Peter Piper picked a peck of pickled peppers. A peck of pickled peppers Peter Piper picked. How many cups is that?

Technical Math for Allied Health
Class notes
Measurement: Household, Metric, and Apothecary Systems (Module 5)

There are three main systems of measurement we use in health care. They are the **Household** (or **English** or **Imperial**), **Metric**, and **Apothecary** systems. We will work with **length**, **volume**, and **weight** in Household and Metric units. We will cover volume and weight in Apothecary units.

A Cautionary Tale:
On December 11, 1998, NASA launched a $125 million robotic space probe called the Mars Climate Orbiter. On its approach to Mars in September 1999, the space probe dramatically crashed through the atmosphere of Mars and was crippled. Why? Many companies were supplying various systems for the probe. It turns out that Jet Propulsion Laboratory (JPL) was using metric units (millimeters and meters) while a subcontractor, Lockheed Martin Astronautics, was using English units (inches, feet, and pounds). Oops. Units matter.

The Household (or English or Imperial) Units of Measure:
The U.S. uses this system and it's what you're probably most familiar with. We'll start with the basics. Most of this table should be familiar and most are Flash Card facts.

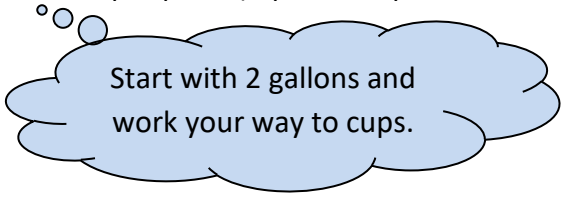
	Unit (Abbreviation)	**Common Equivalent**
Length		
	1 foot (ft)	12 inches (in)
	1 yard (yd)	3 feet
	1 mile (mi)	5,280 feet
Volume		
	1 teaspoon (t)	1/6 of a fluid ounce
	1 tablespoon (T)	3 teaspoons
	1 cup (c)	8 fluid ounces
	1 pint (pt)	2 cups or 16 fluid oz
	1 quart (qt)	2 pints or 32 fluid oz
	1 gallon (gal)	4 quarts or 128 fl oz
	1 fluid ounce (fl oz)	2 tablespoons
	1 fluidram (fl dr)	1/8 of a fluid ounce
	1 minim (min.)	1/60 of a fluidram
Weight		
	1 pound (lb)	16 ounces
	1 measuring cup	8 ounces

Recall that fluid ounces measure volume while ounces measure weight.

OK, this one is suspect. It's in the 114 book but I could *not* verify this.

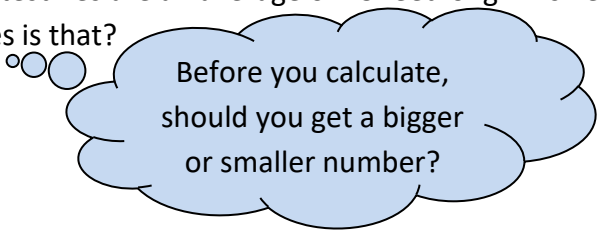
We will practice converting between measures. We have played around with these problems before. Our old friend, unit (or dimensional) analysis, comes to our aid.

expl 1: Seriously, how many cups of pickled peppers did Peter Piper pick? (A peck is equal to 2 gallons.)

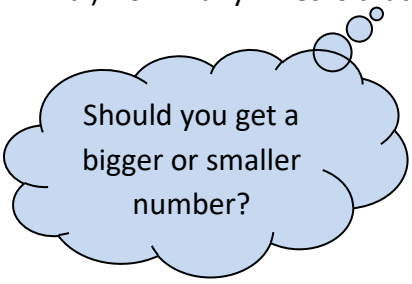


expl 2: An adult's intestines are an average of 23 feet long. Answer the following questions.

a.) How many inches is that?



b.) How many miles is that? Round to the nearest thousandth.



c.) How many yards is that? Use a mixed number.

d.) How many pounds is that? Wait, that doesn't make sense! Why not?

Unit factors:

Unit factors are those fractions we have been using to convert from one unit to another. The cool thing about them (you may have noticed) is that they are always equal to 1. By this, I mean that their top and bottom are always equal. Look for that below.

$$\frac{1\ foot}{12\ inches} \quad \frac{1\,cup}{8\ fl\ oz} \quad \frac{1\,mile}{5{,}280\ ft} \quad \frac{16\,oz}{1\ pound} \quad \frac{2\ pt}{1\,qt} \quad \frac{2\,T}{1\ fl\ oz}$$

From fraction math, we can always multiply by a fraction equal to 1 and *not* change the value.

An awful lot of these conversions will use multiple unit factors. The metric system has its own way of using this method.

