

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

اللهم اغفر لوالديَّ صاحب العمل والتفريغ

# 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

من أكثر  
المحالات التي  
يحدث فيها خطأ  
في مجال  
الرياضيات والحسابات  
الصعبة نوع

فاصلة اعشارية

قيمة مقدرة

لا أعذار  
للخطأ  
لنا



L: 50 C: 100 D: 500 M: 1000

# 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

L C 100  
D 500

M 1000

# Decimals

تعبير

- A decimal is a fraction whose denominator is 10 or a multiple of 10

• e.g.:

تعبير الأعداد الإحصائية بصيغة الفاصلة

-  $0.7 = 7/10$

عند الدقة

-  $0.06 = 6/100$

-  $0.006 = 6/1000$

•  $0.3 = \boxed{0.30} = 0.300$

•  $0.3 = 3/10$

•  $0.03 = 3/100$

•  $0.003 = 3/1000$

# Using ratios, proportions, and percentages in dosage calculations:

- Example: <sup>زجاجه</sup> a vial of Rociphen contains 100 milligrams per 1 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

$$\frac{100 \text{ mg}}{1 \text{ ml}} \rightarrow 1 \text{ ml}$$

كل مله يحتوي 100 ملو غرام

ما عليك إلا السعي والباتي على ربة العالمين

# Using ratios, proportions, and percentages in dosage calculations:

- Always look for what is being asked:

- Number of doses *عدد الجرعات*
  - Total amount of drug *كمية الدواء*
  - Size of dose *حجم الجرعة*
- حصولك على اثنين من جدول  
تحصل على الثالثة  
تلقائياً*

- Given any two of the above, you can solve for the third

- General Formula: *العلاقات المتبادلة تساعد على إيجاد ما تبقى*

Number of doses = Total amount / Size of dose *عدد الجرعات = الكمية الكلية / حجم الجرعة*

Total amount = number of doses X size of dose

Size of dose = Total amount / number of doses

*يمكن بالنسبة والتناسب اعتقد احدكم وحقاً*

# 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?

السؤال يقول أنه لو بوخذ 300mg ثلاث مرات باليوم

•  $X \text{ total amount} = 3 \times 300\text{mg}$

إذا باليوم لو بوخذ 300mg  
أو نسبة

$X = 900 \text{ mg total}$

300mg → 8 hours  
x → 24 hours

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

x = 900mg

$X \text{ dose} = 160 \text{ mg} / 4 \text{ doses}$

$X = 40 \text{ mg}$

160 → 24  
x → 6

$$\frac{24}{24} \times x = \frac{160 \times 6}{4}$$

x = 40g

ممکن قرانین و ممکن نسب

و ممکن فهم

reconstituted ← أعاد (يعني أدوية)

# 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:

$$(50/100) \times (40/100) = 0.5 \times 0.4 = 0.2 = 20/100 = 20\%$$

المعرفة نسبة من نسبة أخرى

اضرب النسبتين ببعض

$$\begin{array}{r} 50 \\ \times 40 \\ \hline 2000 \\ 2000 \\ \hline 20000 \end{array}$$

# 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)

تعبير عن عدد غرامات الدواء أو المركب  
النسبة في 100g من المزيج

- 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

0.4

التجزئة الكمية الكلية 100g

تركيز الإيثانول  $\frac{40}{100}$  أو 0.4

0.4 ، لا تنسى

Wt %

سبحان الله وبحمده سبحان الله العظيم

الحل: يجب أن نعرف كتلة اعديب (الجليسرين) اللازمة وذلك من خلال الكثافة

# Mass percentage (fraction)

- Examples: Prepare 500 ml of Phenol glycerin

$$1.25 = \frac{m}{500}$$

$$m = 500 \times 1.25 = 625 \text{ g Glycerin}$$

أكماله بعد الأول 9.5

معها  
هاي  
الحداد  
وحكا  
حضر  
500ml

Phenol: 150 gm

Glycerin 850 gm

الحجم لعم  
حجم الجليسرين

1.25 = الكثافة

لقد  
نسبة

Weight per ml of glycerin: 1.25g

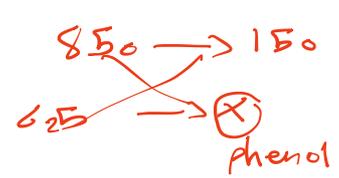
للمواد

So for preparing 500 ml of phenol glycerin the quantity of glycerin required = 500ml X 1.25 = 625 gm

- Quantity of phenol required =  $150 \times 625 / 850 = 110 \text{ gm}$
- So for preparing 500 ml of phenol glycerin the formula becomes:

- Phenol 110 g
- Glycerin 625 g

التكافؤ أعطانا نسبة وهي كل 850g تحتاج 150 phenol Glycerin



$$x = \frac{150 \times 625}{850} = 110 \text{ gm}$$

# Phenol Glycerin IP

- Method: Phenol and glycerin are mixed in a beaker. The beaker is warmed gently until it 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.

