Principles of pharmacy (lec1)

Pharmaceutical calculations

is the area of study that applies the basic principles of mathematics to the preparation and safe and effective use of pharmaceuticals.

Common fractions are portions of a whole, expressed at 1⁄3, 7⁄8, and so forth. They are used only rarely in pharmacy calculations nowadays.

Examples:
If the adult dose of a medication is 2 teaspoonsful (tsp.), calculate the dose for a child if it is 1⁄4 of the adult dose.

If a child's dose of a cough syrup is 3⁄4 teaspoonful and represents 1⁄4 of the adult dose, calculate the corresponding adult dose.

NOTE: When common fractions appear in a calculations problem, it is often best to convert them to decimal fractions before solving.

A ***decimal fraction*** is a fraction with a denominator of 10 or any power of 10 and is expressed decimally rather than as a common fraction. Thus,1/10 is expressed as 0.10 and 45/100 as 0.45. It is important to include the zero before the decimal point. This draws attention to the decimal point and helps eliminate potential errors. Decimal fractions often are used in pharmaceutical calculations.
To convert a common fraction to a decimal fraction, divide the denominator into the numerator.

Example:

If 30 milliliters (mL) represent $\frac{1}{6}$ of the volume of a prescription, how many milliliters will represent $\frac{1}{4}$ of the volume?

$$\tfrac{1}{6} = 0.167 \text{ and } \tfrac{1}{4} = 0.25$$

$$\frac{0.167 \text{ (volume)}}{0.25 \text{ (volume)}} = \frac{30 \text{ (mL)}}{x \text{ (mL)}}$$

$$x = 44.91 \text{ or} \approx 45 \text{ mL, } \textit{answer.}$$

The term ***percent*** and its corresponding sign, %, mean ‘‘in a hundred.’’ So, *50 percent (50%)* means 50 parts in each one hundred of the same item.

The relative magnitude of two quantities is called their ***ratio***. Since a ratio relates the relative value of two numbers, it resembles a common fraction except in the way in which it is presented. Whereas a fraction is presented as, for example, 1⁄2, a ratio is presented as 1:2 and is not read as ‘‘one half,’’ but rather as ‘‘one is to two.’’

When two ratios have the same value, they are equivalent.
e.g., 2⁄4 = 4⁄8,
2 * 8 (or 16) = 4 * 4 (or 16).

A ***proportion*** is the expression of the equality of two ratios. It may be written in any one of three standard forms:

(1) $a:b = c:d$
(2) $a:b :: c:d$
(3) $\frac{a}{b} = \frac{c}{d}$

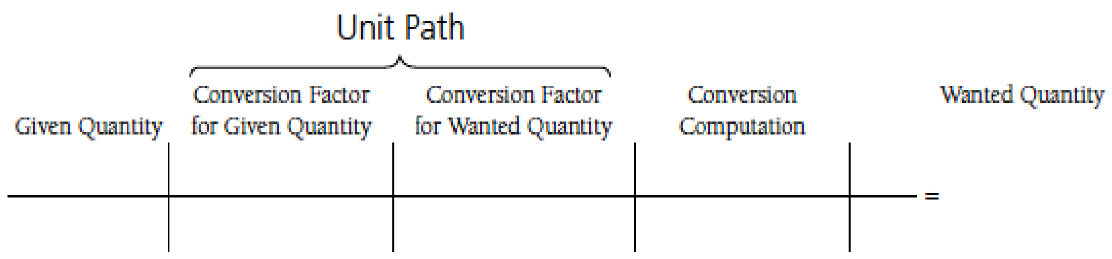
Examples:

If 3 tablets contain 975 milligrams of aspirin, how many milligrams should be contained in 12 tablets?

If 3 tablets contain 975 milligrams of aspirin, how many tablets should contain 3900 milligrams?
If 12 tablets contain 3900 milligrams of aspirin, how many milligrams should 3 tablets contain?

