# ADVANCED ASSESSMENT
# Medical Math

Version 2014  Ontario Base Hospital Group

# ADVANCED ASSESSMENT
# Medical Math


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# MENU

- START AT THE BEGINNING
- METRIC SYSTEM
- WORKING WITH FRACTIONS
- HOW MUCH DRUG TO ADMINISTER
- WEIGHT VS. VOLUME
- DRUG CONCENTRATIONS
- INTRAVENOUS THERAPY CONCEPTS
- POUNDS TO KILOGRAMS
- OTHER "MUST KNOWS"
- REVIEW OF EQUIVALENTS

- have paper and pen/pencil for notes and/or solving equations
- use a calculator to confirm your answers

Medical Math holds people back

Flattens their learning curve

Paralyzes the professional from doing their job with confidence

Medical Math does not have to be this way!

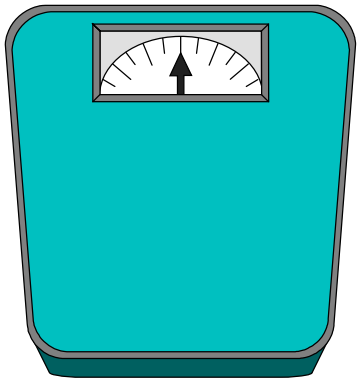
Our goal is to change this!

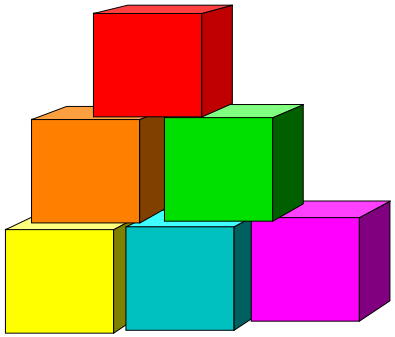
# Metric System

- The metric system must be fully understood to accurately deliver various volumes of fluid and various weights of drugs
- These are usually given based on the patients weight
- Basic metric units of measurement are:
  1. Length - Meter
  2. Volume - Liter
  3. Weight - Gram

# Basic Metric Units

| MASS | VOLUME | LIQUID |
| --- | --- | --- |
| GRAM<br>G | CUBIC CENTIMETER<br>cc | MILLILITER<br>ml |





# Metric System

- subdivisions of these basic units are made by moving the decimal point to the left
- multiples of the basic units are indicated by moving the decimal point to the right

# Metric System

Based on the Decimal system or multiples of 10

- primary unit of weight is the GRAM
- smaller unit of weight is the MILLIGRAM
- larger unit of weight is the KILOGRAM

1 GRAM is equal to 1,000 MILLIGRAMS

1 KILOGRAM is equal to 1,000 GRAMS

# BASE UNITS

| Quantity | Base Unit | SI symbol |
|---|---|---|
| length | metre | m |
| mass | kilogram | Kg |
| time | second | s |
| amount of substance | mole | mol |
| temp | Kelvin | K |
| electical current | ampere | A |

# Metric System

| Micro | Milli | Centi | Deci | BASE | Deka | Hecto | Kilo |
|---|---|---|---|---|---|---|---|
| .000001 | .001 | .01 | .1 | Meter | 10 | 100 | 1000 |
| .000001 | .001 | .01 | .1 | LITER | 10 | 100 | 1000 |
| .000001 | .001 | .01 | .1 | GRAM | 10 | 100 | 1000 |

**Note: When documenting a drug dose that is less than 1, always place a "0" before the decimal point so that the dosage isn't mistaken for a larger one.**

