PHA 389 PHARMACEUTICAL TECHNOLOGY- I

2nd week
Prescription, Dose and Measuring Systems

Prescription;

- is a paper document written, typed or computer generated detailing the medicine(s) to be dispensed for the patient and issued by an authorized prescriber (doctor, dentist or veterinary doctor).

- It is a part of the professional relationship among the prescriber, pharmacist and the patient.
- It is the pharmacist responsibility to provide the quality of the medication which the patient needs.

Following information is required in a prescription:

- Prescriber's office information (name, address, telephone number, name of the hospital…
- Patient information (name, address, age, diagnosis for illness)
- Date
- Medication prescribed
- Dispensing directions to the pharmacist
- Directions for patient
- Special labelling and other instructions
- Prescriber's signature and license number

A prescription involves the following parts:

1- Supercription : R., Rp., Rx.

It is used as an abbreviation of «recipe» which means «take»

2- Inscription : Medication prescribed

It is the general body of the prescription.
It gives the information about the name of the drug (generic or trade name), its formulation and unit dosage.

3- Subcription :

Subscription provides information to the pharmacists about the quantity and dosage form of the drug to be dispensed.

4- Instruction : Sign. / Sig./ S. (Signatura)

It is the directions written to the patient by the prescriber; contains instruction about the amount of drug, time and frequency of doses to be taken.

Examples for Pharmacy Abbreviations

term	meaning
Nonrep.	Do not repeat
Ad	(complete) to
āā, ââ	of each
q.s.	sufficient
d.t.d. No.IV	give four doses
div.	divide
a.c.	Before meals
p.c.	After meals
mist.	Mixture
Ung.	Ointment
Collyr.	Eye lotion

term	meaning
IM	intramuscular
IV	intravenous
po	by mouth (per oral)
q.i.d.	four times a day
t.i.d.	three times a day
b.i.d.	two times a day
supp	suppository
SR, XR, XL	slow/extended release
sol	solution
susp	uspension

General terminology related with precription;

➨ **Dosage form**

Type of formulated product such as tablet (enteric coated tablet, modified release tablet, buccal tablet etc.), capsule, cream, ointment, eye drop, patch…

➨ **Strength**

This is the amount of drug in the dosage form . It can be expressed as,

- Amount of drug/volume for liquid preparations
  Ex: 125 mg/5 mL codein phosphate in a syrup
- Amount/weight in topical preparations and external liquids ...
  Ex: 10 mg/g diclofenac sodium in an emulgel
- International units for biological materials;
  Ex:100 000 IU Penicillin G in a suspension
- Percentage concentration; Ex: Chloramphenicol 0.5 % in an eye drop

➨ **Dose**
Amount of drug taken at any one time. Dose can be expressed as;
*the weight of drug (500 mg paracetamol)
*volume of drug solution (100 mL codein syrup)
*number of dosage forms (1 tablet)

➨ **Dose regimen**
Number of times the dose must be taken in a period of time (Frequency of administration)

Examples; 5 mL twice Daily; 1 tablet three times Daily
200 mg three times daily

➨ **Total amount**
Total amount of medicine supplied to the patients
Example, 21 tablets, 30 g ointment, 10 mL eye drop

➨ **Propriarity name :** Brand name, trade name

➨ **Generic name**: Approved name (adopted by WHO)
Example; amoxycillin, sulphasalazine

What are the pharmacist's responsibilities on a prescription?

When a prescription comes you must;

- Check the appropriateness of the prescription, the usual and maximum doses, the possible drug interactions and the repeatability of the prescription

- **Pharmacist must check the doctor's and patient's information;**

✓For example; age and diagnosis of the patient must be available.

- There must be address, protocol number and signature of the doctor (you should need to consult with the doctor).

- **Pharmacist must check the possible drug interactions**

✓A potential drug-drug interaction, or drug-food interation must be consulted with the prescriber.

- **Pharmacist should check if the prescription is on a repeat basis.**

✓Repeats are stated on the prescription as defined time intervals or a defined number of occasions. After the final repeat being dispended, the pharmacist should retain the prescription.

