Southwest Wisconsin Technical College

Dimensional Analysis in Nursing

Module 1.9

DRUG CALCULATIONS – LIQUID MEDICINES (ADVANCED)

Table of Contents

Noteworthy

These problems give you the chance to use *all* the dimensional analysis skills you've learned so far!!

Pete Esser
Knox Learning Center Mathematics Instructor
Contact: pesser@swtc.edu

Dimensional Analysis in Nursing

Module 1.9

DRUG CALCULATIONS – LIQUID MEDICINES (ADVANCED)

Introduction

In this module you will learn to apply more skills to solve drug calculations involving liquid medicines. The overall game plan is the same as the previous module; convert from doctor's orders (*mass*) to the amount (*volume*) measured and given to the patient either by mouth, injection, or IV.

What's New

The scenarios presented here will require more than one computational "step". Some problems will require converting from one metric unit of measure to another, while others might involve converting to a different time frame.

Multiple examples will be offered to illustrate the necessary dimensional analysis skills.

Using Concentration

As before, you will need to use the concentration of the available drug to convert from mass to volume.

A concentration of **150 mg/mL** is treated as the equivalency **150 mg = 1 mL**.

Metric Prefix Chart

Provided below is a portion of the metric prefix chart which can serve as a reference when making metric-to-metric conversions.

kilo hecto deka **base** deci centi milli | | micro

Example 1.9.1

Prescription: Loading dose of Lanoxin 525 mcg IV

Inventory: Lanoxin 0.25 mg/mL

Quantity to give patient: ___________ (for the loading dose)

The goal in this example is to determine ***mL***.

Goal: mL

Step 1 Write doctor's orders in fractional form with a denominator of 1.

Continue Step 1 by writing a multiply symbol (×) and another fraction bar with the *same units of measure* in the denominator.

$$\frac{525\text{ mcg}}{1} \times \frac{\qquad}{\text{mcg}}$$

Goal: mL

Step 2 – The units of measure for the order (mcg) do not match the units of measure for mass in the available drug (mg). Use the conversion, **1 mg = 1000 mcg**.

$$\frac{525\text{ }\cancel{\text{mcg}}}{1} \times \frac{1\text{ mg}}{1000\text{ }\cancel{\text{mcg}}}$$

Goal: mL

Step 3 – Now that we have milligrams (mg), we can use the drug concentration of 0.25 mg/mL. Think of it as **0.25 mg = 1 mL**.

$$\frac{525\text{ }\cancel{\text{mcg}}}{1} \times \frac{1\text{ }\cancel{\text{mg}}}{1000\text{ }\cancel{\text{mcg}}} \times \frac{1\text{ mL}}{0.25\text{ }\cancel{\text{mg}}}$$

In order to cancel-out "mg", **0.25 mg** must be in the denominator.

Goal: mL

Step 4 – The goal of achieving *mL* has been accomplished. Multiply the numerators together, then multiply the denominators. Finish by dividing numerator by denominator.

$$\frac{525\text{ }\cancel{\text{mcg}}}{1\text{ dose}} \times \frac{1\text{ }\cancel{\text{mg}}}{1000\text{ }\cancel{\text{mcg}}} \times \frac{1\text{ mL}}{0.25\text{ }\cancel{\text{mg}}} = \frac{525\text{ mL}}{250} = \mathbf{2.1\text{ mL}}$$

Answer!

Example 1.9.2

Prescription: Lyrica 200 mg PO TID

Inventory: Lyrica 20 mg/mL

Determine *milliliters per day*: ________

The goal in this example is to determine ***mL per day***. **Goal:** $\frac{mL}{day}$

Step 1 Note that the goal contains **two** measurements. There is both a *quantity* (milliliters) and *time* (day).

