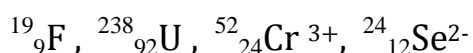




Exercise 1:

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

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



Exercise 2 : Atom, molecule, mole and Avogadro number

We have 60 g of alum $\text{Al}_2(\text{SO}_4)_3$. How many is there:

- $\text{Al}_2(\text{SO}_4)_3$ molecules.
- atoms of Aluminum (Al), Sulfur (S) and oxygen (O)
- grams of Al, S and O.

$M(\text{Al})=27\text{g/mol}$, $M(\text{O}) 16\text{g/mol}$, $M(\text{S})=32\text{g/mol}$

Exercise 3 :

- How many grams of NaCl must be dissolved to obtain 100mL of 0.1M NaCl solution?
 $M_{\text{NaCl}}=58.5\text{g}\cdot\text{mol}^{-1}$
- How many grams of $\text{Ca}(\text{OH})_2$ are there in 0.25 L of 0.01N solution of this body?
- 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?
- We take $V_0=20\text{mL}$ from a CuSO_4 solution with a concentration $C_0=5\cdot 10^{-2}\text{mol}\cdot\text{L}^{-1}$. This volume is introduced into a 500mL volumetric flask, filled with distilled water, then homogenized. Calculate the molarity, the normality of this solution?.

Exercise 4 : Calculate molarity and normality:

- a solution of hydrochloric acid HCl knowing that on the label we find the following information: 37% by mass; 1.19kg/L and $M =36.5\text{g/mol}$.
- of a concentrated solution of H_2SO_4 , that it is 96% by mass and that its density is 1.84. We give $M(\text{H}_2\text{SO}_4) =98\text{g/mol}$
- an aqueous solution of aluminum chloride (AlCl_3) by dissolving 0.55 g of this salt in 50 mL water.

Exercise 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?

$$\rho_{\text{water}} = 1000 \text{ g l}^{-1}$$



Exercise 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
${}^{19}_{9}\text{F}$	9	9	$19 - 9 = 10$
${}^{238}_{92}\text{U}$	92	92	$238 - 92 = 146$
${}^{52}_{24}\text{Cr}^{3+}$	24	$24 - 3 = 21$	$52 - 24 = 28$
${}^{24}_{12}\text{Se}^{2-}$	12	$12 + 2 = 14$	$24 - 12 = 12$

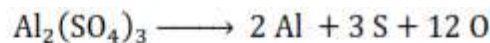
Exercise 2 :

Number of Al molecules $\text{Al}_2(\text{SO}_4)_3$ $N_{\text{Al}_2(\text{SO}_4)_3} = \frac{m}{M} N_A = n N_A$

$$N_{\text{Al}_2(\text{SO}_4)_3} = \frac{m}{M} N_A = n N_A = \frac{60}{342} \times 6,023 \cdot 10^{23}$$

$$n = 0,175 \text{ mol} \Rightarrow N_{\text{Al}_2(\text{SO}_4)_3} = 0,175 \times 6,023 \cdot 10^{23} = 1,05 \cdot 10^{23} \text{ molecules}$$

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



$$N_{\text{Al}} = \frac{m}{M} 2N_A = 2nN_A \quad \text{A.N: } N_{\text{Al}} = 2 \times 1,05 \cdot 10^{23} = 2,10 \cdot 10^{23} \quad \text{atoms}$$

$$N_{\text{S}} = \frac{m}{M} 3N_A = 3nN_A \quad \text{A.N: } N_{\text{S}} = 3 \times 1,05 \cdot 10^{23} = 3,15 \cdot 10^{23} \quad \text{atoms}$$

$$N_{\text{O}} = \frac{m}{M} 12N_A = 12nN_A \quad \text{A.N: } N_{\text{O}} = 12 \times 1,05 \cdot 10^{23} = 12,6 \cdot 10^{23} \quad \text{atoms}$$

c- The mass of (Al, S and O) in 60g of $\text{Al}_2(\text{SO}_4)_3$

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

$$m_{\text{S}} = 3nM_{\text{S}} = 0,175 \times 3 \times 32 = 16,8 \text{ g}$$

$$m_{\text{O}} = 12nM_{\text{O}} = 0,175 \times 12 \times 16 = 33,6 \text{ g}$$

Exercise 3 :

1- The mass m of NaCl

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

2- The mass m of Ca(OH)₂

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

3- The concentration of the solution obtained

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

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

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

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

Exercise 4 :

1- The molarity of the solution HCl=?

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

$$\rho = \frac{m_{\text{solution}}}{V_{\text{solution}}} = 1190 \text{ g/l} = \frac{m_{\text{solution}}}{V_{\text{solution}}} \Rightarrow V_{\text{solution}} = \frac{m_{\text{solution}}}{\rho}$$
$$\% = \frac{m_{\text{solute}}}{m_{\text{solution}}} 100 = 37\% \Rightarrow m_{\text{solute}} = \frac{m_{\text{solution}} \times 37}{100} \Rightarrow n_{\text{solute}} = \frac{m_{\text{solution}} \times 37}{100M}$$
$$C_M = \frac{n_{\text{solute}}}{V_{\text{solution}}} = \frac{\frac{m_{\text{solution}} \times 37}{100 \cdot M}}{\frac{m_{\text{solution}}}{\rho}} = \frac{37 \cdot \rho \cdot 10^3}{100 \cdot M} = 12,06 \text{ moles/l}$$

The normality of the solution HCl=?

$$C_N = \frac{EG_{\text{solute}}}{V_{\text{solution}}} = \frac{m_{\text{solute}}}{MV_{\text{solution}}} Z = \frac{m_{\text{solute}} Z}{MV_{\text{solution}}} = \frac{n_{\text{solute}} Z}{V_{\text{solution}}} = Z C_M$$

For an HCl solution (Z=1)

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

Molality

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

2- The molarity of the solution H_2SO_4 =?

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

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

The normality of the solution H_2SO_4 =?

For an H_2SO_4 solution ($Z=2$)

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

Molality:

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

3- The molarity of the solution AlCl_3 =?

$$C_M = \frac{n_{solute}}{V_{solution}} = \frac{m}{MV_{solution}} = \frac{0.55}{133.5 \times 50 \cdot 10^{-3}} = 8.24 \cdot 10^{-2} \text{ moles/L}$$

The normality of the solution AlCl_3 =?

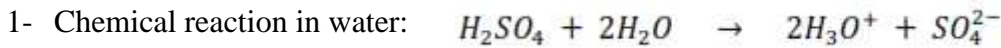
For an AlCl_3 solution ($Z=3 \times 1$)

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

Molarity

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

Exercise 5 :



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:

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

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

We replace (2) in (1):

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

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

We replace (2) in (1):

$$C_{H_2SO_4} = \frac{\%mass_{H_2SO_4} \times d_{solution} \times \rho_{water}}{M_{H_2SO_4} \cdot 100}$$
$$C_{H_2SO_4} = \frac{98 \times 1.84 \times 1000}{98.100} = 18.4 \text{ moles/L}$$

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

3- Volumes of this solution H_2SO_4 and water

$$N_1 V_1 = N_2 V_2, N_1 = N_{H_2SO_4} = 36,8 \text{ N}, \quad V_1 = ?, \quad N_2 = 2N, V_2 = 2L$$
$$V_1 = \frac{N_2 V_2}{N_1} = \frac{2 \times 2}{36,8} = 0,1087 \text{ L} = 108,7 \text{ ml}$$
$$V_2 = V_1 + V_{H_2O} = 2L \Rightarrow V_{H_2O} = V_2 - V_1 = 2000 - 108,7 = 1891,3 \text{ mL}$$