

PHARMACEUTICAL CALCULATIONS



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Shaping Lives...
Empowering Communities...

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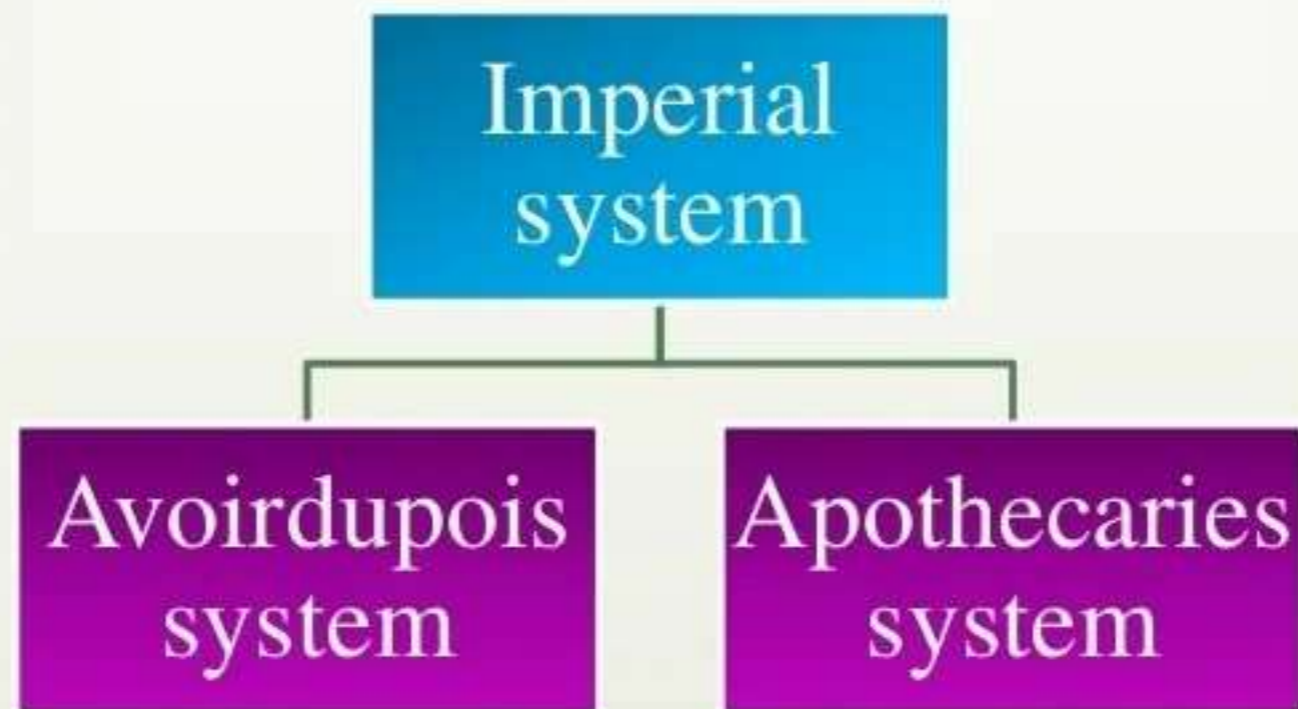
INTRODUCTION

- To have a complete understanding of various types of calculations, which are involved in dispensing, it is desirable that the pharmacist should have a thorough knowledge regarding weights and measures which are used in calculations.
- There are **two** systems of weights and measures.
 - 1.The Imperial system
 - 2.The Metric system



IMPERIAL SYSTEM

- Imperial system is an old system of weight and measures.



Avoirdupois system :

- In this system **the pound is the standard unit** for weighing and all measures of mass are derived from the Imperial standard pound (lb).

Apothecaries system :

- This system is also known as **Troy system**.
- **The grain is the standard unit** in this system and all other weights are derived from it.



CONVERSION TABLE-1

FROM APOTHECARIES TO AVOIRDUPOIS

1 Lb	16 oz (avoir)
1 Lb	7000 grains
1 oz (avoir)	$7000/16 = 437.5$ grains
20 grains (gr)	1 scruple (↪)
60 grains	1 drachm
480 grains	1 ounce (apoth)
12 ounces	1 pound (Lb) (apoth)
5760 grains	1 pound (apoth)



Measurement of capacity in imperial system :

- The standard units for capacity is **same** for both the avoirdupois and the apothecaries systems.
- The **gallon** is the standard unit and other measures of capacity are derived from it.

CONVERSION TABLE-2

1gallon (c)	=	160 fluid ounces
1/4 th of gallon	=	1 Quart
1/8 th of gallon	=	1 pint(O)
1/160 th of gallon	=	1 flounce
1 quart	=	40 flounces
1 pint	=	20 flounces
1 flounce	=	480 minims
1 fl drachm	=	60 minims



METRIC SYSTEM

- Metric system is used in the Indian pharmacopeia for the measurement of **weights** and **capacity**.
- It was implemented in India from **1st April , 1964** in pharmacy profession.

