Pharmaceutical Calculations

- One of the greatest potentials for error in prescription compounding is in the area of pharmacy math or pharmacy calculations
- A misplaced decimal or “estimated” value for a medication can have serious consequences including death
- There is no excuse for ignorance in this area and an individual unprepared to do the necessary calculations should not be involved in pharmaceutical compounding

Numbers and Numerals

- Number: a total quantity or amount
- Numeral: a word, sign, or group of words and signs representing a number:
- Roman Numerals:
  - A numeral system of ancient Rome based on letters of the Alphabet
  - I: one, V: five, X: ten, L:50, C:100, D: 500, M:1000
  - The first ten Roman numerals are: I, II, III, IV, V, VI, VII, VIII, IX, X
  - XXX:? 30
  - LX:? 60

Numbers and Numerals

- Arabic Numerals:

- Most common symbols used to represent numbers
- The basic symbols called digits are: 0,1,2,3,4,5,6,7,8,9
- The position of a digit determines its value
- 237 (مكان الرقم يحدد هو قيمته)

Decimals

- A decimal is a fraction whose denominator is 10 or a multiple of 10
- e.g.:
  - 0.7= 7/10
  - 0.06= 6/100
  - 0.006= 6/1000
- 0.3 = 0.30 = 0.300
- 0.3= 3/10
- 0.03=3/100
- 0.003=3/1000

Systems of measure
International System of Units (SI)

- The ***International System of Units (SI)***, formerly called the ***metric system***, is the internationally recognized decimal system of weights and measures.
- For length, the primary unit is the ***meter***; for volume, the ***liter***; and for weight, the ***gram***

metric system في عندي نظام اسمه ال

الطول الوحدة بعتمدة هي ال meter

للحجم ← liter

للوزن ← gram

Systems of measure

International System of Units (SI)

- Prefixes

TABLE 2.1 PREFIXES AND RELATIVE VALUES OF THE INTERNATIONAL SYSTEM (SI)

PREFIX	MEANING
Subdivisions	
atto-	one quintillionth (10^{-18}) of the basic unit
femto-	one quadrillionth (10^{-15}) of the basic unit
pico-	one trillionth (10^{-12}) of the basic unit
nano-	one billionth (10^{-9}) of the basic unit
micro-	one millionth (10^{-6}) of the basic unit
milli-	one thousandth (10^{-3}) of the basic unit
centi-	one hundredth (10^{-2}) of the basic unit
deci-	one tenth (10^{-1}) of the basic unit
Multiples	
deka-	10 times the basic unit
hecto-	100 times (10^{2}) the basic unit
kilo-	1000 times (10^{3}) the basic unit
myria-	10,000 times (10^{4}) the basic unit
mega-	1 million times (10^{6}) the basic unit
giga-	1 billion times (10^{9}) the basic unit
tera-	1 trillion times (10^{12}) the basic unit
peta-	1 quadrillion times (10^{15}) the basic unit
exa-	1 quintillion times (10^{18}) the basic unit

Systems of measure
International System of Units (SI)

Guidelines for the Correct Use of the SI

- 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.
- In the United States, the decimal marker (or decimal point) is placed on the line with the denomination and denominate number; however, in some countries, a comma or a raised dot is used.
  - *Examples:* 4.5 mL (U.S.); 4,5 mL or 4·5 mL (non-U.S.).
- 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.

raised dot

ما يوضع نقطة بعد الوحدة إلا إذا كانت في نهاية الجملة

Systems of measure
International System of Units (SI)

إذا كان عندي نسبة بين وحدتين يا بدهم
هيك mL/h أو mL·h⁻¹

Guidelines for the Correct Use of the SI

- 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 $mL \cdot h^{-1}$, *not* 5 mL per hour.
- Symbols should not be combined with spelled-out terms in the same expression.
  - *Examples:* 3 mg/mL, *not* 3 mg/milliliter.
- Plurals of unit names, when spelled out, have an added *s*. Symbols for units, however, are the same in singular and plural.
  - *Examples:* 5 milliliters or 5 mL, *not* 5 mLs.

لما بدي اجمع الوحدة ، بجمعها فقط في حالة الكتابة للوحدة مش اختصارها

Systems of measure
International System of Units (SI)

Guidelines for the Correct Use of the SI

- Two symbols exist for microgram: *mcg* (often used in pharmacy practice) and μ*g* (SI).
- Decimal fractions are used, not common fractions.
  - *Examples:* 5.25 g, *not* $5\frac{1}{4}$ g.
- 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.