The Metric Units of Measure:

Metric units are ubiquitous and so we must know our way around them. There is a beautiful logic to them as we will see. We will define them and learn to convert among various metric units. If you travel 1500 kilometers, how far is that?

Only three countries in the world do *not* use metric units as their standard – U.S., Liberia, and Myanmar.

Here is a table for the main metric units with which we will work.

Quantity Measured	**Unit (abbreviation)**	**Rough equivalent to U.S. Standard**	**Appropriate Things to Measure**
length (distance)	meter (m)	1 m is about 1 yard	your height, room width
weight	kilogram (kg)	1 kg is about 2.2046 lbs	patient's weight
liquid capacity (or volume)	liter (L)	1 L is about ¼ of a gallon (or 0.264172 gallon)	liquid consumed
temperature	Celsius (°C)	0°C = 32°F and 100°C = 212°F	room or body temperature

A *kilo*meter is 1000 meters. We will see the decimal system plays a large role in conversions.

Water freezes at 0°C and boils at 100°C .

When to Use What?

So, meter measures length but we use kilometers to measure *really large* lengths, like the length of a road. Likewise, kilograms measure weight but what if we have a small object, like your pencil, to weigh?

One of the nicest things about the metric system is its dependence on the decimal system. It is *not* a coincidence that 1 kilometer is 1000 meters, and not say, 1257 meters. We'll look into that more.

For metric units like meters, liters, or grams, we will attach prefixes to make the other units like centimeters, milliliters, or kilograms. Here, we see a picture of how these prefixes are organized.

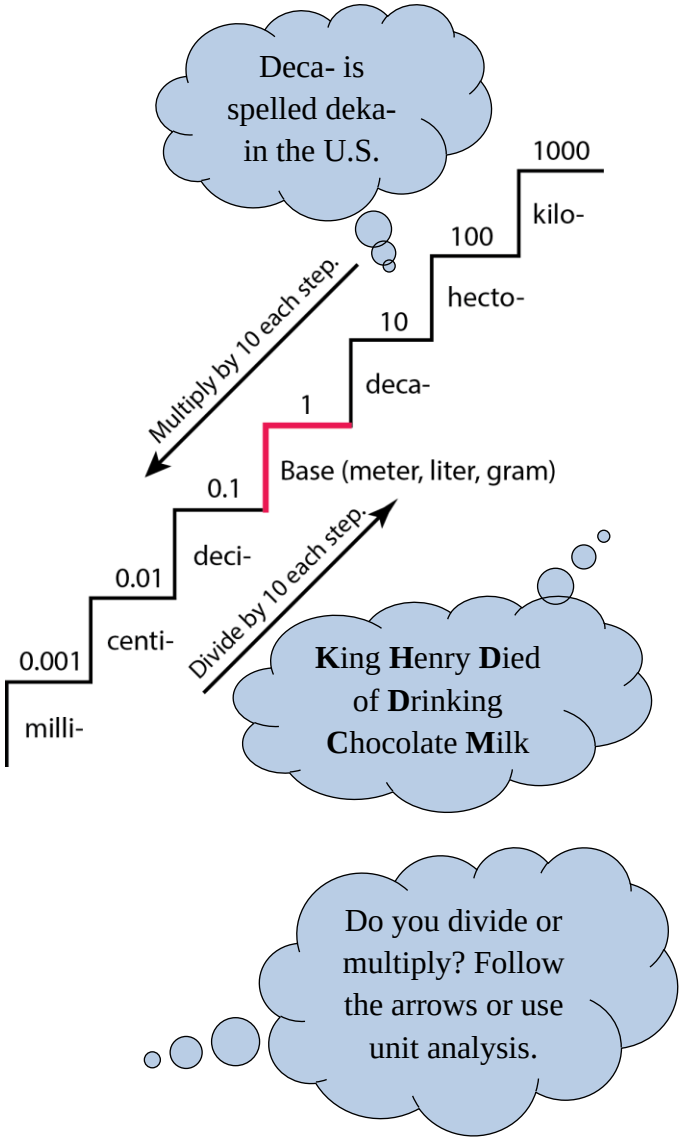
Metric Staircase for Conversions:

We see the bases in the middle of this staircase. We would choose whichever base makes sense for what we are measuring.

If you go up the stairs, you get bigger units.
A decameter is equal to 10 meters.
A hectometer is equal to 100 meters.
A kilometer is equal to 1000 meters.

If you go down the stairs, you get smaller units.
A deciliter is 0.1 (or 1/10) of a liter.
A centiliter is 0.01 (or 1/100) of a liter.
A milliliter is 0.001 (or 1/1000) of a liter.