DOSE

Dose is the amount of drug taken at any one time. When we check a prescription we must be sure that there is not any exceeding dose. Thus, we must both check single and daily maximum doses for the drugs.

- **Usual dose:** This is the dose given in pharmacopoeias. It changes according to the treatment

- **Maximum dose:** This is the dose which can be given without toxic effects. It is defined in Turkish Pharmacopoeia as "**the dose which is taken orally by adults at any one time or daily and must not be exceeded unless indicated otherwise by the doctor** "

Example from TF 1974

Drug	Application	Usual doses		Maximum doses	
		Single dose	24 hour	Single dose	24 hour
Acetyl salicylic acid	Per os or rectal	0.30- 0.50 or up to 1g	1- 5 g	1g	8 g

Example:

Rx

Paracetamol .... 0.8 g
Aspirin .... 0.1 g

p. 1 cachet No: XX
S : 3x1 Daily p.c.

The patient will take this medicine after food and three times daily, which means patient will take 0.8 g of paracetamol each time.

If the pharmacist chech the prescription, he will see that the maximum dose for paracetamol is 0.65 g and the prescription exceeds this dose.

Approximate Measures

- Generally pharmaceutical manufacturers use 5mL measure (teaspoonful) as a basis of liquid formulations. **Teaspoonful is the basic measure here.**

Household measure	Volume (mL)
Teaspoonful	5
Dessertspoonful	10
Tablespoonful	15
Teacupful	120
Tumblerful	150-240

- **Standart dropper:** can be used as an approximate measure, especially for aromatic solutions. According to EP 6.0

«20 drops of water at 20 ±1ºC flowing freely from the dropper held in the vertical position at a constant rate of 1 drop/sec weighs 1 g.»

Rx

Phosphate de codeine .... 1 g
Eau distilleé................................... 10 mL
Sirop de menthe ....q.s............... **110 g**
S : 3x1 dessertspoon

(Single maximum dose : 0.1 g)
(Daily maximum dose: 0.3 g)
1 dessertpoonful is 10 mL

- You must convert 10 mL to weight by using the density of the formulation.
- Assume that the weight is found as 13 g from the density.

110 g **1 g**
13 g **x**

x = 13 / 11o = 0.118 g

0.118 g x 3 = 0.354 g

Rx

Bismuth subnitrate.................. 2 g
Belladone tincture..................
Simple syrup .... / aa 10 g
Lime tree infusion......ad......... **100 ml**
S : 3x1 tablespoonful daily

(single maximum dose: 1 g)
(Daily maximum dose: 3 g)

- 1 tablespoonful is 15 mL
- aa 10 g means «take 10 g each»
- ad means «complete to»

100 mL 10 g
15 mL x

x = 1.5 g

1.5 x 3 = 4.5 g

Reconstitution and «Unıt» Dose

Antibiotics (penicillin..), vitamins, chemotherapeutics are not chemically stable in solution form so are supplied as dry powders for reconstitution just before use.

Ex: An oral antibiotic for reconstitution comes as a powder in a bottle with sufficient space to add water. The powder itself will remain stable up to shelf life when it is in dry form. However, when reconstituted shelf life will be 10-14 days. If the formulation is for injection, powder must be steril and steril injectable water must be used for reconstitution under aceptic conditions. The formulation must be used within hours of reconstitution.

Unit (IU: international unit)
is a certain quantitiy of biological activity of that drug. Drug doses such as vitamins, hormones, antibiotics can be stated as unıts.

	IU amount equivalent to 1 mg	Amount equivalent to 1 IU
Penicillin	1670	0.000598 mg
Streptomycin sulphate	780	0.0001282 mg
İnsulin	23.99	0.04167 mg
Digitoxin	273.97	3.65 µg

Example;

350 000 IU penicillin G is needed for reconstitution. If the pharmacist have a stock amount of 500 000 IU penicillin G, how much he must take from this stock?

1) **You can calculate the amount you need converting IU to mg**.
Assume that you weighed 500000 IU as 0.300 g. Then,
(350 000 /500 000) x 0.300 = 0.210 g

If you weigh 201 mg from your stock and reconstitute it to a final volue you will obtain 350 000 IU penicillin G.