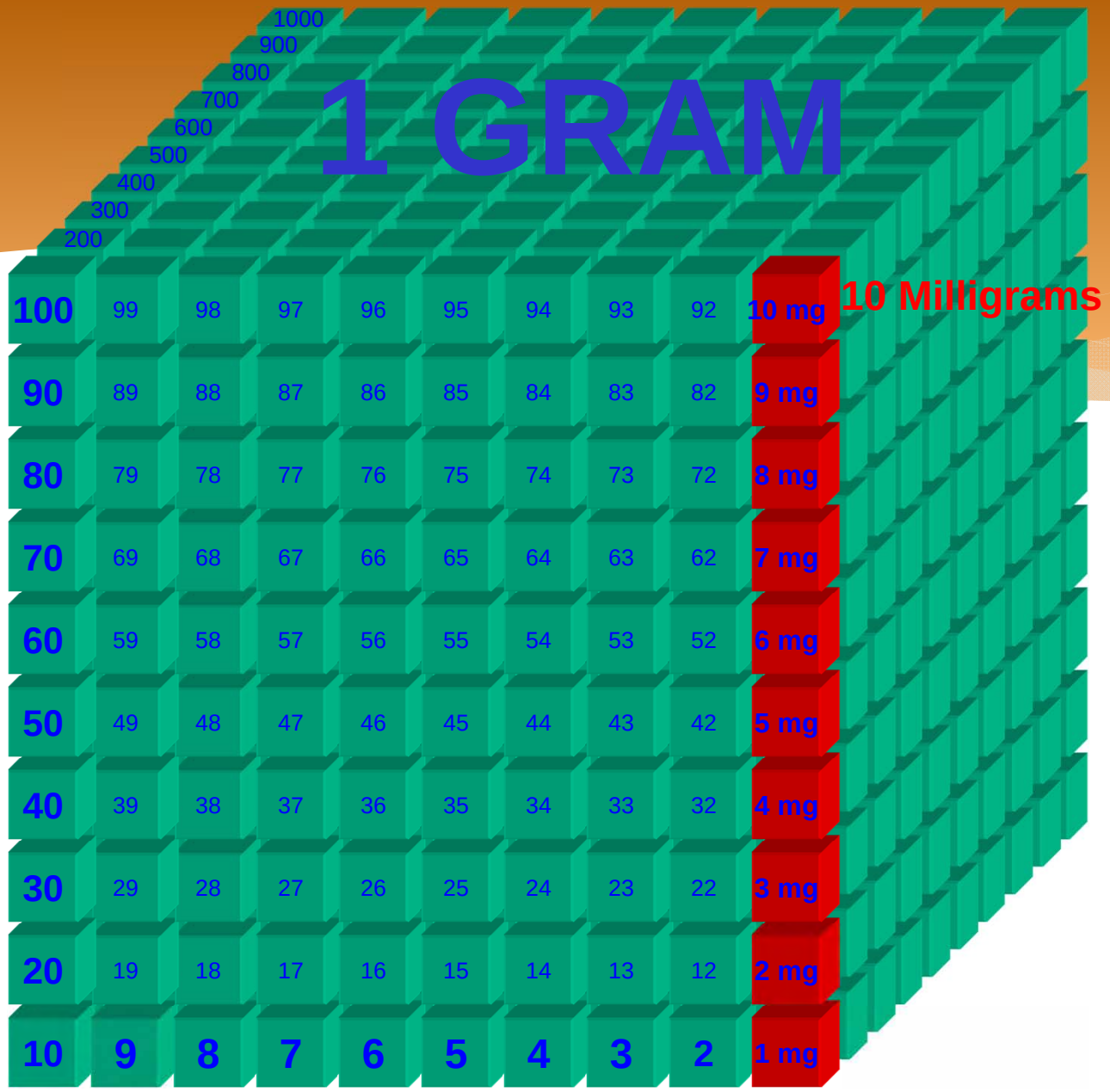
**e.g. 0.5 mg epinephrine IM (not .5 mg epinephrine, as this may appear on the chart as "5" mg which would be an excessive dose)**

# Metric System

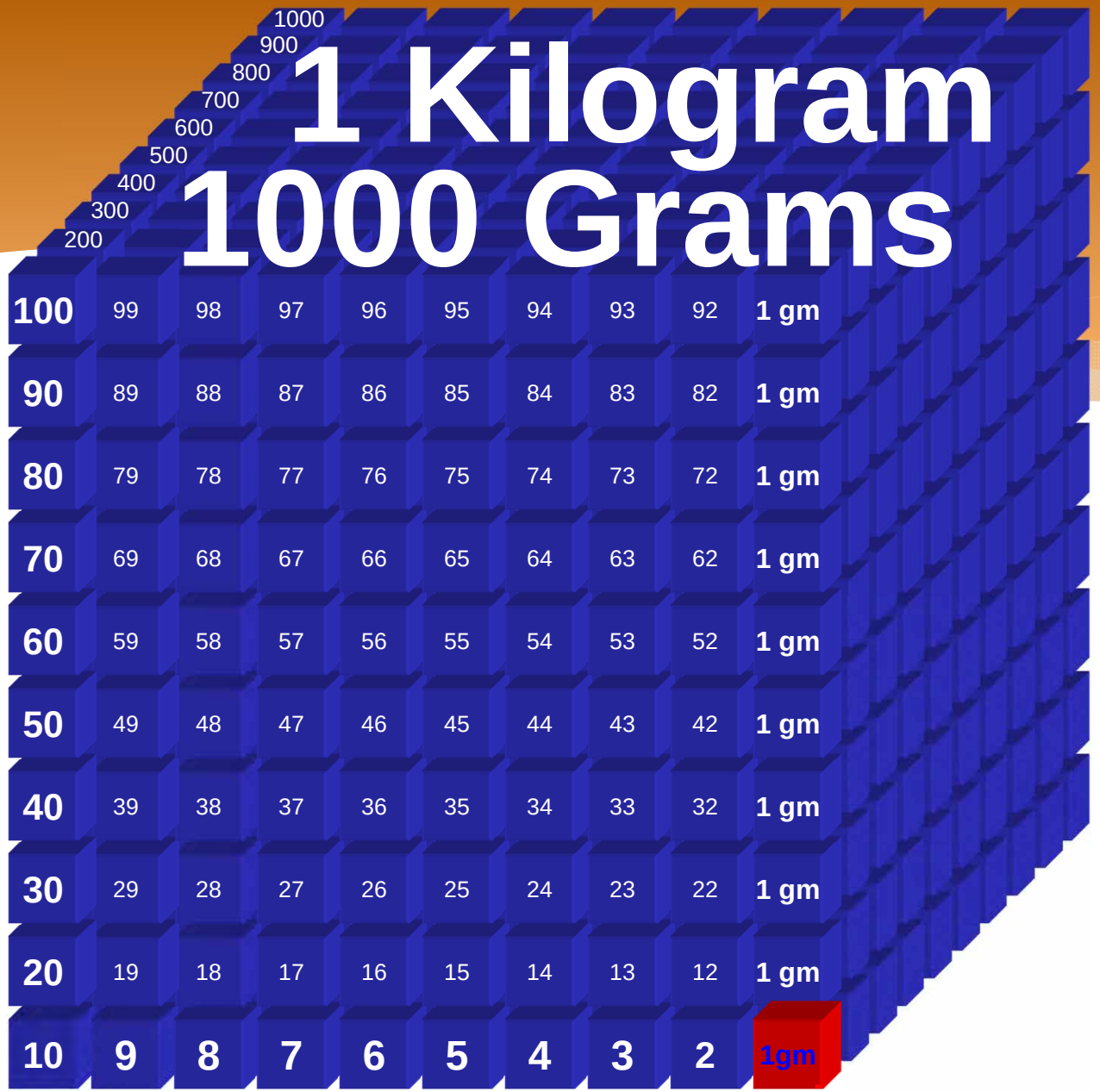
| gram(G) | milligram(mg) | microgram(mcg) |
|---|---|---|
| | *Click to see answer* | |
| 0.00001 G | = 0.001 mg | = 1.0 mcg |
| 0.001 G | = 1.0 mg | = 1,000 mcg |
| 1.0 G | = 1,000 mg | = 1,000,000 mcg |

