Southwest Wisconsin Technical College

Dimensional Analysis in Nursing
Module 1.0
INTRODUCTION TO DIMENSIONAL ANALYSIS

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Noteworthy

- Dimensional analysis is a problem-solving technique you can use throughout your nursing career.

- Equivalencies (ex. 1 pound = 2.2 kilograms) are used to achieve the correct units of measure for any situation.

- It is a technique with several built-in computational safeguards.

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INTRODUCTION TO DIMENSIONAL ANALYSIS

Welcome!

The purpose of this textbook is to help you learn a powerful problem-solving technique called *dimensional analysis*.

In nursing, you will primarily use dimensional analysis to solve drug calculation problems. The technique, when properly applied, will give you; *confidence* in your problem-solving ability, *speed* in your calculations, and *accuracy* in your answers.

Introduction

As in any technical discipline, you will encounter quantities expressed in units of measure that you find unsuitable for your purposes.

EXAMPLE 1.0.1
The scale you use to weigh patients only indicates **pounds**.
For charting purposes, you need to report **kilograms**.

EXAMPLE 1.0.2
The doctor communicates the amount of aspirin required in terms of **milligrams**.
To carry out the order, you need to know the correct quantity of **tablets** to give the patient.

You can use *dimensional analysis* to solve these problems and ones that are much more complex. You will learn about the elements of dimensional analysis starting on the next page.

The Elements of Dimensional Analysis

Element 1 - Equivalencies

Equivalencies are statements like, **1 tablet = 250 milligrams** or **1 kilogram = 2.2 pounds**.

Equivalencies are selected, then used in a computation to do two things;
1) Remove units of measure we *don't* want.
2) Introduce new units of measure that we *do* want.

Equivalencies come from:

1) **Your own Memory**
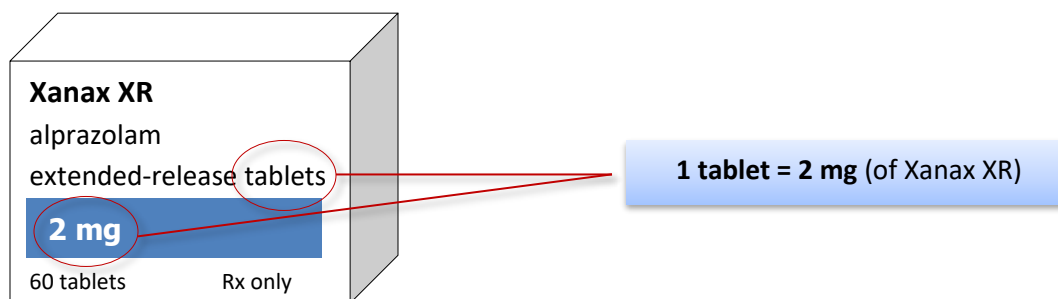These usually come from past experience or are things your nursing instructor asks you to memorize.

2) **Reference Tables**
Here is an excerpt from Appendix 1.0 in this textbook:

Length	Weight and mass	Volume
1 foot = 12 inches	1 pound = 16 ounces	3 teaspoons = 1 tablespoon
3 feet = 1 yard		16 fluid ounces = 1 pint
5280 feet = 1 mile	2.2 pounds = 1 kilogram (kg)	2 pints = 1 quart

3) **Drug Labels**
Every drug label has at least one equivalency displayed.

Xanax XR
alprazolam
extended-release tablets

2 mg

60 tablets   Rx only

1 tablet = 2 mg (of Xanax XR)

Element 2 – Fractions

Equivalencies used in dimensional analysis computations are <u>always</u> arranged in fractional form.

Such fractions are mathematically equal to 1 because the quantity in the numerator (top) is equal to the quantity in the denominator (bottom).

The equivalency **1 kg = 2.2 lbs** can be written as either $\dfrac{1 \text{ kg}}{2.2 \text{ lbs}}$ or $\dfrac{2.2 \text{ lbs}}{1 \text{ kg}}$.

Both arrangements are equal to 1.

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Element 3 – Multiply by 1

Dimensional analysis relies on the fact that multiplying a quantity by 1 causes no harm.

25 milligrams x 1 = 25 milligrams

Literally using a 1 does not accomplish much!

Instead, we use something that is *worth 1*, namely an *equivalency written as a fraction*.