Measurement of weight in metric system :

• **A kilogram** is the standard unit for measurement of weight and all other measures are derived from it.



CONVERSION TABLE - 3 FROM HIGHER TO LOWER

1 kilogram = 1000gms

1 hectogram = 100 gms

1 decagram = 10 gms

1 decigram = 0.1 gms

1 centigram = 0.01 gms

1 milligram = 0.001 gms

1 microgram = 0.000,001 gms



Measurement of capacity in Metric System

A **litre** is the standard unit for measurement of capacity and all measures of capacity are derived from it.

1 litre (lt) = 1000 milliliters (ml)



Conversion Tables

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- The pharmacopeia of India uses only the metric system in formulae, But the prescription are still written in the imperial system by many old time physicians. So a conversion tables is used by the pharmacists.



- Weight measures

Metric system		Imperial system
1 kilogram (kg)	=	2.2 lb (pound)
30g	=	1 ounce
450g	=	1 pound (avoir)
1g	=	15 grains
60mg	=	1 grain

- Capacity measures

1000 ml	=	1 Quart
500 ml	=	1 pint
30 ml	=	1 fluid ounce
4 ml	=	1 fluid drachm
1 ml	=	15 minims
0.06 ml	=	1 minim



Conversion table for Domestic Measures

<i>Domestic Measure</i>	<i>Metric system</i>	<i>Imperial system</i>
1 drop	0.06 ml	1 minim
1 tea spoonful	4.00 ml	1 fluid drachm
1 desert spoonful	8.00 ml	2 fluid drachm
1 tablespoonful	15.00 ml	4 fluid drachm
2 tablespoonful	30.00 ml	1 fluid ounce
1 wine glassful	60.00 ml	2 fluid ounce
1 tumblerful	240.00 ml	8 fluid ounce



CALCULATIONS BASED ON DENSITY :

- Density is defined as **the mass of a substance per unit volume.**
- It has the units of mass over volume.
- Specific gravity is defined as **the ratio of the mass of a substance in air to that of an equal volume of water.**
- In the metric system both density and specific gravity are numerically equal.



$$\text{WEIGHT} = \text{VOLUME} * \text{DENSITY}$$

Example problems for calculations based on density

1. Calculate the volume of 2kg of glycerin. The density of glycerin is 1.25g/ml.

$$\text{VOLUME} = \frac{\text{WEIGHT}}{\text{DENSITY}}$$

$$\begin{aligned} &= \frac{2\text{kg}}{1.25\text{g/ml}} \\ &= \frac{2000\text{ g}}{1.25\text{ g/ml}} \\ &= 1600\text{ ml} \end{aligned}$$



2. Calculate the weight of 200ml of alcohol whose density is 0.816 g/ml

WEIGHT = VOLUME X DENSITY

$$= 200 \text{ ml} \times 0.816 \text{ g/ml}$$

$$= 163.2\text{g}$$





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ALCOHOLIC DILUTIONS

Example problem For Alcoholic Dilutions

- Calculate the amount of 95% alcohol required to prepare 400ml of 45% alcohol

volume required = 400ml

percentage of alcohol required = 45

percentage of alcohol used = 95

$$\text{Volume of strong alcohol to be used} = \frac{\text{Volume required} \times \text{percentage required}}{\text{percentage used}}$$

$$= \frac{400 \times 45}{95}$$

$$= \frac{3600}{19}$$

$$= 184.47 \text{ ml}$$



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Alligation method



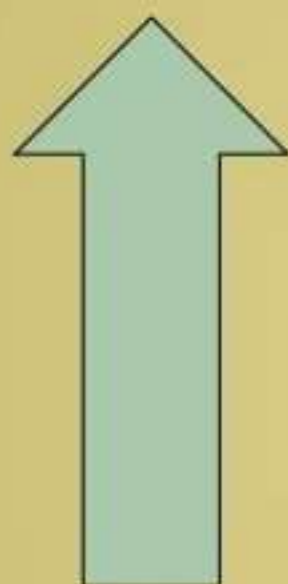
ALLIGATION METHOD

- When the calculation involves mixing of two similar preparations of different strengths, to produce a preparation of intermediate strength, the alligation method is used.