Systems of measure
International System of Units (SI)

Measure of length

- 1 kilometer (km) 1000.000 meters
- 1 hectometer (hm) 100.000 meters
- 1 dekameter (dam) 10.000 meters
- 1 decimeter (dm) 0.100 meter
- 1 centimeter (cm) 0.010 meter
- 1 millimeter (mm) 0.001 meter
- 1 micrometer (m) 0.000,001 meter
- 1 nanometer (nm) 0.000,000,001 meter

Systems of measure
International System of Units (SI)

Measure of volume

- The *liter* is the primary unit of 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 (L) 0.000,001 liter

Systems of measure
International System of Units (SI)

Measure of weight

- The primary unit of weight in the SI is the *gram*.

- 1 kilogram (kg) 1000.000 grams
- 1 hectogram (hg) 100.000 grams
- 1 dekagram (dag) 10.000 grams
- 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 (g or mcg) 0.000,001 gram
- 1 nanogram (ng) 0.000,000,001 gram
- 1 picogram (pg) 0.000,000,000,001 gram
- 1 femtogram (fg) 0.000,000,000,000,001 gram

Systems of measure
Other systems

Avoirdupois system for measuring weight

- According to this system the standard unit for weighing is pound (lb) and all other measures of mass are derived from pound
  - 1 pound [lb] = 16 ounce (avoir) [oz]
  - 1 lb = 7000 grains
  - 1 ounce (avoir) = 7000/16 = 437.5 grains

Systems of measure

Other systems

Apothecaries system for measuring weight

- The standard weight in this system is the grain

20 grain (gr) = 1 scruple

60 grain = 1 drachm [ ] = 3 scruples

480 grain = 1 ounce (Apoth) [ ] = 8 drachm

5760 grain = 12 ounce (Apoth) = 1 pound (Apoth)

The smallest weight (grain) is equal in weight for both systems, but the weight of pound and ounce is different

Using ratios, proportions, and percentages in dosage calculations:

- Example: a vial of Rociphen contains 100 milligrams per milliliter. How many milliliters should be given to a patient to obtain 650 milligrams?
- 100 mg → 1 ml

  650mg → X ml
- X= 6.5 ml

Ratios, proportions and percentages

1. If 240 mL of a cough syrup contains 480 mg of dextromethorphan hydrobromide, then what mass of drug is contained in a child's dose, 1 teaspoonful (5 mL) of syrup?

$$\frac{240\ \text{mL}}{5\ \text{mL}} = \frac{480\ \text{mg}}{x\ \text{mg}}$$

$$x = \frac{480 \times 5}{240} = 10\ \text{mg}$$

Ratios, proportions and percentages

3. If the amount of dextromethorphan hydrobromide in 240 mL of cough syrup is 480 mg, what would be the volume required for a child's dose of 10 mg?

$$\frac{x \text{ mL}}{240 \text{ mL}} = \frac{10 \text{ mg}}{480 \text{ mg}}$$

$$x = \frac{10 \times 240}{480} = 5 \text{ mL}$$

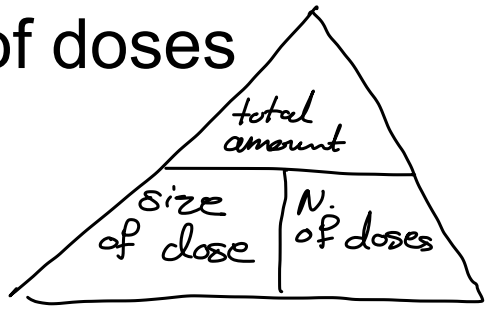
Using ratios, proportions, and percentages in dosage calculations:

- Always look for what is being asked:
- Number of doses (عدد الجرعات)
- Total amount of drug (كل الكمية)
- Size of dose حجم الجرعة الواحدة
- Given any two of the above, you can solve for the third
- General Formula:

Number of doses= Total amount/Size of dose

Total amount= number of doses X size of dose

Size of dose= Total amount/number of doses



Using ratios, proportions, and percentages in dosage calculations:

- Example: how many milligrams of theophylline does a patient receive per day, if the prescription indicates 300mg tid?
- X total amount= 3 X 300mg

X= 900 mg total

- How much propranolol will a patient receive every 6 hours if he is to receive 160 mg per day?

