Why do I need to know how to convert units, which units to report, and to what level of accuracy?

Any measurement answer without the units defined is meaningless.

You can use different units to describe the same length; for example, 1 foot translates to 12 inches, which translates to 30.48 centimeters. The key point is that they all refer to the same thing.

Sometimes you'll see mixed measures in a problem (ex. Both meters and centimeters). A conversion will need to be done in order to work in only one measure.

Precision and Accuracy relate to how exact your measurements need to be.

Get a feel for units and how you can relate to them in the next slides.

Mars Probe Lost Due to Simple Math Error

October 01, 1999 | ROBERT LEE HOTZ | TIMES SCIENCE WRITER

NASA lost its $125-million Mars Climate Orbiter because spacecraft engineers failed to convert from English to metric measurements when exchanging vital data before the craft was launched, space agency officials said Thursday.

A navigation team at the Jet Propulsion Laboratory used the metric system of millimeters and meters in its calculations, while Lockheed Martin Astronautics in Denver, which designed and built the spacecraft, provided crucial acceleration data in the English system of inches, feet and pounds.

As a result, JPL engineers mistook acceleration readings measured in English units of pound-seconds for a metric measure of force called newton-seconds.

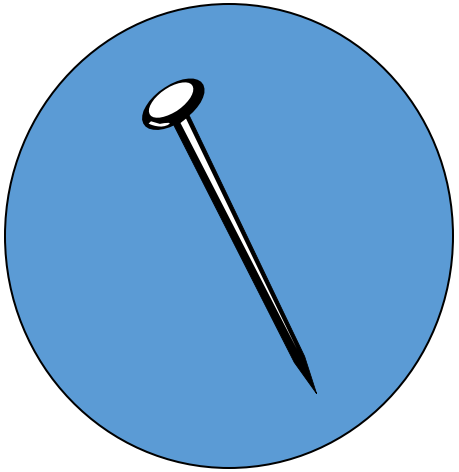
In a sense, the spacecraft was lost in translation.

"**That is so dumb**," said John Logsdon, director of George Washington University's space policy institute.

The apology, "**My Bad**," was not accepted. (added)

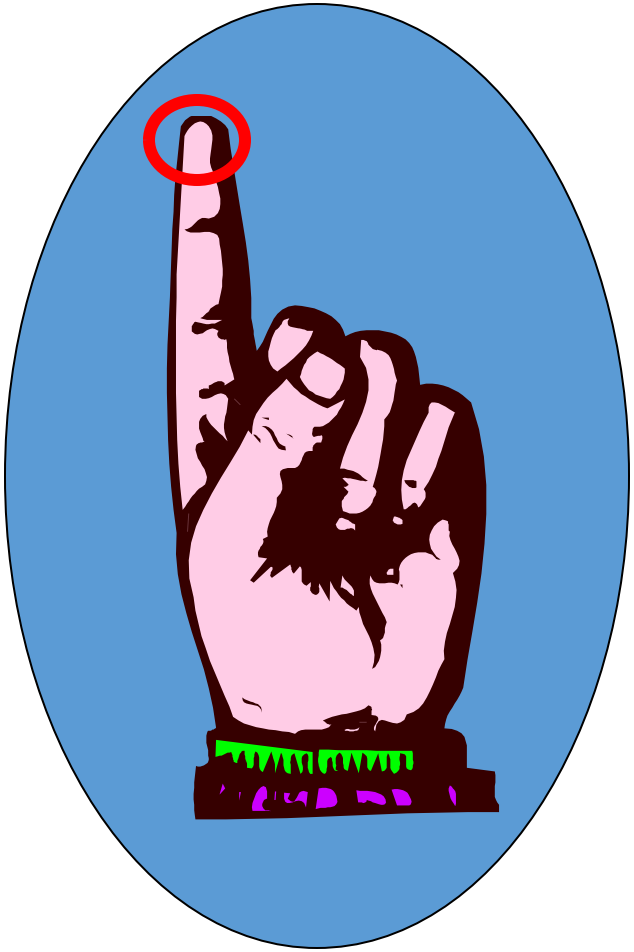
How large is a millimeter?

The width of a pin



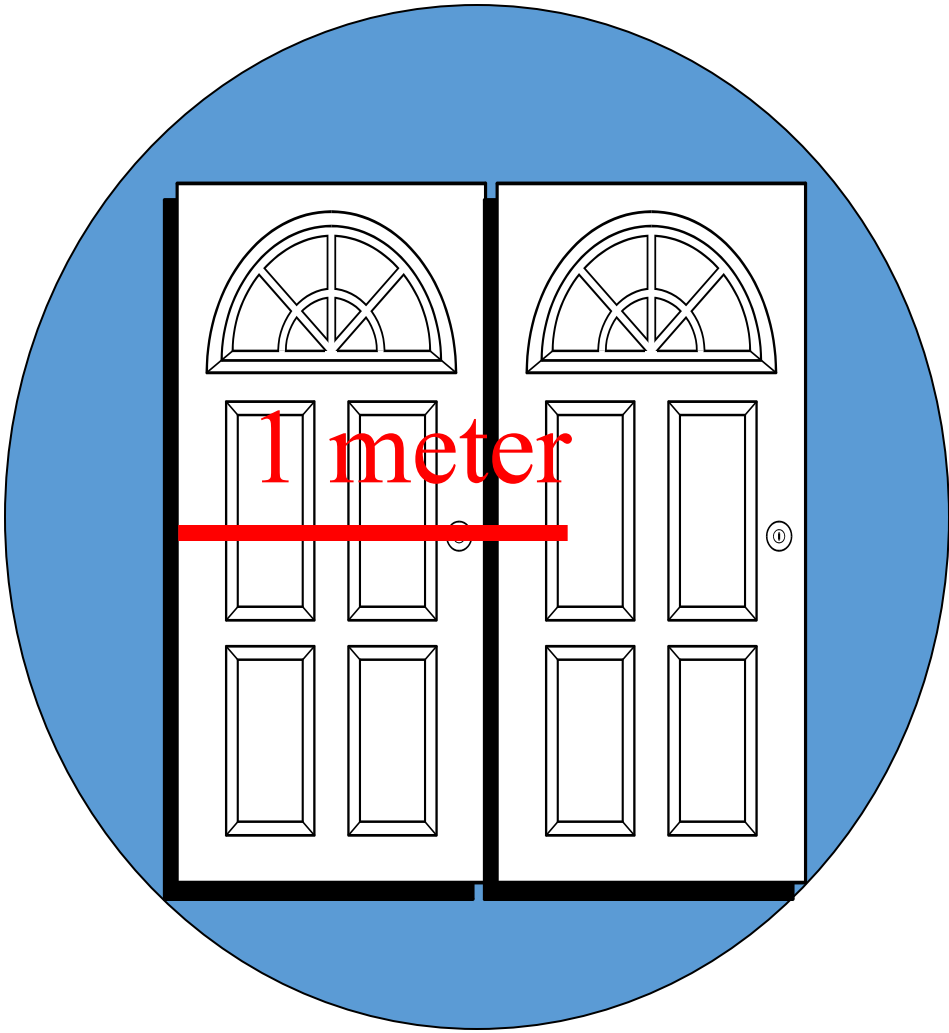
How long is a centimeter?