2) **You can calculate the amount you need converting IU to mL.**
Assume that when reconstituted final volume of 500000 IU Peniciilin G is measured as 10 mL. Then,
350 000/500 000 x 10 = 7 ml

If you reconstitute the powder to 10 mL and take 7 mL of this formulation you will provide 350 000 IU Penicillin G.

Children and infant doses

Children often require different doses from those of adults. Amongst the given equations BSA (body surface area) is believed to be the best, as the correct dosage of drugs seems more nearly proportional to the surface area. However, if the information is not available other rules can also be used. These are;

1- Young's rule
   Age basis (more than 1and up to 12 years old)

2- Cowling's rule
   Age basis (more than 1 years old)

3- Fried's rule
   Age basis (for infants up to 12 months old)

4- Clark's rule
   Body weight basis

5- Body surface area method (BSA)
   Depends on body weight and height

Young's rule

Children dose = (Age (in years)/ Age +1) x Adult dose

This equatin is suitable for children up to 12 years old

If the adult dose of a drug is 5 mg, what is the dose for a 8 years of old child?

C.D.= (8 / 8 + 12) x 5 mg
= 2 mg

Cowling's rule

Children dose = Age +1 (in years) /24 x Adult dose

If the adult dose of a drug is 5 mg, what is the dose for a 8 years of old child?

C.D.= (8+1 /24) x 5 mg
= 1.875 mg

Clark's rule

This equation is based on weight. 68 kg is assumed as the weight of a healthy adult man.

Children dose = Weight (in pound)/150 x Adult dose

In metric system we can convert as;

Children dose = Weight (in kg)/68 x Adult dose

If the adult dose of a drug is 5 mg,
what is the dose for a 6 kg weighed child?

C.D.= (6/68) x 5 mg
= 0.460 mg

Fried's rule

This equation is suitable for infants.

Children dose = Age (in months)/150 x Adult dose

If the adult dose of a drug is 5 mg, what is the dose for a 1 years of old child?

C.D.= (12/150) x 5 mg
= 0.400 mg

BSA (body surface area) method

Children dose = (Children BSA/1.73) x Adult dose

This equation can be applied with the help of a diagram called as «West Nomogramme».

BSA method is preferably used in hospitals and for the drugs with narrow therapeutical index, because of its accuracy.

It can also be calculated with the equation given below:

$BSA\ (m^2) = weight^{0.475} (kg) \times height^{0.725}\ (cm) \times 0.007184$

1.73 cm^2 is an assumed amount for Adult BSA

It is the body surface area of a man with 180 cm height and 70 kg weighed.

Note that in some reference books this value is given as 1.87 cm^2

Some children BSA:

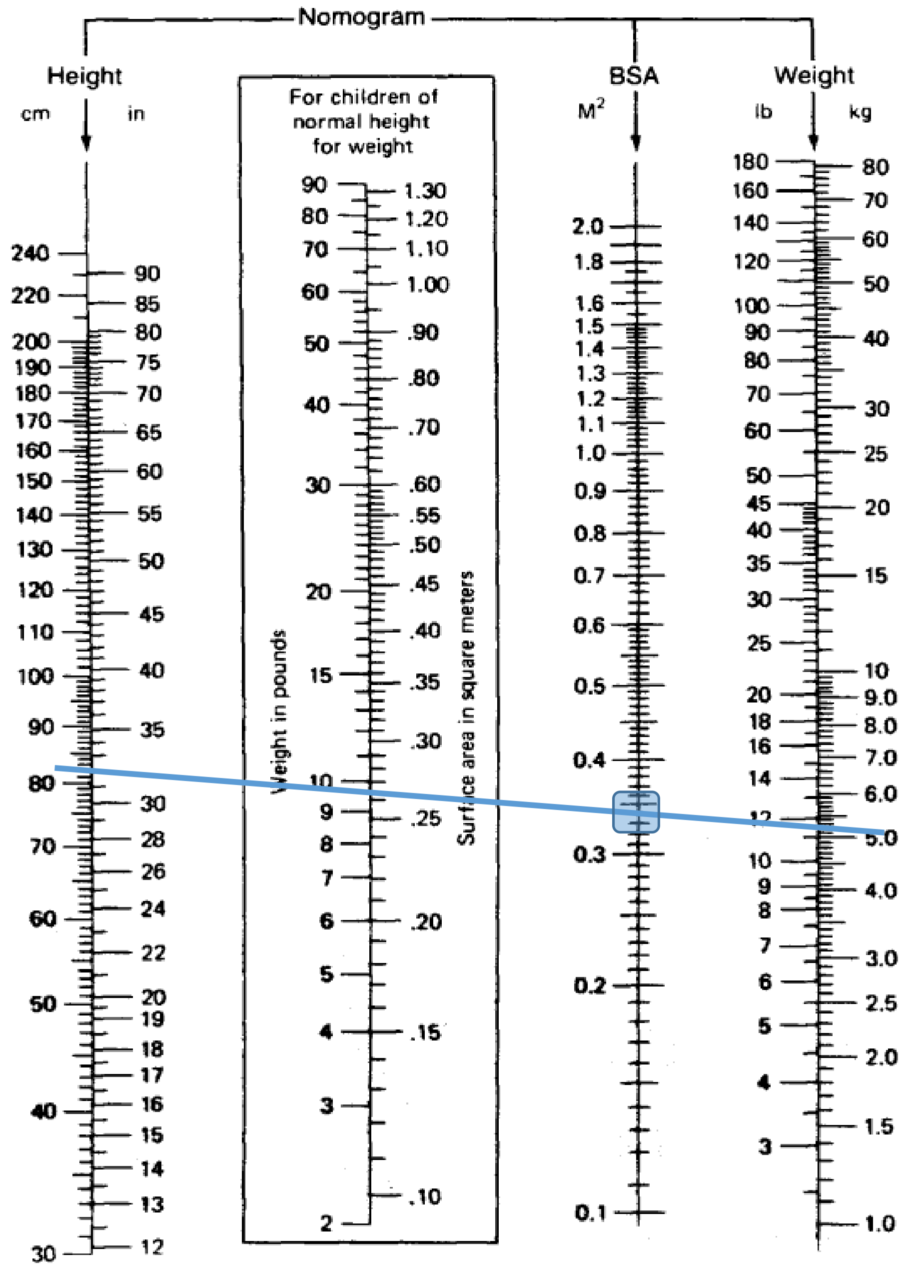
Infant (new born) = 3.5 kg, <u>0.25 m^2</u>
Infant (2 years old) = 12 kg, <u>0.50 m^2</u>
Child of 9 years old = 30 kg, <u>1 m^2</u>

Example:

If the daily adult dose for an antibiotic is 50 mg, what will be the dose for a child with 81 cm and 5kg?

- BSA for child is = 0.35
- BSA for adult is =1.87

C.D.= (0.35 / 1.87) x 50
= 9.36 mg



West Nomogramme

Pharmaceutical calculations

Checking solubility

Solubility is the maximum amount of solid dissolved in the liquid.

Solubility can be expressed as g, mL or part (in Turkish kısım; k)

Part can be used instead of **gram for solids** and **mL for liquids**

Example:

✓Sorbic acid dissolves in 600 parts of water, 120 parts of alcohol and 300 parts of glycerine.

✓This means; 1 g sorbik asit dissolves in 600 mL of water or 120 mL of alcohol or 300 mL of glycerine

Pharmaceutical calculations

Concentration

is the amount of material dissolved in a known volume of solution. It can be given as percentage, mole fraction or molality, normality etc.

Most common ones are:

Per cent weight in weight (w/w%)
- **Amount of substance (gram) dissolved in 100 g of a solution.**

Per cent volume in volume (v/v%)
- **Amount of substance (mL) dissolved in 100 mL of a solution.**

Per cent weight in volume (w/v%)
- **Amount of substance (gram) dissolved in 100 mL of a solution.**

Per cent volume in weight (v/w%)
- **Amount of substance (mL) dissolved in 100 g of a solution.**

Term	Abr.	Definition
Molarity (Molarite)	M, c	Mole number of the substance in 1000 mL of the solution.
Molality (Molalite)	m	Mole number of the substance dissolved in 1000 gr of the solvent.
Normality (Normalite)	N	Equivalent amount of substance dissolved in 1000 mL solution.
Mole Fraction	X, N	Ratio of the mole numbers of individual substances to the total mole number inside a solution.
Mole %		mole fraction x100

Example,

Prepare 3 % w/v Borik acid aqueous solution.