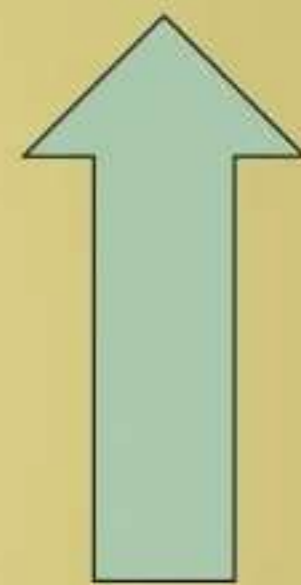


Stronger Percentage

Weaker percentage



Required Percentage



Required percentage –
Weaker Percentage

Stronger percentage –
Required Percentage

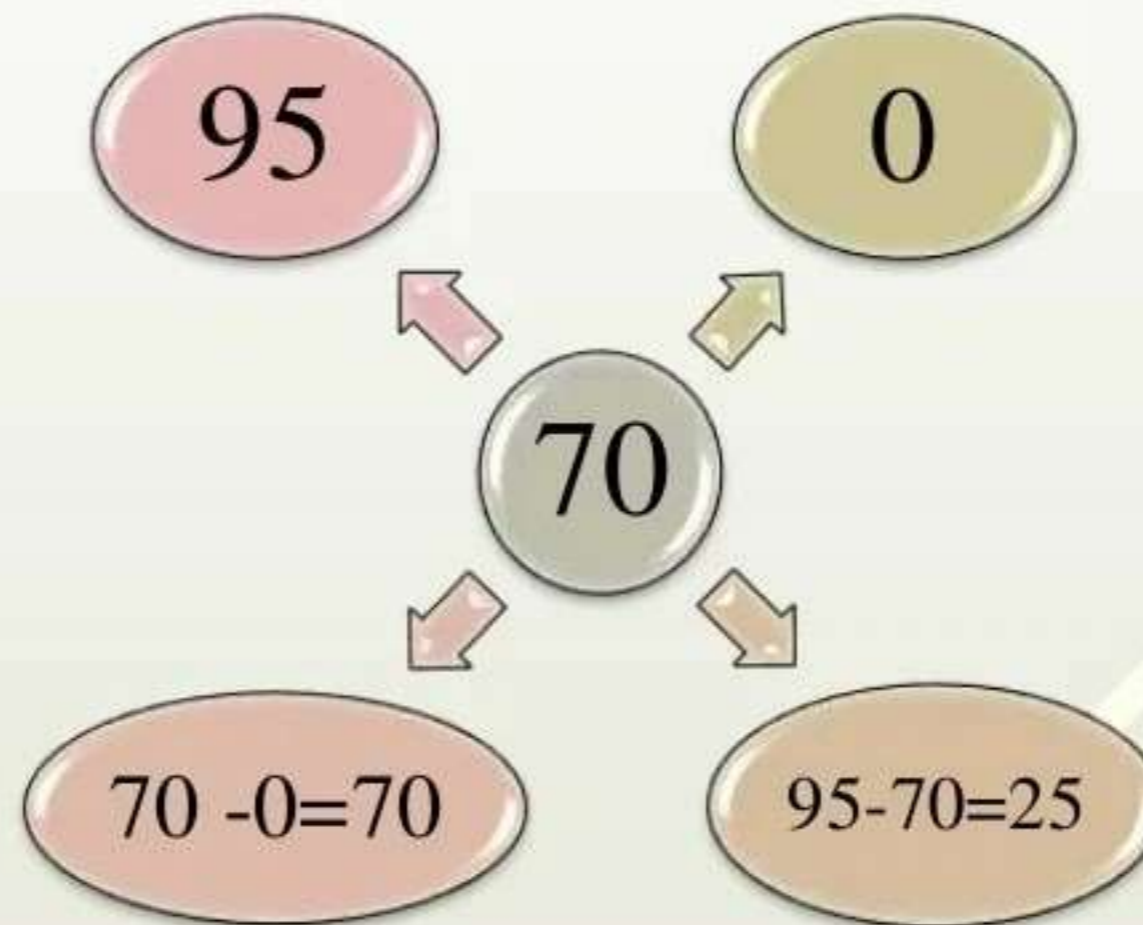
Example problems For Alligation method

1. Calculate the volume of 95% alcohol required to prepare 600ml of 70% alcohol.

Volume required = 600 ml

Percentage of alcohol required = 70

Percentage of alcohol used = 95



(Problem Contd.....)