The width of the top of your finger



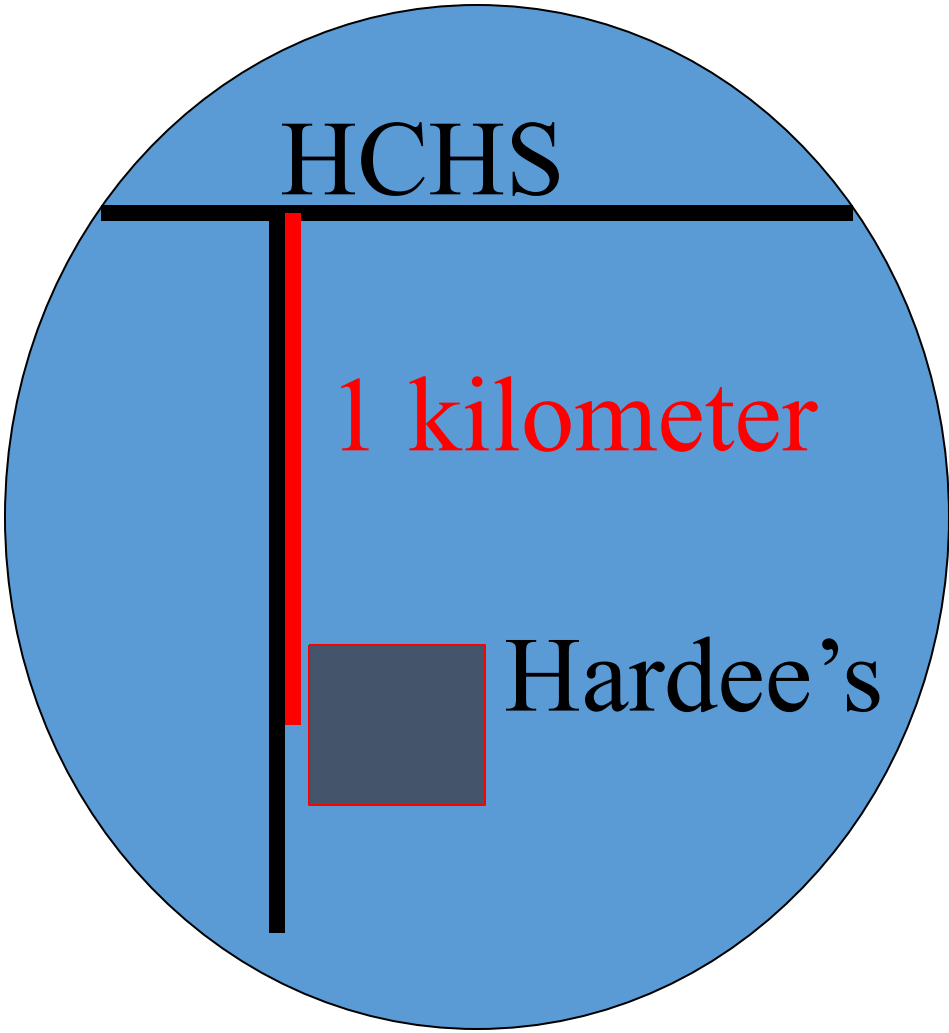
How long is a meter?

About the width of one & 1/4 doors



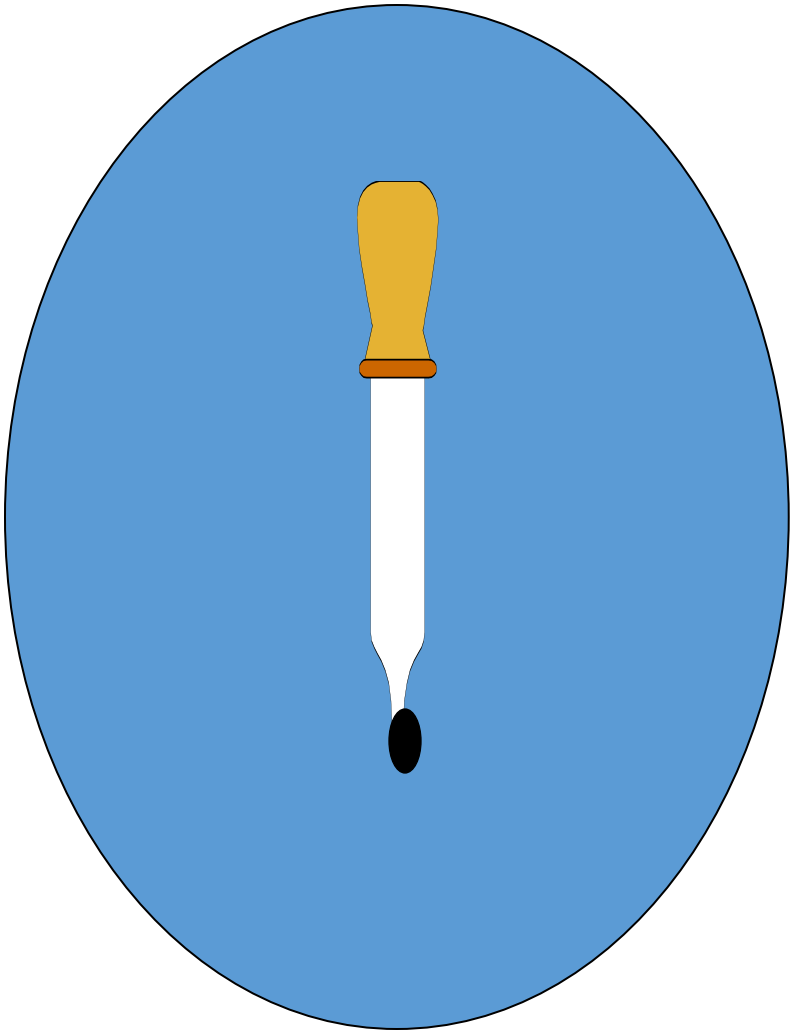
How long is a kilometer?

