Almustaqbal University college

Medical Laboratories Techniques Department

First year students

Subject :General chemistry 1 - Lecture 4

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Molarity of liquids:

The molarity of liquids Can be determined by applying the following formula:

$$\textbf{Molarity of liquid(M)} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x1000}{Mwt}$$

Sp.gr = specific gravity $= \frac{density\ of\ substance}{density\ of\ water}$

Sp.gr = specific gravity $= \frac{d_{substance}}{d_{H_2O}}$

$(\ sp.gr\ \approx\ d_{substance})$

Example:

Calculate the molarity of 70.5 % HNO_3 (w/w) (63.0 g /mol) solution that has specific gravity of (1.420) .

Solution:

$$\textbf{Molarity(M)} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x\ 1000}{Mwt}$$

$$\mathbf{M} = \frac{1.420\ x\ \left(\frac{70.5}{100}\right) x\ 1000}{63.0} = \frac{1.420\ x\ 70.5 x\ 10}{63.0} = \mathbf{15.9\ M}$$

Example :

Calculate the Molarity of NaOH (40 g/mol) solution of 50 $\left(\frac{w}{w}\right)\%$ knowing that its specific gravity(sp.gr) is 1.525 .

Solution:

$$\textbf{Molarity(M)} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x\ 1000}{Mwt}$$

$$\textbf{Molarity (M)} = \frac{1.525\ x\ \left(\frac{50}{100}\right) x\ 1000}{40}$$

$$\textbf{Molarity (M)} = \frac{1.525\ x\ 50\ x\ 10}{40} = \mathbf{19.06\ M}$$

Example:

Describe the preparation of (100 mL) of (6.0 M) HCl from its concentrated solution that is 37.1 % (w/w) HCl (36.5 g/mole) and has specific gravity (sp.gr) of (1.181) .

Solution:

1. نحسب تركيز الحامض الاصلي (المركز) من القانون التالي:

$$\mathbf{M_{HCl}} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x\ 1000}{Mwt}$$

$$\mathbf{M_{HCl}} = \frac{1.181\ x \frac{37.1}{100}\ x\ 1000}{36.5}$$

$$M_{HCl} = \frac{1.181 \; x \; 37.1 \; x \; 1000}{36.5 \; x \; 100}$$

$$M_{HCl} = \frac{1.181 \; x \; 37.1 \; x \; 10}{36.5} = 12.0 \text{ M}$$

The Molarity of the concentrated acid is 12.0M

الان نذهب الى قانون التخفيف لحساب الحجم المطلوب اخذه من الحامض المركز وتخفيفه الى الحجم المطلوب (100 مللتر في هذا المثال) وكمايلي:

No. of moles of Conc. solution = No. of moles of dil. Solution

also

No. of mmoles of Conc. solution = No. of mmoles of dil. Solution

$$M_{conc.} V_{conc.} = M_{dil.} V_{dil.}$$

$$12.0 \text{ x } V_{conc} = 6.0 \text{ x } 100$$

$$V_{conc} = \frac{6.0 \; x \; 100}{12} = 50 \text{ mL.}$$

Then 50 mL of concentrated acid is to be diluted to 100 mL to give 6 M solution

Example:

Describe the preparation of 500 mL of 3.00 M H_2SO_4(98 g /mol) from the commercial reagent that is 93% H_2SO_4 (w/w) and has a specific gravity of 1.830.

Solution:

1. **We have to calculte the concentration of the original conc. Solution**

$$\mathbf{M}_{H2SO4} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x\ 1000}{Mwt}$$

$$\mathbf{M}_{H2SO4} = \frac{1.830\ x\ \frac{93}{100}\ x\ 1000}{98}$$

$$\mathbf{M}_{H2SO4} = \frac{1.830\ x\ 93\ x\ 1000}{98\ x\ 100}$$

$$\mathbf{M}_{H2SO4} = \frac{1.830\ x\ 93\ x\ 10}{98} = 17.\ 37\ \mathbf{M}$$

لحساب الحجم المطلوب اخذه من الحامض المركز وتخفيفه الى الحجم المطلوب (500 مللتر في هذا المثال) نطبق قانون التخفيف التالي:

$$\mathbf{M_{conc.}\ V_{conc.}} = \mathbf{M_{dil.}\ V_{dil.}}$$

$$\mathbf{17.37\ x\ V_{conc} = 3.0\ x\ 500}$$

$$\mathbf{V_{conc} = \frac{3.0\ x\ 500}{17.37} = 86.36\ mL.}$$

Then 86.36 mL of concentrated acid is to be diluted to 500 mL to give 3 M solution.

Calculation of Normality of liquids

$$\textbf{Normality of liquid(N)} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x\ 1000}{eq.wt}$$

Example:

Describe the preparation of 500 mL of 3.00 N H_2SO_4(98 g /mol) from the commercial reagent that is 96% H_2SO_4 (w/w) and has a specific gravity of 1.840.

Solution:

$$\mathbf{N_{H2SO4}} = \frac{sp.gr\ x\ \left(\frac{w}{w}\right)\%\ x\ 1000}{eq.wt}$$

$$\mathbf{eq.wt} = \frac{Mwt}{\eta}$$

For H_2SO_4 **η=2 then**

$$\mathbf{eq.wt} = \frac{98}{2} = 49$$

$$\mathbf{N_{H2SO4}} = \frac{1.840\ x\ \frac{96}{100}\ x\ 1000}{49}$$

$$\mathbf{N_{H2SO4}} = \frac{1.840\ x\ 96\ x\ 1000}{49\ x\ 100}$$

$$\mathbf{N_{H2SO4}} = \frac{1.840\ x\ 96\ x\ 10}{49} = 36.04\ \mathbf{N}$$

The Normality of the concentrated acid is 36.04 N

لحساب الحجم المطلوب اخذه من الحامض المركز وتخفيفه الى الحجم المطلوب (500 مللتر في هذا المثال) نطبق قانون التخفيف التالي:

$$\mathbf{N_{conc.}\ V_{conc.}} = \mathbf{N_{dil.}\ V_{dil.}}$$

$$\mathbf{36.04\ x\ V_{conc} = 3.0\ x\ 500}$$

$$\mathbf{V_{conc}} = \frac{3.0\ x\ 500}{36.04} = \mathbf{41.62\ mL.}$$

Then 41.62 mL of concentrated acid is to be diluted to 500 mL to give 3 N solution.

Excercise 1:
A solution of 6.42 (w/w)% of $Fe(NO_3)_3$ (241.86 g/mol) has a specific gravity of 1.059 g/mL. Calculate:

(a) the molar concentration of this solution.
(b) the mass in grams of $Fe(NO_3)_3$ contained in each liter of this solution.

Excercise 2:

A 12.5% (w/w)aqueous solution of $NiCl_2$ (129.61 g/mol) has specific gravity of 1.149. Calculate:

(a) the Molarity of $NiCl_2$ in this solution.

(b) the molar concentration of Cl^- in the solution.

(c) the mass in grams of $NiCl_2$ contained in 500 mL of this solution.

Excercise 3:
A solution was prepared by dissolving 327. 8 mg of Na_3PO_4 (163.9 g/mol) in sufficient water to give 750 mL . Calculate:

A) The Molarity and Normality of the solution.

B) the Molar concentration of Na^+ in the solution.