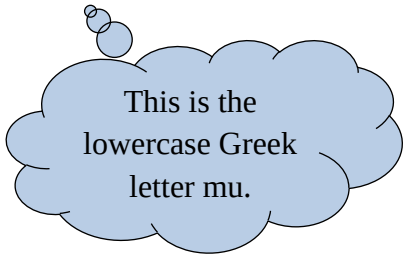
From left to right, we use the abbreviations m, c, d (mLg) da, h, and k. Always use the proper case (lower versus upper).



expl 3: Convert 6,500 meters to kilometers.

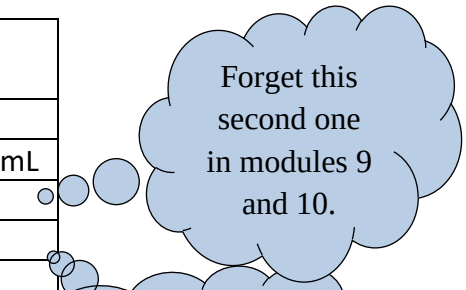
expl 4: Convert 0.035 kg to g.

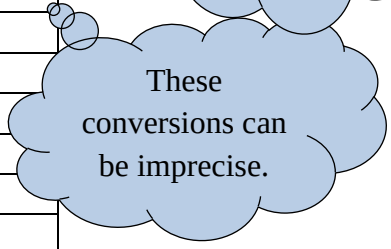
expl 5: Margaret is dosing her patient with a medicine that only comes in 500 µg tablets. If the patient needs 2.5 mg per dose, how many tablets is that?
(A Flash Card fact tells us that 1000 µg equals 1 mg.)



Ye Olde Apothecary Units of Measure:
These measures may be found on medicine that have been on the market for a long time like aspirin. There is *no* apothecary measure for length. (Probably because we *no* longer measure the king's foot to determine that length.)

	Apothecary Unit (Abbreviation)	Approximate Equivalents
Volume		
	1 drop (gtt)	0.067 mL but often given as 0.05 mL
	15 drops (gtt)	1 mL
	15 minims (min.)*	1 mL
	1 fluidram (fl dr)	60 minims or 1/8 of a fluid ounce
	8 fluidrams (fl dr)	1 fluid ounce
Weight		
	1 scruple (s)	20 grains (gr)
	3 scruples (s)	1 dram (dr)
	60 grains (gr)	1 dram (dr)
	1 grain (gr)	60 mg
	15 grains	1 g or ¼ teaspoon**
	8 drams	1 ounce
	480 grains	1 ounce



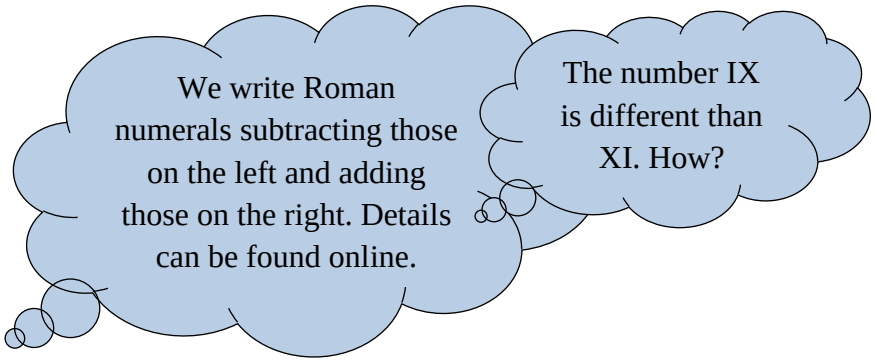


*As this abbreviation can be mistaken for minutes and the other abbreviation (m, *not* given here) has another meaning too, we will take to writing out minims when they are used.
**Teaspoons measure volume but grains and grams measure weight. However, this is taken as a standard conversion for a light powder or water. If the density of what you are measuring is far off those, then this will mislead you. For instance, do *not* use this to measure out your gold dust (or salt or flour).

Standard for Writing Apothecary Units:
We will use the standard that we write the apothecary unit first, followed by the value. For instance, to write 15 grains, we will actually write “gr 15”. This will help prevent misreadings.

You may also see Roman numerals used as that apparently stops tampering. Are you a good Roman lad or lass who knows the following?

Roman	Equivalent
I	1
V	5
X	10
L	50
C	100
D	500
M	1,000



expl 6: Griselda needs 0.3 g of wrinkled wormroot. (Best ye keep outta heer busnezz as to why if you like yer wart-free complexion.) How many grains would thar be?

expl 7: The Wizard of Worsley has been prescribed 52 fluidrams of a tonic most foul. How many fluid ounces dost he musteth consumeth (at the fair light of the first gibbous moon in Weodmōnath (August))?