A little over 1/2 of a mile



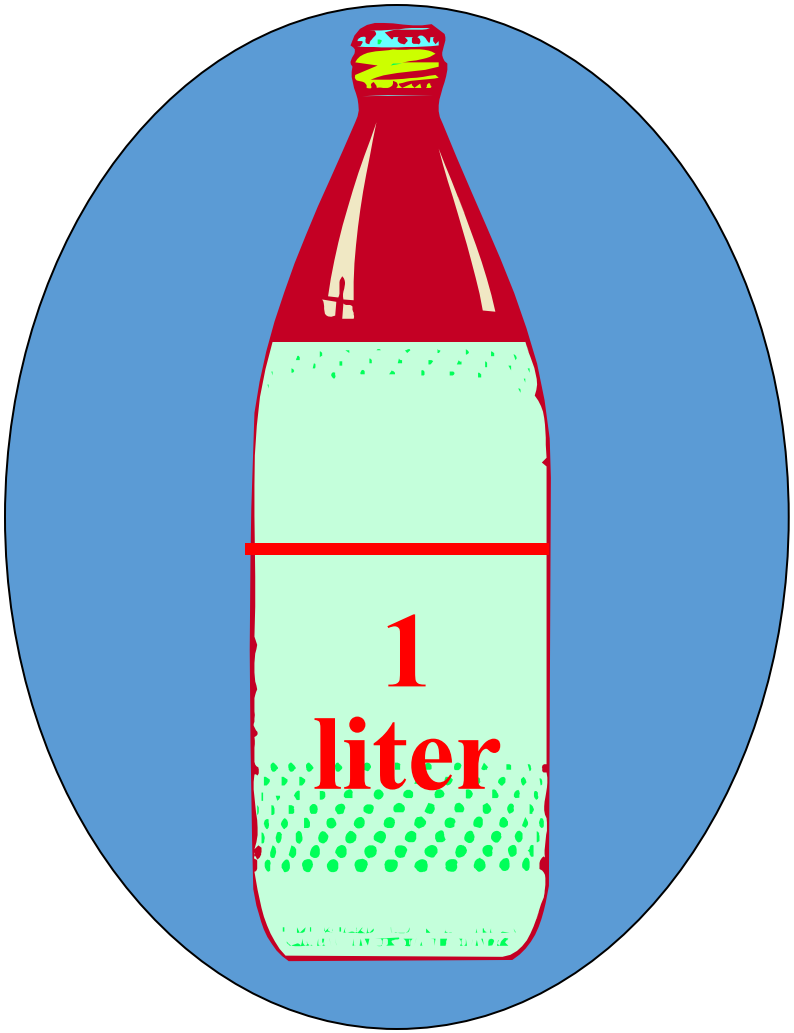
How large is a milliliter?

About a drop of liquid



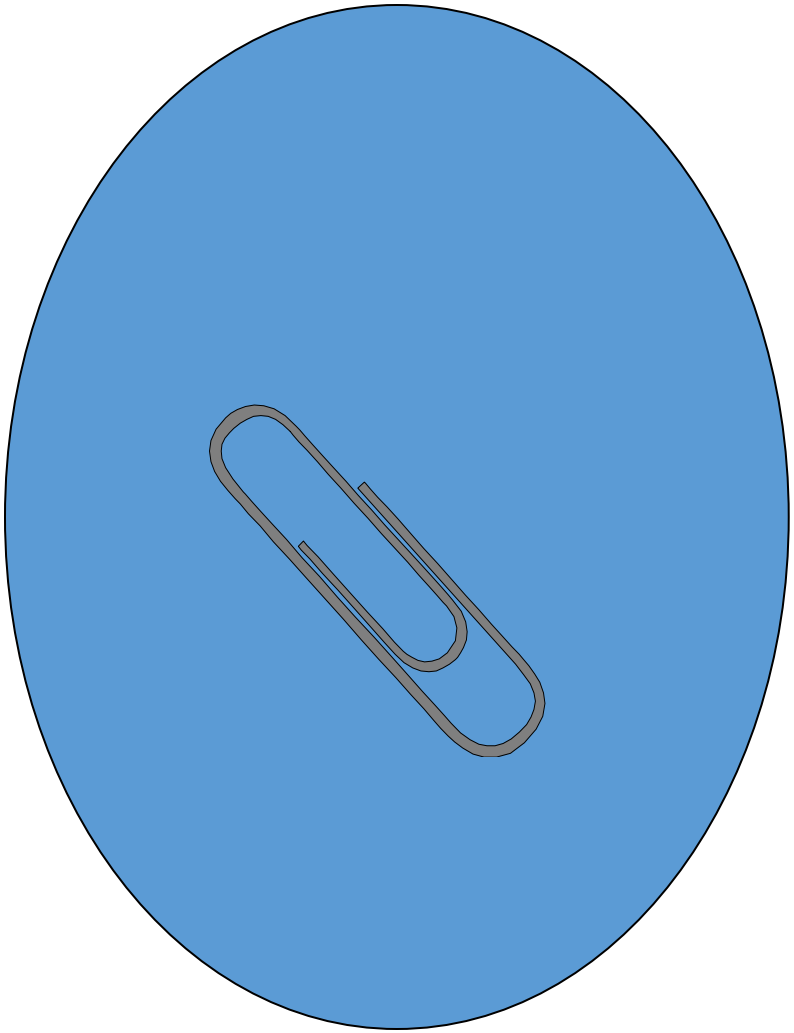
How large is a liter?

Half of a large pop bottle



How heavy is a gram?

