

# PHARMACEUTICAL CALCULATIONS



- Some fundamentals of measurement and calculations
  - Balance sensitivity, significant figures,
  - accuracy and percentage of errors
  - Measurement of volume and weight
  - Aliquot method of weighing and measuring
  - Density, specific gravity, specific volume

# Pharmacy measurement system

- Metric system
  - Liquid (volume)
    - Liter
      - $1\text{ L} = 10\text{ dL} = 1000\text{ ml}$
    - milliliters
      - $1\text{ ml} = 0.001\text{ L}$

- Metric system
  - Solids(weight)
    - Kilogram
      - $1\text{ kg} = 1000\text{ g}$
    - Gram
      - $1\text{ g (gm)} = 0.001\text{ kg} = 1000\text{ mg}$
    - Milligram
      - $1\text{ mg} = 0.001\text{ g} = 1000\text{ mcg}$
    - Microgram
      - $1\text{ mcg} = 0.001\text{ mg} = 0.000001\text{ g}$

- Avoirdupois system
  - Pound
    - $1\text{ lb} = 16\text{ oz}$
  - Ounce
    - $1\text{ oz} = 437.5$
  - Grain
    - $1\text{ gr} = 64.8\text{ mg}$

- Apothecary
  - Gallon
    - $1\text{ gal} = 4\text{ qt} = 3840\text{ ml}$
  - Quart
    - $1\text{ qt} = 2\text{ pt} = 960\text{ ml}$
  - Pint
    - $1\text{ pt} = 16\text{ fl oz} = 480\text{ ml}$
  - Fluid ounce
    - $1\text{ fl oz} = 6\text{ fl dr} = 30\text{ ml}$
  - Fluid dram
    - $1\text{ fl dr} = 60\text{ minims} = 5\text{ ml}$

- Household units
  - Teaspoon
    - $1 \text{ tsp} = 5 \text{ ml}$
  - Tablespoon
    - $1 \text{ tbsp} = 3 \text{ tsp} = 15 \text{ ml}$
  - Cup
    - $1 \text{ cup} = 8 \text{ fl oz}$

- Change one unit of measure into another

- 1 pt = 473.167 ml

- 1 fl oz = 29.57 ml

- 1 kg = 2.2 lb

- 1 g = 1000 mg

- 1 oz = 28.35 gm

- 1 gr = 64.8 mg

- 1 g = 1000 mg

- 1 fl dr = 5 ml

# balance sensitivity, significant figures, accuracy and percentage of error

- Weighing and measuring are two of the most important aspects of dispensing, compounding, and administration of medicines
- The successful performance of dispensing and compounding operations in a pharmacy depends on a thorough understanding of the principles of the prescription balance

- Solid and semi-solid substances are weighed on special weighing paper which has a glazed surface.
- The paper protects the pans of the prescription balance from chemical reactions and eliminates the need for repeated cleaning

# Prescription balances

## Class A

- Sensitivity requirement= 6mg
- Maximum amount that can be weighed=120g

## Class B

- Sensitivity requirement= 30mg
- Maximum amount that can be weighed=600g

- Sensitivity requirement is the minimum weight required to move the pointer by one division on the scale
- The smaller the weight required to move the pointer by one division, the more sensitive is the balance

- Sensitivity requirement (SR) is related to the percent error or maximum potential error by the equation

$$\% \text{Error} = \text{SR} * 100 / \text{quantity to be weighed (Q)}$$

$$\% \text{E} = \frac{\text{I actual weight} - \text{intended weight I}}{(\text{intended weight})}$$

- If the potential for a maximum error is 5%, the percent confidence of being correct is 95.
- The sensitivity requirement can also be determined by finding the number of divisions a pointer moves when a 10 or 20mg weight is added to the pan

- For example, if the pointer moves by three divisions with a weight of 20mg, the sensitivity requirement is  $20/3=6.67\text{mg}$

## Exercise 1:

What is the minimum amount that  
can be

Weighed on a class A prescription  
balance

with a potential error of not more  
than 10%

$$\% \text{Error} = 100 * 6 \text{mg} / Q$$

$$Q = 100 * 6 / 10 = 60 \text{mg}$$

**Note:** if the sensitivity requirement for a class A prescription balance is not provided, it should be assumed as 6mg.

## Exercise 2:

If a pharmacist attempts to weigh 80mg on a prescription balance with a sensitivity requirement of 4mg, what is the percent error associated with weighing?

$$\begin{aligned}\% \text{Error} &= 100 * 4\text{mg} / 80 \\ &= 400 / 80 \\ &= 5\%\end{aligned}$$

### Exercise 3:

If the pointer moves two divisions when a 10mg weight is placed on the right hand side of a prescription balance, what is its sensitivity requirement?

$$SR = 10/2 = 5\text{mg}$$

# Practical problems

- ❖ To achieve 92% accuracy, the amount to be weighed must be how many times greater than the sensitivity requirement of the balance?
- ❖ If 2gm of sulfur is weighed on a prescription balance with a sensitivity requirement of 2mg, what would be the potential percent error?

- ❖ What is the smallest quantity that can be weighed with a potential error of not more than 5% on a balance with sensitivity requirement of 4mg?
- ❖ If a 10% error is observed while weighing 0.15gm, what would be the sensitivity requirement of the balance?