- **Dimensional Analysis**

In solving problems by dimensional analysis, the student unfamiliar with the process should consider the following steps:
Step 1. Identify the given quantity and its unit of measurement.
Step 2. Identify the wanted unit of the answer.
Step 3. Establish the *unit path* (to go from the given quantity and unit to the arithmetic answer in the wanted unit), and identify the conversion factors needed.
Step 4. Set up the ratios in the unit path such that cancellation of units of measurement in the numerators and denominators will retain only the desired unit of the answer.
Step 5. Perform the computation by multiplying the numerators, multiplying the denominators, and dividing the product of the numerators by the product of the denominators.



How many fluidounces (fl. oz.) are there in 2.5 liters (L)?
Step 1. The given quantity is *2.5 L.*
Step 2. The wanted unit for the answer is *fluidounces.*
Step 3. The conversion factors needed are those that will take us from liters to fluidounces.
As the student will later learn, these conversion factors are:

1 liter _ 1000 mL (to convert the given 2.5 L to milliliters), and
1 fluidounce _ 29.57 mL (to convert milliliters to fluidounces)
Step 4. The unit path setup:

Step 5. Perform the computation:

	Unit Path			
Given Quantity	Conversion Factor for Given Quantity	Conversion Factor for Wanted Quantity	Conversion Computation	Wanted Quantity
$2.5\ \cancel{L}$	$\frac{1000\ \cancel{mL}}{1\ \cancel{L}}$	$\frac{1\ fl.\ oz.}{29.57\ \cancel{mL}}$	$\frac{2.5 \times 1000 \times 1}{1 \times 29.57} = \frac{2500}{29.57}$	= 84.55 fl. oz.

or

$$2.5\ \cancel{L} \times \frac{1000\ \cancel{mL}}{1\ L} \times \frac{1\ fl.\ oz.}{29.57\ \cancel{mL}} = \frac{2.5 \times 1000 \times 1}{1 \times 29.57} = \frac{2500}{29.57} = 84.55\ fl.\ oz.$$

Note: The student may wish to see the problem solved by ratio and proportion:

Step 1.

$$\frac{1\ (L)}{2.5\ (L)} = \frac{1000\ (mL)}{x\ (mL)};\ x = 2500\ mL$$

Step 2.

$$\frac{29.57\ (mL)}{2500\ (mL)} = \frac{1\ (fl.\ oz.)}{x\ (fl.\ oz.)}$$

$$x = 84.55\ fl.\ oz.,\ \textit{answer}.$$

Q2/A medication order calls for 1000 milliliters of a dextrose intravenous infusion to be administered over an 8-hour period. Using an intravenous administration set that delivers 10 drops/milliliter, how many drops per minute should be delivered to the patient?

- Solving by dimensional analysis:

8 hours = 480 minutes (min.)

$$1000\ \cancel{\text{mL}} \times \frac{10\ \text{drops}}{1\ \cancel{\text{mL}}} \times \frac{1}{480\ \text{min.}} = 20.8 \text{ or } 21 \text{ drops per minute, } \textit{answer}.$$

Note: "Drops" was placed in the numerator and "minutes" in the denominator to arrive at the answer in the desired term, *drops per minute*.

The student may wish to see this problem solved by ratio and proportion:

Step 1.

$$\frac{480\ (\text{min.})}{1\ (\text{min.})} = \frac{1000\ (\text{mL})}{x\ (\text{mL})};\ x = 2.08\ \text{mL}$$

Step 2.

$$\frac{1\ (\text{mL})}{2.08\ (\text{mL})} = \frac{10\ (\text{drops})}{x\ (\text{drops})};\ x = 20.8\ \text{mL } \textit{or } 21 \text{ drops per minute, } \textit{answer}.$$

Roman Numerals

Roman numerals commonly are used in prescription writing to designate *quantities*, as the: (1) quantity of medication to be dispensed and/or (2) quantity of medication to be taken by the patient per dose.

ss	I	v	x	l	c	d	m
ss	I	V	X	L	C	D	M
1/2	1	5	10	50	100	500	1000

ss	i	ii	iii	iv	v	vi	vii	viii	ix	x
1/2	1	2	3	4	5	6	7	8	9	10

Roman numerals reading and writing rules:

1- A letter repeated once or more repeats its value.(ex., XX=20 , XXX=30)

2- A letter place after a letter of greater value increases value of greater letter

e.g., VI= 6, XII = 12 , LX=60)

3- A letter place before a letter of greater value decreases value of greater letter.

e.g., IV =4 , XL=40 , CM= 900)

4- A bar place above the letter or letters increase it value by 1000 times.

e.g., XV= 15 but XV = 15000

International system of units

The ***International System of Units (SI)***, formerly called the ***metric system***, is the internationally recognized decimal system of weights and measures. It was formulated in France in the late eighteenth century. The base units of the SI are the meter and the kilogram.

The features of SI are:

1- The simplicity.
2- The clarity provided by the base units and prefixes of the SI.
3- standardized and internationally accepted system of weights and measures.

Each table of the SI contains a definitive, or primary, unit. For length, the primary unit is the ***meter***; for volume, the ***liter***; and for weight, the ***gram*** Subdivisions and multiples of these primary units, their relative values, and their corresponding prefixes are shown in this Table.

	PREFIX	MEANING
Multiples	tera-	1 trillion times (10^{12}) the basic unit
	giga-	1 billion times (10^{9}) the basic unit
	mega-	1 million times (10^{6}) the basic unit
	myria-	10,000 times (10^{4}) the basic unit
	kilo-	1000 times (10^{3}) the basic unit
	hecto-	100 times (10^{2}) the basic unit

	deka-	10 times the basic unit
	Basic unit	1 time the basic unit
Subdivisions	deci-	one tenth (10^{-1}) of the basic unit
	centi-	one hundredth (10^{-2}) of the basic unit
	milli-	one thousandth (10^{-3}) of the basic unit
	micro-	one millionth (10^{-6}) of the basic unit
	nano-	one billionth (10^{-9}) of the basic unit
	pico-	one trillionth (10^{-12}) of the basic unit

Guidelines for the correct use of SI :

1.Unit names and symbols generally are not capitalized except when used at the beginning of a sentence or in headings. However, the symbol for liter (L) may be capitalized or not.
Examples: 4 L or 4 l, 4 mm, and 4 g; *not* 4 Mm and 4 G.
2.Periods are not used following SI symbols except at the end of a sentence. *Examples:* 4 mL and 4 g, *not* 4 mL. and 4 g.
3. A compound unit that is a ratio or quotient of two units is indicated by a solidus (/) or a negative exponent. *Examples:* 5 mL/h or 5 mL·h_1, *not* 5 mL per hour.
4. Symbols should not be combined with spelled-out terms in the same expression. *Examples:* 3 mg/mL, *not* 3 mg/milliliter.
5. Plurals of unit names, when spelled out, have an added *s*. Symbols for units, how1.Unit names and symbols generally are not capitalized except when used at the beginning of a sentence or in headings. However, the symbol for liter (L) may be capitalized or not.
Examples: 4 L or 4 l, 4 mm, and 4 g; *not* 4 Mm and 4 G.
6.Periods are not used following SI symbols except at the end of a sentence. *Examples:* 4 mL and 4 g, *not* 4 mL. and 4 g.
ever, are the same in singular and plural. *Examples:* 5 milliliters or 5 mL, *not* 5 mLs.
7. Two symbols exist for microgram: *mcg* (often used in pharmacy practice) and μ*g* (SI).

8.The symbol for square meter is m^2; for cubic centimeter, cm^3; and so forth. In pharmacy practice, cm^3 is considered equivalent to milliliter. The symbol cc, for cubic centimeter, is *not* an accepted SI symbol.
9.Decimal fractions are used, not common fractions. *Examples:* 5.25 g, *not* 5 $^{1/4}$ g.
10. A zero should be placed in front of a leading decimal point to prevent medication errors caused by *uncertain* decimal points. *Example:* 0.5 g, *not* .5 g.
It is critically important for pharmacists to recognize that a misplaced or misread decimal point can lead to an error in calculation or in dispensing of a minimum of one tenth or ten times the desired quantity.
11. To prevent misreadings and medication errors, ‘‘trailing’’ zeros *should not* be placed following a whole number on prescriptions and medication orders. *Example:* 5 mg, *not* 5.0 mg. However, in some tables (such as those of the SI in this chapter), pharmaceutical formulas, and quantitative results, trailing zeros often are used to indicate exactness to a specific number of decimal places.