The doctor has specified *200 mg per dose*. 200 mg takes care of the *quantity* requirement, while *dose* meets the time requirement since it is associated with time. Note how they are arranged:

$$\frac{200\text{ mg}}{1\text{ dose}}$$

Goal: $\frac{mL}{day}$

Step 2 – We must convert *mg* to *mL*, so let's start there. Since the available drug is expressed in *mg*, we can use can use "20 mg/mL" (which is interpreted as **20 mg = 1 mL**) right away.

$$\frac{200\ \cancel{\text{mg}}}{1\text{ dose}} \times \frac{1\text{ mL}}{20\ \cancel{\text{mg}}}$$

Goal: $\frac{\text{mL}}{\text{day}}$

Step 3 – We have converted *mg* to *mL*. Now we must convert *dose* to *day*. TID is interpreted as "three times per day". Think of it as **3 doses = 1 day**.

$$\frac{200\ \cancel{\text{mg}}}{1\ \cancel{\text{dose}}} \times \frac{1\text{ mL}}{20\ \cancel{\text{mg}}} \times \frac{3\ \cancel{\text{doses}}}{1\text{ day}}$$

In order to cancel-out "dose", **3 doses** must be in the numerator

Goal: $\frac{\text{mL}}{\text{day}}$

Step 4 – Everything is cancelled except for *mL* and *day*, which is our goal. Multiply the numerators together, then multiply the denominators. Finish by dividing numerator by denominator.

$$\frac{200\ \cancel{\text{mg}}}{1\ \cancel{\text{dose}}} \times \frac{1\text{ mL}}{20\ \cancel{\text{mg}}} \times \frac{3\ \cancel{\text{doses}}}{1\text{ day}} = \frac{600\text{ mL}}{20\text{ days}} = \mathbf{30\ mL/day}$$

Answer!

Example 1.9.3
Prescription: Codeine 60 mg PO q4h
Inventory: Codeine 30 mg/5 mL
Determine *milliliters per day*: ________

The goal in this example is to determine ***mL per day***.

$$\textbf{Goal: } \frac{\text{mL}}{\text{day}}$$

Step 1 Note that the goal contains **two** measurements. There is both a *quantity* (milliliters) and *time* (day).

The doctor has specified *60 mg per dose*. 60 mg takes care of the *quantity* requirement, while *dose* (which is associated with time) meets the time requirement. Note how they are arranged:

$$\frac{60\text{ mg}}{1\text{ dose}} \qquad \textbf{Goal: } \frac{\text{mL}}{\text{day}}$$

Step 2 – We must convert *mg* to *mL*, so let's start there. Since the available drug is expressed in *mg*, we can use can use "30 mg/5 mL", interpreted as **30 mg = 5 mL**.

$$\frac{60\text{ }\cancel{\text{mg}}}{1\text{ dose}} \times \frac{5\text{ mL}}{30\text{ }\cancel{\text{mg}}} \qquad \textbf{Goal: } \frac{\text{mL}}{\text{day}}$$

Step 3 – Having converted *mg* to *mL*, we must now convert *dose* to *day*.
Using "q4h" helps towards that goal since it means "a dose every 4 hours". Interpret q4h as **1 dose = 4 hours**. It will not get us directly to days, but we'll be heading in the right direction.

$$\frac{60\text{ }\cancel{\text{mg}}}{1\text{ }\cancel{\text{dose}}} \times \frac{5\text{ mL}}{30\text{ }\cancel{\text{mg}}} \times \frac{1\text{ }\cancel{\text{dose}}}{4\text{ hours}} \qquad \textbf{Goal: } \frac{\text{mL}}{\text{day}}$$

In order to cancel-out "dose", **1 dose** must be in the numerator

Step 4 – We can achieve our goal of *mL per day* if we next use the equivalency, **1 day = 24 hours**. That's the last step. To finish, multiply the numerators together, then multiply the denominators. Finish by dividing numerator by denominator.

$$\frac{60\text{ }\cancel{\text{mg}}}{1\text{ }\cancel{\text{dose}}} \times \frac{5\text{ mL}}{30\text{ }\cancel{\text{mg}}} \times \frac{1\text{ }\cancel{\text{dose}}}{4\text{ }\cancel{\text{hours}}} \times \frac{24\text{ }\cancel{\text{hours}}}{1\text{ day}} = \frac{7200\text{ mL}}{120\text{ days}} = \textbf{60 mL/day}$$

Answer!