next slide

# WEIGHTS

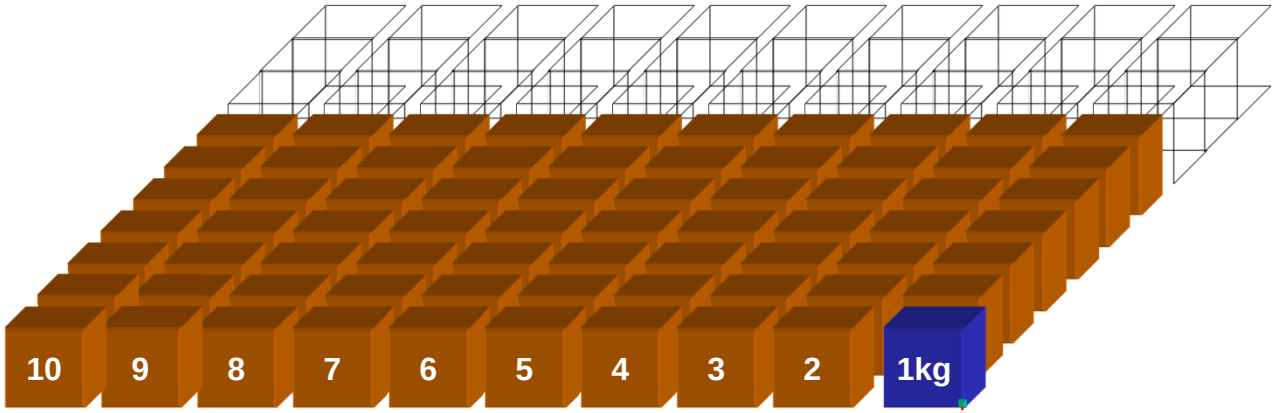

1000
900
800
700
600
500
400
300
200
1 GRAM
100 99 98 97 96 95 94 93 92 10 mg
90 89 88 87 86 85 84 83 82 9 mg
80 79 78 77 76 75 74 73 72 8 mg
70 69 68 67 66 65 64 63 62 7 mg
60 59 58 57 56 55 54 53 52 6 mg
50 49 48 47 46 45 44 43 42 5 mg
40 39 38 37 36 35 34 33 32 4 mg
30 29 28 27 26 25 24 23 22 3 mg
20 19 18 17 16 15 14 13 12 2 mg
10 9 8 7 6 5 4 3 2 1 mg
10 Milligrams