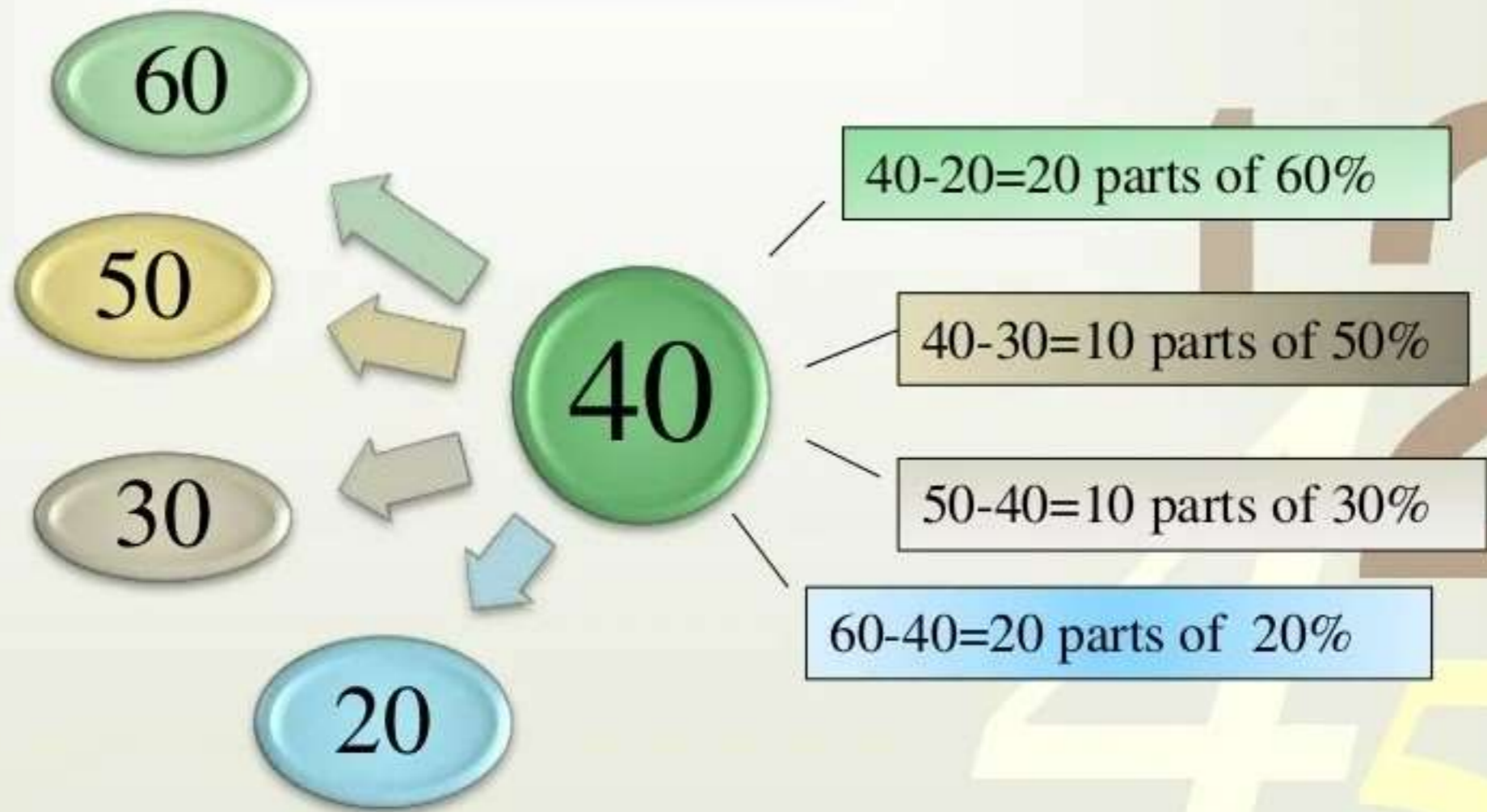
- 70 parts of 95 %alcohol and 25 parts of water will produce the required %alcohol.

$$\text{Quantity of 95\% alcohol required} = \frac{600 \times 70}{95}$$
$$= 422.10\text{ml}$$

$$\text{Quantity of water required} = \frac{600 \times 25}{95}$$
$$= 157.90\text{ml}$$



2. How much quantity of 60%, 50%, 30% and 20% alcohol should be mixed to get 40% alcohol.



(Problem contd.....)


- Quantity required = 20parts of 60%+10 parts of 50%+10 parts of 30%+20 parts of 20% alcohol are mixed together, the resulting solution will produce 60% alcohol.

Calculation can be checked by the following method:

$$= (20 \times 60 + 10 \times 50 + 10 \times 30 + 20 \times 20)$$

$$= 1200 + 500 + 300 + 400$$

$$= 2400$$


$$20 + 10 + 10 + 20 = 60$$

$$\text{i.e., } 60 \times 40 = 2400$$





PROOFSPIRIT

CALCULATIONS

Proof spirit calculations

Introduction

- The strength of alcohol is calculated in **proof degrees**. The Indian standards of 100% proof spirit is equal to 57%v/v of ethyl alcohol.

i.e., 100% p.s = 57%v/v ethyl alcohol

- If the value is more than 57% then it is said to be as **over proof spirit**.

If the value is less than 57% then it is said to be as **under proof spirit**.