Element 4 - Cancellation

The objective in a dimensional analysis computation is to get rid of units of measure you ***don't*** *want* and replace them with units of measure that you ***do*** *want*.

This is done using the concept of *cancellation*. When multiplying fractions built from measurements, you can remove (cancel) units of measure that are *on the diagonal* from one another. Lines are drawn through the unit of measure that is removed.

$$\frac{30 \text{ kg}}{1} \times \frac{2.2 \text{ lbs}}{1 \text{ kg}} = \frac{66 \text{ lbs}}{1} = \textbf{66 lbs}$$

Element 5 – The Big Picture

Any dimensional analysis computation can be summarized by:

Original Measurement x Equivalency = New Measurement

Using this statement along with the previous elements gives us the big picture of dimensional analysis:

First – You *must* start with the original measurement.

Second – You will multiply that measurement by an equivalency arranged as a fraction (which is mathematically worth 1). Depending upon the problem, you may need to use *more than one* equivalency.

Third – The equivalency must be arranged so that the units of measure you want to remove are located diagonally from one another. Lines are drawn through the eliminated units of measure to verify their removal.

Fourth – Your new measurement is computed by multiplying all the numerators together. Next, you will multiply the denominators together. Finally, these two results are divided; (numerator ÷ denominator) to achieve your final answer.

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Let's solve Example 1.0.1

This will be a quick overview. The details will be taught starting in Module 1.1.

Convert a patient weight of 68 pounds to kilograms.

68 pounds

How many kilograms?

Scale

The calculation sequence shown below puts all of the dimensional elements to work:

$$\overset{①}{\frac{68 \text{ pounds}}{1}} \times \overset{②}{\frac{1 \text{ kilogram}}{\underset{③}{2.2 \text{ pounds}}}} = \overset{④}{\frac{68 \text{ kilograms}}{2.2}} = \overset{⑤}{\mathbf{30.9 \text{ kg}}} \text{ (kilograms)}$$

Comments:

① We are starting with the original measurement, **68 pounds**.

② We are multiplying the original measurement by the equivalency **1 kg = 2.2 pounds**.

③ Here we are demonstrating, by drawing lines, that *pounds* have been cancelled-out. This happens because *2.2 pounds* is positioned on the diagonal from the original *68 pounds*.

④ This is the *intermediate answer*.
It is the result of multiplying the numerators, then multiplying the denominators.

⑤ Here is the <u>final answer</u>!!
To get this, divide the numerator of the intermediate answer by the denominator.
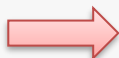In this case; 68 kg ÷ 2.2 = **30.9 kg**

Let's solve Example 1.0.2

Once again, this will be an overview. Problems like this will be taught starting in Module 1.5.

Doctor's orders are, aspirin 500 mg. We have aspirin in 200 mg tablets. How many tablets will be given to the patient?

Prescription		How many tablets?
℞ Aspirin 500 mg PO TID	⟹	**?**

The calculation sequence shown below puts all of the elements reviewed together:

$$\underset{1}{\overset{①}{\frac{500\ mg}{1}}} \times \underset{\underset{③}{200\ mg}}{\overset{②}{1\ tablet}} = \overset{④}{\frac{500\ tablets}{200}} = \overset{⑤}{\mathbf{2.5\ tablets}}$$

Comments:

① We are starting with the doctor's orders, **500 mg** (of aspirin).

② We are multiplying the original measurement by the equivalency **1 tablet = 200 mg**.

③ Here we are demonstrating by drawing lines that *milligrams* (mg) have been cancelled-out. This happens because *200 mg* is positioned on the diagonal from doctor's orders, *500 mg*.

④ This is the *intermediate answer*.
It is the result of multiplying the numerators, then multiplying the denominators.

⑤ Here is the <u>final answer</u>!!
To get this result, divide the numerator of the intermediate answer by the denominator.
In this case; 500 tablets ÷ 200 = **2.5 tablets**

Confidence in Your Work

Taken as a whole, there are several computational safeguards built into the dimensional analysis process. These safeguards are part of the computational process, they aren't something extra that you need to learn. The end result is that you and your patients can have a high degree of confidence in your calculations. In Module 1.14 you will review these safeguards in detail and learn how to avoid commonly-encountered mistakes.

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