# 1 Kilogram
# 1000 Grams



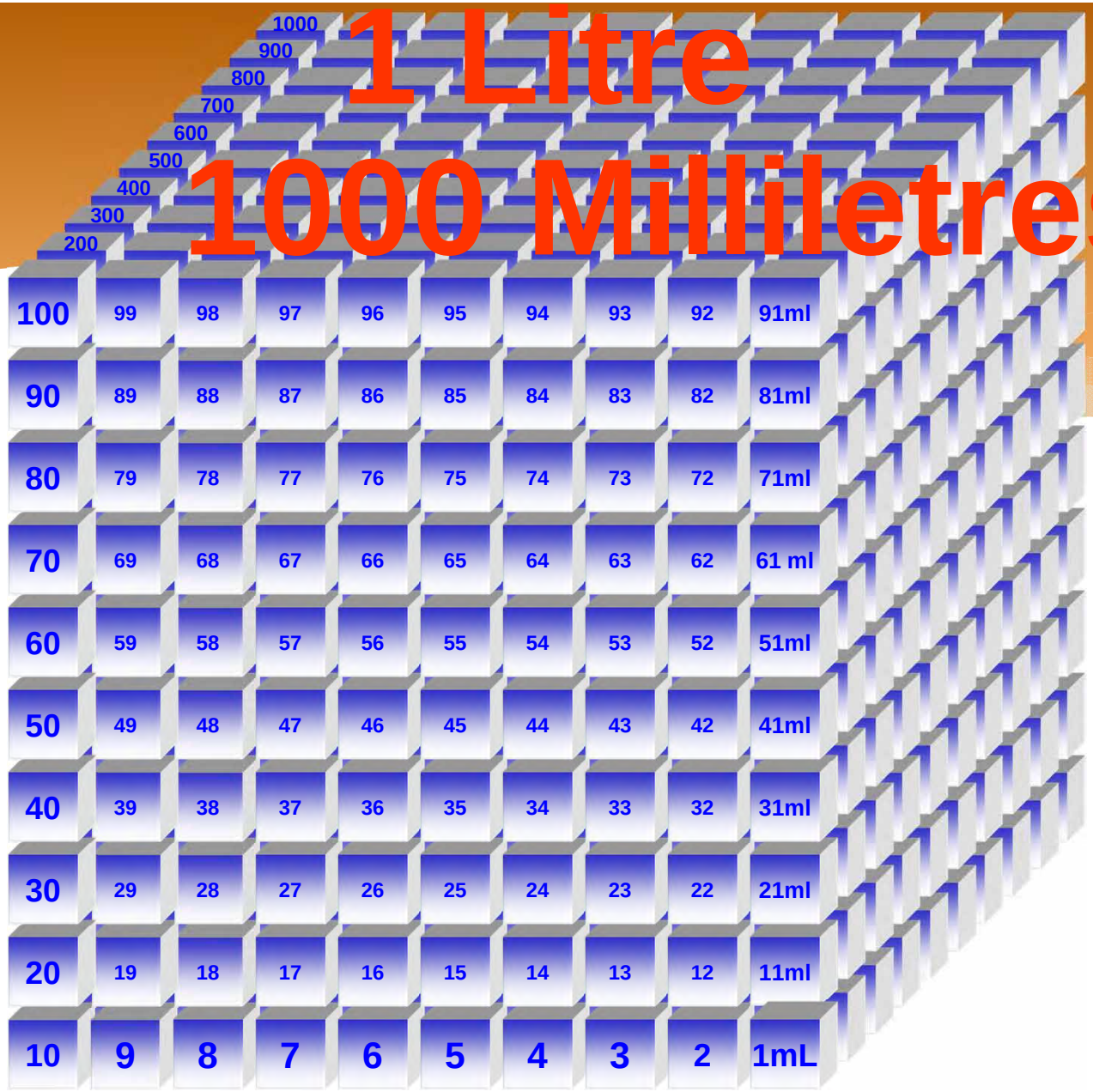
# WEIGHTS

## 70 Kilograms



# VOLUME

# 1 Litre
# 1000 Milliletres



# ABBREVIATIONS

- **kilogram** **Kg (= 1,000 G)**
- **gram** **G**
- **milligram** **mg**
- **microgram** **mcg (= 0.001 mg)**
- **liter** **L**
- **milliliter** **ml**

# WORKING WITH FRACTIONS….

The return to school.

# MULTIPLYING FRACTIONS

$$\frac{\cancel{4}^{1}}{\cancel{5}_{1}} \times \frac{\cancel{10}^{2}}{\cancel{12}_{3}} = \frac{2}{3}$$

$$\frac{\cancel{7}^{1}}{9} \times \frac{4}{\cancel{21}_{3}} = \frac{4}{27}$$

**Try creating your own fractions and use the same procedure**

# DIVIDING FRACTIONS

$$\frac{4/5}{4/15}$$

$$= \frac{\cancel{4}^{1}}{\cancel{5}_{1}} \times \frac{\cancel{15}^{3}}{\cancel{4}_{1}}$$

$$= 3$$

$$\frac{1/9}{3/18}$$

$$= \frac{1}{\cancel{9}_{1}} \times \frac{\cancel{18}^{2}}{3}$$

$$= \frac{2}{3}$$

Treat both sides of the = sign the same

$$\frac{X+10}{5} = 5 \qquad x\ \frac{5}{1} \qquad x\ \frac{5}{1}$$

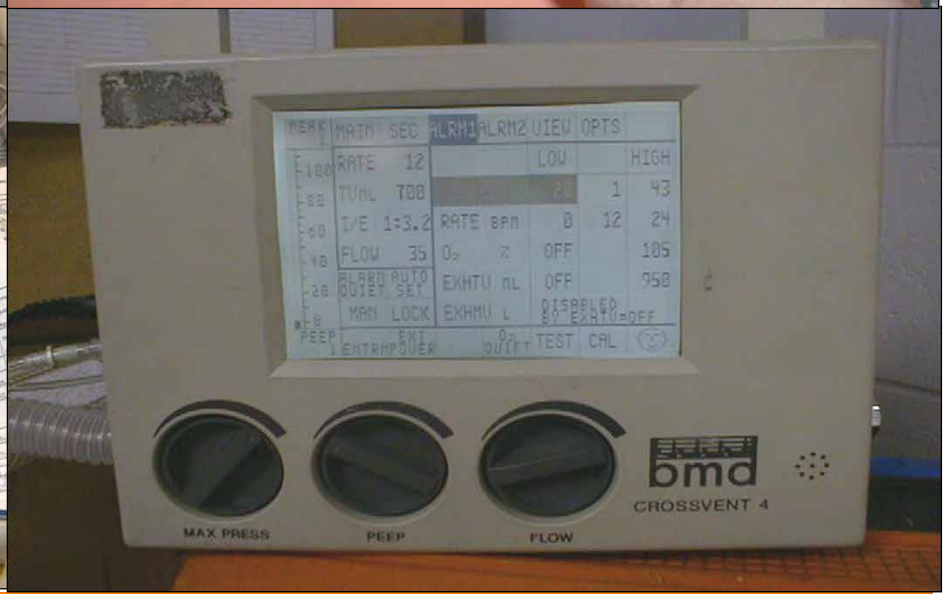
Use the opposite function if you move across an '=' sign

$$X + 10 = 25$$

$$X + 10 - 10 = 25 - 10$$

$$X = 15$$

# Where will I apply medical math????

# MEDICAL MATH

- Calculators and medication tables are more than welcome, only if you intend on using them in your practice.

