Practical Pharmaceutical calculation
1st stage
College of Pharmacy

Lab.3 : Volume measurements

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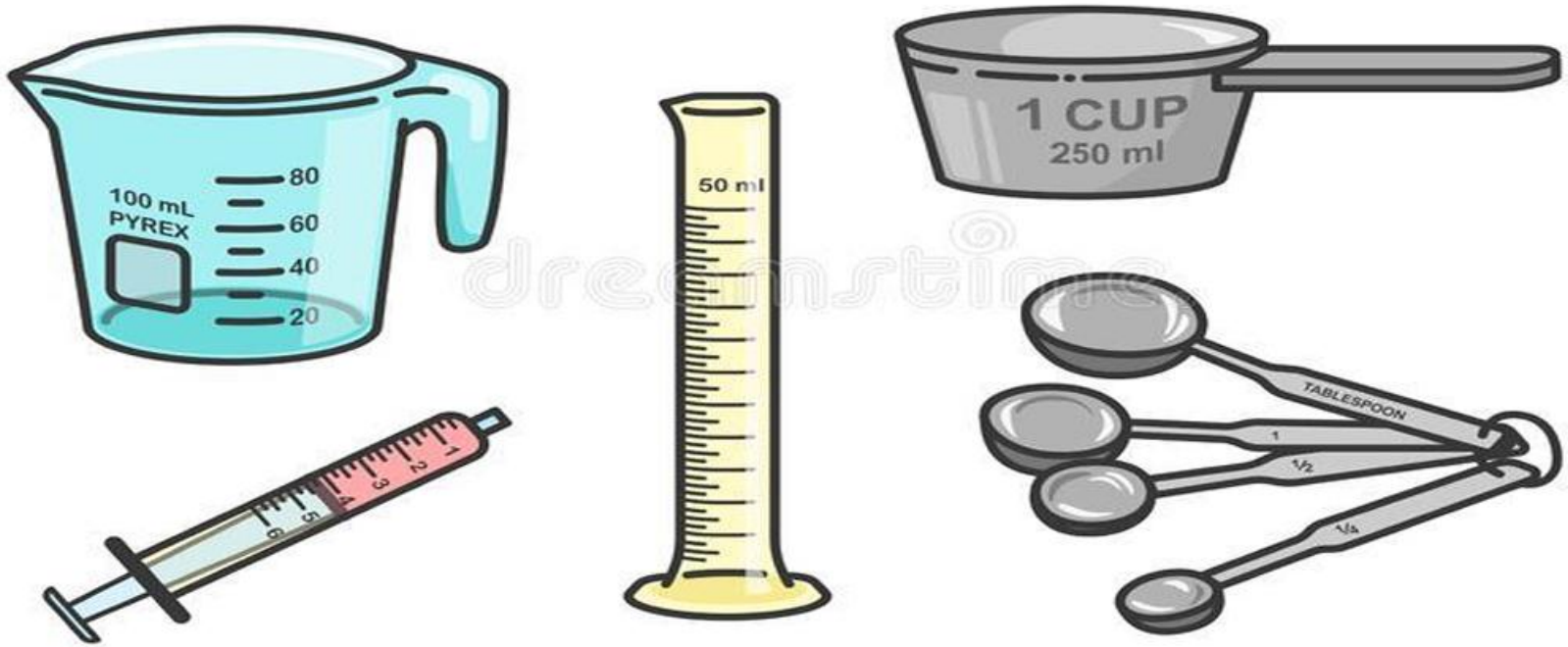


Volume measurements

- **VOLUME**: means space that is occupied by a given amount of matter.