A paper clip weighs about 1 gram

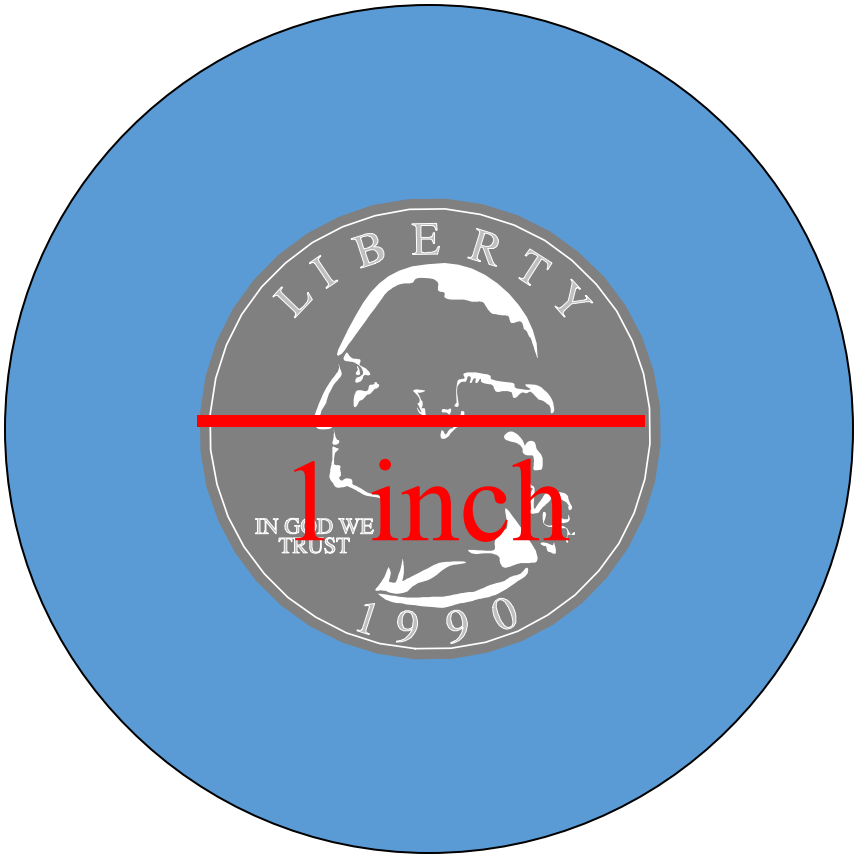


How heavy is a kilogram?

A kitten weighs about 1 kilogram

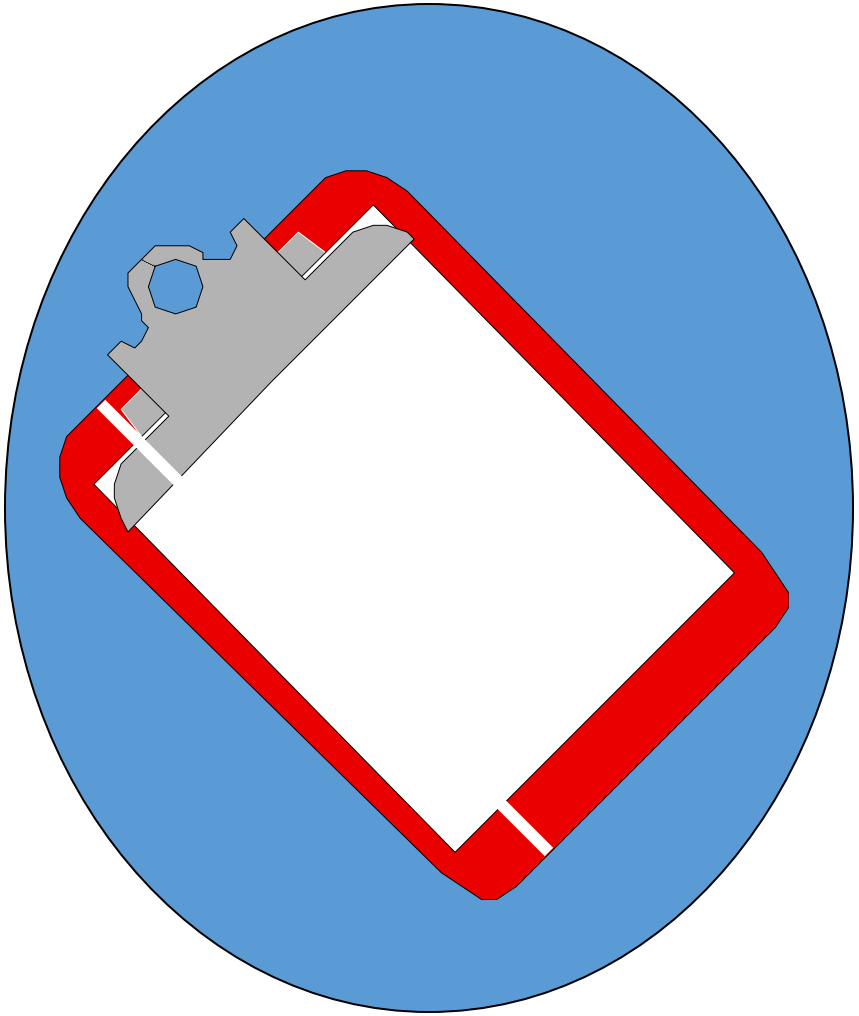
How long is an inch?

A quarter is about an inch wide



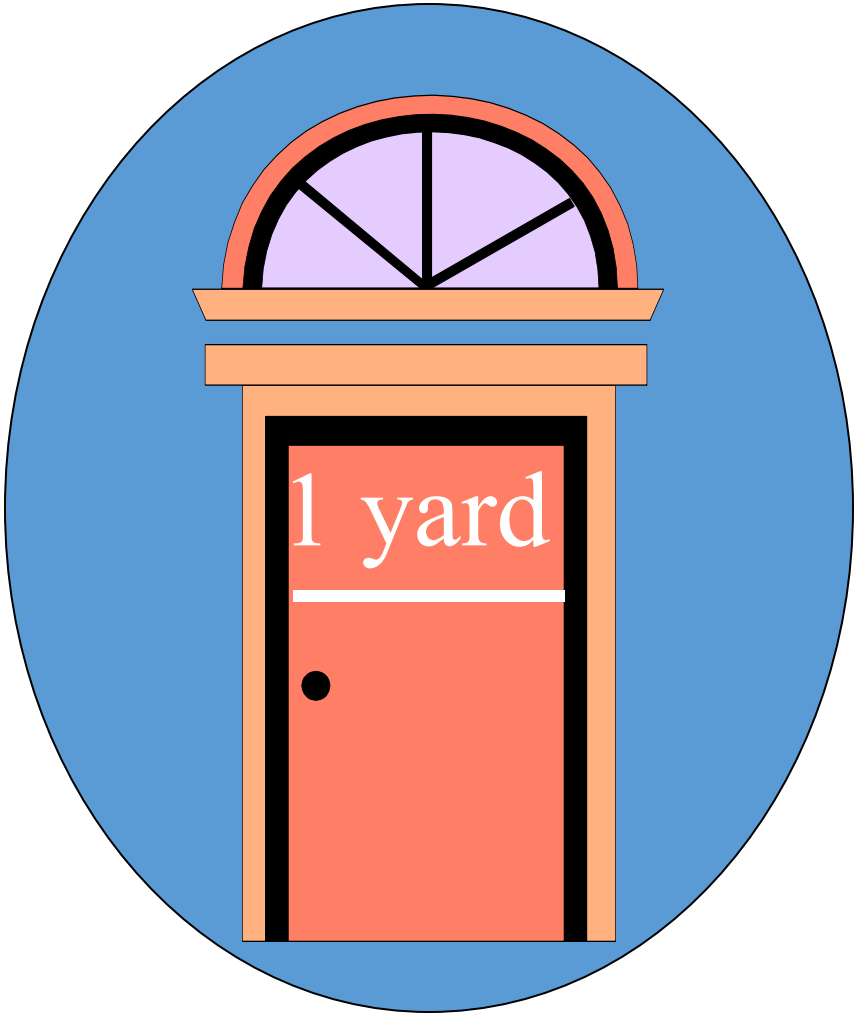
How long is a foot?