- You are encouraged to use the formulas supplied.  If you have your own method and it works for you, do it your way.

# HOW MUCH TO ADMINISTER?

**WANT**

**---------- = AMOUNT TO**

**HAVE ADMINISTER**

**WNT / HAVE = GIVE**

# WANT

- Medical Directives i.e. 0.5 mg Epi. 1:1,000 IM
- verbal orders by patch phone
- written orders as per Medical Directives

$\frac{\text{WANT}}{\text{HAVE}}$ = GIVE

# HAVE

- Concentration of the Drug
  - Nitro, Salbutamol, Glucagon, Lidocaine
- Contents of the IV Bag
- Amount in a given Ampoule or Vial

# WEIGHT vs. VOLUME

## REMEMBER:

Weight and Volume
are not the same thing

Weight is the amount of a drug -5.0mg of Ventolin

Volume is the amount of fluid the drug is dissolved in - 2.5 ml Nebule

# REMEMBER:

Always document drug administration by weight

– e.g. 2.5 mg

never 2.5 ml

**WANT / HAVE = GIVE**

# HAVE = CONCENTRATION

$$\text{Concentration} = \frac{\text{Weight}}{\text{Volume}}$$

# CONCENTRATION

- mol/L
- G/L
- G% or %
- mg%
- Eq/L
- m/Eq/L
- mg/ml
- mcg/ml

- moles per litre
- grams per litre
- grams/100mL
- mg per 100 mL
- equivalents/ L
- milliequivalents per litre
- milligrams/millilitre
- micrograms/millilitre

# CONCENTRATION

Reduce the Volume to 1 ml which will make the math easier

**mg/ml** Click to see answer

**100 mg in 20 ml =** **5 mg/ml**

**250 mg in 100 ml =** **2.5 mg/ml**

**60 mg in 15 ml =** **4 mg/ml**

next slide

# CONCENTRATION

## EXAMPLE


**mg/ml**

Click to see answer

**100 mg in 5 ml =** **20 mg/ml**

next slide

# CONCENTRATION


EXAMPLE

**mg/ml**

Click to see answer

**50 mEq in 50 ml =** **1 mEq/ml**

next slide

# CONCENTRATION

EXAMPLE

**mg/ml**


Click to see answer

**25 g in 50 ml = 500 mg/ml**

next slide

# INJECTION - ml

$$\frac{\text{Amount Ordered (want)}}{\text{Concentration (have)}} = \text{Amount to administer (ml)}$$

$$\frac{50\ \text{mg}}{5\ \text{mg/ml}} = 10\ \text{ml}$$

$$\frac{0.5\ \text{mg}}{1\ \text{mg/ml}} = 0.5\ \text{ml}$$

$$\frac{0.5\ \text{mg}}{5\text{mg/2ml}} = 0.2\ \text{ml}$$

$$\frac{2.5\ \text{mg}}{5\ \text{mg/2.5ml}} = 1.25\ \text{ml}$$

Reduce to 2.5mg/ml

Reduce mg per ml

# INFUSION - ml/min

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml/min)}$$

$$\frac{20 \text{ mcg/min}}{200 \text{ mcg/ml}} = \frac{1 \cancel{\text{mcg}}/\text{min}}{10 \cancel{\text{mcg}}/\text{ml}} = 0.1 \text{ ml/min}$$

$$\frac{15 \text{ mg/min}}{5 \text{ mg/ml}} = 3 \text{ ml/min}$$

$$\frac{3 \text{ mg/min}}{10 \text{ mg/ml}} = 0.3 \text{ ml/min}$$

# IV CONCEPTS

Two concepts:

1. Flow rate:

   the rate at which IV fluid is given.

2. The drip factor:

   the number of drops per mL determined by the administration set.

# I.V ADMINISTRATION SETS

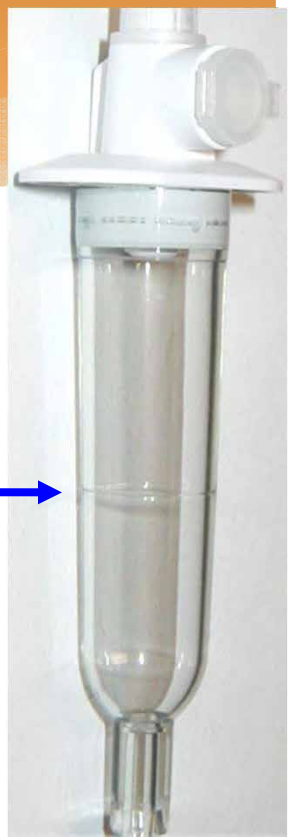
- Are constructed to deliver a specific number of drops per milliliter.
- This is called the **DRIP FACTOR** and can be found on the package containing the set.

**Some examples**:

- 10 drops/ml ---(or 10 gtts/ml) Macro
- 15 drops/ml---Macro
- 60 drops/ml---Micro

# I.V ADMINISTRATION SETS

- The line scribed on the drip chamber denotes 1 ml of fluid
- 60 gtt set: takes 60 gtts of the fluid to reach the line.
- 10 gtt set: takes only 10 gtts, because the drops are much bigger.



