Dilution of Concentrated Solutions

Dilution is one of the main preparation processes which used daily in all laboratories; any chemist should be familliar with dilution calculations to prepare a correct diluted solution.

Chemicals are sometimes bought and stored as concentrated solutions that must be diluted before use. The key fact to remember when diluting a concentrated solution is that the number of moles of solute is constant, only the volume is changed by adding more solvent.

Moles of solute (constant) = Molarity x volume

$$M_i \times V_i = M_f \times V_f$$

where M_i is the initial molarity, V_i is the inital volume, M_f is the final molarity, and V_f is the final volume after dilution.

$M_f = M_i \times \frac{V_i}{V_f}$, part $\frac{V_f}{V_i}$ called dilution factor

where DF (Dilution Factor) = $\frac{M_i}{M_f}$, therefore

$\frac{V_f}{V_i} = \frac{M_i}{M_f}$, $M_f = \frac{M_i}{DF}$

Question (1)
How would you prepare 500ml of 0.25 M NaOH solution starting from a concentration of 1.0M

The problem gives initial and final concentration (M_i and M_f) and final volume (V_f) and asks for the initial volume (V_i) that we need to dilute

$$M_f = M_i * \frac{V_i}{V_f} \rightarrow V_i = \frac{M_f \times V_f}{M_i} \rightarrow$$

$$V_i = \frac{500ml \times 0.25M}{1.0M} = 125\ ml$$

This mean to prepare solution with concentration of 0.25 M NaOH you have to transfer 125 ml from initial solution and complete with solvent to 500ml

Question (2) بتق رصدل
How many milliliters of 5M Copper(II) sulfate solution must be added to 160 ml of water to achieve a 0.3 M Copper II sulfate solution ?

$$M_i \times V_i = M_f \times V_f \rightarrow (5M * x(ml)) = 0.3\ M * (160 + x)$$

$$x5 = 48 + 0.3x \rightarrow 4.7x = 48 \rightarrow x = 10\ ml$$

Question (3):- what volume of 4.5 M HCl can be made by mixing 5.65 M HCl with 250ml of 3.55 M HCl ?
(Homework)

Acid and Base Concepts

Arrhenius Concept :- According to arrhenius concept, Substances which produce $\overset{+}{H}$ ions when dissolved in water are called acids, while those which ionize in water to produce $\overset{-}{OH}$ ions are called bases. for example the HCl, H_2SO_4, and HNO_3 Considered as acids according to Arrhenius, while the NaOH and KOH Considered as Bases according to Arrhenius

Bronsted Lowry Concept :- The acid is a proton donor $\overset{+}{H}$, while the base is a proton acceptor, for example NH_3 and H_2O are an base and acide respectively according to Bronsted

Lewis Concept :- The acid is electron pair acceptors, while the Base is electron pair donor for example BF_3 and NH_3 are an acide and base respectively according Lewis

Note :- Arrhenius Concept is limited to water solutions only. While Bronsted Concept is limited to proton transfer reactions only

Examples

① Arrhenius

HNO_3 Considered acid

$$HNO_3 \longrightarrow H^+_{(aq)} + NO_3^-{}_{(aq)}$$

Dissociates in water to produce hydrogen ions (H^+)

NaOH Considered base

$$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

Dissociates in water to produce hydroxide ions (OH^-)

② Bronsted - Lowry

CH_3COOH Considered acid, is a proton donor, while the base is a proton acceptor as shown

$$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$$

CH_3COOH is acid (H^+ donor)

H_2O is base (H^+ acceptor)

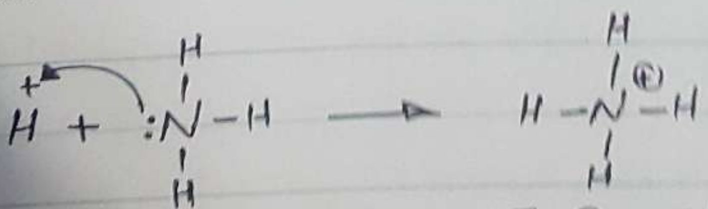
$$NH_3 + H_2O \rightleftharpoons OH^- + NH_4^+$$

NH_3 is base (H^+ acceptor)

H_2O is acid (H^+ donor)

③ Lewis

Acid as an electron pair acceptor and a base as an electron pair donor



For example $BF_3 + :NH_3 \longrightarrow F_3B:NH_3$

Acids :- Acidity is a characteristic property of acids. Acidic substances are usually very sour. Apart from hydrochloric acid, there are many other types of acids around us. Citrus fruits like lemons and oranges contain citric and ascorbic acids, while tamarind paste contains tartaric acid.

In fact, the word "acid" and acidity are derived from the Latin word acidus which means sour. If you dip a blue litmus paper into an acid, it will turn red while a red litmus paper will not change colour.

Bases :- Bases turn red litmus paper blue while the blue litmus paper stays blue. They taste bitter and also feel soapy. Some other common examples of bases include sodium bicarbonate that is used in cooking and household bleach.

Conjugate Acid-Base Pairs

Consider a reaction

$$Acid\ (1) + Base\ (2) \rightarrow Acid\ (2) + Base\ (1)$$

$$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$$

In this reaction, HCl donates a proton to H_2O therefore is acid. The water accepts a proton from HCl therefore is a base. In the reverse reaction which at equilibrium proceeds at the same rate as the forward reaction, the H_3O^+ ions donate a proton to Cl^- ion, hence H_3O^+ is acid.