- This means in 100 mL of solution there is 3 g boric acid.
- You must weight boric acid, dissolve it in solvent (water in this case)
- You must complete the boric acid solution by adding the same solvent up to a volume of 100 mL.
- Graduated cylinder is a suitable apparatus for this procedure

Pharmaceutical calculations

Dilution

- **Stock solutions are known as strong solutions from which the weaker ones may be prepared.**
- When they are correctly made pharmacist can obtain small quantities of medicinal substances.
- They can be prepared as w/v % or v/v% basis and their concentration is expressed as ratio or percentage.

For example;

- Aluminium Subacetate Topical Solution (USP 27)
- Hydrogen Peroxide Solution

are prepared as stock solution and must be/can be diluted before use

Dilution

By using the formula below we can prepare a desired dilution of a stock formulation.

$C1 . V1 = C2 . V2$

C1, C2 are initial and final concentrations, respectively.
V1, V2 are initial and final volumes, respectively.

Example:

If we dilute a stock solution of 15v/v%, 500 mL to a 1500 mL what will be the final concentration for diluted solution?

Our initial concentration is 15% → 100 mL 15 mL
We have 500 mL → 500 mL
x **= 75 mL**

If the final volume of 1500 mL consists a 75 mL stock solution;
1500 mL 75 mL
100 mL x **= 5 v/v %**

$C1 . V1 = C2 . V2$

$15 . 500 = C2 . 1500 \Rightarrow C2 = \%5$ (h/h)

Example;

How can you prepare a 500 mL of 50%(v/v) alcohol from a stock solution of 85° alcohol?

Your stock is 85% v/v and you need a 50% v/v alcohol;

C1 . V1 = C2 . V2

85 x V1 = 50 x 500 V2= 294,10 mL water

This means, if you measure a 294,10 ml of 85% alcohol to a graduated cylinder and complete to a final volume of 500 mL, you will have 50% v/v alcohol.

Note that; alcohol grades and
final amounts must ve given in same units !

$$(\%v/v)_1 \times mL_1 = (\%v/v)_2 \times mL_2$$

or

$$(\%w/w)_1 \times mg_1 = (\%w/w)_2 \times mg_2$$

Pharmaceutical calculations

Trituration

These are dilutions of potent medicinal substances prepared by mixing finely powdered medicaments with finely powdered lactose in a definite proportion by weight.

Generally trituration is given as:

Dilute one part by weight of the substance with nine parts by weight of lactose.

→ 10 %
→ 1 :10
→ 1 + 9

This dilution type offers to the pharmacist to obtain small quantities of potent substances conveniently and accurately.

Rx

100 capsules

Colchicine……. 8.33×10^{-5} g 8.33×10^{-3} g (0.0083 mg)

Aspirin ……….. 0.325 g   32.5 g

M.f.t. Caps no: 100

- For preparing 1 capsule you must weigh $8.33 \cdot 10^{-5}$ g colchicine and you need $8.33 \cdot 10^{-3}$ g colchicine for 100 capsules.
- Both amounts are very small for your balances.
- Thus you can prepare;

1 g colchicine + 9 g lactose = 10 g (%10 trituration)

100g   10 g

X   0.0083 g

X = 0.083 g = 83 mg trituration has the amount of drug you need

32.5 g aspirin and 83 mg trituration weighed and mixed for 100 capsules

Pharmaceutical calculations

Alligation

This is a method for solving the number of parts of 2 or more components of known concentration to be mixed when final desired concentration is known Alligation has two types;

- **Alligation medial**

This is a method by which the weighted average percentage strength of a mixture of 2 or more substances whose quantities and concentrations are known may be quickly calculated.

