University of Al-Ameed
College of Pharmacy

2nd stage , 1st Semester

Practical Physical pharmacy

Expression of concentrations in pharmaceutical preparations/Lab 1

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Importance of Physical Pharmacy

- Physical pharmacy is a fundamental course that leads to proper understanding of subsequent courses in Pharmaceutics and pharmaceutical technology.
- Physical pharmacy integrates knowledge of mathematics, physics and chemistry and applies them to the pharmaceutical dosage form development.
- Physical pharmacy provides the basis for understanding the chemical and physical phenomena that govern the in vivo and in vitro actions of pharmaceutical products.
- Enable the pharmacist to make rational decisions on scientific basis concerning the art and technology of solutions, suspensions, emulsions, etc.

Expression of concentration in pharmaceutical preparations

- Pharmaceutical preparations come in specific concentration expressions whether they are in terms of weight, volume or parts.
- The presentation of medicines and pharmaceutical products in the forms of concentration is to ensure standardization during quality control and market authorization, uniformity of dose, reproducibility of biological response.
- The concentration of an ingredient in a preparation expresses the ratio of the amount of a particular ingredient to that of the whole formulation.

Definitions

- **Concentration:** is a quantity of solute in a definite volume of solution, or quantity of solute in a definite mass of solvent or solution.
- A **solution** is a homogeneous mixture of two or more substances.
- The **solute** is the substance present in a smaller amount.
- The **solvent** is the substance present in a larger amount.

Solution, Solvent, and solute

- The simplest solution (sugar + water)
- Which is the solvent and which is solute and why?

Methods of expressing concentration in pharmaceutical preparations

- Molarity (M)
- Molality (m)
- Normality (N)
- Percent concentration (%)
  - Weight per unit volume W/V %
  - Volume per unit volume V/V %
  - Weight per unit weight W/W %
- Part per million (ppm)
- International Unit
- Osmolarity and Osmolality

1. Molarity

Molarity (M):

- The molarity of a solution describes the **number of moles** of the solute in a **liter** of the solution.
- This is a commonly seen expression of concentrations in laboratory researches in the physical sciences, pharmaceutical as well as medicinal chemistry.

- **Molarity** = $\frac{\text{Moles of solute}}{\text{Liter of solution}}$

- **Moles** = $\frac{\text{Mass of substance}}{\text{Molecular mass of substance}}$

- The unit is mol/L with M as symbol.

- Mass of substance= Molarity × Molecular mass of substance × Volume (liter)

Example 1:

Substance ‘P’ is a new analgesic to be formulated as effervescent granules. If 5 g of a substance ‘P’ with molecular mass 150 g/mole is dissolved in water to form 120 mL solution, calculate the molarity of the solution?

Solution

No of moles = mass of substance/molecular mass of substance

= 5/150

= 0.033 moles

Volume of solution is 120 mL = 0.12 L

Thus the molarity of the solution is $\frac{0.033}{0.12}$ **= 0.275 M**

Example 2:

Determine the weight of KCl needed to make 250 mL of a 1 M solution. (M.W. of KCl = 74.55 g/mol)?

Solution:

- Volume: V=250 mL =0.250 L
- Molarity: M=1 M
- Molecular weight: M.W.=74.55 g/mol

Weight of KCl = M × V × M.W.

= 1 × 0.250 × 74.55

= **18.64 g**

Exercises:

1) Calculate the molarity of 0.25 g benzoic acid (M.wt is 122.12 g/mole) dissolved in 1.5 L ethanol?

2) Calculate the weight of $Ca(OH)_2$ required to prepare a 0.5 M solution with a volume of 50 mL, given its Molecular weight is 74.09 g/mol.

2. Normality

- **Normality** of a solution expresses the number of equivalents of solute contained in 1 L of solution.

- **Normality** = $\frac{\text{Number of equivalents of solute}}{\text{Litre of solution}}$

- **Number of equivalents** = $\frac{\text{Weight}}{\text{Equivalent weight}}$

- **Equivalent weight** = $\frac{\text{Molecular weight}}{\text{Valency}}$

Examples

A patient with hypokalaemia is to be treated with potassium chloride solution. If 60 g quantity of potassium chloride salt is dissolved in water to form a 750 mL solution, what is the normality of the solution? (KCl has a molecular weight of 74.5 g/mole. Valency of K^+Cl^- = 1)

Solution

- Equivalent weight = $\frac{\text{molecular weight}}{\text{valency}} = \frac{74.5}{1} = 74.5$ g/Eq

- Number of equivalents of the KCl = $\frac{\text{weight}}{\text{equivalent weight}} = \frac{60}{74.5} = 0.805$ Eq

- **Normality** = $\frac{0.805}{0.75\ \text{L}}$ **= 1.074 Eq/L or 1.074 N**

- **Exercise:**

1) **Magnesium sulphate is a major component of an antacid; 70 g of the salt was used to prepare a solution that was to be added to aluminum hydroxide to form the desired antacid. Assuming the Magnesium solution prepared was 2.6 L, determine the normality of the solution?**

Magnesium sulphate with a valency of 2 (Mg^{2+} $(SO_4)^{2-}$) has a molecular mass of 120 g/mole

3. Molality

- **Molality (*m*)**: is the number of moles of solute in 1 kilogram of solution mass

$$\text{molality} = \frac{\text{moles of solute}}{\text{weight of solvent in Kg}}$$

- The concern here is the solvent and not the solution.
- One advantage of expressing concentration this way is that the variation in concentration due to temperature fluctuation is avoided.