- Examples:

Prepare 500 ml of sugar solution

Sugar 100 gm

Water 900 gm

Weight per ml of water = 1 gm

The quantity of water required ? (500g)

The quantity of sugar required ? (55 g)

$$f = \frac{m}{500}$$

$$\underline{\underline{m = 500 \text{ gm}}}$$

$$\begin{array}{l} 900 \text{ g} \rightarrow 100 \text{ g} \\ \swarrow \quad \searrow \\ 500 \text{ g} \rightarrow x \end{array}$$

$$\frac{900x}{900} = \frac{50000}{900}$$

$$x = 55 \text{ g}$$

# 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  
يعبر عن عدد الأجزاء الموجودة في 100 من المزيج
- Often used for solutions made from a solid solute dissolved in a liquid  
يستخدم للمحاليل و المذاب صلب
- For example a 40% w/v sugar solution contains 40 gm of sugar per 100 ml of resulting solution

$$\begin{array}{l} 2\text{g} \rightarrow 100\text{ml} \\ X \rightarrow 400\text{ml} \end{array}$$

$$\frac{800}{100} = 8\text{ gm}$$

# Mass-volume percentage:

- Example:

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

2g NaCl  $\rightarrow$  100 ml solution

X  $\rightarrow$  400 ml

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

$$\begin{array}{l} 2\text{g NaCl} \rightarrow 100\text{ml sol} \\ X \rightarrow 400\text{ml} \end{array}$$

$$\frac{1}{5000} \times \frac{2}{10000} \times 100\%$$

$$0.02\%$$

# Mass-volume percentage:

• Example:

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

نضع الحجم المطلوب على عدد مرات التخفيف والنتيجة تكون

0.01%

2 → 10000

2 مرة  
0.01%

بعض  
قدرة  
بصالحه

درجة التخفيف

العوي  
التخفيف

الحجم المطلوب من المحلول المركز

$$C_1 \times V_1 = C_2 \times V_2$$

## Mass-volume percentage: قانون التخفيف

الطريقة الأولى تم التركيز عليها من الدكتور  
(أحمد بكري) يس

- Solve by yourself:

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

نفس المثال السابق

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

$$\frac{1}{500} \times 100\%$$

$$= 0.2\%$$

$$5\%$$

$$\frac{5\%}{25} = 0.2\%$$

25 times

حاله دعاء بعد الاستعداد

# Volume-volume percentage:

حجم المادة المذابة من المحلول الكلي

- (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

هذا نزيه مادة المذابة في مادة المذيب

• Example:

$x = 25 \text{ ml}$   
ما المطلوبه  
هذا هو المذيب

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

5 ml chloroform → 100 ml of 50% alcohol

5ml → 100ml  
x → 500ml  
x = 25ml chloroform

X ml → 500 ml of 50% alcohol

السؤال  
لده  
كمية  
الكلور فورم

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

الكل

استخدم النسبة والتناسب

$$5 \text{ ml} \rightarrow 100 \text{ ml} \\ \swarrow \searrow \\ \times \rightarrow 500 \text{ ml}$$

$$\frac{2500}{100}$$

$$25 \text{ ml}$$

السر  
السر

خالصة من السر

- What is the percentage of alcohol in the following mixture ?

Alcohol  $\begin{matrix} 2 \rightarrow 100 \\ x \rightarrow 5 \end{matrix}$   $x = 0.1 \text{ ml}$   $\boxed{2\%}$   $\boxed{5 \text{ ml}}$

نكون محلول حجمه 15 ml  
الالكحول 5 ml

Alcohol ( $x = 0.4 \text{ ml}$ ) 4% 10 ml

(can be solved by the alligation method)

Answer:

$$X = 3.33\%$$

$$0.5 \rightarrow 15 \text{ ml} \\ \swarrow \searrow \\ x \rightarrow 100 \text{ ml}$$

$$\begin{array}{r} 2 \rightarrow 100 \\ \hline x \rightarrow 15 \end{array}$$

اخذناها لاجل نسبة مئوية

الصيغة لثري

$$3.33\% = 100\% \times \frac{0.5}{15}$$

$$3.33\% = \frac{0.5 \times 100}{15}$$

$$4 \rightarrow 100$$

$$x \rightarrow 15$$

fraction نسبة الكحول نحو له نسبة مئوية

# Using ratios, proportions, and percentages in dosage calculations:

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?

$$\begin{array}{l} 480 \text{ mg} \rightarrow 240 \text{ mL} \\ x \rightarrow 5 \text{ mL} \end{array}$$

$$\frac{240x}{240} = \frac{5 \times 480}{240}$$

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

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

ملاحظة: النسبة تحتوي 10 mg

# Using ratios, proportions, and percentages in dosage calculations:

2. If a child's dose (5 mL) of a cough syrup contains 10 mg of dextromethorphan hydrobromide, what mass of drug is contained in 240 mL?

$$\begin{array}{l} 5 \text{ mL} \rightarrow 10 \text{ mg} \\ \cancel{240 \text{ mL} \rightarrow x} \end{array}$$

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

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

# Using ratios, proportions, and percentages in dosage calculations:

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:

4. How many milligrams of dextromethorphan base (molecular weight = 271.4) are equivalent to 10 mg of dextromethorphan hydrobromide (molecular weight = 352.3)?

$$\frac{10 \text{ mg}}{352.3}$$

$$\frac{x \text{ mg}}{10 \text{ mg}} = \frac{271.4}{352.3}$$

$$x = 10 \times \frac{271.4}{352.3} = 7.7 \text{ mg}$$

# Using ratios, proportions, and percentages in dosage calculations:

## Inverse proportion

- The most common example of the need for inverse proportion for the pharmacist is the case of **dilution** ( i.e., as volume increases, concentration decreases).