Known parameters are → initial percentage and amounts

Unknown parameter is → final concentration

- **Alligation alternate**

This is a method by which we may calculate the number of parts of two or more components of a given strength when they are mixed to prepare a mixture of desired strength.

Known parameters are → initial and final percentage

Unknown parameter is → initial amounts to be used

Alligation alternate

- Alligation is a rapid method of calculation.
- The term comes from the lines drawn during calculation with alligation alternate method.
- Main rule is,

✓The substance with higher value (%, concentration..) than required is the one with lower amount

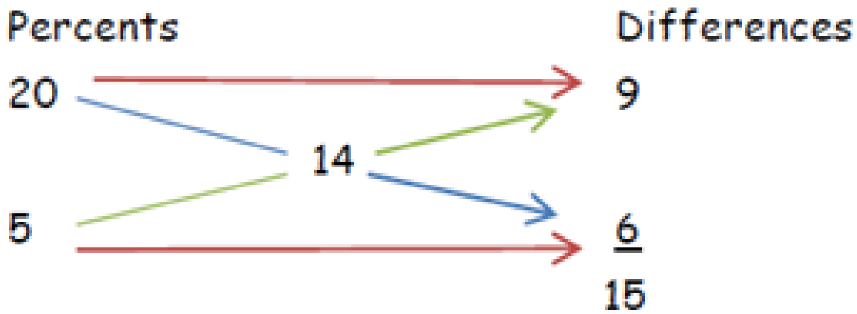
✓The gain in amount/value of one substance balances the loss in amount/value of another substance

Example;

How much 5% solution and 20% solution must be combined to make 120 mL of 14% solution ?

➢Higher concentration (20%) must be lower in volume

➢You must find the differences between the known and desired percentages



20-14 = 6 part
14-5 = 9 part
9+ 6 part = 15 part (corresponds to total volume of 120 mL)

15 part 120 mL
1 part x = 8 mL

8 ml x 9 part = 72 mL (20 %)
8 mL x 6 part = 48 mL (5 %)

If we mix 72 mL of 20% and 48 mL of 5% solutions we can make a 120 mL of 14% final solution.

Alligation medial

In this method, in order to mix different strengths, a series of quantities are multiplied by their respective concentrations which equals to the product obtained by multiplying a concentration by the sum of the quantities.

Example,

What is the percent of a final solution in a mixture made by mixing 72 mL of 20% solution and 48 mL of 5% solution?

72 mL x (20/100)= 72 x 0.2 = 14.4
48 mL x (5/100) = 48 x 0.05 = 2.4

Total volume is: 72 + 48 = 120 mL
Total part calculated is 14.4+ 2.4 = 16.8 (16.8 %)

120 ml	16.8 %
100	**x= 14 %**

Pharmaceutical calculations

Density

density= Mass in grams/ Volume in mL

d = g/mL (g/cm^3)

In pharmacy practice it is important to convert grams to mL for the solutions given in % w/w concentration.

Several terms are used to express the mass of equal volumes of different substances.

- Absolute density
- Apparent density
- Relative density
- Specific gravity

Absolute density is the ratio of the mass of an object. It is determined in a vacuum at a specified temperature.

Apparent density differs from absolute one only in that the mass is determined in air.

Relative density is the ratio of the density of a substance to the density of a given reference material.

Specific gravity

- is the ratio of mass of a substance to the mass of an equal volume of another substance taken as the standart.
- For gases hydrogen or air, for liquids and solids water can be used as the standart.
- The specific gravity of a substance and its density is numerically equal but specific gravity is a ratio which decimally expressed and has no dimensions.

$$\text{Specific gravity} = \frac{\text{mass of substance}}{\text{mass of equal volume of water}}$$

Density= Mass/volume

- Specific gravity can be determined by using a specific gravity bottle (pycnometer) or can be determined from Archimedes law (using areometer).

