MATH 191 FUNDAMENTALS OF MATHEMATICS II
SECTION 11.1: FUNDAMENTALS OF MEASUREMENT
JANUARY 31, 2014

Measurement

When measuring things, we have to *choose* an attribute to look at. Examples include:

height of a tree
circumference of the trunk of a tree
Volume of the tree
area of entire footprint (including branches) of a tree

Measuring means comparing to a fixed reference amount, called a unit of measurement. The principle of *additivity* says that, for example, something weighing 2 pounds weighs the same as two one-pound objects put together.

Systems of Measurement

Historically, units of measurement were defined by things like

1 inch = width of an average man's thumb or 3 barleycorns
1 foot = length of a shoe/foot.

Now we define units of measurement using

absolute constants and international standards.

Around the time of the French Revolution, during the Age of Enlightenment, there was a movement to standardize the units of measurement, leading to the *metric system.* The metric system is based on our base 10 system and has a uniform way of naming units using prefixes.

nano-	billionth	10^{-9}	deka-	ten	10^{1}
micro-	millionth	10^{-6}	hecto-	hundred	10^{2}
milli-	thousandth	10^{-3}	kilo-	thousand	10^{3}
centi-	hundredth	10^{-2}	mega-	million	10^{6}
deci-	tenth	10^{-1}	giga-	billion	10^{9}

Ex: A centimeter is $\frac{1}{100}$ of a meter
A kilogram is 1000 grams.

	US (Imperial) System	Metric System
Units of Length	inch foot = 12 in. yard = 3 ft mile = 1760 yd = 5280 ft	millimeter (mm) centimeter (cm) meter (m) kilometer (km)
Units of Area	square inch square foot square yard square mile acre (= 3,560 ft^2)	square milimeter square centimeter square meter square kilometer
Units of Volume	cubic inch cubic foot cubic yard ~~teaspoon~~ tablespoon = 3 tsp fluid ounce = 2 Tbs cup = 8 fl. oz. pint = 2 c quart = 2 pt gallon = 4 qt	cubic milimeter cubic centimeter cubic meter cubic kilometer milliliter liter
Units of Weight	ounce pound = 16 oz ton = 2000 lb	milligram gram kilogram
Units of Temperature	°F	°C

1 inch = 2.54 cm
1 gal ≈ 3.79 L
1 kg ≈ 2.2 lb.

How to Measure Length

We can measure length by lining up objects of the same length (for example, 1 inch paperclips) and counting how many it takes to get to the desired length. Challenges include:

- lining objects up in a straight line with no overlaps or gaps
- choosing objects of the same size

We often measure length with a ruler. Challenges for children include:

- why to line up the end of the object being measured with "0" or unlabeled line and not "1"

What Measurements Mean and Common Misconceptions

What does it mean for a rug to have area 80 square feet?

It takes 80 1ft by 1ft squares to cover the rug with no overlaps or gaps.

What does it mean to have 100 grams of sugar?

The sugar you have weighs the same amount as 100 one-gram weights.

Which of the following have the same meaning/volume? Which are different?

- 2 cubic inches
- A cube with all sides of length 2 inches
- 2 $in.^3$
- 2 in. $\times$ 2 in. $\times$ 2 in.

2 cubic inches = $2 in^3$.

A cube with all sides 2 inches has the same volume as a 2in x 2in x 2 in cube ($8 in^3$).

Why might we choose to say "2 cubic inches" instead of "2 inches cubed" for 2 $in.^3$?

"2 inches cubed" might sound like 2in x 2in x 2in. It is ambiguous.

What is wrong with saying that area is length times width?

This is only true of rectangles and doesn't take into account the units.