Example

The chemical structure of a new drug ‘anxietin’ known to calm political tension was recently elucidated and the molecular weight found to be 302 g/mol. In its pure form, 5 g of it dissolved in 60 g of water for injection, elicited an effective blockade of the adrenergic receptors. State the molality of this potent solution.

Solution

- No of moles of solute = $\frac{\text{reacting mass}}{\text{molecular weight}} = \frac{5\text{g}}{302\text{g/mol}}$ = 0.017 moles
- Thus the 0.017 moles of anxietin was dissolved in 60 g of water.
- The amount that will be in 1 kg (1000 g) of water is $= \frac{0.017\text{moles}}{0.06\text{kg}}$ = **0.283 *m***

4. Percentage concentration(%)

Percentage Weight by Volume (% w/v)

- This shows the amount of a given ingredient (in g) present in 100 mL volume of the composition.
- It is readily used in mixtures, infusions and solutions to reflect the concentration of a particular solute in the solution.

$$\% \, w/v = \frac{\textbf{Weight of a particular ingredient (g)}}{\textbf{Volume of composition (mL)}} \times 100$$

Example 1:

Syrup paracetamol is presented as 125 mg/5 mL. Express this as percent weight by volume.

- **Solution**

$$\%w/v = \frac{\text{Weight of a particular ingredient (g)}}{\text{Volume of composition (mL)}} \times 100$$

(since 125 mg = 0.125 g)

$$\%w/v = \frac{0.125(g)}{5(mL)} \times 100 = 2.5\%w/v$$

- So the syrup contains 2.5% w/v paracetamol.

Example 2:

Calculate the weight of glucose required to prepare 250 mL of a 5% w/v solution.

Percentage Volume by Volume (% v/v)

This shows the amount of a given ingredient (in mL) present in 100 mL volume of the composition.

$$\% \, \mathbf{v/v} = \frac{\textbf{Volume of a particular ingredient (mL)}}{\textbf{Volume of composition (mL)}} \times \mathbf{100}$$

- **Example**

What volume of eucalyptus oil is required to prepare 10,000 mL solution of eucalyptus (0.5% v/v) for inhalation to manage nasal congestion?

- **Solution**

$$\%v/v = \frac{\text{volume of ingredient}}{\text{Volume of composition}} \times 100$$

$$0.5\% = \frac{\text{v} \times 100}{10{,}000} \Rightarrow \qquad \text{v} = \frac{0.5 \text{ x } 10{,}000}{100} = \mathbf{50\ mL}$$

- 50 mL eucalyptus is required for the preparation.

➨ Example 2:

Calculate how to prepare 100 mL of ethanol 70% v/v solution?

- **Solution:**

Percentage Weight by Weight (% w/w)

- This expression of concentration indicates the amount of an ingredient (g) in 100g of a substance.
- It could be the g of a solute in 100 g of the solution or a weight in g of a part in 100 g of the whole.
- It is a common expression seen on topical preparations and solid dosage forms.

$$\%\,\mathrm{w/w} = \frac{\text{weight of particular ingredient (g)}}{\text{weight of composition (preparation)(g)}} \times 100$$

Example

Mycoten® cream contains 0.2 g clotrimazole in 20 g tube of cream. State the concentration in % w/w.

- **Solution**

- $\%w/w = \frac{\text{weight of particular ingredient}}{\text{weight of composition}} \times 100$

$$= \frac{100 \times 0.2}{20}$$

= 1% w/w

Example

How much zinc oxide is required to prepare 50 g of a 20% w/w zinc oxide cream?

Solution:

Experiment 1

Title: preparation of simple solution.

Aim: to prepare 50ml of 0.5 M sodium chloride solution (M. wt NaCl is 58.5gm/mol).

Materials and equipment: sodium chloride, water, beaker, volumetric flask.

Procedure:

1. Find the weight of NaCl.
2. Weight and dissolve the needed amount of NaCl in about 40ml of DW in beaker
3. Stir until dissolve
4. Transfer to a 50 ml volumetric flask
5. Complete the volume by DW up to 50ml

Experiment 2

Title: preparation of simple solution.

Aim: to Prepare 100ml of 0.9 % w/v sodium chloride solution.

Materials and equibment: sodium chloride, water, beaker, volumetric flask.

Procedure:

1. Find the weight of NaCl
2. Weight and dissolve the needed amount of NaCl in about 60ml of DW in beaker
3. Stir until dissolve
4. Transfer to a volumetric flask
5. Complete the volume by DW up to 100 ml

Experiment 3

Title: preparation of simple solution.

Aim: to Prepare 100ml of 70 % v/v ethanol solution.

Materials and equipment: ethanol , water, beaker, volumetric flask.

Procedure:

1. Find the volume of pure ethanol
2. Place ---- ml of pure ethanol in volumetric flask,
3. Then add enough DW to it up to the mark of 100ml.

Experiment 4

Title:

Preparation of Zinc oxide paste.

Aim:

to Prepare 25g of 25% w/w Zinc oxide paste.

Materials and equipment:

Zinc oxide , white petrolatum , starch, mortar and pestle.

Prepare 25g of 25% w/w Zinc oxide paste.

Zinc oxide ……..25%

Starch ……25%

White petrolatum ……..50%

Procedure:

1. Weight the needed ingredients accurately.
2. Triturate the zinc oxide and starch in a mortar and pestle.
3. Incorporate the powder mixture into a small portion of white petrolatum until a smooth nucleus is formed.
4. Add the rest of white petrolatum portion by portion until a smooth paste is obtained.
5. Place in appropriate container and label the container properly.

Thank You