- ***Measure of Length***: The meter is the primary unit of length in the SI

The **table of metric length**:	The table may also be written:
1 kilometer (km) = 1000 meters	1 meter = 0.001 kilometer
1 hectometer (hm) = 100 meters	= 0.01 hectometer
1 meter (m)	= 0.1 dekameter
1 dekameter (dam) = 10 meters	= 10 decimeters
1 decimeter (dm) = 0.100 meter	= 100 centimeters
1 centimeter (cm) = 0.010 meter	1 meter = 1000 millimeters
1 millimeter (mm) = 0.001 meter	= 1,000,000 micrometers
1 micrometer (μm) = 0.000,001 meter	=1,000,000,000 nanometers
1 nanometer (nm) = 0.000,000,001 meter	

The **table of metric weight**:	**This table may also be written:**
1 kilogram (kg) = 1000 grams	1 gram = 0.001 kilogram
1 hectogram (hg) = 100 grams	= 0.010 hectogram
1 dekagram (dag) = 10 grams	= 0.100 dekagram

1 gram (g) = 1.000 gram 1 decigram (dg) = 0.1000 gram 1 centigram (cg) = 0.010 gram **1 milligram (mg) = 0.001 gram** **1 microgram (µg or mcg) = 0.000,001 gram** 1 nanogram (ng) = 0.000,000,001 gram 1 picogram (pg) = 0.000,000,000,001 gram	= 10 decigrams = 100 centigrams = 1000 milligrams = 1,000,000 micrograms = 1,000,000,000 nanograms = 1,000,000,000,000 picograms

- ***Measure of Weight***: The primary unit of weight in the SI is the *gram*, which is the weight of 1 cm3 of water at 4°C.

- ***Measure of Volume***: The *liter* is the primary unit of volume in SI . It represents the volume of the cube of one tenth of a meter, that is, of 1 dm^3.

The **table of metric volume**: 1 kiloliter (kL) = 1000.000 liters 1 hectoliter (hL) = 100.000 liters 1 dekaliter (daL) = 10.000 liters 1 liter (L) = 1.000 liter 1 deciliter (dL) = 0.100 liter 1 centiliter (cL) = 0.010 liter **1 milliliter (mL) = 0.001 liter** **1 microliter (µL) = 0.000,001 liter**	This table may also be written: 1 liter = 0.001 kiloliter = 0.010 hectoliter = 0.100 dekaliter = 10 deciliters = 100 centiliters = 1000 milliliters = 1,000,000 microliters

- Reducing SI Units to Lower or Higher Denominations by Using a Unit-Position Scale

To change a metric denomination to the next smaller denomination, move the decimal point one place to the right.
To change a metric denomination to the next larger denomination, move the decimal point one place to the left.

Example 1:
Reduce 1.23 kilograms to grams.
1.23 kg = 1230 g, *answer*.

Examples 2:
Reduce 85 micrometers to centimeters.
85 µm = 0.085 mm = 0.0085 cm, *answer*.
Reduce 2.525 liters to microliters.
2.525 L = 2525 mL = 2,525,000 µL, *answer*.

- **Relation of the SI to Other Systems of Measurement :**

In addition to the International System of Units, the pharmacy student should be aware of two other systems of measurement: the ***avoirdupois*** and ***apothecaries'*** systems (widely used in the United States) .

TABLE 2.3 SOME USEFUL EQUIVALENTS

Equivalents of Length		
1 inch	=	2.54 cm
1 meter (m)	=	39.37 in
Equivalents of Volume		
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
Equivalents of Weight		
1 pound (lb, Avoirdupois)	=	454 g
1 kilogram (kg)	=	2.2 lb