Specific volume

- **is the ratio of volume of a substance to the volume of an equal weight of another substance taken as standart, both having the same temperature.**
- **This is the comparison of equal weights in the same volume**

(note: specific gravity is the comparison of equals volumes of the same weight)

- **Temperature is generally 20^{o}C and standart is water.**

Areometer (hydrometer)

- is the device used to determine specific gravity of a liquid directly
- consists of thin glass tube closed at both ends, with a bulb which contains mercury to cause the instrument to float upright in a liquid.
- Areometer has two types due to the density of liquid, which can be heavier or lighter than water.

❑ A commercial type is Baumé densitometer which has constant weight and scaled according to water consisting salt.

❑ Following equations can be used for test liquids denser or ligher than water.

B^o: 145-145/D (Denser than water)
B^o: 140/D-130 (Lighter than water)

❑ Areometer is useful to convert w/w amounts to v/v in heavy liquids such as syrups.

Measuring systems

- FPS (English) unit system (Foot-Pound-Second)
- CGS unit sytem (Centimeter-Gram-Second)
- MKS unit system (Meter-Kilogram-Second)
- Common systems; * Avoirdupois
  * Apothecary

Problem:

Difficulty in understanding the scientific data in different countries

Solution :

Usage of an international unit system ⟶ SI

Common unit systems used in pharmacy

- ✓ **Avoirdupois (imperial) system** They are not official for today
- ✓ **Apothecary (troy) system**

- ❑ They were used for bulk buying/selling medicines (avoirdupois) in weight and compounding them by another (apothecary) in old England
- ❑ still have some place in daily life in England and USA.
- ❑ They use grain and minim as basic mass and volume units.

Grain: weight of wheat kernel (gm) 1 gm= 64.8 mg
Minim: one drop of water

	Mass	Volume
AVORDUPOIS	*grain (gm)* 437.5 gr = 1 ounce (oz) 16.0 oz = 1 pound (lb)	
APOTHECARY	*grain (gm)* 20 gr = 1 scruple 3 scruple = 1 dram 8 dram = 1 once 12 ounce = 1 pound	*minim* 60 minim = 1 fluid dram 8 fluid dram = 1 fluid ounce (fl oz) 16 fl oz = 1 pint 2 pint = 1 quart (qt) 4 qt = 1 galon (gal)

English unit system

Lenght	(Foot)	ft
Mass	(Pound, libre)	p, lb
Time	(Second)	s

CGS unit system

Lenght	(Centimeter)	cm
Mass	(Gram)	g
Time	(Second)	s

MKSA unit system

Lenght	(Meter)	m
Mass	(Kilogram)	kg
Time	(Second)	s
Electric intensity	(Amper)	*I*

International unit system (SI)

(Systéme International de'Unités)

This system was created by the International Bureau of Weights and Measures after 1950's due to the need of using a universal measuring system instead of converting the systems.

- **Also called as «Metric system»**
- SI was accepted by WHO in 1977 and by Turkey in1989.

Fractions

	Prefix	Symbol
• deci	d	10^{-1}
• Centi	s	10^{-2}
• milli	m	10^{-3}
• micro	µ	10^{-6}
• nano	n	10^{-9}
• pica	p	10^{-12}
• femto	f	10^{-15}
• atto	a	10^{-18}

Multiples

	Prefix	Symbol
➨deka	da	10
➨hekto	h	10^{2}
➨kilo	k	10^{3}
➨mega	M	10^{6}
➨giga	G	10^{9}
➨tera	T	10^{12}
➨peta	P	10^{15}
➨exa	E	10^{18}

For very small or large quantities of weight or volume fractions and multiples can be used for avoiding the use of many zeros.

Metric system

Mass	Volume
Mass unit is gram (g)	***Volume unit is litre (L)***
1000 g = 1 kilogram (kg)	1000 L = 1 kilolitre (kL)
100 g = 1 hectagram (hg)	100 L = 1 hectalitre (hL)
10 g = 1 decagram (dkg)	10 L = 1 decalitre (dkL)
0.1 g = 1 desigram (dg)	0.1 L = 1 desilitre (dL)
0.01 g = 1 centigram (cg)	0.01 L = 1 centilitre (cL)
0.001 g = 1 milligram (mg)	0.001 L = 1 millilitre (mL)
0.0001 g = 1 microgram (µg)	0.0001 L = 1 microlitre (µL)
(apothecary) 1 oz = 31.1 g	16.23 minim = 1 mL
(avoirdupois) 1 oz = 28.35 g	1 fl oz = 29.57 mL
15.432 gm = 1 gram	1 pint = 473.2 mL
1 lb = 454 gram	1 galon = 3785 mL

SI basic units	Units and symbols
Mass	Kilogram (kg)
Distance	Meter (m)
Time	Second (s)
Electricity current	Ampere (A)
Temperature	Kelvin (K)
Amount of substance	Mole (mol)
Intensity of light	Candela (cd)

- Second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom.