Common Measuring Instruments

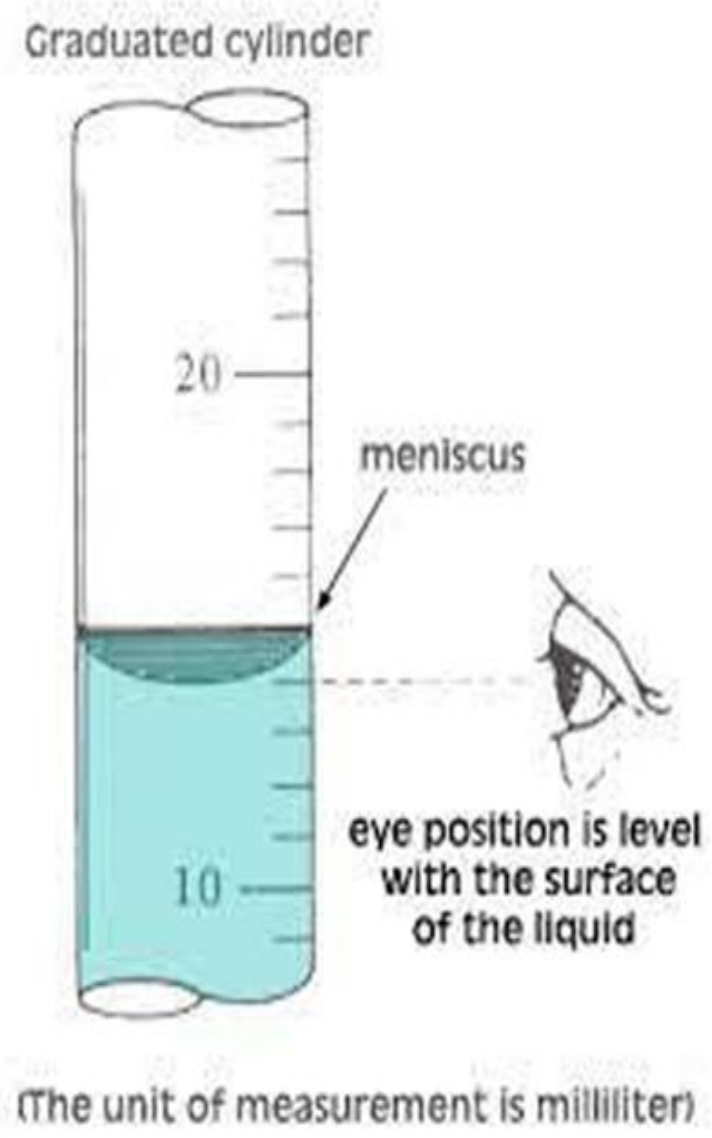
- **Micropipettes & burettes** → high precision (lab work) → Provides very precise delivery of liquid volume
- **Graduated cylinders (cylindrical/conical)** → common in pharmacy
- **Syringes & pipettes** → for small volumes
- **Volumetric Flask** → Used to prepare solutions of exact volume
- **Beaker** → Used for approximate volume measurements → Not very precise.

- Choice depends on:
  1. Type of liquid
  2. quantity
  3. Required accuracy

Technique of measuring liquid Properly

Steps:

1. Hold the **liquid bottle in the right hand**
2. Hold the **measuring cylinder in the left hand**
3. Pour liquid close to required volume
4. The graduate cylinder is then raised to level of eyes to minimize the error in reading
5. Add dropwise until **bottom of meniscus** reaches the mark



Sources of Error in Volume Measurement

1. **improper Use of Equipment**
   - Not using the instrument for its intended purpose (e.g., **using a beaker instead of a volumetric flask for precise measurement**) reduces accuracy.
   - Using **large cylinders for small volumes**
2. **Meniscus Reading Error**
   - Reading the top instead of the bottom of the meniscus (for most liquids like water) can cause errors.
3. **Parallax Error**
   - Occurs when the **liquid level (meniscus) is read from an incorrect eye position**.
4. **Temperature Effects**
   - volume of liquids and glassware **changes with temperature**.
5. **Incomplete Drainage**
   - Some liquid may **remain on the walls of pipettes or burettes**, leading to less liquid being delivered than expected.
6. **Air Bubbles**
   - Air bubbles trapped in the **pipette tip or burette** reduce the actual volume delivered.

Systems of Volume Measurement

❑ Metric System

- Units:
  - Liter (L), milliliter (mL), microliter (µL)
  - The **liter** is the primary unit of volume.

Conversions:

- 1 L = 1000 mL
- 1 mL = 1000 µL
- 1 cc = 1 mL

❑ Imperial System

- Units:
  - Minim (♏)
  - Fluid drachm (f℥)
  - Fluid ounce (f℥)
  - Pint, Gallon

Imperial Conversion ↔ Metric

Equivalents of Volume

1 minim = 0.06 mL

1 ml =16.23 Minims

1 fluid drachmae **f℥ ≈ 4 mL**

1 fluidounce (fl. oz.) = 29.57 mL

1 pint (16 fl. oz.) = 473 mL

1 quart (32 fl. oz.) = 946 mL

1 gallon, US (128 fl. oz.) = 3785 mL

1 gallon, UK = 4545 mL

Q1

A patient takes 2 fluid drachms per dose, twice daily for 5 days. Calculate total volume in mL.