About the length of a clipboard



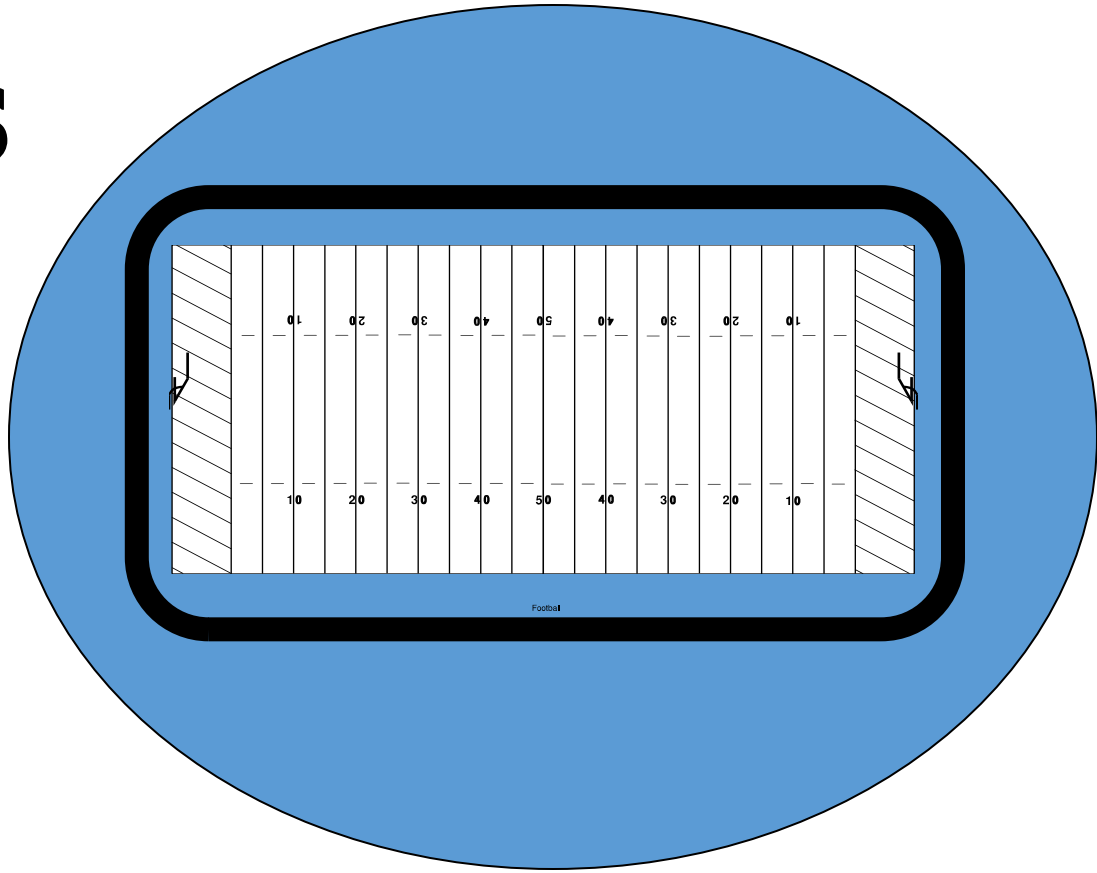
How long is a yard?

About the width of a door



How long is a mile?

