PREPARATION GUIDE FOR LABORATORY SOLUTIONS USED IN CHEMISTRY PRACTICALS

THE STRENGTH OF LABORATORY SOLUTIONS:

The strength of laboratory solutions is always given in terms of moles per liter (mol ltr^{-1}), grammes per liter (gl^{-1}), percentage of solutes in solutions or fractions of solutions in solutions.

Some of the examples of the strength of acids and bases used include:

Concentrated solution	***Percentage***	***Molar mass (g)***	***Molarity***
Ammonia solution	*30- 35*	*17.03*	*15*
Acetic acid- glacial		*60.05*	*17*
Hydrochloric acid	*36*	*36.46*	*10- 11*
Nitric acid	*70*	*63.01*	*16*
Sulfuric acid	*98*	*98.08*	*18*

SIMPLE CALCULATIONS IN MAKING SOLUTIONS

a) Dilution of concentrated solutions of known molarities:

To prepare a dilute solution from a concentrated solution, we use an expression usually written as $M_cV_c = M_dV_d$

Where, Mc and V_c is Molarity and volume of concentrated solution respectively,

M_d and V_d is Molarity and volume of dilute solution respectively.

Example:

To make one liter of 1M hydrochloric acid from concentrated HCl of molarity 10M, i.e.

$$\text{Volume of conc. HCl required} = \frac{M_d V_d}{M_c}$$

$$= \frac{1 \times 1000}{10}$$

$$= 100cc$$

Therefore 100cc is dissolved in water to make 1000cc of 1M HCl solution.

Example:

Calculate the volume of 1M H2SO4 required to make 0.1M H2SO4 solution.

$$M_d V_d = M_c V_c$$

$$V_c = \frac{M_d V_d}{M_c}$$

$$= \frac{0.1 \times 1000}{1}$$

$$= 100cc$$

Therefore the volume of concentrated H_2SO_4 required in making 1000cc of 0.1M H_2SO_4 is 100cc.

When the molarity of a given concentrated solution is not given, it can be calculated from the density and percentage composition of the concentrated solution. The density, *percentage composition and molar mass are always given on the labels on the original container.*

Let the density of the concentrated solution be ***P,*** *relative molecular mass* ***RMM*** *and percentage purity* ***ʒ%,*** *the molarity of concentrated solution can be calculated as:*

$$\text{Density of pure solution} = \frac{\text{ʒ} \times p}{100}$$

$$\text{Mass concentration of pure solution} = \frac{\text{ʒ} \times p}{100} \times 1000$$

From molarity = mass / molar mass,

$$\text{molarity of concentration solution} = \frac{\text{ʒ}}{100} \times p \times 100 \times 1/RMM$$

Example:

Determine the molarity of stock concentrated nitric acid if its density is 1.41g/cc, molar mass = 63.01g and percentage purity = 70%.

Solution:

Original molarity = density x %age purity x 1000/RMM

$$\text{Density of pure nitric acid} = \frac{70 \times 1.41}{100}$$

$$\text{Mass concentration of pure nitric acid} = \frac{70}{100} \times 1.41 \times 1000$$

Molarity = 70 x 1.41 x 1000 x 1

$$= \frac{\dots}{100} \qquad \frac{\dots}{63.01}$$

$$= 15.66M$$

Example:

Calculate the molarity of concentrated HCl whose density is 1.18g/cc, assay 36% and relative molecular mass 36.46

Solution:

$$Molarity = \frac{36}{100} \times 1.18 \times 1000 \times \frac{1}{36.46}$$

$$= 11.65M$$

b) Dilutions of solutions which are expressed in percentages of volumes

Solutions whose concentrations are expressed in percentages when diluting them, we do so in percentages also. Likewise those whose concentrations are given in volumes can be diluted in volumes or percentages.

When preparing solutions in percentages we use an expression given as:

$$V_c = \frac{V_d \times \%diluted}{\%concentrated}$$

Also when preparing solutions whose concentrations are given in volumes, we use an expression given as:

$$V_c = \frac{M_d \times V_d}{M_c}$$

Example:

Calculate the volume of 40% formaldehyde required to prepare 3% solution of formaldehyde.

Solution:

From $V_c = \dfrac{M_d \times V_d}{M_c}$

$$V_c = \frac{3 \times 100}{40}$$

$$= 7.5cc$$

Example:

Determine the volume of 20 volume hydrogen peroxide required to prepare 1000cc or 1liter of 10 volume hydrogen peroxide solution.

Solution:

From $V_c = \dfrac{M_d \times V_d}{M_c}$

$$V_c = \frac{10 \times 1000}{20}$$

$$= 500cc$$

Example:

To prepare 1000cc of 10 volume hydrogen peroxide solution from 50 volume hydrogen peroxide, the volume of 50 volume solution required

$$= \frac{1000 \times 10}{50}$$

$$= 200cc$$

c) *Preparation of solutions using solid solutes*

For making bench reagents and preparing solutions from solids of high purity, we use the:

*Let the mass, **m,** of solute with relative molecular mass **μ** and molarity **α,***

mass required to make a solution, $\boldsymbol{m = \frac{\alpha \times \mu \times V}{1000}}$

***NB: T**he relative molecular mass is always given on the labels of the containers; however it can also be calculated from the atomic masses of elements in the given compound.*

Example:

Calculate the mass of sodium hydroxide required to make 500cc of 0.02M sodium hydroxide solution.

Mass of sodium hydroxide required $= \frac{0.02 \times 40 \times 500}{1000}$

$= \quad 0.4g$

For solids of low percentage purity if they are able to be used in volumetric analysis, the mass of pure substance required in the impure substance should be calculated the total mass weighed out.

Example:

If you are required to prepare 1500cc of 0.02M sodium hydroxide solution with a minimum assay 94% of molar mass 40g.

The mass of the impure sodium hydroxide that is required to make this solution is found by first getting the pure mass, then the impure mass, as follows:

Mass required to make a solution, $\boldsymbol{m = \frac{\alpha \times \mu \times V}{1000}}$

$$= \frac{0.02 \times 40 \times 1500}{1000}$$

$$= 1.20g$$

But the hydroxide is only 94% pure,

1.20g of pure NaOH is in $\frac{100 \times 1.20}{95}$

$$= 1.26g$$

Therefore the mass of the hydroxide to be weighed out is 1.26g