(Introduction contd....)

- In **India**, the exercise duty is calculated in terms of rupees per liter of proof alcohol. So, any percentage volume in volume of alcohol can be converted into proof strength and vice versa by using the following method.

i. Multiply the percentage strength of alcohol by 1.753 and deduct 100 from the product.

ii. If the **result is positive**, it is known as **over proof**

iii. If the **result is negative**, it is known as **under proof**.



- **1.753 is obtained as follows:**

57.1 volume of ethyl alcohol = 100 ml of proof spirit.

1 volume of ethyl alcohol = $100 / 57.1$

= 1.753 volume of proof spirit

Example problems for Proof Spirit calculations

Calculate the strength of 30⁰ O.P and 40⁰ U.P

30⁰ OVER PROOF = $100 + 30 = 130$

40⁰ Under proof = $100 - 40 = 60$



(Problem Contd....)

$$\begin{aligned}\text{Alcohol strength} &= \frac{100 + 30}{1.753} \\ &= \frac{130}{1.753} \\ &= 74.15\%v/v\end{aligned}$$

$$\begin{aligned}\text{Alcohol strength} &= \frac{100 - 40}{1.753} \\ &= \frac{60}{1.753} \\ &= 34.23\%v/v\end{aligned}$$

Check :



If strength is 74.15%v/v

$$74.15 \times 1.753 - 100 = 129.9 - 100 = +29.9^{\circ} \text{ or } 30^{\circ} \text{ O.P}$$

If strength is 34.23 %v/v

$$34.23 \times 1.753 - 100 = 60.00 - 100 = - 40^{\circ} \text{ U.P}$$

2. What is the proof strength of 95% v/v alcohol.

By applying the formula:

$$\text{percentage strength of alcohol} \times 1.753 - 100$$

$$= 95 \times 1.753 - 100$$

$$= 166.53 - 100$$

$$= +66.53^{\circ} \text{ O.P}$$



3. How many proof gallons are contained in 5 gallon of 70% v/v alcohol

Applying the formula:

$$\text{Value in proof} = \% \text{ strength of alcohol} \times 1.753 - 100$$

$$= 70 \times 1.753 - 100$$

$$= 122.71 - 100$$

$$= 22.71^{\circ} \text{ o.p}$$

100 gallons of 70% v/v alcohol = 122.71 units of p.s

1 gallon of 70% v/v alcohol = $122.71/100 = 1.2271$

5 gallons of 70% alcohol = 1.2271×5
= 6.1355 gallons of p.s

5 gallons of 70% v/v alcohol are equivalent to 6.1355 gallons of p.s



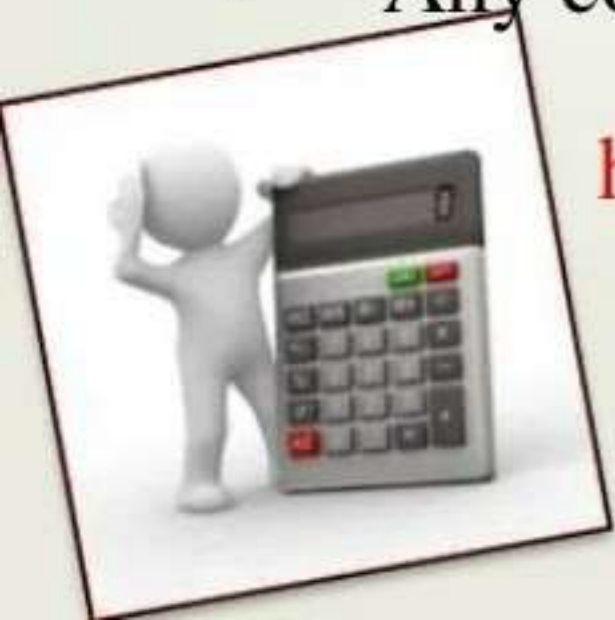
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ISOTONIC SOLUTIONS