# INFUSION = ml/hr

Calculate the drip rate when the
Physician Orders - 400 ml/hr
using a 10 gtts/ml drip set

400 ml/hr x 10 gtts/ml

4000 gtts/hr ÷ 60 min/hr

66.67 gtts/min ÷ 60 sec/min

= 1 gtt/sec

**or**

400 ml/hr ÷ 60 min/hr

6.667 ml/min ÷ 60 sec/min

0.111 ml/sec x 10 gtts/ml

= 1 gtt/sec

# INFUSION - gtt/min

$$\frac{\text{Amount Ordered}}{\text{Concentration}} \times \text{drip factor} = \text{Amount to Administer (gtt/min)}$$

$$\frac{20\ \text{mcg/min}}{200\ \text{mcg/ml}} = 0.1\ \text{ml/min} \times 60\ \text{gtt/ml} = 6\ \text{gtt/min}$$

$$\frac{15\ \text{mg/min}}{5\ \text{mg/ml}} = 180\ \text{gtt/min}$$

$$\frac{3\ \text{mg/min}}{10\ \text{mg/ml}} = 18\ \text{gtt/min}$$

# POUNDS TO KILOGRAMS

Some medications:
like Lidocaine and Dopamine,
are administered based on body weight.

Once you determine the Pt.'s weight in lbs.,
simply divide by 2.2

$$\frac{\textbf{170 Lb}}{\textbf{2.2 Lb/ kg}} = \textbf{77 kg}$$

# Pounds to Kilograms Exercise

work it out by hand or using a calculator, then...

Click to see answer

1. **39 Lb = how many kg?** — **= 18 kg**
2. **120 Lb = how many kg?** — **= 55 kg**
3. **22 Lb = how many kg?** — **= 10 kg**
4. **88 Lb = how many kg?** — **= 40 kg**
5. **280 Lb = how many kg?** — **= 127 kg**

next slide

# HOW MUCH ?/KILOGRAM

Click to see answer

| | | |
|---|---|---|
| 1. | 3mg/kg of Lidocaine to a 75 kg Patient | = 225 mg |
| 2. | 5mcg/kg of Dopamine to a 80 kg Patient | = 400 mcg |
| 3. | 1mg/kg of Lidocaine to a 220 lb Patient | = 100 mg |
| 4. | 0.05mg/kg of Epi 1:1000 to a 110 lb Patient | = 2.50 mg |
| 5. | 12mg/kg of Chocolate to a 110 kg Patient | = 1320 mg |

next slide

# WEIGHT BASED INFUSION

$$\frac{\text{Amount Ordered}}{\text{Concentration}} \times \text{Weight} = \text{Amount to administer (ml/min)}$$

$$\frac{\cancel{10\ \text{mcg/kg/min}}}{\cancel{800\ \text{mcg/ml}}} \times \cancel{80\ \text{kg}} = \frac{1}{80} \times 8 = 1\text{ml / min}$$

**If drop/ minute are required multiply by drop factor x 60 gtt/ml**

**= 60 gtt/min**

# Single Strength Dopamine Chart

| mcg/min | gtts/min |
|---|---|
| 800 | 60 |
| 400 | 30 |
| 200 | 15 |
| 100 | 7.5 |
| 50 | 3.75 |

# Double Strength Dopamine Chart

| mcg/min | gtts/min |
|---|---|
| 1600 | 60 |
| 800 | 30 |
| 400 | 15 |
| 200 | 7.5 |
| 100 | 3.75 |
| 50 | 1.875 |

# Using the Chart System

1. Estimate the patients weight in kg and round to nearest 10's.

2. Multiply the (weight) x (order).

3. Use chart to add up drip rate.

4. Run IV at approximate rate or use an infusion pump.

# PROBLEM

## Parkland Burn Formula

- a) total volume to be administered (ml)=
  4 ml x weight (kg) x % of burn surface area(BSA) or [**4ml x kg x % BSA]**
- b) administer 1/2 of this volume in first 8 hours
- c) administer second half over the next 16 hours

# PROBLEM

## 100 kg patient with 50 % BSA

## 4ml/kg x weight (kg) x % BSA = ml

## WORK THIS OUT!

(4 x 100 x 50) ⍰ 2

Click to see answer

20,000 ml or 20 litres in 24 hours
= 10 litres in first 8 hours

next slide

# PROBLEM

Now calculate gtts/min

10 litres in first 8 hours (10L / 8hrs.)

10 L = 10,000 ml

8 hrs. = 480 min.

10,000 ml/480 min

= 20.833 ml/min.