## Example

- If 120 mL of a 10% stock solution is diluted to 240 mL, what is the final concentration?

$$\frac{120 \times 10\%}{240} = \frac{240 \times x}{240}$$

$$x = 5\%$$

$$\frac{120 \text{ mL}}{240 \text{ mL}} = \frac{x\%}{10\%} \quad \text{12} \sqrt{240}$$

$$120 \times \frac{10}{240} = 5\%$$

# Using ratios, proportions, and percentages in dosage calculations:

## Percentage weight in volume (w/v)

- Percentage, indicating parts per hundred, is an important means of expressing concentration in pharmacy practice.
- Percentage w/v indicates the number of grams of a constituent per 100 mL of solution or liquid formulation.

# Using ratios, proportions, and percentages in dosage calculations:

## Percentage weight in volume (w/v)

### Example

- Tolu balsam tincture contains 20% w/v tolu balsam. What is the percentage concentration of tolu balsam in the following syrup?

Handwritten calculations:

$$20 \rightarrow 100$$
$$\rightarrow 50$$

~~100~~

$$10 \times$$
$$\frac{10g}{50 mL} \times 100$$

tolu balsam tincture	50 mL
magnesium carbonate	10 g
sucrose	820 g
purified water, qs ad	1000 mL

# Using ratios, proportions, and percentages in dosage calculations:

## Percentage weight in volume (w/v)

- Calculations: First, determine what the amount of tolu balsam is in the 50 mL quantity of tincture used for the syrup. Then, by proportion, calculate the
- concentration of tolu balsam in the syrup.

$$\text{tolu balsam tincture} = 50 \text{ mL} \times \frac{20 \text{ g}}{100 \text{ mL}} = 10 \text{ g tolu balsam}$$

$$\frac{10 \text{ g}}{1000 \text{ mL}} = \frac{x \text{ g}}{100 \text{ mL}}; x = \frac{1 \text{ g}}{100 \text{ mL}} = \underline{1\% \text{ tolu balsam in the syrup}}$$

# Using ratios, proportions, and percentages in dosage calculations:

## Percentage weight in volume (w/v)

- what volume of syrup could be prepared if we had only 8 g of magnesium carbonate?
- Answer:

$$\frac{10 \text{ g}}{1000 \text{ mL}} = \frac{8 \text{ g}}{x \text{ mL}}; x = 800 \text{ mL}$$

tolu balsam tincture	50 mL
magnesium carbonate	10 g
sucrose	820 g
purified water, qs ad	1000 mL

# Using ratios, proportions, and percentages in dosage calculations:

## Percentage volume in volume (v/v)

- The percentage strength of mixtures of liquids in liquids is commonly indicated by percent v/v, which indicates the parts by volume of a substance in 100 parts of the liquid preparation.
- **Example: What is the percentage strength v/v of the tolu balsam tincture in the syrup preparation?** By proportion, we can solve the problem in one step:

$$\frac{50 \text{ mL tolu balsam tincture}}{x \text{ mL tolu balsam tincture}} = \frac{1000 \text{ mL syrup}}{100 \text{ mL syrup}}; x = 5\%$$

# Using ratios, proportions, and percentages in dosage calculations:

## Percentage weight in weight (w/w)

- Percentage w/w indicates the number of grams of a constituent per 100 g of formulation (solid or liquid).
- **Example: How many grams of drug substance should be used to prepare 240 g of a 5% w/w solution in water?**
- **Answer:**

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

# Using ratios, proportions, and percentages in dosage calculations:

## 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  $30 \text{ mL} \times 1 \text{ g/mL} = 30 \text{ g}$
- The water represents  $100\% - 10\% = 90\%$  of the total mixture.

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

$$5 \quad \begin{array}{l} 2000 \text{ gm} \rightarrow 75 \text{ gm} \\ 100 \text{ g} \rightarrow X \end{array} \quad \begin{array}{r} 75 \\ \hline 2000 \end{array}$$

- Example:

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

2000 gm ointment  $\rightarrow$  75 gm hydrocortisone

100 gm ointment  $\rightarrow$  X

X = 3.75%

3.75%

3.75g

# Using ratios, proportions, and percentages in dosage calculations:

Solve by your self:

$$\begin{array}{l} 1 \rightarrow 5\text{ml} \\ x \rightarrow 120\text{ml} \end{array}$$

$$\frac{120}{5} = 24$$

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

$$\begin{array}{l} 1\text{ml} \rightarrow 50\text{mg} \\ x \rightarrow 900\text{mg} \end{array}$$

$$\frac{900}{50}$$

$$x = 18\text{ml}$$

$$0.9\text{ gm} \times \frac{1000\text{mg}}{1\text{gm}}$$

# Using ratios, proportions, and percentages in dosage calculations:

## Ratio strength

- Ratio strength is the expression of concentration by means of a ratio.
- The numerator and denominator of the ratio indicate grams (g) or milliliters (mL) of a solid or liquid constituent in the total mass (g) or volume (mL) of a solid or liquid preparation.

