Drug Calculation Instruction Using the Dimensional Analysis Approach

- Unit Equivalencies - the value of equivalencies between two units.

For Example: 1 kg = 2.2 lbs, 5 mL = 1 tsp, 30 mL = 1 ounce,
1 gram = 1000 mg, 60 minutes = 1 hour, 15 gtt = 1 mL, 1 grain = 60 mg

- Unit - a dimension that is given to a number.

For Example - If you are to give 50, you would ask, 50 what? This could be mg, mL, tablets, teaspoons, etc. (mg, mL, tablets, tsp. are the units)

- Conversion Factor - it is a unit equivalency written as a fraction.

$\frac{60 \text{ mg}}{1 \text{ grain}}$ or $\frac{1 \text{ grain}}{60 \text{ mg}}$

(The above is simply stating that 60 mg is equal to 1 grain or 1 grain is equal to 60 mg….both mean the same thing regardless of how they are set up)
Conversion factors are derived from information provided in the dosage problem.

- Dimensional Analysis ("chemistry math") - a process of manipulating units, which are actually descriptions of numbers, to solve mathematical equations. This method of mathematic problem solving is used in chemistry with great success. The goal of this approach to drug calculation problem solving is to:

CANCEL OUT UNWANTED UNITS LEAVING ONLY THOSE UNITS YOU WANT YOUR ANSWER TO BE EXPRESSED AS!

- Think of Unit Equivalence as a link that will help you get the desired units you are solving for.

For example:
Covert 50 lb to kg
The Unit Equivalence (link) is: 2.2 lb = 1 kg
Note: $\frac{2.2 \text{ lb}}{1 \text{ kg}}$ is another way of saying that 2.2 lb = 1 kg
The desired units we are seeking are kg in this example.

Using Dimensional Analysis in the above example, we set the problem up in the following format:
Problem: Covert 50 lb to kg

$50 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 22.7 \text{ kg}$ (lb cancel one another out and we are left with kg, the units we want)

Another way of stating this problem is: How many kg are there in 50 lb? or 50 lb is equal to how many kg?
In this example, the units of lbs cancel each other out, leaving behind kg (the units we want our answer to be in). We have eliminated the units we don't want and are left with the units we do want.
Note: In Dimensional Analysis we simply multiply straight across first (on both sides of the horizontal line if applicable) and then divide. There is no cross multiplication or algebra involved in this method of problem solving.
Note: This approach to drug calculations can be used with every type of problem. This is not true of other methods.

- Remember, drug calculation problems are simply story problems. You have to develop a mathematical problem from the information that is provided. Using the Dimensional Analysis approach, this can be accomplished in a few simple steps:
    - Determine what it is that is being asked
    - Determine what units your answer must be represented in (desired units)
    - Determine what the unwanted units are
    - Determine what the link (unit equivalence) is (there may be more than one link per problem, and these conversions may have to be made before the final problem can be set up))
    - Set up your problem so that you can eliminate unwanted units to end up with desired units

    Apply this method to the problem above: Covert 50 lb to kg
    - Determine what it is that is being asked - How many kg are there in 50 lb? or 50 lb is equal to how many kg?
    - Determine what units your answer must be represented in (desired units) - kg is what we are solving for
    - Determine what the unwanted units are - We want to eliminate lb
    - Determine what the link is - 2.2 lb = 1 kg
    - Set up your problem so that you can eliminate unwanted units to end up with desired units

Problem: Covert 50 lb to kg

$$50 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 22.7 \text{ kg}$$

lb cancel each other out and you are left with kg (the units we want)

Example: A nurse must infuse 1000 mL of IV fluids over 8 hours. The tubing drip factor is 10 gtts/mL. How many gtts per minute will there be?
- Determine what it is that is being asked - How many gtts/min?
- Determine what units your answer must be represented in (desired units) - gtts/min is what we are solving for
- Determine what the unwanted units are - We want to eliminate hours and mL
- Determine what the link is - 60 min = 1 hour
- Set up your problem so that you can eliminate unwanted units to end up with desired units

$$\frac{1000 \text{ mL}}{480 \text{ min}} \times \frac{10 \text{ gtt}}{\text{mL}} = \frac{10{,}000 \text{ gtt}}{480 \text{ min}} = 20.8 \frac{\text{gtt}}{\text{min}} \text{ or } 21 \frac{\text{gtt}}{\text{min}}$$

We converted hours to minutes before setting up the final problem, and then mL cancelled each other out and we are left with gtt/min (the units we want)

Example: A physician's order reads aspirin (acetylsalisylic acid) 600 mg PO stat. The label reads *gr* 5 per caplet. How many caplets of this antipyretic drug should be given to the patient?
- The order of conversion for this problem is: 600 mg > gr > cap

- We set the problem up as follows:

$$\frac{600\text{ mg}}{} \times \frac{1\text{ gr}}{60\text{ mg}} = \frac{10\text{ gr}}{} \times \frac{1\text{ cap}}{5\text{ gr}} = 2\text{ caplets}$$

Example: The prescriber orders 15 mg/kg of a drug for a patient who weighs 80 kg. How many mg of this drug should the patient receive?

$$\frac{80\text{ kg}}{} \times \frac{15\text{ mg}}{1\text{ kg}} = 1200\text{ mg}$$

Example: The prescriber orders Klonopin (clonazepam) 0.05 mg/kg PO daily in three divided doses for a patient who weighs 60 kg. If each tablet contains 1 mg, how many tablets of this anticonvulsant drug should the patient receive per day? How many tablets would the patient receive per dose?

$$\frac{60\text{ kg}}{} \times \frac{0.05\text{ mg}}{\text{kg}} = 3\text{ mg per day, or 3 tablets per day}$$

The patient should receive 3 tablets per day in three divided doses = 24 hours ÷ 3 doses = 1 tablet every 8 hours

Example: The prescriber ordered Heparin 2,000 units subcutaneously q 12 hours. The label on the multidose vial reads 10,000 units/mL. How many mL will you administer to the patient?

$$\frac{2000\text{ units}}{} \times \frac{1\text{ mL}}{10{,}000\text{ units}} = 0.2\text{ mL}$$

Example: The patient is to receive Isuprel (isoproterenol) at a rate of 4 mcg/min. The concentration of the Isuprel is 2 mg per 500 mL of IV fluid. Find the pump setting in mL/hr.

$$\frac{4\text{ mcg}}{} \times \frac{1\text{ mg}}{1000\text{ mcg}} = \frac{0.004\text{ mg}}{\text{min}} \times \frac{500\text{ mL}}{2\text{ mg}} = \frac{2\text{ mL}}{2\text{ min}} = \frac{1\text{ mL}}{1\text{ min}} \times \frac{60\text{ min}}{1\text{ hour}} = \frac{60\text{ mL}}{\text{hr}}$$

Example: Calculate the flow rate in mL per hour if the medication order reads: Add 10,000 units of heparin to 1000 mL 5%D/W IV. Your patient is to receive 1,250 units of this anticoagulant per hour via an infusion pump.

$$\frac{1{,}250\text{ units}}{1\text{ hour}} \times \frac{1{,}000\text{ mL}}{10{,}000\text{ units}} = \frac{125\text{ mL}}{\text{hr}}$$