Four times around a track



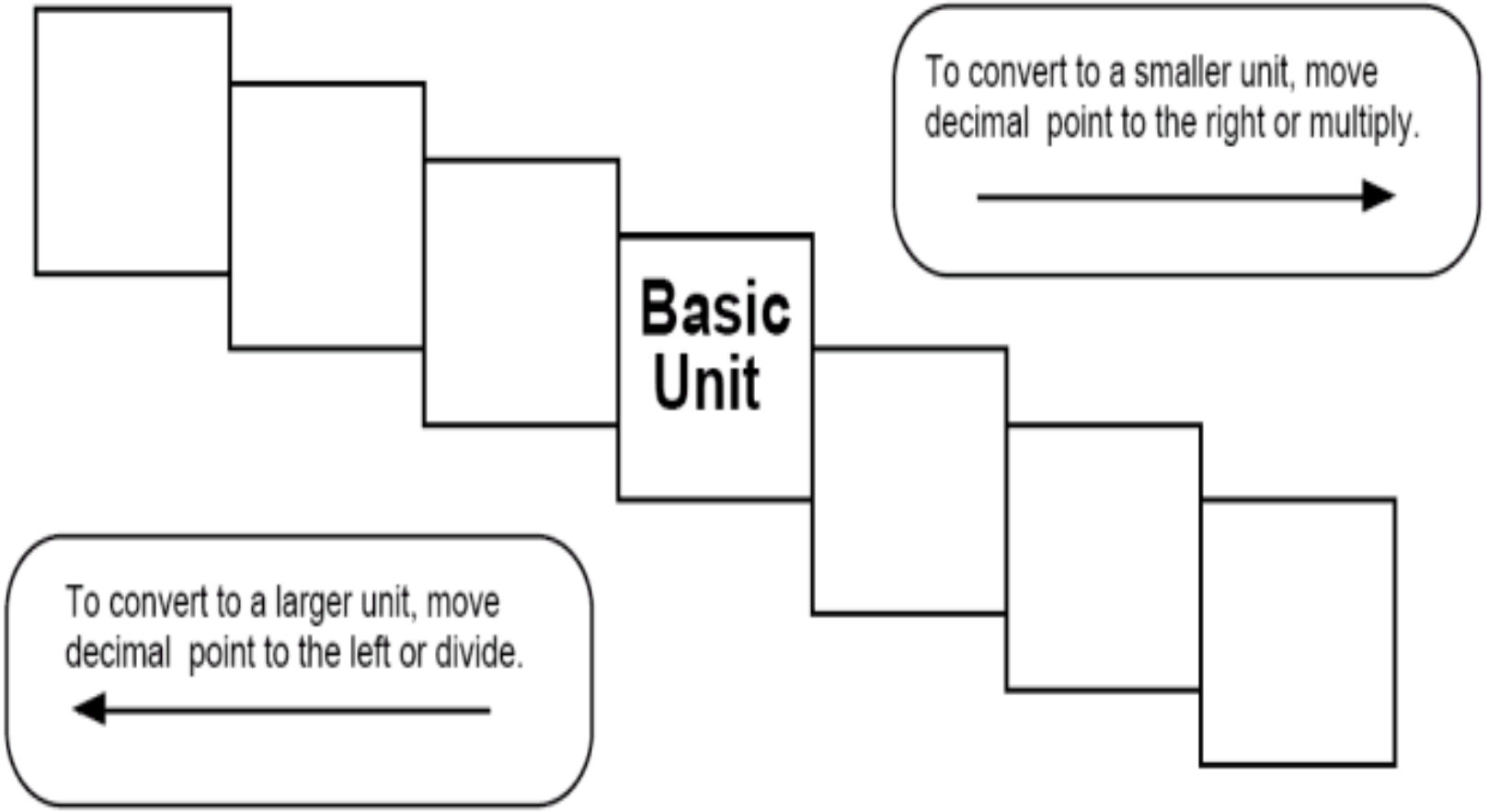
Metric Conversions

- The Metric System of measurement is based on multiples of TEN. Conversions are performed by moving the decimal point.

- The 3 base units are: **meters**, **liters**, and **grams**.

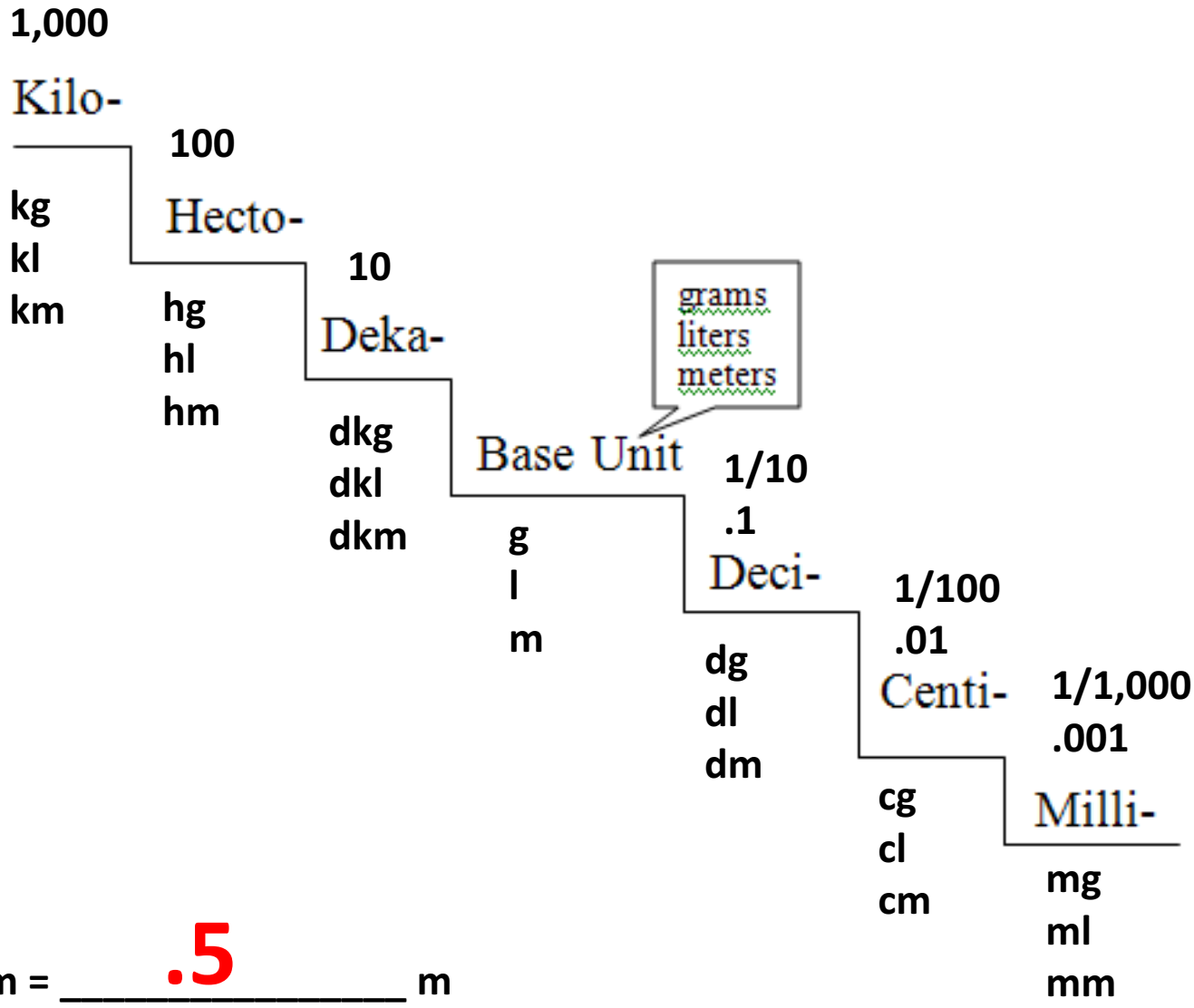
- The 6 prefixes are:
- kilo (1000)
- hecto (100)
- deka (10)
- deci (.1)
- centi (.01)
- milli (.001)