# 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
  - 1 gm solid to 200 gm solid
  - 1 ml liquid to 200 ml liquid
  - 1 gm solid to 200 ml liquid

# Using ratios, proportions, and percentages in dosage calculations:

Ratio strength  $\frac{1}{1000}$  1:1000

## Examples

Express 0.1% w/v as a ratio strength

$$\frac{0.1 \text{ g}}{100 \text{ mL}} = \frac{1 \text{ part}}{x \text{ parts}}; x = 1000 \text{ parts, for a ratio strength of 1:1000}$$

Express 1:2500 as a percentage strength  $\frac{1}{2500} \times 100\%$

$$\frac{1 \text{ part}}{2500 \text{ parts}} = \frac{x \text{ parts}}{100 \text{ parts}}; x = 0.04, \text{ indicating } 0.04\%$$

$25 \overline{) 100} \rightarrow 0.04$

$$\frac{8}{480} \times 100\%$$

$$\begin{array}{l} 8 \text{ ml} \rightarrow 480 \\ \times \rightarrow 100 \text{ ml} \\ 1.6\% \end{array}$$

$$\frac{800}{480}$$

## Ratio strength

- If 8 ml of phenol were added to 480 ml of lotion what is the percentage of phenol in the lotion?
- X=1.6% of phenol
- 100 ml of lotion contain 1.6 ml of phenol

# 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

من كل مئة حبي عنا (0.1%)  
 فكم لا استخراج انغرام  
 تقوم بالنسبة التالية

$$\begin{array}{l}
 1, 2 \rightarrow 480 \\
 x \rightarrow 100 \\
 \frac{1.2}{480} \times 100 = x
 \end{array}$$

$$\begin{array}{l}
 0.1g \rightarrow 100 ml \\
 1 \rightarrow x
 \end{array}$$

$$\frac{0.1x}{0.1} = \frac{100}{0.1} \Rightarrow x = 1000 ml$$

$$\begin{array}{l}
 0.1 \rightarrow 100 \\
 1 \rightarrow x \\
 x = 1000
 \end{array}$$

# Dilution and concentration

- If the amount of drug remains constant in a dilution or concentration, then any change in the mass or volume of a mixture is inversely proportional to the concentration.

**Dilution and concentration problems can be solved by:**

1. Inverse proportion
2. The equation:  $\text{quantity1} \times \text{concentration1} = \text{quantity2} \times \text{concentration2}$
3. Determining the amount of active ingredient present in the initial mixture and, with the assumption that the initial quantity does not change, calculating the final concentration of the new total mass or volume
4. Alligation medial
5. Alligation alternate

# Concentration and Dilution

- Stock solutions are concentrated bulk solutions from which more dilute solutions can be quickly prepared
- General formula for solving:  $V_1 \times S_1 = V_2 \times S_2$
- $V_1$  = the quantity or the amount of the original preparation
- $S_1$  = the % strength of the original preparation expressed as a decimal or percent
- $V_2$  = the quantity or amount of the wanted preparation
- $S_2$  = the % strength of the wanted preparation expressed as a decimal or percent

# Dilution and concentration

- **Example**
- How many milliliters of a 1:50 stock solution of ephedrine sulfate should be used in compounding the following prescription?

R <sub>x</sub>	ephedrine sulfate	0.25%
	rose water, ad	30 mL

$$\frac{0.25 \text{ g}}{100 \text{ mL}} \times 30 \text{ mL} = 0.075 \text{ g drug required}$$

$$\frac{50 \text{ mL}}{1 \text{ g}} = \frac{x \text{ mL}}{0.075 \text{ g}}$$

$$x = 3.75 \text{ mL of stock solution required}$$

$$\frac{500 \text{ ml} \times 15\%}{1500} = \frac{1500 \times x}{1500} \quad x = 5\%$$

# Concentration and Dilution

- Example: if 500 ml of a 15% solution are diluted to 1500 ml, what will be the percent strength ?

$$500 \text{ ml (V1)} \times 15\% (S1) = 1500 \text{ ml (V2)} \times S2$$

$$S2 = 5\%$$

5

$$1000 \times \frac{20\%}{5} = 5000 \times x$$

- If ~~1000~~ ml of a <sup>5</sup>20% solution are diluted to ~~5000~~ ml what will be the percent strength?

$$1000 \text{ ml (V1)} \times 20\% (S1) = 5000 \text{ ml (V2)} \times S2$$

$$S2 = 4\%$$

القانون الأول، تطبيع صيغته

# Concentration and Dilution

• Solve:

$V_1 S_1 = V_2 S_2$        $d_2 d_1$

1. How many milliliters of a 25% solution can be prepared from 750ml of a 65% solution?

Answer: 1950 ml

2. If ~~30~~ gm of a 45% powder was diluted to make a 30% powder, how many grams will the new preparation weigh?

$30 \times 45\% = 30\% \times x$        $x = 45g$

Answer: 45 gm

3. If 20 ml of a 1:200 solution of a chemical is diluted to 500 ml, what is the ratio strength?

$1 : 200$        $\frac{1}{200}$  لغز

Answer: 1:5000

$S_2 = \frac{1}{5000}$

$\frac{20 \times \frac{1}{200}}{500} = \frac{500}{500} S_2$

# Reducing and Enlarging formulas

- Determine the total weight or volume of ingredients and convert to the required quantity. The quantity in the original and new formulas will have the same ratio

# Reducing and enlarging formulas

- The pharmacist is often required to reduce or enlarge a recipe.
- Problems of this type are solved through **proportion**, or by **multiplication** or **division** by the **appropriate factor** to obtain the required amount of each ingredient that will give the **desired total mass or volume** of the formula.

# Reducing and enlarging formulas

## Formulas that indicate parts

- When dealing with formulas that specify parts, parts by weight will require the determination of weights of ingredients, whereas parts by volume warrant the calculation of volumes of ingredients.
- Always find the total number of parts indicated in the formula and equate that total with the total mass or volume of the desired formula in order to set up a proportion.

# Reducing and Enlarging formulas

- Calculate the amount needed for 50 ml strong sodium salicylate mixture

1000ml

Sodium salicylate	10g
Sodium metabisulfate	1 gm
D.S. chloroform water	525 ml
Water	1000 ml

## Answer:

Sodium salicylate	0.5gm
Sodium metabisulfate	0.05g
D.S. chloroform water	26.25 ml
Water	50 ml

$$\frac{1000}{50} = 20$$

$$\frac{1000}{50} = 20$$

$$\frac{1000 \text{ ml}}{50 \text{ ml}} = 20$$

بقسم كل المواد بال 20

أو كل نسبة

و هنا مع كل

$$\frac{1000}{50} = 20$$

# Reducing and Enlarging formulas

- Calculate the amounts needed for 100 ml peppermint water?

Peppermint water:

Peppermint            ~~2 ml~~  
Talc                    ~~15 gm~~  
Purified water q.s. 1000 ml

نقص النسبة الى السابق

$\frac{100}{1000} = \frac{1}{10}$

Answer:

Peppermint ~~0.2 ml~~  
Talc            1.5 gm  
Purified water q.s. 100 ml

# Reducing and enlarging formulas

## Formulas that indicate parts

### Example

- What quantities should be used to prepare 100 g of camphorated parachlorophenol?

R <sub>x</sub>	parachlorophenol	7 parts
	camphor	13 parts
	7 parts + 13 parts = 20 parts total	

$$\frac{7 \text{ parts}}{20 \text{ parts}} = \frac{x \text{ g}}{100 \text{ g}}; x = 35 \text{ g of parachlorophenol}$$

$$\frac{13 \text{ parts}}{20 \text{ parts}} = \frac{x \text{ g}}{100 \text{ g}}; x = 65 \text{ g of camphor}$$

# Reducing and enlarging formulas

## Formulas that indicate quantities

### Example

- The following prescription for cold cream provides a 100 g quantity.
- What mass of each ingredient is required to provide 1 pound (AV) of cream?

R <sub>x</sub>	white wax	12.5 g
	mineral oil	60.0 g
	lanolin	2.5 g
	sodium borate	1.0 g
	rose water	24.0 g

# Reducing and enlarging formulas

Formulas that indicate quantities

## Example (solution)

1 pound (AV) = 454 g

$454/100 = 4.54$  (factor used in calculating quantities for each ingredient)

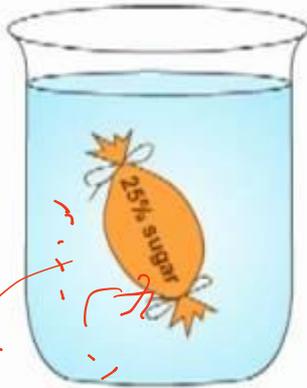
$12.5 \text{ g} \times 4.54$	=	56.8 g of white wax
$60.0 \text{ g} \times 4.54$	=	272 g of mineral oil
$2.5 \text{ g} \times 4.54$	=	11.4 g of lanolin
$1.0 \text{ g} \times 4.54$	=	4.54 of sodium borate
$24.0 \text{ g} \times 4.54$	=	109 g of rose water

# Iso-osmoticity and Isotonicity

- <sup>الأسموزية</sup> Osmosis is a phenomenon that occur when a <sup>أخذتها من</sup> semipermeable membrane (permeable only to solvent molecules) is used to separate solutions of different solute concentrations
- The solvent molecules cross the membrane from lower to higher concentration to establish a concentration equilibrium
- The pressure driving this movement called osmotic pressure
- Osmotic pressure is governed by the number of particles of solute in solution
- Iso-osmotic solutions: solutions containing the same concentration of particles and thus exert equal osmotic pressure