Answer:

1 fluid drachm = 4 mL

2×4=8 mL per dose

8×2×5=80 mL

Q2

A container holds 1 quart (US). How many fluid drachms does it contain?

Answer:

1 quart = 946 mL

1 drachm = 4 mL

946/4=236.5 drachms

Q3

Convert 0.5 pint into minims.

Answer:

1 pint = 473 mL

0.5 pint = 236.5 mL

1 mL = 16.23 minims

$236.5 \times 16.23 \approx 3839.6$ minims

Q4

A bottle contains 3 fluid ounces. Express this in minims.

Answer:

1 fl oz = 29.57 mL

$3 \times 29.57 = 88.71$ mL

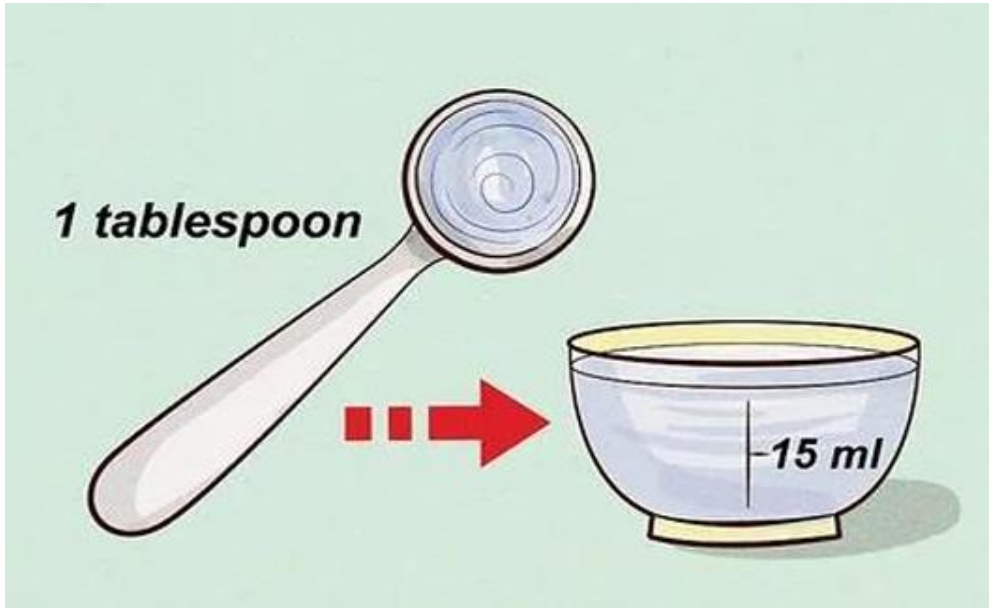
$88.71 \times 16.23 \approx 1440$ minims

Household Measurements (Domestic measure) :

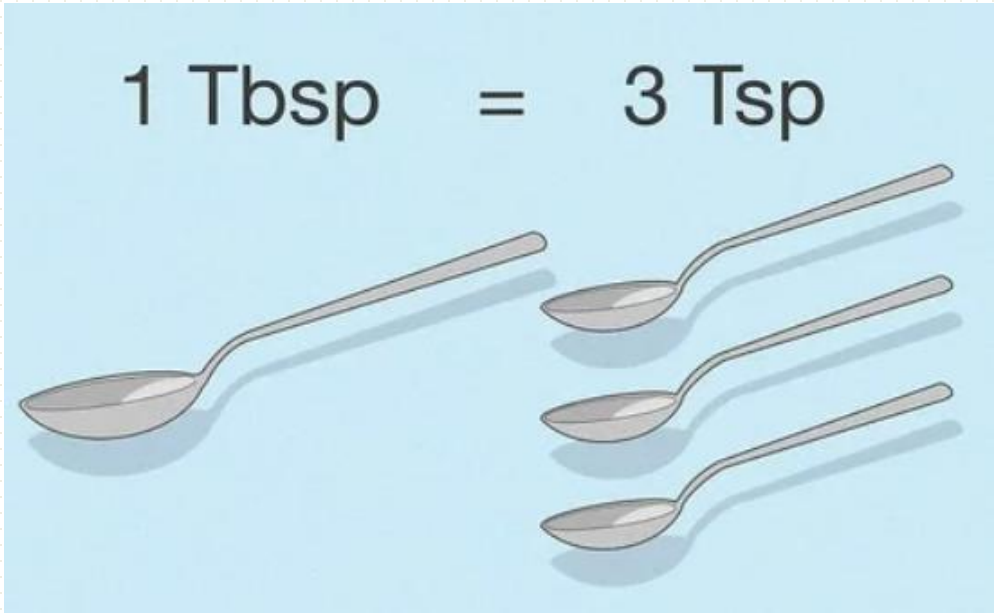
- These are the measure usually used at home for administration of drugs.
- They are always extremely inaccurate and depend on the shape of the measure

