Dimensional Analysis

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Dimensional analysis is just a fancy name for a method of calculating that

1. uses numbers in the form of fractions.
2. enables us to convert from one type of unit measurement to another.

It is something that you will encounter heavily in this class and can also be useful in your daily lives outside our class (cooking, work, etc). This worksheet is intended to help you get comfortable with manipulating numbers in terms of their units (i.e. dimensional analysis). In this worksheet you will encounter some definitions or terms that you may or may not have seen before. These are terms that we will be using in the class, so please get to know them. I identify these terms by putting them in **bold green** font.

What is a Unit?

A **unit** is something that gives definition to a numerical value, quantity, or measurement. Let us consider "1 mile". The **unit** involved here is the "mile". Without the **unit**, you would not know what is being referred to. Different measurements often times have multiple possible **units** associated with them. For example:

Measurement	**Some Possible Units**
Length	Meters, centimeters, feet, inches, miles, kilometers
Mass	Kilograms, grams, pounds
Time	Hours, minutes, seconds, days, months
Volume	Cups, teaspoons, liters, milliliters, gallons, quarts
Currency	Dollars, cents, dimes

Turning Numbers (or quantities) into Fractions.

If a quantity does not appear as a fraction, it is possible to put it in a fraction form. Doing this sometimes makes solving **dimensional analysis** problems easier. Remember that numbers and **units** that appear above the fraction line are in the "**numerator**" and numbers and units that appear below the fraction line are in the "**denominator**". Here are some examples.

- **2 eggs**: This quantity is not in the form of a fraction. To put in a fraction form we put the number and **unit** that is given in the **numerator**, and simply put "1" in the **denominator**.

$$2\ \text{eggs} = \frac{2\ \text{eggs}}{1}$$

The numbers on both sides of the equal sign mean the same thing. We have not changed the value or the unit involved.

- **60 seconds/minute**: This quantity does not look like a fraction, but it actually is fraction. This quantity reads "60 seconds **per** minute". The word "**per**" refers to the "fraction line" mentioned above. Again, notice that we have not changed the value or meaning of the quantity.

60 seconds/minute = $\frac{60 \text{ seconds}}{1 \text{ minute}}$ ← "**per**" (the fraction line)

The quantity given tells us there are 60 seconds. This goes in the **numerator**. We are not specifically given the number of minutes. In this case we can assume it is 1. This value then goes in the **denominator**.

Canceling Units

If a **unit** appears in the **numerator** and the same **unit** appears in the **denominator**, it can be **cancelled** or removed. This **unit** can be in the **numerator** and **denominator** of the same fraction or in two different fractions being **multiplied** together.

Sometimes in order to change the quantity we are "**given**", we must "**invert**" the other quantity (or quantities) we intend on using to **convert** from one set of **units** to the other. The quantity (or quantities) that is **given** is the quantity (or quantities) specifically identified in a problem. It is what we start out with and need to **convert** (or change) into what is being asked for. In order to **convert** from one quantity to another, we must use other sets of known quantities called **constants**. Your text will identify **constants** that you may use for problem solving.

What do I mean by "**invert**"? First, it is important to know that the quantities you are **given** are **not** to be **inverted**. Only the **constants** you are using to perform dimensional analysis can be **inverted**. To **invert** a **constant** simply flip it over or around.

Constant		**Inverted**
$\frac{7 \text{ days}}{1 \text{ week}}$	←→	$\frac{1 \text{ week}}{7 \text{ days}}$

Practice Problems

There are 10 practice problems in this worksheet. Each problem involves changing a quantity (the **given** quantity) from one type of **unit** to another in a step by step manner. For all 10 problems, I have indicated how many **constants** (known quantities) you will need to use in order to get to the final answer. Problems one through five indicate the **units** involved in each step. For problems six through ten you will have to determine the **units** involved in each step yourself.

Good luck and don't hesitate to ask questions.

Dimensional Analysis Practice Problems

1) 0.56kg = ? mg

0.56 kg x $\frac{\text{g}}{\text{kg}}$ x $\frac{\text{mg}}{\text{g}}$ = _____ mg

2) 1.2ng = ? g

1.2 ng x $\frac{\text{g}}{\text{ng}}$ = _____ g

3) 2.0 in = ? mm (1in = 2.54 cm)

2.0 in x $\frac{\text{cm}}{\text{in}}$ x $\frac{\text{m}}{\text{cm}}$ x $\frac{\text{mm}}{\text{m}}$ = _____ mm

4) 500ft = ? m

500 ft x $\frac{\text{in}}{\text{ft}}$ x $\frac{\text{cm}}{\text{in}}$ x $\frac{\text{m}}{\text{cm}}$ = _____ m

5) 10µL = ? cc (1mL = 1cm^3 = 1 cc)

10µL x $\frac{\text{L}}{\mu\text{L}}$ x $\frac{\text{mL}}{\text{L}}$ x $\frac{\text{cc}}{\text{mL}}$ = _____ cc

6) 3 wk = ? min

3 wk x _____ x _____ x _____ = _____ min

7) 50mL = ? cups (1L = 4.226cups)

50mL x _____ x _____ = _____ cups

8) 5.33km = ? dm

5.33 km x _____ x _____ = _____ dm

9) 123.0 ng = ? Mg

123.0ng x _____ x _____ = _____ Mg

10) 3yds = ? in (1 yd = 3ft)

3 yds x _____ x _____ = _____ in