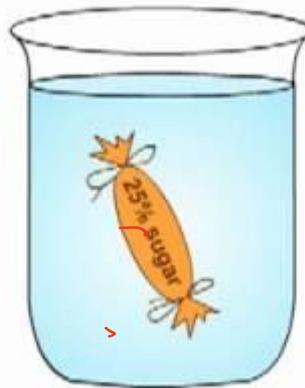
the same concentration

This is a  
**Hypotonic Solution**  
(in relation to the bag contents)



**Beaker A**  
100 ml dH<sub>2</sub>O

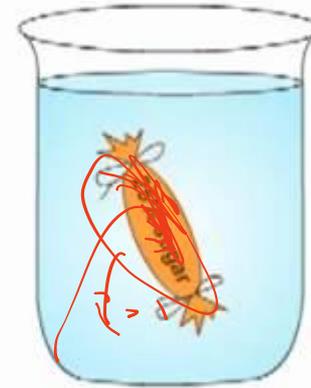
This is an  
**Isotonic Solution**  
(in relation to the bag contents)



**Beaker B**  
100 ml 25% sugar

*Hypertonic*

*25ml*



**Beaker C**  
100 ml 50% sugar

In the final experiment, watch what happens when a bag containing 25% sugar is placed in a beaker containing 50% sugar. In this case, the solute concentration of the beaker is higher than that of the bag.

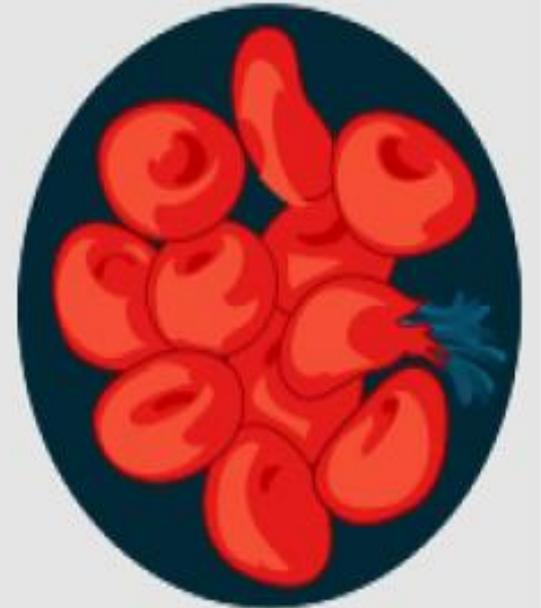
Hypertonic



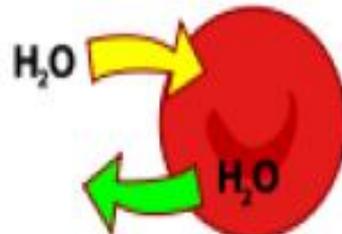
Isotonic



Hypotonic



خرج الماء



Isotonic  
Tonic  
osmotic



دخل الماء  
وخرج

0,9% (w/v)

0,9g NaCl → 100ml

# Iso-osmoticity and Isotonicity

عربي

- A 0.9% solution of sodium chloride (normal saline) is iso-osmotic with blood  
*normal saline*
- Isotonic means equal tone and sometimes is used interchangeably with the term iso-osmotic
- The importance of using isotonic or iso-osmotic solutions is to assure that there is no tissue damage or pain when the formulation is administered  
*حتى لا تتفجر الأنسجة أو تتدمر*
- Hypotonic solutions produce painful swelling of tissues  
*انفجار*
- Hypertonic solutions produce painful shrinking of tissues  
*استخدم في isotonic solution*

# Methods used to adjust the isotonicity of compounded solutions: طرق

1. Sodium chloride equivalent method:

the most widely used التعريف

The NaCl equivalent (E) is the amount of NaCl that has the same osmotic effect (based on the number of particles) as

1gm of drug

Tables of (E) for various drugs are available in standard references

2. Cryoscopic method

3. Isotonic solution  $V$  values

- التركيز هنا

كم في جاد  
NaCl من  
تأثير  
osmotic

(270)

NaCl

0.6  
1g → 0.3      water 5ml  
0.6 → 0.78

سوال بالاسطوانة

# Sodium Chloride Equivalent Method:

- Example: Calculate the amount of NaCl required to make the following ophthalmic solution isotonic:

Atropine Sulfate

2%

NaCl

q.s.

Aqua. Dist. q.s. ad.

