The Metric System

7/8 STEM

Historical Background

- In the early days, each scientist used their own local system of units.

Historical Background

- This created much confusion because anytime scientists wanted to share information with one another they lost a great deal of time figuring out conversions between the different systems.

Thus the **Metric System** was formed.

I. The Metric System

- The metric system is a universal, standardized form of measurement that is used by all scientists around the world.

The official name of the metric system used by scientists is:

Systeme International d'unites

Otherwise known as "SI"

Advantages of the Metric System

1. It allows us to understand each others work and duplicate each others experiments in order to check our results.

2. The metric system is based on number…

10

The Metric System Base Units

- The metric system uses a specific base unit for each type of measurement:

  - **Length = meter, m**
  - **Mass = gram, g**
  - **Time = second, s**
  - **Volume = liter, L**
  - **Temperature = Celsius, C**

The SI Base Units

- The units used by scientists in the SI system are the same, except for Mass and Temperature:

  - **Length = meter, m**
  - **Mass = kilogram ,kg**
  - **Time = second, s**
  - **Volume = liter, L**
  - **Temperature = kelvin, K**

TABLE 1-1 *SI Base Units*

Base quantity	Name	Abbreviation
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

The Prefixes

- The metric system also uses the exact same prefixes for all of the base units.

  - **Kilo – k, 1000**
  - **Hecto – h, 100**
  - **Deca – da, 10**
  - **L/m/g – (Liter, meter, gram), 1**
  - **Deci – d, 0.1**
  - **Centi – c, 0.01**
  - **Milli – m, 0.001**

TABLE 1-2 *Some SI Prefixes*

Prefix	Abbreviation	Factor of base unit
giga	G	1,000,000,000
mega	M	1,000,000
kilo	k	1,000
hecto	h	100
deka	da	10
deci	d	0.1
centi	c	0.01
milli	m	0.001
micro	μ	0.000001
nano	n	0.000000001
pico	p	0.000000000001

An Mnemonic to Help…

- Kilo
- Hecto
- Deca
- Meter/Liter/Gram
- Deci
- Centi
- Milli

- King
- Henry
- Died
- "by" (base unit)
- Drinking
- Chocolate
- Milk

What is a meter?

- Originally defined as "1/10,000,000th of the distance from the Equator to the North Pole measured along the meridian that runs through Dunkirk, France."
- Currently defined as the "distance a beam of light travels in 1/299,792,458 of a second
- A meter is also 39.37 inches.

Thus making the combinations of the prefixes and bases rather simple:

a) Centi + meter = Centimeter

b) Kilo + liter = Kiloliter

c) Deca + gram = Decagram

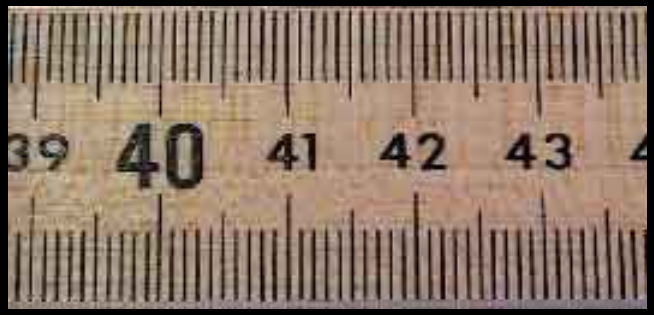
II. Metric Conversions

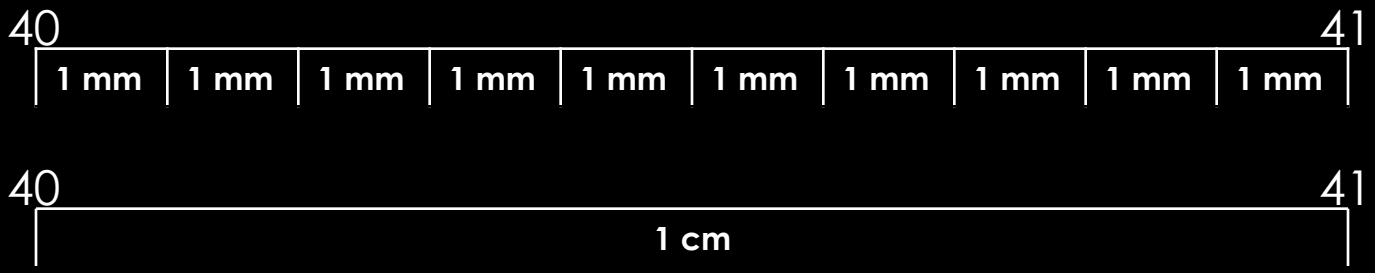
- Since metrics are based the on the power of **10** each "step" is either:

  10 times larger or **10** times smaller

Kilo 1000	Hecto 100	Deca 10	Base Units meter gram Liter	Deci .1	Centi .01	Milli .001

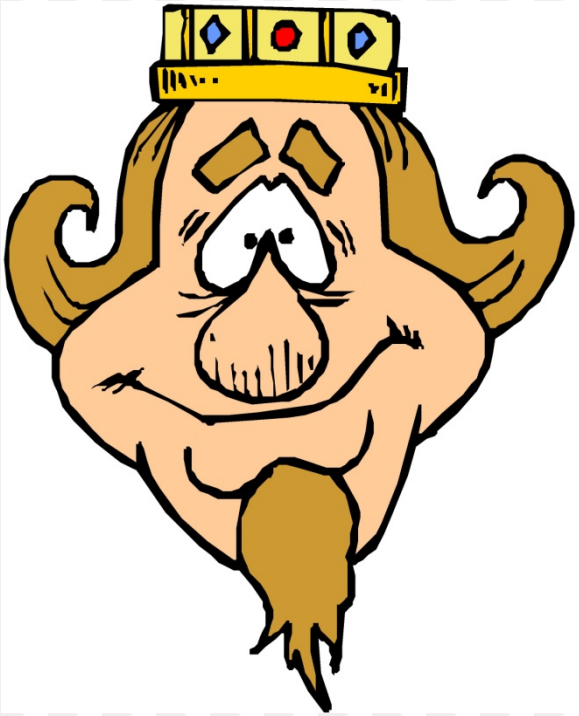
For example, centimeters are larger than millimeters so it takes more millimeters to equal the same length in centimeters.





The mnemonic:

King Henry Died by
Drinking Chocolate Milk

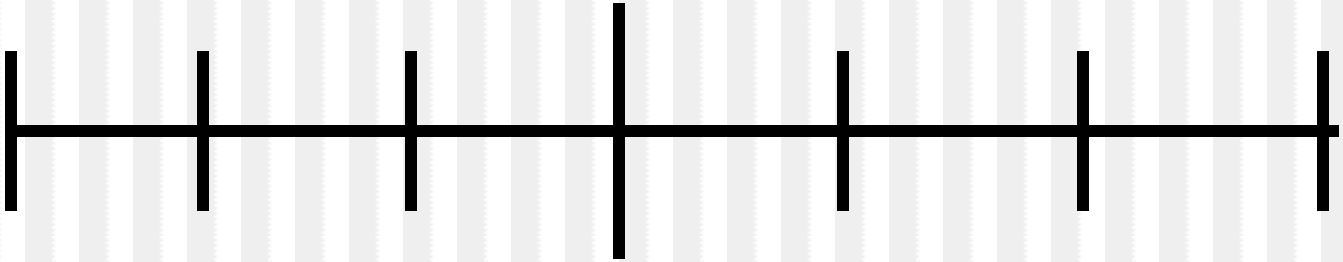


Memorize this!