Practice Problems

Directions – For each problem, use <u>dimensional analysis</u> to determine the quantity of medicine required for the patient. Write your goal in the provided box. Your answers should include the appropriate units of measure.

1.) Prescription: Liothyronine Sodium 0.05 mg IV
Inventory: Liothyronine Sodium 10 mcg/mL
Quantity to give patient: __________

Goal: ______

2.) Prescription: Acetaminophen 1 g IV
Inventory: Acetaminophen 120 mg/5 mL
Quantity to give patient: __________

Goal: ______

3.) Prescription: Octreotide 150 mcg SUBCUT BID
Inventory: Octreotide 100 mcg/mL
Determine *milliliters per day*: __________

Goal: ______

4.) Prescription: Metformin 2 g per day in two divided doses PO
Inventory: Metformin 500 mg/5 mL
Determine *milliliters per day*: __________

Goal: ______

5.) Prescription: Ciprofloxacin 0.4 g IV BID
Inventory: Ciprofloxacin 500 mg/5 mL
Determine *milliliters per day*: __________

Goal: ______

Solutions to Practice Problems

1.) Prescription: Liothyronine Sodium 0.05 mg IV
Inventory: Liothyronine Sodium 10 mcg/mL
Quantity to give patient: ___________

$$\frac{0.05\ \cancel{\text{mg}}}{1}\times\frac{1000\ \cancel{\text{mcg}}}{1\ \cancel{\text{mg}}}\times\frac{1\text{ mL}}{10\ \cancel{\text{mcg}}}=\frac{50\text{ mL}}{10}=\mathbf{5\ mL}$$

Goal: mL

2.) Prescription: Acetaminophen 1 g IV
Inventory: Acetaminophen 120 mg/5 mL
Quantity to give patient: ___________

$$\frac{1\ \cancel{\text{g}}}{1}\times\frac{1000\ \cancel{\text{mg}}}{1\ \cancel{\text{g}}}\times\frac{5\text{ mL}}{120\ \cancel{\text{mg}}}=\frac{5000\text{ mL}}{120}=\mathbf{41.7\ mL}$$

Goal: mL

3.) Prescription: Octreotide 150 mcg SUBCUT BID
Inventory: Octreotide 100 mcg/mL
Determine *milliliters per day*: ___________

$$\frac{150\ \cancel{\text{mcg}}}{1\text{ dose}}\times\frac{1\ \cancel{\text{mL}}}{100\ \cancel{\text{mcg}}}\times\frac{2\text{ doses}}{1\ \cancel{\text{day}}}=\frac{300\text{ mL}}{100\text{ days}}=\mathbf{3\ mL\ per\ day}$$

Goal: mL/day

4.) Prescription: Metformin 2 g per day in two divided doses PO
Inventory: Metformin 500 mg/5 mL
Determine *milliliters per day*: ___________

$$\frac{2\ \cancel{\text{g}}}{1\text{ day}}\times\frac{1000\ \cancel{\text{mg}}}{1\ \cancel{\text{g}}}\times\frac{5\text{ mL}}{500\ \cancel{\text{mg}}}=\frac{10000\text{ mL}}{500\text{ days}}=\mathbf{20\ mL\ per\ day}$$

Goal: mL/day

5.) Prescription: Ciprofloxacin 0.4 g IV BID
Inventory: Ciprofloxacin 500 mg/5 mL
Determine *milliliters per day*: ___________

$$\frac{0.4\ \cancel{\text{g}}}{1\ \cancel{\text{dose}}}\times\frac{1000\ \cancel{\text{mg}}}{1\ \cancel{\text{g}}}\times\frac{5\text{ mL}}{500\ \cancel{\text{mg}}}\times\frac{2\ \cancel{\text{doses}}}{1\text{ day}}=\frac{4000\text{ mL}}{500\text{ days}}=\mathbf{8\ mL\ per\ day}$$

Goal: mL/day