30 ml

0.6g

1g Atro → 0.13g NaCl

(ا) بحسب اناكم يحتاج اتروبيين

2 → 100

x → 30

x = 30, 6g

الماء

كمية الماء

0.9%

[2]

1g Atro → 0.13 NaCl

0.6 → x

x = 0.078g

Evalue

1g = 0.13 NaCl  
Atro

Hyper  $\rightarrow$  Hypo

الحلول  $\rightarrow$  أن يكون  $\frac{1}{2}$  كان

# Sodium Chloride Equivalent Method:

0.9g  $\rightarrow$  100ml  
0.27g  $\rightarrow$  30

1. Determine the amount of NaCl to make 30 ml of an isotonic solution:

- 0.9g of sodium chloride in 100 ml of water will make an isotonic solution

لزم

- 0.9gm  $\rightarrow$  100 ml

NaCl 0.27g

لزم أذوب

- X  $\rightarrow$  30 ml

- X = 0.27 gm

اذن المحلول Hypo  $\frac{1}{3}$  NaCl قليلة

0.078

لذا يجب أن نضيف ملح

0.27 - 0.078 = 0.192g

0,192 مقدار، اناج اناج

## Sodium Chloride Equivalent Method:

2. Calculate the contribution of atropine sulfate to the osmotic pressure of the solution (the sodium chloride equivalent for atropine sulfate  $(E) = 0.13$ ):

- $30 \text{ ml} \times 2 \text{ g} / 100 \text{ ml} = 0.6 \text{ g}$  atropine sulfate will be present in the formulation
- $0.6 \text{ g} \times 0.13 = 0.078 \text{ gm}$  will be the sodium chloride equivalent contribution of atropine sulfate

0,078

1g  $\rightarrow$  0,13

# Sodium Chloride Equivalent Method:

3. Determine the amount of NaCl to add to the formulation:

- The sodium chloride needed to make the final solution isotonic is calculated by:

$$0.27 \text{ gm} - 0.078 \text{ g} = 0.192 \text{ gm}$$

4. What if boric acid is used to adjust isotonicity in ophthalmic solution because of its buffering and anti-infective properties:

- E for boric acid = 0.5
- 0.192g NaCl  $\rightarrow$  X g boric acid
- 0.5 g NaCl  $\rightarrow$  1 g boric acid
- X = 0.38 g

$$\begin{array}{l} 1 \text{ g} \rightarrow 0.5 \text{ g NaCl} \\ x \rightarrow 0.192 \text{ g} \end{array}$$

x =

السؤال هو  
ب Boric Acid  
NaCl

$$\begin{array}{l} 1 \text{ g boric} \rightarrow 0.5 \text{ NaCl} \\ x \rightarrow 0.192 \end{array}$$

من السؤال السابق

رغم لتحويل التركيبة في السؤال  
المساوية بالتصنيف

# Cryoscopic Method

الطريقة الثانية

Boric

The freezing point decrease is proportional to the percentage content of the solute in the solution

0.192

0.5

$\Delta T_f$  is the freezing point depression caused by 1% solution of the solute

Example:

محلول 1% من المذاب

معرفة  $\Delta T_f$

لما يجب

Lidocaine hydrochloride	0.25g	$\Delta T_f = 0.13C^\circ$	1% Lid.
Purified Water q.s.	50ml		
Make isotonic with sodium chloride q.s.		$\Delta T_f = 0.52C^\circ$	(0.9% NaCl) لما يجب

تحت

نفسه

freezing

(1) نظارة إعادة الصلابة كم نعمل انضامن

# Cryoscopic Method

NaCl 0.9% → 0.52  
→ 0.455  
(3) ورجعنا تباين  
نتائج التفرج

- The decrease caused by 1% lidocaine hydrochloride is 0.13C°
- Then for 50 ml of water that contain 0.25 gm lidocaine hydrochloride:  
1% lidocaine hydrochloride → 0.13 C°  
0.5% Lidocaine hydrochloride → X

(4) النتائج نسبتا ورجعنا مكان تباين

$X = 0.065 C^\circ$

- Isotonic sodium chloride 0.9% decreases the freezing point of water by 0.52 C° so:
- $0.52 C^\circ - 0.065 C^\circ = 0.455 C^\circ$
- Thus, the percentage of sodium chloride (X) to give this freezing point depression is:

0.9% → 0.52  
→ 0.455

$0.9\% \rightarrow 0.52 C^\circ$

$X \rightarrow 0.455 C^\circ$

$X = 0.788\%$

0.788 → 100  
X → 50

$100 \times = 0.788 \times 50$   
100      25100

8394  
- 2788  
-----  
1818  
1800  
-----  
18

So 50 ml of 0.788% NaCl will require 0.394 g of sodium chloride

# Isotonic Solution V Values

- The V value of a drug is the volume of water to be added to a specified weight of drug to prepare an isotonic solution
- The V values are given in tables constructed for 0.3g and 1.0g of drug
- The basic principle is to prepare an isotonic solution of the prescribed drug and then dilute this solution to a final volume with a suitable isotonic vehicle

وإذا كانت المادة دوائية 0.3g و 1.0g من الدواء  
إذنا نستخدم قيم V لإيجاد حجم الماء الذي  
يحتاجه لإنتاج محلول إيزوتوني

# Percentage, ratio strength, and other concentration expressions

## Parts per Million (PPM) and Parts per Billion (PPB)

- The strengths of very dilute solutions are commonly expressed in terms of *parts per million (ppm)* or *parts per billion (ppb)*, i.e., the number of parts of the agent per 1 million or 1 billion parts of the whole.

