Series N° :1

Exercise 1:

1- Caffeine is found in coffee, tea, and chocolate. It is a stimulant substance and becomes toxic if its dose exceeds 600 mg per day. Its chemical formula is $C_8H_{10}N_4O_2$.
a. What is the molar mass of caffeine?
b. What is the quantity of the substance present in a cup containing 80 mg of caffeine, and what is the number of caffeine molecules present in the same cup?
c. How many cups of coffee can a person drink per day without being exposed to toxicity?
d. What is the number of nitrogen atoms in 10 mg of caffeine?
e. Calculate the mass of 10^5 molecules of caffeine in grams.
2- Which of the following samples contains the greatest number of atoms:
- 1 g of Silver (Ag)
- 1 g of Ammonia (NH_3)
- 1 g of Neon (Ne)
- 1 g of Octane (C_8H_{18})

Ag=107.87 ; H=1 ; C=12 ; N= 14 ; Ne= 20.18 ; O= 16   (U.m.a)

Exercise 2:

A sample of 1.5276 g of Cadmium Chloride ($CdCl_2$) is transformed into metallic Cd and a compound free of cadmium using an electrochemical process. The obtained mass of cadmium is 0.9367 g. Assuming the atomic mass of Cl is 35.453 g/mol, what is the molar atomic mass of cadmium?

Exercise 3:

1. Two elements, A and B, combine to form compounds A and B. In the first compound, 14 g of A combine with 3 g of B, and in the second compound, 7 g of A combine with 4.5 g of B. Explain how these data illustrate the Law of Multiple Proportions.

2. The chemical analysis of two different samples of a compound with the formula X_aY_b yielded the following results:

Sample 1: Contains 25.13% by weight of X.
Sample 2: Contains 0.3106 g of X in 1.2360 g of the sample.
Verify that these results are consistent with the Law of Definite Proportions.

Exercise 4:

1. An impure sample of calcium carbonate with a mass of 40 g reacted with hydrochloric acid (HCl), producing 5.6 liters of carbon dioxide gas (under standard conditions). Calculate the mass percentage of calcium carbonate in the sample.

2. Calculate the mass percentage of each element in ammonium nitrate fertilizer (NH_4NO_3).

<div align="center">Ca=40 ; C= 12 ; O=16 H=1 ; N= 14</div>

Exercise 5:

In the laboratory, there is a bottle of concentrated hydrochloric acid (HCl) solution (S_0) with a molar concentration of C_0. The bottle label contains the following information:
Molar Mass: M = 36.5 g/mol,
Density: d = 1.18
Mass Percentage: P = 31%

1- Prove that the mass percentage P can be expressed in terms of d, M, and C_0 using the relationship:

$$P = \frac{MC_0}{10\,d}$$

Note that the Volumic Mass of water is $\rho(H_2O) = 1000$ g/L.

2- To confirm the value P = 31%, we dilute a sample of the solution (S_0) by a factor of 100 to obtain a solution (S) with a molar concentration of C= 0.1 mol/L.
✓ Deduce the molar concentration C_0 of the original solution (S_0).
✓ Calculate the mass percentage P and compare it with the information on the bottle label. What conclusion can you draw?

Exercise 6:

1. A gas sample occupies a volume of 360 mL at a pressure of 0.75 atm. If the temperature remains constant, what volume will it occupy at a pressure of 1 atm?

2. If the volume of a gas sample is 79.5 mL at 45°C, what volume will the sample occupy at 0°C if the pressure remains constant?

3. If the pressure of a gas sample is 30.7 kPa at a temperature of 0°C, how much should the Celsius temperature rise for the sample's pressure to double?