X dose=160 mg/4 doses

X= 40 mg

Using ratios, proportions, and percentages in dosage calculations:

Solve by your self:

total amount

- How many doses are in 120ml of Benadryl Elixir, if one dose is 5ml? (Answer 24 doses)

size

- When erythromycin lactobionate is reconstituted, it yields a concentration of 50 mg/ml. How many milliliters are required to give a 0.9 gm dose? (Answer: 18 ml)… be careful for the unit

0.9g ⟶ 900mg

50 mg ⟶ 1 ml

900 mg ⟶ ??

$$\frac{900 * 1}{50} = 18\,ml$$

Percentage

- 45% = 45/100= 0.45
- It is not correct to divide by 100 and use the percent sign at the same time:

e.g. 25%= 25/100 and not 25%/100

- To calculate a percentage of a percentage:

50% of 40% is:

(50/100) X (40/100) = 0.5 X 0.4= 0.2 = 20/100 = 20%

يعني نص ل 40%

Mass percentage (fraction)

- Wt%: Percent weight-in-weight (w/w) expresses the number of grams of a drug or active ingredient in 100 grams of a mixture (g/g)

→ 1g → 100g

- If a bottle contains 40 gm of ethanol and 60 gm of water then it contains 40% ethanol by mass or 0.4 mass fraction ethanol

- **Example: How many grams of drug substance should be used to prepare 240 g of a 5% w/w solution in water?**
- **Answer:**

$$240 \text{ g mixture} \times \frac{5.0 \text{ g drug}}{100 \text{ g drug}} = 12 \text{ g}$$

5g ⟶ 100 g

?? ⟶ 240 g

= 12 g

water + drug = 100%
water + 10% = 100%
water = 90%

water = 30 ml = 30 g (density = 1 g/ml)
90% ⟶ 30 g
10% ⟶ ??

$\frac{10\% * 30g}{90\%} = \frac{300}{90} = 3.33g$ drug

Percentage weight in weight (w/w)

- **Example: How much drug should be added to 30 mL of water to make a 10% w/w solution?**
- **Answer:**
- the mass of solvent is 30 mL × 1 g/mL = 30 g
- The water represents 100% - 10% = 90% of the total mixture.

$$\frac{30 \text{ g of mixture (water)}}{x \text{ g of mixture (drug)}} = \frac{90\%}{10\%};\ x = 3.33 \text{ g of drug required}$$

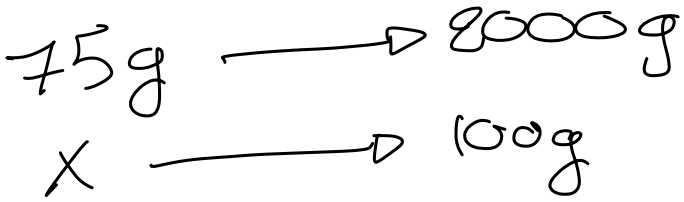
- Example:

If 2000 gm of ointment contain 75 gm of hydrocortisone, what is the percentage strength (w/w) of the ointment?

2000 gm ointment →75 gm hydrocortisone

100 gm ointment → X

X=3.75%



$$\frac{100 * 75}{2000} = 3.75$$

Phenol Glycerin IP

- Method: Phenol and glycerin are mixed in a beaker. The beaker is warmed gently until is becomes a solution.
- Use: Local anesthetic and local antiseptic. Phenol glycerin is used to prepare Phenol Gargle and Phenol Glycerin Ear Drop.
- Cautions: Phenol Glycerin when diluted with water becomes caustic so it is diluted with glycerin.
- Label: FOR EXTERNAL USE ONLY should be displayed in the label.

Mass-volume percentage:

- Weight-in-volume (w/v) percentage: expresses the number of grams of a drug or active ingredient in 100 milliliters of a mixture
- Often used for solutions made from a solid solute dissolved in a liquid
- For example a 40% w/v sugar solution contains 40 gm of sugar per 100 ml of resulting solution

Mass-volume percentage:

- Example:

Calculate the quantity of sodium chloride required to prepare 400 ml of 2 (w/v)% solution

2g NaCl → 100 ml solution

X → 400 ml

X= 8 g of sodium chloride is dissolved in water to produce 400 ml makes 2% w/v solution

2g → 100 ml

x → 400 ml

x = 8g

$M_1 V_1 = M_2 V_2$

$C_1 V_1 = C_2 V_2$

(w/v)% g → 100ml

Mass-volume percentage:

- Example: V_2 M_2 M_1 V_1??

