1V_1 \Rightarrow C_1 = \frac{0{,}05 \times 0{,}02}{0{,}5} = 0{,}002\ mol/L \qquad N_1 = C_1Z = 0{,}002 \times 2 = 0{,}004N$$

Exercice 4 :

1- The molarity of the solution HCl=?

$$C_M = \frac{n_{solute}}{V_{solution}} \Rightarrow$$

$$\rho = \frac{m_{solution}}{V_{solution}} = 1190\ g/l = \quad V_{solution} = \frac{m_{solution}}{\rho}$$

$$\% = \frac{m_{solute}}{m_{solution}} 100 = 37\% \Rightarrow m_{solute} = \frac{m_{solution} \times 37}{100} \Rightarrow n_{solute} = \frac{m_{solution} \times 37}{100M}$$

$$C_M = \frac{n_{solute}}{V_{solution}} = \frac{\frac{m_{solution} \times 37}{100.M}}{\frac{m_{solution}}{\rho}} = \frac{37.\rho\, 10^3}{100.M} = 12.06\ moles/l$$

The normality of the solution HCl=?

$$C_N = \frac{EG_{solute}}{V_{solution}} = \frac{m_{solute}}{MV_{solution}} Z = \frac{m_{solute}\, Z}{MV_{solution}} = \frac{n_{solute}\, Z}{V_{solution}} = ZC_M$$

For an HCl solution (Z=1)

$$C_N = ZC_M = 12.06 \ \ eq\ g/l^{-1} = 12.06 \ \ N$$

Molality

$$m_l = \frac{n_{solute}}{1kg\ of\ solvent} = \frac{(\frac{m}{M})_{solute}}{m\ solvent(Kg)} = \frac{37/\ 36.5}{(100-37)10^{-3}} = 16.09\ moles\ .Kg^{-1}$$

2- The molarity of the solution H_2SO_4=?

$$\% = 96\% \ , \qquad \text{d} = \ \rho = 1840\ g/l$$

$$C_M = \frac{n_{solute}}{V_{solution}} = \frac{96\ \rho\ 10^3}{100.M} = 18.02\ moles/l$$

The normality of the solution H_2SO_4=?

For an H_2SO_4 solution (Z=2)

$$C_N = ZC_M = 2 \times \ 18.02 \ \ eq\ g/l^{-1} = 36.04 \ \ N$$

Molality:

$$m_l = \frac{n_{solute}}{1kg\ of\ solvent} = \frac{(\frac{m}{M})_{solute}}{m\ solvent(Kg)} = \frac{96/\ 98}{(100-96)10^{-3}} = 244.9\ moles\ .Kg^{-1}$$

3- The molarity of the solution $AlCl_3$=?

$$C_M = \frac{n_{solute}}{V_{solution}} = \frac{m}{MV_{solution}} = \frac{0.55}{133.5 \ \times \ 50.10^{-3}} = 8.24\ 10^{-2}\ moles/L$$

The normality of the solution $AlCl_3$=?

For an $AlCl_3$ solution (Z=3 x 1)

$$C_N = ZC_M = 3 \ \times \ 8.24 \ \ \ eq\ g/l^{-1} = 24.72 \ \ N$$

Molarity

$$m_l = \frac{n_{solute}}{1kg\ of\ solvent} = \frac{(\frac{m}{M})_{solute}}{m\ solvent(Kg)} = \frac{0.55/\ 133.5}{(50-0.55)10^{-3}} = 8.33\ 10^{-2} \ \ moles\ .Kg^{-1}$$

Exercice 5 :

1- Chemical reaction in water: $H_2SO_4 + 2H_2O \rightarrow 2H_3O^+ + SO_4^{2-}$

The H_2SO_4 molecule releases two protons. Each proton attaches to the negative pole of the water molecule and gives H_3O^+. H_2SO_4 is said to be a diacid.

2- Molarity:

$$C_{H_2SO_4} = \frac{n_{H_2SO_4}}{V_{H_2SO_4}}$$

$$C_{H_2SO_4} = \frac{n_{H_2SO_4}}{V_{H_2SO_4}} = \frac{m_{H_2SO_4}}{M_{H_2SO_4}V_{solution}} \dots\dots\dots\dots\dots\dots..(1)$$

$$\%mass_{H_2SO_4} = \frac{m_{H_2SO_4}}{m_{solution}}.100 \Rightarrow m_{H_2SO_4} = \frac{\%mass_{H_2SO_4} \times m_{solution}}{100} \dots\dots\dots\dots.(2)$$

We replace (2) in (1):

$$C_{H_2SO_4} = \frac{\%mass_{H_2SO_4} \times m_{solution}}{M_{H_2SO_4}V_{solution}.100}$$

$$C_{H_2SO_4} = \frac{\%mass_{H_2SO_4} \times \rho_{solution}}{M_{H_2SO_4}.100} \dots\dots\dots\dots..(3)$$

$$d_{solution} = \frac{\rho_{solution}}{\rho_{water}} \Rightarrow \rho_{solution} = d_{solution} \times \rho_{water} \dots\dots\dots\dots..(4)$$

We replace (2) in (1):

$$C_{H_2SO_4} = \frac{\%mass_{H_2SO_4} \times d_{solution} \times \rho_{water}}{M_{H_2SO_4}.100}$$

$$C_{H_2SO_4} = \frac{98 \times 1.84 \times 1000}{98.100} = 18.4\ moles/L$$

The normality of a diacid solution: N =2C = 2 × 18.4 = 36.8 eq-g l^{-1}

3- Volumes of this solution H_2SO_4 and water

$$N_1V_1 = N_2V_2\ , N_1 = N_{H_2SO_4} = 36{,}8\ N, \quad V_1 = ?, \quad N_2 = 2N, V_2 = 2L$$

$$V_1 = \frac{N_2V_2}{N_1} = \frac{2 \times 2}{36{,}8} = 0{,}1087\ L = 108{,}7\ ml$$

$$V_2 = V_1 + V_{H_2O} = 2L \Rightarrow V_{H_2O} = V_2 - V_1 = 2000 - 108{,}7 = 1891{,}3\ mL$$