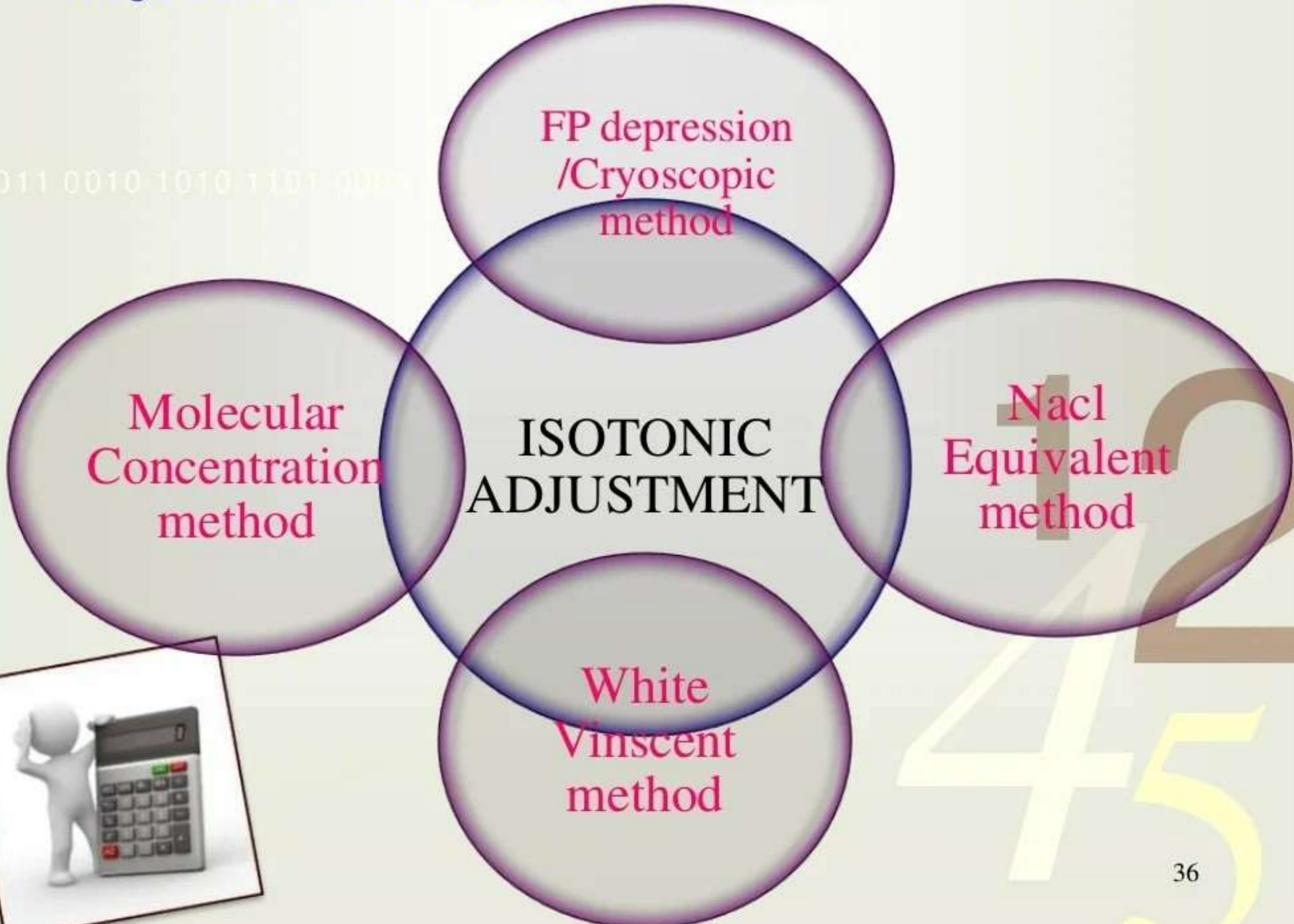


Isotonic solutions

- Isotonic solutions are which have same osmotic pressure or equal solute concentrations.
- 0.9% sodium chloride solution is considered to passes the same osmotic pressure and hence it is a standard solution which is isotonic with blood plasma.
- Any concentration **above this (0.9%)** is considered as **hypertonic** and **below this (0.9%)** is considered as **hypotonic**.



ADJUSTMENT OF ISOTONICITY:



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I. Freezing point method/ Cryoscopic method

$$\% \text{ w/v of adjusting substance needed} = \frac{0.52 - PSM * a}{b}$$

Where

PSM = percentage strength of medicament

a = Freezing point of the unadjusted solution

b = Freezing point of a 1% w/v solution of a adjusting substance



Example Problem for Freezing point method

- Using cryoscopic method. How will you prepare 1% solution of boric acid, iso osmotic with blood plasma.

[Hint : The freezing point of 1%w/v solution of boric acid is 0.288°C

The freezing point of 1%w/v solution of sodium chloride is 0.576°C]

$$\begin{aligned}\text{Percentage of w/v of sodium chloride required} &= \frac{0.52 - PSM * a}{b} \\ &= \frac{0.52 - 1 * 0.288}{0.576} \\ &= 0.402\% \text{ w/v}\end{aligned}$$

1gm of boric acid is needed for 0.402gm of NaCl to become isotonic.



2. Nacl Equivalent method:

$$\text{Quantity of Nacl required to adjust tonicity} = 0.9 - (\text{PSM} \times E)$$

Where

PSM = Percentage strength of medicament.

E = Nacl equivalent (quantity of Nacl i.e., equivalent to 1gm of drug)

3. White Vincet method :

$$V = W \times E \times 111.1$$

Where

V = volume of isotonic solution in ml that can be prepared by dissolving drug in water

W = weight of the drug.