Stair Rule



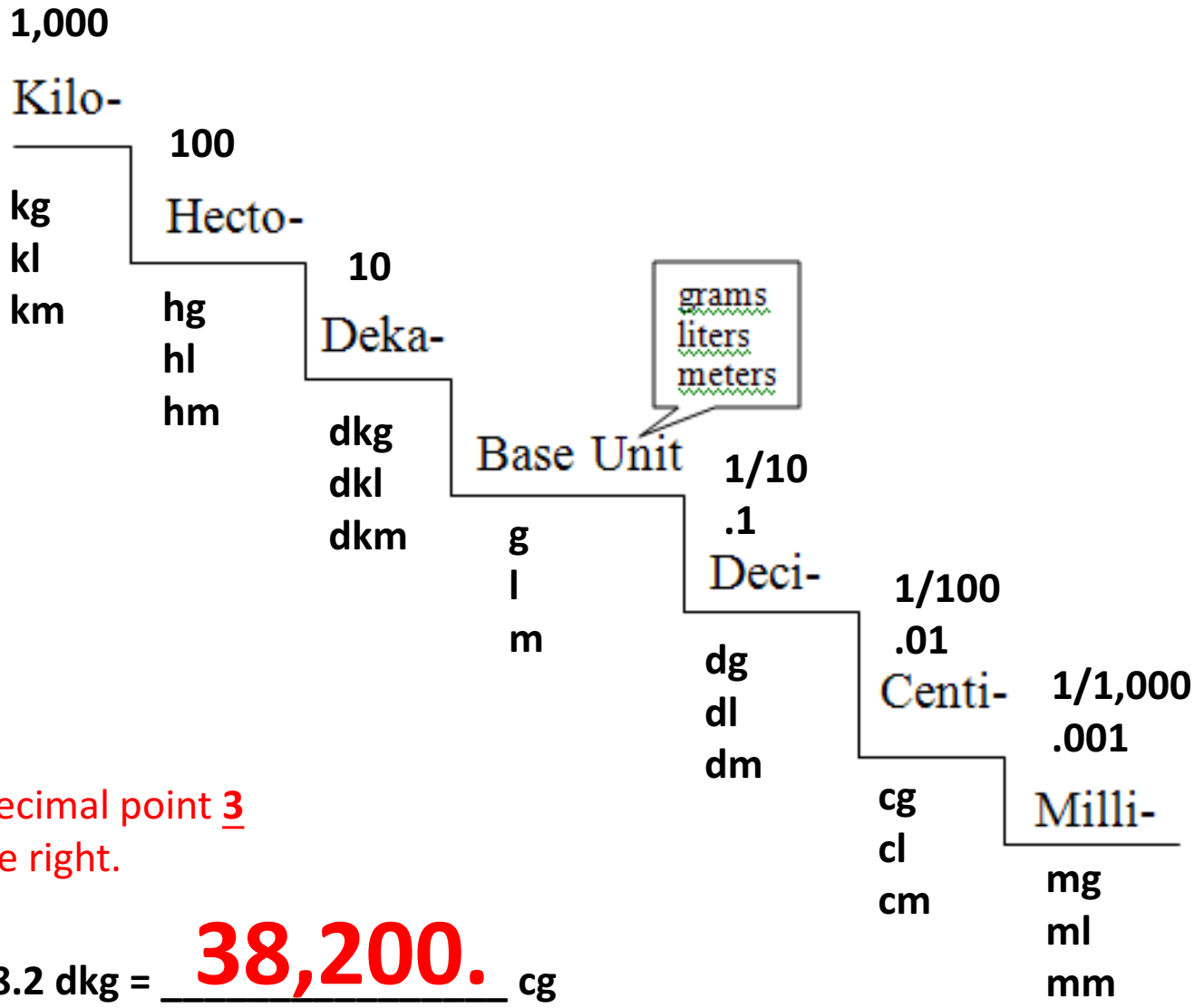
To use the Stair-Step method, you will move the DECIMAL POINT the direction you have to move on the stairs.

Stair Rule Examples



Ex 1 5 dm = _____ .5 _____ m

Stair Rule Examples

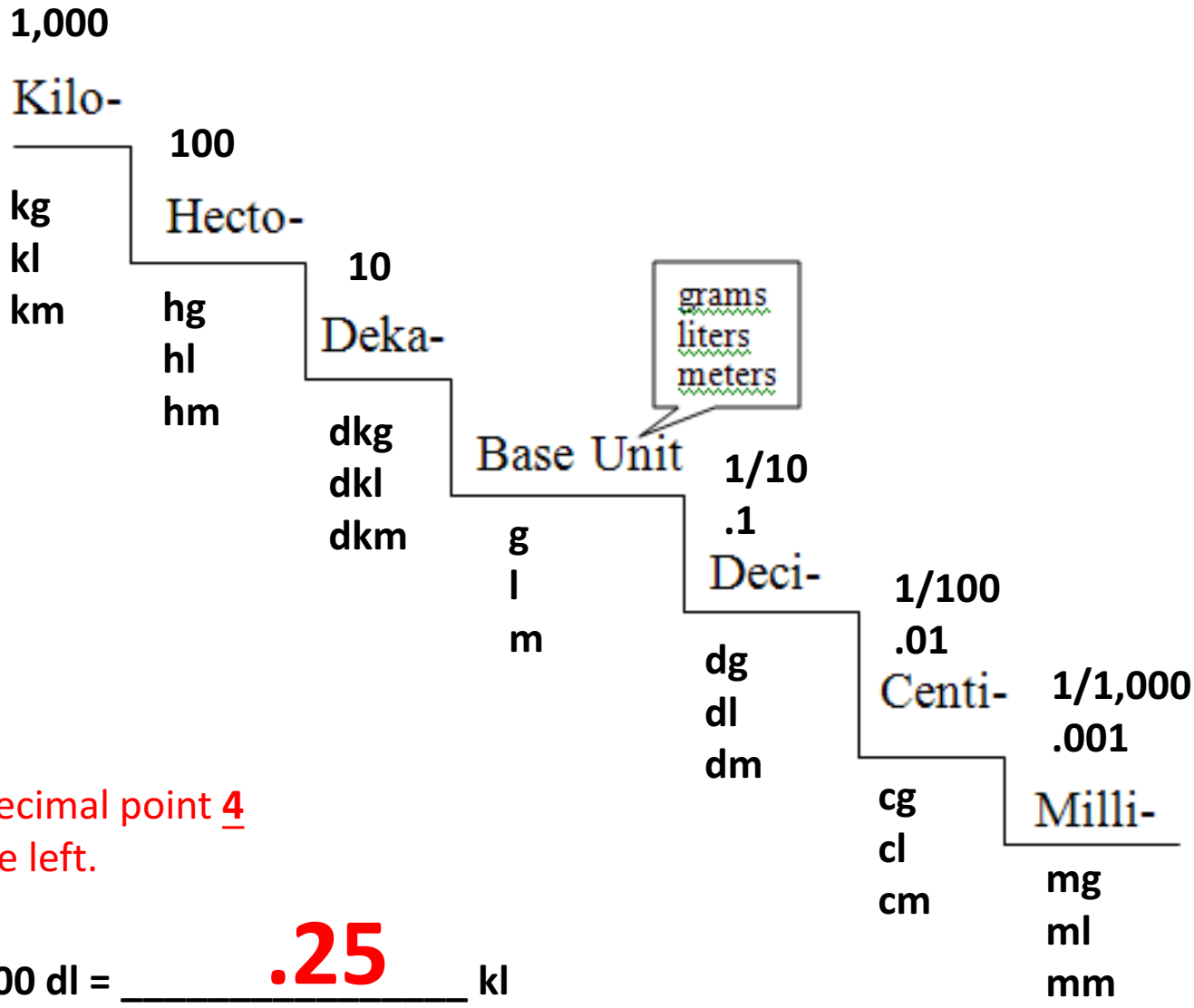


Move the decimal point **3** places to the right.

Ex 2 **38.2 dkg = _____ cg**

38,200.

Stair Rule Examples



Move the decimal point 4 places to the left.

