Introduction to Pharmaceutical Calculations and Dosage Forms

Metric System of Weights and Measures

Definition

- The metric system is an internationally accepted decimal system of weights and measures used in pharmaceutical calculations.
- It is based on multiples and submultiples of ten, making calculations simple and accurate.
- The metric system is the standard system used in pharmaceutical industries, hospitals, laboratories, and research institutions.

Basic Units

1. Unit of Length

- The basic unit of length is the **metre (m)**.

2. Unit of Mass (Weight)

- The basic unit of mass is the **gram (g)**.

3. Unit of Volume

- The basic unit of volume is the **litre (L)**.

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Prefixes Used in the Metric System

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Prefix	Symbol	Value	Power of 10	Example
Kilo	k	1,000	10^{3}	1 kg = 1,000 g
Hecto	h	100	10^{2}	1 hg = 100 g
Deca	da	10	10^{1}	1 dag = 10 g
Deci	d	0.1	10^{-1}	1 dL = 0.1 L
Centi	c	0.01	10^{-2}	1 cm = 0.01 m
Milli	m	0.001	10^{-3}	1 mg = 0.001 g
Micro	μ	0.000001	10^{-6}	1 μg = 0.001 mg
Nano	n	0.000000001	10^{-9}	1 ng = 0.001 μg

Common Metric Conversions

1. Weight

- 1 kilogram (kg) = 1000 grams (g)
- 1 gram (g) = 1000 milligrams (mg)

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- 1 milligram (mg) = 1000 micrograms (µg)
- 1 microgram (µg) = 1000 nanograms (ng)

2. Volume

- 1 litre (L) = 1000 millilitres (mL)
- 1 millilitre (mL) = 1000 microlitres (µL)

3. Length

- 1 metre (m) = 100 centimetres (cm)
- 1 centimetre (cm) = 10 millimetres (mm)

Advantages of the Metric System

- The metric system is simple because it is based on multiples of ten.
- Unit conversions are easy to perform.
- It reduces calculation errors.
- It is accepted worldwide for pharmaceutical practice.
- It provides accurate measurement of pharmaceutical ingredients.

Calculations Based on Alligation

Definition

- Alligation is a mathematical method used to calculate the proportion in which two or more substances of different strengths must be mixed to obtain a mixture of the desired strength.
- It is commonly used in pharmacy for preparing solutions, ointments, creams, and alcohol mixtures.

Types of Alligation

1. Alligation Medial

- Alligation medial is used to determine the strength of a mixture prepared by combining two or more ingredients of known strengths.
- **Formula:**

$$\text{Strength of mixture} = \frac{\text{Total amount of active ingredient}}{\text{Total quantity of mixture}} \times 100$$

Alligation Alternate

- Alligation alternate is used to determine the ratio in which two ingredients of different strengths must be mixed to obtain a desired strength.
- The desired strength must lie between the higher and lower strengths.

Procedure

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1. Write the higher strength at the top.
2. Write the lower strength at the bottom.
3. Write the desired strength between them.
4. Subtract the values diagonally.
5. Use the differences as the required mixing ratio.

Formula

- Parts of higher strength = Desired strength − Lower strength
- Parts of lower strength = Higher strength − Desired strength

Example

Question:

- Prepare a 30% solution by mixing 50% and 20% solutions.

Solution	Diagonal calculation	Parts required
50% solution	30 − 20	10 parts
20% solution	50 − 30	20 parts

Required ratio:

- **50% solution : 20% solution = 10 : 20 = 1 : 2**
- Therefore, **one part of the 50% solution** should be mixed with **two parts of the 20% solution** to obtain a 30% solution.

Applications

- Preparation of alcohol solutions.
- Preparation of ointments.
- Preparation of creams.
- Preparation of pharmaceutical solutions.

Advantages

- Alligation provides a quick method for concentration calculations.
- It reduces mathematical complexity.
- It is widely used in pharmaceutical compounding.

Proof spirit

Definition

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- Proof spirit is an alcohol solution that contains a specific concentration of ethanol as defined by pharmacopeial standards.
- In the British system, **100° proof spirit contains 57.1% v/v ethanol**.
- In the United States system, **100 proof spirit contains 50% v/v ethanol**.

Types of Spirit

1. Under Proof (U.P.)

- Under proof spirit contains less alcohol than proof spirit.

2. Over Proof (O.P.)

- Over proof spirit contains more alcohol than proof spirit.

Calculations Involving Proof Spirit

Formula

Proof Strength = (Actual % Alcohol ÷ Proof % Alcohol) × 100

- In British calculations, **57.1% v/v** is taken as proof spirit.

Example

- If a solution contains **28.55% v/v ethanol**, it is **50° Under Proof (50° U.P.)** because it contains half the alcohol concentration of British proof spirit.

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Applications

- Preparation of pharmaceutical alcoholic preparations.
- Manufacture of tinctures.
- Preparation of spirits.
- Quality control of alcohol-containing products.

Importance

- Proof spirit calculations ensure accurate alcohol concentration.
- They help maintain pharmacopeial standards.
- They improve product quality and consistency.

Isotonic solutions

Definition

- An isotonic solution has approximately the same osmotic pressure as body fluids, such as:
  - Blood plasma
  - Tears

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- Body cells

- It does not normally cause cells to shrink or swell.

Principle of Isotonicity

- Osmotic pressure depends on the number of dissolved particles rather than their mass.
- Body fluids have a freezing point of approximately **−0.52°C**.
- A solution with a freezing-point depression of about **0.52°C** is considered approximately isotonic.

Freezing-Point Depression Formula

$$\Delta Tf = i \times Kf \times m$$

- Where:
  - **ΔTf** = Freezing-point depression
  - **i** = Van't Hoff factor
  - **Kf** = Freezing-point depression constant
  - **m** = Molality of the solution

Importance

- Prevents cells from shrinking or swelling
- Protects tissues from damage
- Reduces pain and irritation
- Improves patient comfort
- Is essential for ophthalmic and parenteral preparations

Examples

- **0.9% sodium chloride solution**
  - Also called normal saline
  - Isotonic with blood plasma
- **5% dextrose solution**
  - Approximately isotonic when prepared

Methods of Preparing Isotonic Solutions

1. Sodium Chloride Equivalent Method

- The sodium chloride equivalent is known as the **E-value**.
- It represents the amount of sodium chloride osmotically equivalent to **1 gram of a drug**.

Formula:

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