  - 1 teaspoon = 5 mL
  - 1 dessert spoon = 10 mL
  - 1 tablespoon = 15 mL
  - 1 teacup = 120 mL
  - 1 glass = 240 mL
  - Coffee cupful = 30 ml




1 tablespoon
15 ml


1 CUP


1 Tbsp = 3 Tsp

problem 1

- A standard **teaspoonful** is defined as **5 mL**.
  A student measures the volume of water using a teaspoon three times and gets: 4.6 mL, 5.4 mL, 4.8 mL
  1. Calculate the **average experimental volume**
  2. Calculate the **percentage error**

Standard = 5 mL Readings = 4.6, 5.4, 4.8 mL

1) Average experimental volume

$$\text{Average} = \frac{4.6 + 5.4 + 4.8}{3} = \frac{14.8}{3} = 4.93\ \text{mL}$$

2) Percentage error

$$\%\text{error} = \frac{|4.93 - 5|}{5} \times 100 = \frac{0.07}{5} \times 100 = 1.4\%$$

Problem 2

- A tablespoonful is officially 15 mL.. In an experiment, a student obtains the following readings: 16.2 mL, 14.5 mL, 15.8 mL, 14.9 mL
  1. Find the **mean experimental volume**
  2. Determine the **percentage error** relative to the standard value

1) Mean

$$\text{Mean} = \frac{16.2 + 14.5 + 15.8 + 14.9}{4} = \frac{61.4}{4} = 15.35\ \text{mL}$$

2) Percentage error

$$\%\text{error} = \frac{|15.35 - 15|}{15} \times 100 = \frac{0.35}{15} \times 100 = 2.33\%$$

Problem 3

- A pharmacist compares two spoons:
  - Spoon A (teaspoon): 5.3 mL
  - Spoon B (teaspoon): 4.2 mL

Standard teaspoon = **5 mL**

1. Calculate the % error for each spoon
2. Determine which spoon is more accurate

Spoon A

$$\%\text{error} = \frac{|5.3 - 5|}{5} \times 100 = \frac{0.3}{5} \times 100 = 6\%$$

Spoon B

$$\%\text{error} = \frac{|4.2 - 5|}{5} \times 100 = \frac{0.8}{5} \times 100 = 16\%$$

Spoon A is more accurate (lower error)

Specific gravity

- **Specific gravity** is the **ratio of the density (or weight) of a substance to the density (or weight) of an equal volume of water at a specified temperature**.
- For liquids and solids, water is usually taken at **4 °C or 25 °C** as the reference.
- Specific gravity = **Density of substance / Density of water**
- Because it is a **ratio of two densities**, specific gravity **has no units**.

$$sp.gr = \frac{weight\ of\ substance}{weight\ of\ equal\ volume\ of\ water}$$

- The equation works because **both substances occupy the same volume**, so the comparison depends only on **their weight (or mass)**.

Example 1

A liquid weighs 50 g, and the same volume of water weighs 40 g. calculate its Specific gravity (sp.gr)

$$\text{sp.gr} = \frac{\text{weight of substance}}{\text{weight of equal volume of water}}$$

- Weight of substance = **50 g**
- Weight of equal volume of water = **40 g**

$$\text{sp.gr} = \frac{50}{40}$$

$$\text{sp.gr} = 1.25$$

Example 2:

substance has a specific gravity of 2.5. The weight of the substance is 200 g. Find the weight of an equal volume of water.

$$\text{sp.gr} = \frac{\text{weight of substance}}{\text{weight of equal volume of water}}$$

- specific gravity = **2.5**
- Weight of substance = **200 g**
- Weight of equal volume of water = **?**

$$2.5 = \frac{200}{\text{weight of water}}$$

$$\text{weight of water} = 80 \text{ g}$$


Thank you

Experimental work:

- Measure **tablespoonful and teacup** and write the experimental volume.
- Then find the percentage of error.