SI derived units

Hertz (Hz)	Frequency	s^{-1}
Newton (N)	force	$kg.m/s^2$
Pascal (Pa)	pressure	$kg/m.s^2$ (N/m^2)
Joule (J)	Energy/work	$kg.m^2/s^2$ (N/m)
Watt (W)	power	$kg.m^2/s^3$ (J/s)
Coulomb (C)	Electric charge	A.s
Volt (V)	Electric potential	$(kg.m^2)/(s^3.A)$ (W/A)
Ohm (Ω, omega)	Electric resistance	$kg.m^2.s^4.A^2$ (V/A)
Siemens (S, mho)	Electric conductance	$s^3.A^2/kg.m^2$ (A/V)
Celcius degree (°C)	temperature	(K-273,16)
Radian (rad)	Plane angle	$m.m^{-1}$
Becquerel (Bq)	activity	s^{-1}
Gray (Gy)	Absorbed dose	m^2/s^2(J/kg)
Sievert (Sv)	Dose equivalent	m^2/s^2 (Gy)

Mass

- ➨**International reference standart is kilogram (kg).**
- ➨Kilogram is equal to the mass of the international prototype of the kilogram.

Distance

- ➨**Reference standart is meter (m)**
- ➨Meter is the lenght of the path travelled by light in vacuum during a time interval of 1/ 299792458 of a second.

Volume

International reference standart is cubic meter (m^3) and in metric system it is used as liter (litre) (l, L)

Amount of substance

- Unit is mole
- Mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0,012 kg of carbon 12.

Difference between kilogram and litre

- These two units frequently incorrectly used interchangeably

Kilogram is basic SI unit for mass

Litre is a derived unit for volume

- Only water, aromatic water and oxygenated water as a density of 1 g/cm^3 thus 1 kg of these liquids are also 1L
- All other liquids have different density values.

Example: Density of olive oil is 0.8 g/cm^3 which means that 800 grams of olive oil equals to 1litre.

Difference between mass and gravity

Mass

✓is a physical measure of the amount of substance

✓mass can be found by weighing in a balance

Gravity

✓is the force exerted downward by gravitational acceleration effect

✓calculated mathematically, it is a force unit

SI unit system :

➨**Mass is: kg**

➨**Gravity is: a force unit Newton (N)**

Thermodynamic temperature

- **Reference standart is Kelvin (°K)**
- **Kelvin is the fraction 1/273,15 of the thermodynamic temperature of the triple point of water.**
- In practice Celcius degree is generally used (°C)

1 °C : 273.15 °K

According to Celcius freezing point of water is 0 °C, the boiling point of water is 100 °C and it is equally graduated to 100 units between these two points.

Temperature unit	°C	°K	°F
°C (Celsius)		°C+273.15	1.8 °C+32
°K (Kelvin)	°K-273.15		1.8K-459.4
°F (Fahrenheit)	0.556 F-32	0.556 F+255.3	

Difference between temperature and heat

- **These terminologies are frequently misused**

  Example: it is wrong to say that heat is 25°C for weather , it is the temperature

Temperature : Kelvin unit

➨is the thermal state of substance,

➨it is an expression which gives the amount of heat energy

Heat: Joule unit

- is the energy transfering from one system to another which has lower temperature, due to temperature difference

❑ Calory (cal) is the amount of heat required to raise temperature of 1 g water from 14.5 °C to 15.5 °C (1 cal = 4.187 J)

❑ British Thermal Unit (BTU) (1 BTU = 252 cal = 1055 J)