E = Nacl equivalent .



4 . Molar (or) Molecular concentration :

$$\%W/V \text{ of adjusting substance required} = \frac{0.03M}{N}$$

Where

M = gram molecular weight.

N = no.of ions into which the substance is ionised.

Problem:

- How to prepare an iso osmotic solution using dextrose.

[Hint: mol.wgt of dextrose = 180

[dextrose is non ionising substance]

$$W = 0.03 M$$

$$W = 0.03 \times 180 = 5.4 \text{ g/100ml}$$



POSIOLOGY



POSOLOGY

Posology refers to the calculation of doses for children.

1. Proportion to Age :-

(a) Young's formula:

$$\text{Dose for a child} = \frac{\text{Age (years)}}{\text{Age} + 12} \times \text{Adult dose}$$

The above formula is used for calculating the doses for children 12 years of age.



- Example problem for young's formula

What will be the dose for a child of 5 years if the adult dose of a drug is 400 mg.

$$\text{Dose of the child} = \frac{\text{Age (years)}}{\text{Age} + 12} \times \text{Adult dose}$$

$$= \frac{5}{5 + 12} \times 400$$

$$= 117 \text{ mg (approximately)}$$



(b) Dilling's formula:

$$\text{Dose of a child} = \frac{\text{Age(years)}}{20} \times \text{Adult dose}$$

The above formula is used for calculating the doses of a children in between 4 to 20 years of age.

Example problem:

- What will be the dose for a child of 10 years if the adult dose of a drug is 600mg



$$\begin{aligned}\text{Dose of a child} &= \frac{10}{20} \times 600 \\ &= 300 \text{ mg}\end{aligned}$$

(c) Freid's formula:

$$\text{Dose for a child} = \frac{\text{Age in months}}{150} \times \text{Adult dose}$$

The above formula is applicable only for infants.

Example problem:

- What is the dose for an 8months old infant if the average adult dose of a drug is 250mg

$$\text{Dose for the child} = \frac{8}{150} \times 250$$

$$= 13.3\text{mg}$$



(2) Calculations based on body weight:

Catzel rule:

$$\text{Dose for the child} = \frac{\text{Surface area of child}}{\text{Surface area of Adult}} \times \text{Adult dose}$$

The average body surface area for an adult = 1.73m^2

Hence

$$\text{Dose for the child} = \frac{\text{Surface area of child}}{1.73\text{m}^2} \times \text{Adult dose}$$



Example problem for calculations based on body weight

- Calculate the dose for a child that has a body surface area of 0.57m^2 , when the adult dose of a drug is 50mg .

$$\begin{aligned}\text{Child dose} &= \frac{\text{Surface area of child}}{1.73\text{m}^2} \times \text{Adult dose} \\ &= \frac{0.57}{1.73} \times 50 \\ &= 1.65 \text{ mg}\end{aligned}$$



Calculations based on body weight:

❖ Clarke's rule:-

- $$\text{Dose} = \frac{\text{wt in lb}}{150} \times \text{Adult dose (mg)}$$
- $$\text{Dose} = \frac{\text{wt in kg}}{70} \times \text{Adult dose (mg)}$$

Rule is applicable only when child dose is less than 150 lb or 70kg.



- Example problem for calculations based on body weight

The dose of a drug is 5mg/kg body weight. How much of drug required for a boy of 12 years weighing 21kg.

$$\begin{aligned} \text{Dose} &= \frac{21}{70} \times 5\text{mg} \\ &= 1.5\text{mg} \end{aligned}$$

(3) Calculations based on body surface area:

Most accurate method commonly used in oncology department

Mosteller rule:

$$\text{BSA (M}^2 \text{)} = \sqrt{ht (cm) \times wt (kg) / 3600}$$



Example problem for calculations based on body surface area

- Calculate the BSA of a boy of height 165 cm and weighing 65kg.