Using a 10 gtt/ml set

20.833 ml/min. x 10 gtts/ml

= 208 gtts/min. (fast)

# PROBLEM

alternative approach

100 kg patient with 50 % BSA

4ml x weight (kg) x % BSA = ml/hour__

i.e. $\frac{(4 \times 100 \times 50) \div 2}{8}$

Using a 10 gtt/ml set

= 1250 ml per hour x 10 gtt/ml

(divide by 60 min to get gtts/min)

= 208 gtts/min. (fast)

# SUMMARY

**WANT**

**---------- = GIVE**

**HAVE**

- the WANT may get more complicated involving time or patient weight.
- the HAVE is in your possession and may change in concentration depending on service supplies ("Have" is always based on concentration)

# Concentration Exercises

Work out equations by hand – then by calculator to verify

Click to see answer

| | | |
|---|---|---|
| 1. | 100 mg in 20 ml | = 5 mg/ml |
| 2. | 75 mg in 5 ml | = 15 mg/ml |
| 3. | 250 mg in 100 ml | = 2.5 mg/ml |
| 4. | 30 mg in 3 ml | = 10 mg/ml |
| 5. | 60 mg in 15 ml | = 4 mg/ml |
| 5. | 10 mg in 10 ml | = 1 mg/ml |

next slide

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{50\ \text{mg}}{5\ \text{mg/ml}} =$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\textbf{Amount Ordered}}{\textbf{Concentration}} = \textbf{Amount to Administer (ml)}$$

answer

$$\frac{50\ \text{mg}}{5\ \text{mg/ml}} = 10\ \text{ml}$$

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{45\ \text{mg}}{15\ \text{mg/ml}}$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

answer

$$\frac{45\ \text{mg}}{15\ \text{mg/ml}} = 3\ \text{ml}$$

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{0.5\ \text{mg}}{1\ \text{mg/ml}}$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

answer

$$\frac{0.5\ \text{mg}}{1\ \text{mg/ml}} = 0.5\ \text{ml}$$

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{160\ \text{mg}}{4\ \text{mg/ml}}$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

answer

$$\frac{160\ \text{mg}}{4\ \text{mg/ml}} = 40\ \text{ml}$$

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{25\ \text{mg}}{10\ \text{mg/ml}}$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

answer

$$\frac{25\ \text{mg}}{10\ \text{mg/ml}} = 2.5\ \text{ml}$$

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{5\ \text{mg}}{2.5\ \text{mg/ml}}$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

answer

$$\frac{5\ \text{mg}}{2.5\ \text{mg/ml}} = 2\ \text{ml}$$

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{25\ \text{mg}}{10\ \text{mg/ml}}$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} = \text{Amount to Administer (ml)}$$

try this

$$\frac{25\ \text{mg}}{10\ \text{mg/ml}} = 2.5\ \text{ml}$$

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} \text{ X drip factor} = \text{Amount to Administer (gtt/min)}$$

try this

$$\frac{\text{20 mcg/min}}{\text{200 mcg/ml}} \text{ x 60 gtt/ml}$$

see answer

# EXERCISE

Concentration = mg/ml

$$\frac{\text{Amount Ordered}}{\text{Concentration}} \text{ X drip factor} = \text{Amount to Administer (gtt/min)}$$

answer

$$\frac{20 \text{ mcg/min}}{200 \text{ mcg/ml}} \text{ x 60 gtt/ml} = 6 \text{ gtt/min}$$

# OTHER MUST KNOWS

- CONCENTRATION RATIO:

AMT of drug in **1 ml**

?/1 ml

- PERCENT (%) Solution:

grams in **100 ml**

? G/100 ml

- SERIAL DILUTION:

**1 G** in ? ml

1 G:? ml

# CONCENTRATION RATIO

Valium 10 mg/2 ml ampoule

Concentration ratio is:

- 10 mg/2 ml
- 5 mg/1 ml

# PERCENT SOLUTION

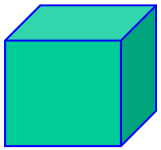
## D50W

50% Dextrose Solution

50 G in 100 ml

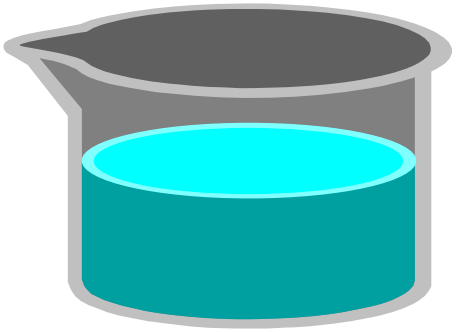
25 G in 50 ml Preload

# Percent Solution =



**number of grams**

**In a**



**100mL solution**

e.g.

D50W is a 50% dextrose solution in water. A pre-load of D50W contains 50 ml.

How many grams does it contains?