Prepare 500 ml of a 1 in 10000 solution from 1 in 5000 solution?

Strength of concentrate 1 in 5000= 100/5000=0.02%

Strength of dilute solution= 1 in 10000= 100/10000= 0.01%

Degree of dilution= strength of concentrate/strength of dilute solution = 0.02/0.01= 2 times

Volume of solution to be prepared = 500 ml

Therefore, dilute solution is obtained by diluting 500/2=250 ml of 1 in 5000 solution to 500 ml

FECHA

$M_1 V_1 = M_2 V_2$

(w/v)%

g ⟶ 100ml

M_1 :-

1g ⟶ 5000ml

?? ⟶ 100 ml

$M_1 = 0.02\%$ w/v

M_2 :-

1g ⟶ 10000 ml

?? ⟶ 100ml

$M_2 = 0.01\%$ (w/v)

$M_1 V_1 = M_2 V_2$

$0.02\% * V_1 = 0.01\% * 500ml$

$V_1 = \frac{0.01\% * 500ml}{0.02\%}$

$V_1 = 250ml$

* في اسئلة dilution لازم اعرف احد (V1, V2) و (M1, M2)

* لـ Solution الي بدي احضره هو $M_1 V_1$

* لـ Solution الي بدي احضر منه هو $M_2 V_2$

Mass-volume percentage:

- Solve by yourself:

How much of a 5% will be required to prepare 1000 ml of a 1 in 500 solution?

Strength of concentrate= 5%

Strength of dilute solution= 0.2%

Degree of dilution= 25 times

Volume to be prepared = 1000 ml

Therefore dilute solution is obtained by diluting 40 ml of 5% solution to 1000 ml

M_1 V_2 V_1

1 ⟶ 500ml

?? ⟶ 100 ml

$\frac{100}{500} = 0.2\% = M_2$

$M_1 V_1 = M_2 V_2$

$5\% * V_1 = 0.2\% * 1000ml$

$V_1 = \frac{0.2 * 1000}{5} = 40\ ml$

Volume-volume percentage:

- (v/v) percentage expresses the number of milliliters of a drug or active ingredient in 100 milliliters of a mixture
- Most useful when a liquid-liquid solution is being prepared
- For example, a 40% v/v ethanol solution contains 40ml ethanol per 100ml total volume
- Example:

Prepare 500 ml of 5% solution of chloroform in 50% alcohol

5 ml chloroform → 100 ml of 50% alcohol

X ml → 500 ml of 50% alcohol

X= 25 ml of chloroform dissolved in sufficient quantity of 50% alcohol to make 500 ml of solution

5 ml → 100 ml

x → 500 ml

x = 25 ml

Ratio strength

- Ratio strength (1:N) is one part by weight or volume in N parts by weight or volume
- 1:200 ratio strength can be
- 1gm solid to 200 gm solid
- 1 ml liquid to 200 ml liquid
- 1 gm solid to 200 ml liquid

Ratio strength

- If 8 ml of phenol were added to 480 ml of lotion what is the percentage of phenol in the lotion?
- X=1.64% of phenol
- 100 ml of lotion contain 1.64 ml of phenol

total = 8 + 480 = 488 ml

8ml ⟶ 488ml

?? ⟶ 100

$\frac{100 \times 8}{488} = 1.64\%$

طريقة ثانية بدون ما اطلع total

8ml ⟶ 480

X ⟶ 100

$\frac{100 * 8ml}{480} = 1.6\%$

* إل 8ml كمية جدًا بسيطة بالنسبة لـ 480ml عشان هيك طارح يفرق كتير إذا حسبتها مع إل 480 أو لأ

Ratio strength

- Solve:

1. If 1.2gm of menthol is added to 480 ml of lotion, what is the percentage of menthol in the lotion?

Answer= 0.25% of menthol

2. How many milliliters of a 0.1% solution can be made from one gram of atropine sulfate?

Answer: 1000ml