- In an attempt to weigh 200mg on a prescription balance, a pharmacist realized that it had % error. What is the sensitivity requirement of that balance?
- For a class B prescription balance with a sensitivity requirement of 30mg, what would be the potential error if a pharmacist attempts to weigh 648mg of salicylic acid?

- For preparing a eutectic mixture, a pharmacist needed  $\frac{1}{4}$  gr of thymol. If a pharmacist weighs that amount on a prescription balance with a sensitivity requirement of  $\frac{1}{10}$  gr, what would be the percent error?
- When a gr ss weight was placed on the right pan of a prescription balance, the pointer moved four divisions. What is the sensitivity requirement of the balance?

- A pharmacist measured 50ml of syrup USP in a measuring cylinder, and transferred that amount to a beaker. To his surprise, he later observed that 5ml of syrup USP was still left in the cylinder. What is the percent error in his syrup USP measurement?

- If one attempts to weigh 150mg of aspirin on a balance having a sensitivity requirement of 30mg, what would be the percent error involved?

**Significant figures-----**  
**reading assignment**

# **Density, specific gravity, and specific volume**

- The pharmacist often uses measurable quantities such as density and specific gravity when inter-converting between weight (mass) and volume.

## **Density**

- Density is derived quantity combining mass and volume.
- It is defined as mass per unit volume of a substance at a fixed temperature and pressure.

# Units

- As grams per cubic centimeter ( $\text{g/cm}^3$ ) Or simply as grams per milliliter ( $\text{g/ml}$ )
- As kilograms per cubic meter
- It may be expressed as number of grains per fluidounce Or the number of pounds per gallon

- Density may be calculated by dividing the mass of substance by its volume
- Eg. If 100ml of lugol's solution weighs 120gm, its density is:

$$120\text{gm}/100\text{ml}=1.2\text{gm/ml}$$

# Specific gravity

- Is the ratio of the density of a substance to the density of water.
- The values for both substances being determined at the same temperature
- For practical purposes, it may be defined as the ratio of the mass of a substance to the mass of an equal volume of water at the same temperature.

- The official pharmaceutical compendia uses 25 0c to express specific gravity.
- For example: if 100ml of simple syrup, NF weighs 131.3, and 100ml of water, at the same temperature, weighs 100gm, the specific gravity of the simple syrup is:  
=weight of 100ml of simple syrup/weight of 100ml of water

$$131.3/100=1.313$$

# Specific volume

- Specific volume is the ratio of volume of a substance to the volume of an equal weight of another substance taken as a standard,
- the volume for both substances being determined at the same temperature
- Specific volume may be calculated by dividing the volume of a given mass of the substance by the volume of an equal mass of water

- For example, if 100gm of a syrup measures 85ml, and 100gm of water, at the same temperature, measures 100ml, the specific volume of that syrup is:
- Volume of 100gm of syrup/volume of 100gm of water  
$$85\text{ml}/100\text{ml}=0.85$$
- Note: the specific gravity and specific volume are reciprocals of each other

- If the specific gravity of the solution is known, inter-conversion between %w/v and %w/w are possible using the following expression:

 **Percent weight in weight (%w/w) of the solution** = (percent weight in volume (%w/v) of the solution / specific gravity of the solution)

- Example 1: how many milliliters of 90%(w/w) sulfuric acid having a specific gravity of 1.788 should be used in preparing a liter of 8% (w/v) acid?

$$90\%w/w$$

$$*1.788=160.92\%w/v$$

$$1000ml*8\%w/v$$

$$v=160.92\%w/v*X$$

- Example 2: a pharmacist mixes 100ml of 35%(w/w) hydrochloric acid with enough purified water to make 400ml. If the specific gravity of hydrochloric acid is 1.20, calculate the percentage strength(w/v) of the final solution?

$$100\text{ml} \times 35\%(\text{w/w}) = 400\text{ml} \times X(\text{w/w})$$

$$X = 100 \times 35 / 400 = 8.75\%$$

$$8.75 \times 1.20 = 10.5\%$$

- Example 3: how many milliliters of a 64%(w/w) sorbitol solution having a specific gravity 1.26, should be used in preparing a liter of a 10%(w/v) solution?

$$64\%w/w * 1.26 = 80.64\%w/v$$

$$1000ml * 10\%w/v$$

$$v = Xml * 80.64\%w/v$$

$$X = 1000 * 10 / 80.64 = 124ml$$

# Practical problems

1. If a liter of mannitol solution weighs 1285gm, what is its specific gravity?
2. If 50ml of glycerin weighs 135gm, what is its specific gravity?
3. The specific gravity of ethyl alcohol is 0.820. what is its specific volume?
4. If 68gm of a sulfuric acid solution measures 55.5ml, what is its

5. What is the weight of 15ml of propylene glycol having a specific gravity of 1.24?
6. What is the weight, in grams of 250ml of iodine solution having a specific gravity of 1.28?
7. What is the volume of 50gm of potassium chloride solution with specific gravity of 1.30?

8. What is the weight, in kilograms of 1 gallon of dextrose solution having a specific gravity of 1.25?
9. The strength of a syrup USP solution is 65%w/w and its specific gravity is 1.313. what is its concentration in %W/V?
10. How many milliliters of 36.5%w/w hydrochloric acid are needed to prepare one gallon of 25%w/v acid? The specific gravity of hydrochloric acid is 1.20.