**25 grams!**

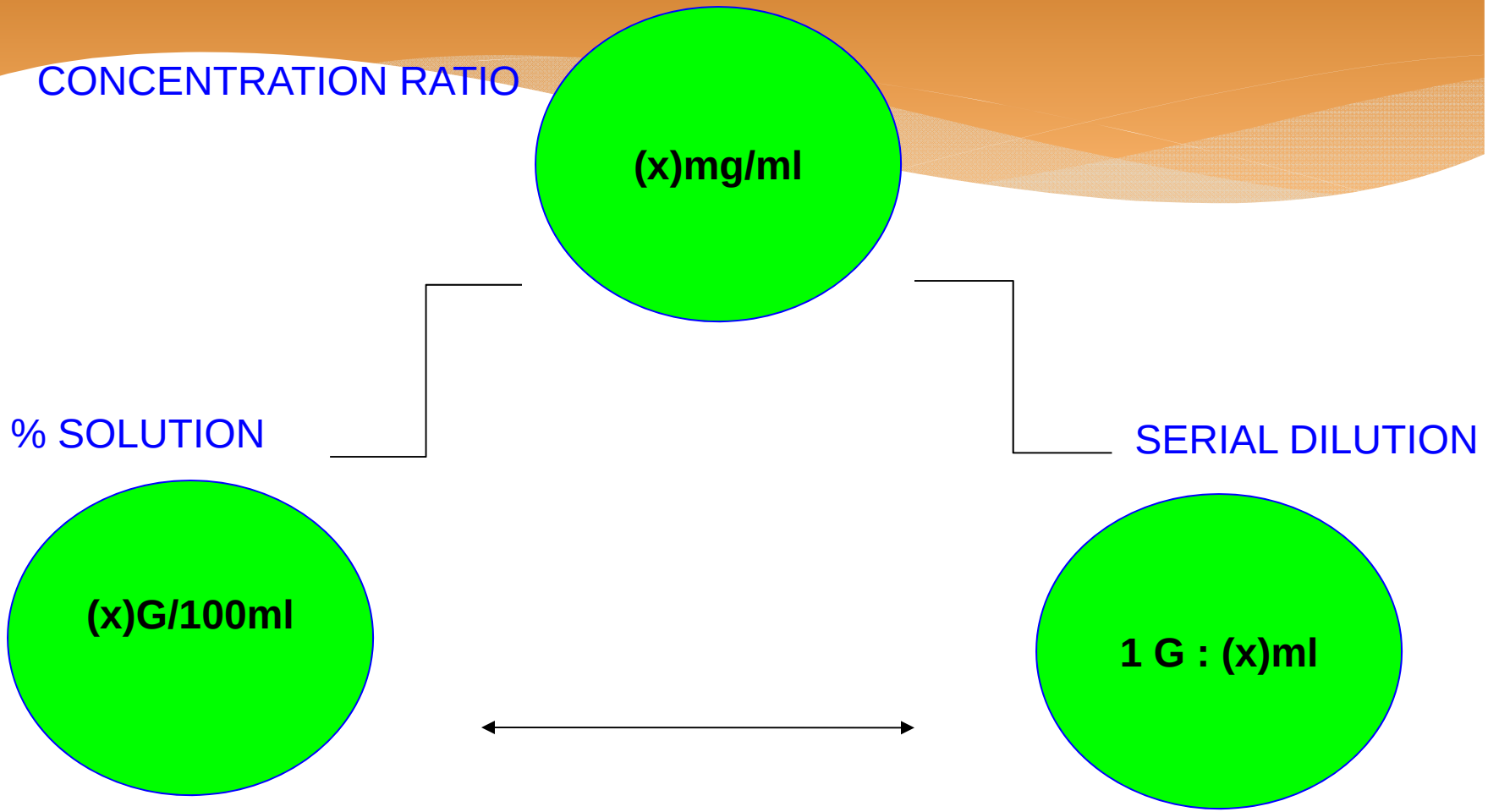
**Well done!**

# SERIAL DILUTION


[another example]

| Epi.1:1,000 | Epi.1:10,000 |
| --- | --- |
| 1 G:1,000 ml | 1 G:10,000 ml |
| 1,000 mg:1,000 ml | 1,000 mg:10,000 ml |
| 1 mg in 1 ml | 1 mg in 10 ml |

# CONVERSION TRIAD



# CONVERSION TRIAD

| Serial Dilution | % Solution | Conc. Ratio |
|---|---|---|
| 1g(x)ml | (x)g/100ml | (x)mg/ml |
| 5:100 | 5% | 50 mg/ml |
| 0.5:100 | 0.5% | 5 mg/ml |
| 1:10,000 | 0.01% | 1 mg/10 ml<br>0.1 mg/ml |

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# OXYGEN TANK CALCULATIONS

## TANK DURATION

$$\frac{\text{Gauge Pressure} - \text{Safe Residual Pressure}}{\text{Flow Rate (liters per minute)}} \times \text{Constant}$$

D Tank constant = 0.16

M Tank constant = 1.56

# SUMMARY

- Use it or Lose it!  And…use what you are comfortable with
- The formulas allow you to cross off units
- The formulas always start with the amount ordered on top "WANT" (Want = Give)
  Have
- Understand the difference between weight and volume!
  - **mg and ml are not the same thing!**

# REVIEW OF EQUIVALENTS

# Equivalents - Distance

| | | |
|---|---|---|
| 1 metre (m) | = | 100 centimetres (cm) |
| 1 metre | = | 1000 millimetres (mm) |
| 1 litre | = | 1000 millimetres (ml) |

# 3 prefixes for fractional units of measure

deci - 0.1 of a unit

centi - 0.01 of a unit

milli - 0.001 of a unit

# Equivalents - Weight

| | |
|---|---|
| 1 gram | = 1000 milligrams (mg) |
| 1 gram | = 1,000,000 micrograms (mcg) |
| 1000 grams | = 1 kilogram (kg) |
| 0.0000001 G<br>or<br>0.001 mg | = 1 microgram (mcg) |

# Units of measure

## Mass

1 kilogram (kg) = 1000 G

1 milligram (mg) = 1/1000 G

1 microgram (mcg) = 1/1,000,000 G

# Unit of measurement
# A Review

## Metric System:

three prefixes are used to indicate multiples:

- deka - units of 10
- hecto - units of 100
- kilo - units of 1000

# Volume

- 1 litre (L) = 1000 millilitres (mL)
- the abbreviation cc has now been replaced by the millilitre (mL).

# Well Done!

Ontario Base Hospital Group

Self-directed Education Program