### Example

- Express 5 ppm of iron in water in percentage strength and ratio strength.
- $5 \text{ ppm} = 5 \text{ parts in } 1,000,000 \text{ parts} = 1:200,000$ , ratio strength = 0.0005% percentage strength,

# Percentage, ratio strength, and other concentration expressions

- **Molarity** (M) is the expression of the number of moles of solute dissolved per liter of solution. It is calculated by dividing the moles of solute by the volume of solution in liters.

$$M_A = \frac{n_A}{\text{solution (L)}}$$

- **Molality** (m) is the moles of solute dissolved per kilogram of solvent. Molality is calculated by dividing the number of moles of solute by the number of kilograms of solvent.

$$m_A = \frac{n_A}{\text{mass}_{\text{solvent}} \text{ (kg)}}$$

# 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*

# Systems of measure

## International System of Units (SI)

- Prefixes

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

PREFIX	MEANING
<b><u>Subdivisions</u></b>	
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
<b><u>Multiples</u></b>	
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.

# Systems of measure

## International System of Units (SI)

### 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·h<sup>-1</sup>, *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.

# 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 *g* (SI).
- ❑ Decimal fractions are used, not common fractions.
  - *Examples: 5.25 g, not 5<sup>1</sup>/<sub>4</sub> 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 ( $\mu\text{m}$ ) 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

$$1 \text{ pound [lb]} = 16 \text{ ounce (avoir) [oz]}$$

$$1 \text{ lb} = 7000 \text{ grains}$$

$$1 \text{ ounce (avoir)} = 7000/16 = 437.5 \text{ grains}$$

# 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

$$30\text{mg} \rightarrow 15\text{ml}$$
$$1.5\text{mg} \rightarrow x$$

$$1.5\text{mg}$$

$$30\text{mg} \rightarrow 15\text{ml}$$
$$1.5\text{mg} \rightarrow x$$

$$120\text{ml}$$

$$1.5\text{mg}$$

## Extra practice

$$x = 15 \times 1.5$$

$$x = 20, 75\text{ml}$$

23A A physician asks a pharmacist to calculate the dose of a cough syrup so that it may be safely administered dropwise to a child. The cough syrup contains the active ingredient dextromethorphan HBr,  $30\text{mg}/15\text{ml}$ , in a  $120\text{-ml}$  bottle. Based on the child's weight and literature references, the pharmacist determines the dose of dextromethorphan HBr to be  $1.5\text{mg}$  for the child.

$$0.75\text{ml}$$

The medicine dropper to be dispensed with the medication is calibrated by the pharmacist and shown to deliver  $20$  drops of the cough syrup per  $1\text{ml}$ .

Calculate the dose, in drops, for the child? (answer  $15$  drops)

$$1\text{ml} \rightarrow 20\text{drops}$$

$$0.75 \rightarrow 15$$

بعض کل کیلو لازم 5 سا کیرو

# Extra practice

1wk 2wk  
5mcg/kg 5mcg/kg

ونقاسب

وزن  
النزله

The regimen for a drug is as follows: 5 mcg/kg q week x 2, then 7 mcg/kg q2weeks. Calculate the dose in mcg that a 143 lb patient receives in a month. (1 lb = 0.453 kg)

- a. 323.9
- b. 647.8
- c. 1101
- d. 453

اول الی بعد وزنه کیلو  
اول الی بعد  
5mcg = 1xg  
x → 64...  
نتیجه المنهج  
7mcg/kg ← 4wk

How many milligrams of a drug does a 187 lb patient receive over a 4 hour period if the recommended dose is 3.5 m/kg/h?

- a. 296.5
- b. 1186
- c. 187
- d. 2372
- e. 595

187  
11b → 0,453  
187 →  
3.5m/kg → 4 hours

# Extra practice

- The pediatric dose for an antibiotic is 50 mcg/kg/day for 5 days. How many micrograms should be given to a 45 lb child for the entire treatment period?

- 1019
- 204
- 2038
- 90
- 40.9

$$\begin{aligned} 11b &\rightarrow 0,453 \\ 45 &\rightarrow x \end{aligned}$$

- A dose of 2 mg/kg of an antibiotic results in a peak blood serum level of 5 mcg/mL. How many milligrams of the drug should be given to a 143 lb patient if a peak blood serum level of 5.5 mcg/mL is desired?

- 130
- 65
- 286
- 357.5
- 143

$$\begin{aligned} 2 &\rightarrow 5 \text{ mcg} \\ x &\rightarrow 5.5 \text{ mcg} \end{aligned}$$

$$\frac{11}{5} = \frac{5x}{5} = \boxed{x=2,5g}$$

$$\boxed{2,5 \text{ mg/kg}}$$

و كذا بالأمثلة السابقة

# Extra practice

- Pharmaceutical Calculations, Howard Ansel, 31th Edition, 2010 (chapter 7 )