$$\text{BSA} = \sqrt{160 \times 65 / 3600}$$

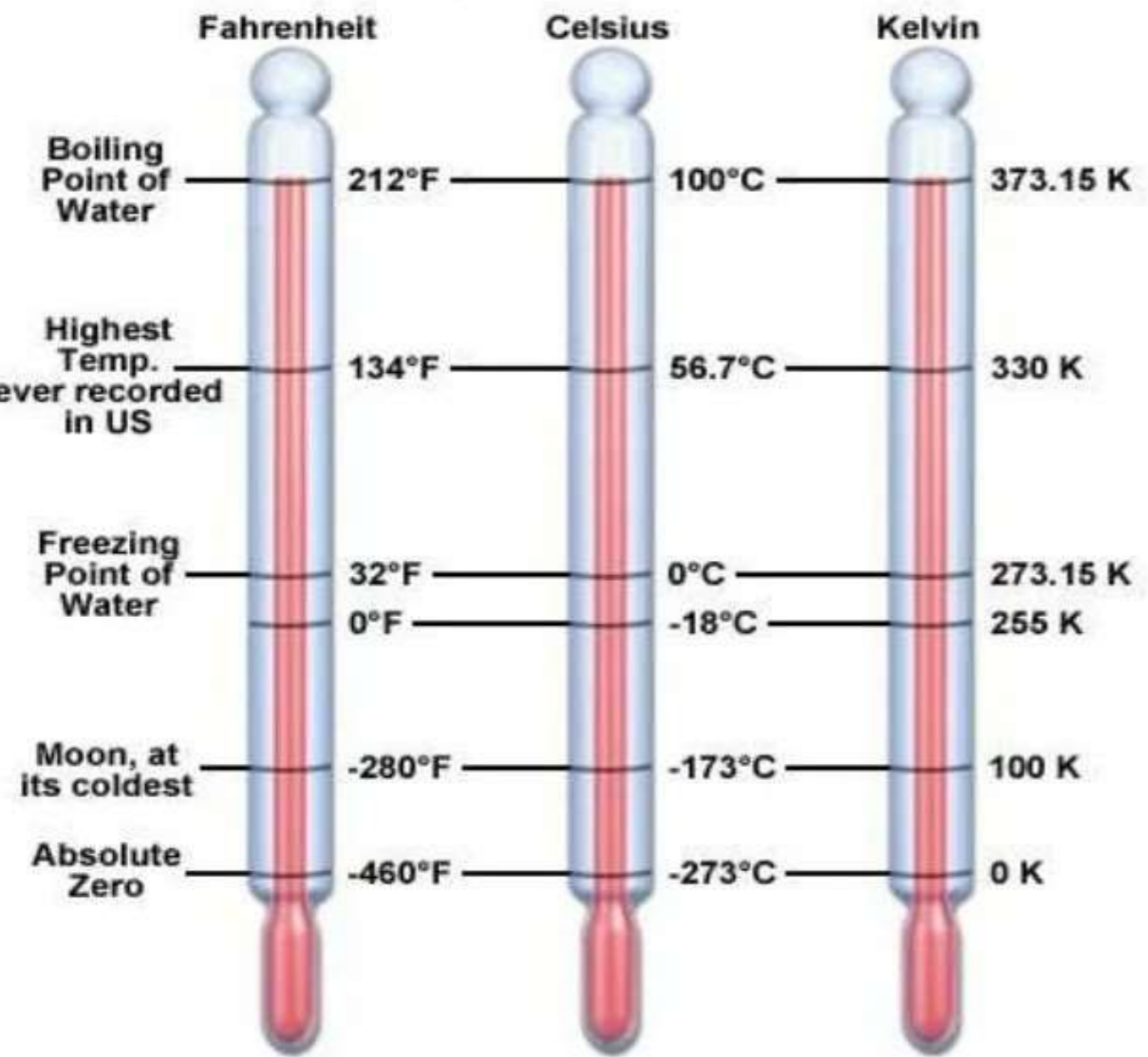
$$= \sqrt{2.979}$$

$$= 1.726$$



TEMPERATURE MEASUREMENTS

Temperature Scales



TEMPERATURE MEASUREMENTS

- The temperature is generally measured in pharmacy by using either **Fahrenheit or Centigrade thermometers.**
- The relationship of Centigrade (C) and Fahrenheit (F) degrees is

$$9^{\circ} (\text{C}) = 5^{\circ} (\text{F}) - 160$$

Where

- $^{\circ} \text{C}$ is the number of degrees Centigrade.
- $^{\circ} \text{F}$ is the number of degrees Fahrenheit.



Example problem for converting Fahrenheit to Centigrade

□ Convert 120° F into ° C

$$\begin{aligned}9^{\circ}(\text{C}) &= 5^{\circ}(\text{F}) - 160 \\ &= 5(120) - 160 \\ &= 600 - 160 \\ &= 440\end{aligned}$$

$$\begin{aligned}^{\circ}\text{C} &= 440/9 \\ &= 48.9^{\circ}\text{C}\end{aligned}$$



Example problem for converting Centigrade to Fahrenheit

□ Convert 30° c into °F

$$\begin{aligned}5^{\circ} \text{ F} &= 9^{\circ} \text{ C} + 160 \\ &= 9(30) + 160 \\ &= 270 + 160 \\ &= 430\end{aligned}$$

$$\begin{aligned}^{\circ} \text{ F} &= \frac{430}{5} \\ &= 86^{\circ} \text{ F}\end{aligned}$$



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Thank You...