Ex 3 2500 dl = **.25** kl

What the Units Represent

Units of	Metric	Standard (USA)
Length/Distance	meters	inches, feet, yards, miles
Weight	grams	dry ounces, pounds
Fluid Capacity, Volume	liters	fluid ounces, cups, pints, quarts, gallons

A way to move from one measure to the next by a system using canceling in steps.

Dimensional Analysis

What is the reciprocal of $\frac{3}{4}$? **1**

What is $\frac{2}{3} \cdot \frac{3}{2}$? **1**

What is $\frac{a}{4} \cdot \frac{4}{a}$? **1**

What is $\frac{x}{y} \cdot \frac{y}{x}$?

1

Our goal with **Dimensional Analysis** is to make units cancel out to……

1

Steps

1. **Given quantity w/its unit**

2. **Set up conversion factor**

3. **Divide Units – only the desired unit should be left**

4. **Multiply across the top (numerator), then multiply across the bottom (denominator)**

5. **Divide again if necessary**

Conversion Factor is the path you follow from the given units to the desired units.
Ex. Miles – Feet – Inches
Ounces – Pounds
oz. – cups – pints – qts – gal
sec – min – hr – day – wk – mo – yr

You can skip some measures. You know there are 365 days in a year. After doing a few problems, you might see that there are 3600 seconds in an hour. One less factor than going from sec – min – hr. Some basic conversions you will know. Others you need to look up in conversion tables.

Example 1

Let's look a the metric problems a different way.

Convert 35m to km.

$$\frac{35 \text{ meters}}{} \cdot \frac{1 \text{ dekameter}}{10 \text{ meters}} \cdot \frac{1 \text{ hectometer}}{10 \text{ dekameters}} \cdot \frac{1 \text{ kilometer}}{10 \text{ hectometers}} =$$

35/1000 = .035 km

Example 2

An aspirin tablet contains 325 mg of active ingredient. How much is this in cg?

$$\frac{325\ \text{mg}}{1} \mid \frac{1\ \text{cg}}{10\ \text{mg}} \mid = \frac{325}{10}$$

= 32.5cg of active ingredient

Example 3

Bob studied for 2.5 hrs. How many minutes did he study for?

Initial unit

2.5 hr

		Conversion factor		*Final unit*
2.5 hr	x	$\frac{60\ \text{min}}{1\ \text{hr}}$	=	150 min

Example 4

- How many seconds are in 1.4 days?

Unit path: days → hr → min → seconds

$$1.4 \text{ day} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ sec}}{1 \text{ min}}$$

$$= 120{,}960 \text{ sec}$$

Example 5

Set up and solve the following:

75 dg/qt to g/gal?

$$\frac{75\ \text{dg}}{\text{qt}} \times \frac{1\ \text{g}}{10\ \text{dg}} \times \frac{4\ \text{qt}}{1\ \text{gal}} = \frac{300\ \text{g}}{10\ \text{gal}} =$$

= 30g /gal

Example 6

John Isner serves 140 miles per hour. How fast is that feet per second?

$$\frac{140 \text{ miles}}{1 \text{ hr}} \times \frac{5{,}280 \text{ ft.}}{1 \text{ mile}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ sec.}} =$$

$$= 205.3 \text{ ft/sec.}$$

Converting multiple measurements

An example of Multiple measurements are things like distance and time. To go from miles per hour (mph) to feet per second (ft/sec), two conversions are performed. Convert distance first, then convert time.

Example 7

Set up and solve the following:

60 ft/sec to mph?

$$\frac{60\ \text{ft}}{\text{sec}} \times \frac{1\ \text{mi.}}{5280\ \text{ft}} \times \frac{60\ \text{sec}}{1\ \text{min.}} \times \frac{60\ \text{min}}{1\ \text{hr}} = \frac{216{,}000\ \text{mi.}}{5280\ \text{hr.}} =$$

40.91 mph

Look at the same problem again.

$$\frac{60\ \text{ft}}{\text{sec}} \times \frac{1\ \textbf{mi.}}{5280\ \text{ft}} \times \frac{60\ \text{sec}}{1\ \text{min.}} \times \frac{60\ \text{min}}{1\ \textbf{hr}} = \frac{216{,}000\ \text{mi.}}{5280\ \text{hr.}} =$$

Notice feet in the 1st numerator and 2nd denominator. Ft cancels with ft. Miles remains in the 2nd numerator so my distance conversion is complete. Distance goes from feet to miles in one step.

Seconds appears in the first denominator. Seconds need to appear in a numerator (in this case the 3rd) so it will cancel. Converting Seconds to Hours takes two steps because
Seconds → Minutes → Hours

Look at the units that are left. Miles in the 2nd numerator and hours in the 4th denominator. Now multiply across both the numerator and denominator.

40.91 mph

Types of Conversions

Types of Conversions	Action
Metric to Metric (ex. Kilograms to decigrams)	Move the decimal point.
Standard to Standard (ex. Miles to inches	Define the conversion factor Set up a path, Cancel units 1 by 1.
Time (ex. Days to seconds)	Define a path from seconds to minutes to hours to days… The direction can be reversed.
Metric to Standard or reverse (ex. Pounds to grams, centimeters to miles)	Use a comparison table where you can connect the two Measurement systems.
Distance/Time (ex. Miles per hour to feet per second)	Work with one item until its finished. Then do the second.

Conversion Examples

Metric to Metric
545,000cm to km

545,000 cm = **54.5000 km**

Zeroes left to show movement of the decimal point

Standard to Standard
1.7 miles to inches

$$\frac{1.7 \text{ mi.}}{1} \times \frac{5280 \text{ ft}}{1 \text{ mi.}} \times \frac{12 \text{ in}}{1 \text{ ft}} = \textbf{107,712 in.}$$

Time
2.6 days to seconds

$$\frac{2.6 \text{ days}}{1} \times \frac{24 \text{ hrs}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ sec}}{1 \text{ min.}} = \textbf{224,640 sec.}$$

Metric to Standard
14.6 dkl to ounces

$$\frac{14.6 \text{ dkl}}{1} \times \frac{10 \text{ liters}}{1 \text{ dkl}} \times \frac{33.812 \text{ oz}}{1 \text{ liter}} = \textbf{4,936.552 oz.}$$

Distance/Time
48 mph to ft/sec

$$\frac{48 \text{ miles}}{1 \text{ hr}} \times \frac{5280 \text{ ft}}{1 \text{ mi.}} \times \frac{1 \text{ hr}}{60 \text{ min.}} \times \frac{1 \text{ min.}}{60 \text{ sec}} = \frac{253{,}440 \text{ ft}}{3600 \text{ sec}}$$

= 70.4 ft/sec

Numbers are meaningless if the unit labels are missing.