You must also know…

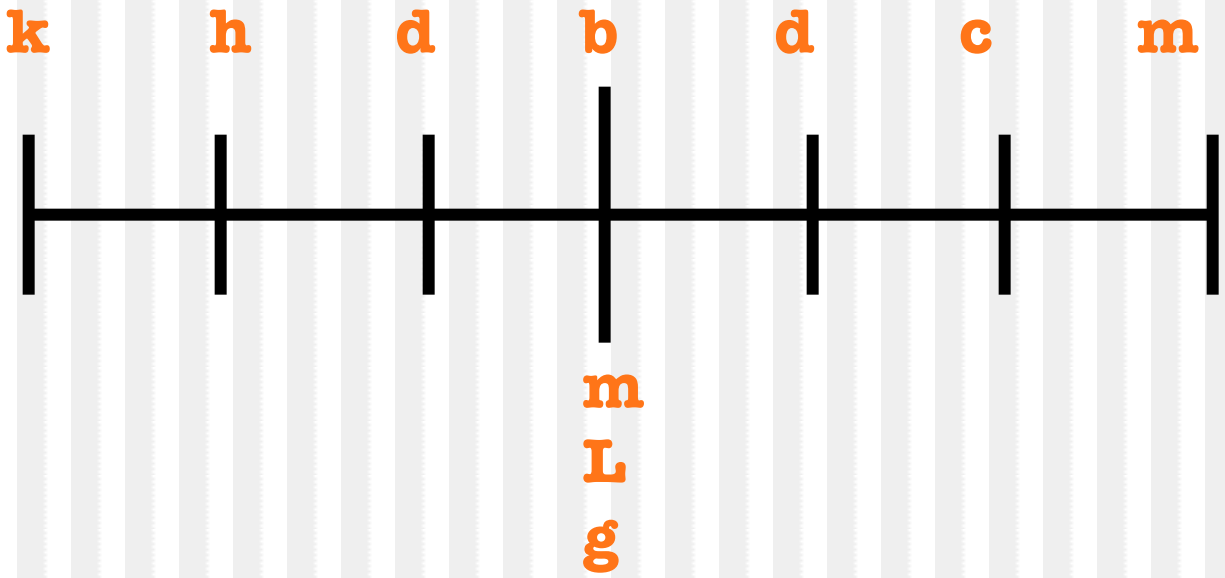
…how to convert within the Metric System. Here's a good device:

On your paper draw a line and add 7 tick marks:



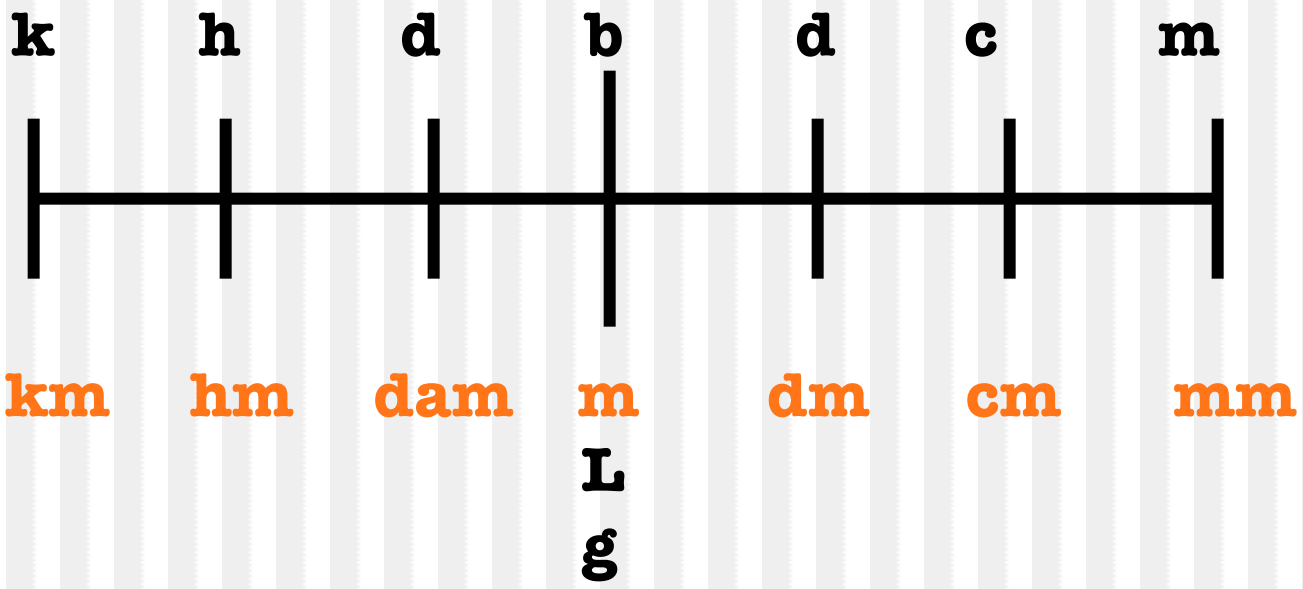
Next:

Above the tick marks write the abbreviations for the King Henry pneumonic:

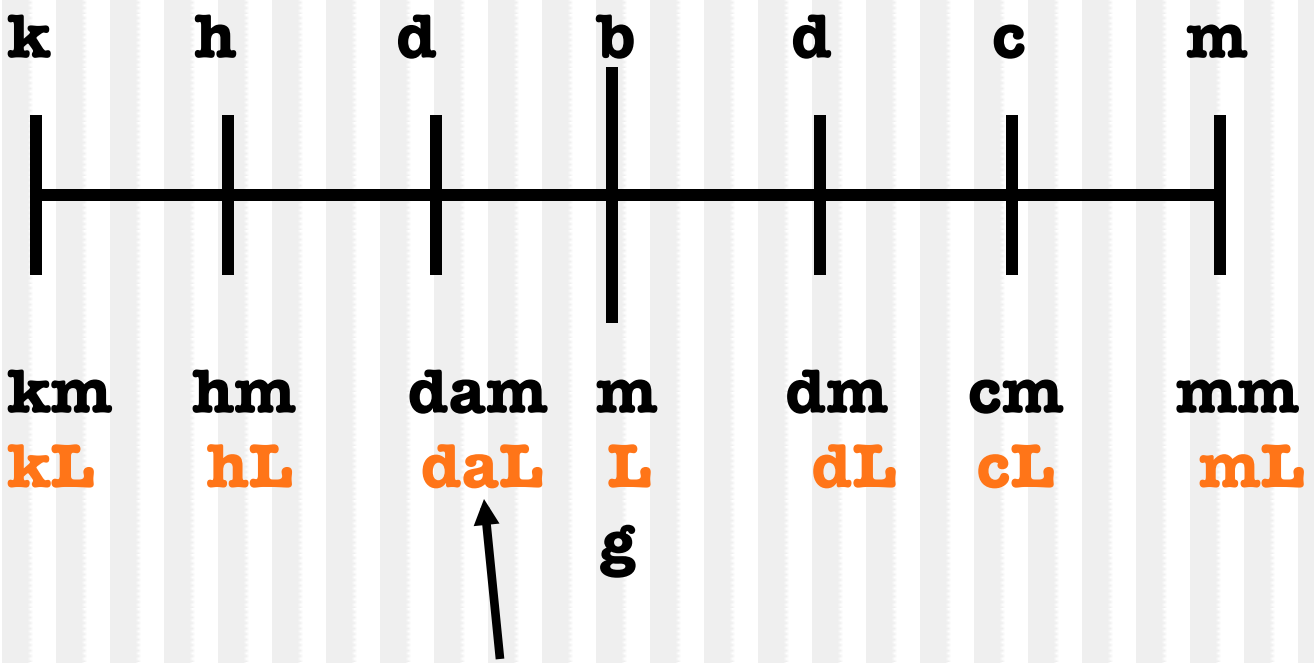


Write the units in the middle under the "b".

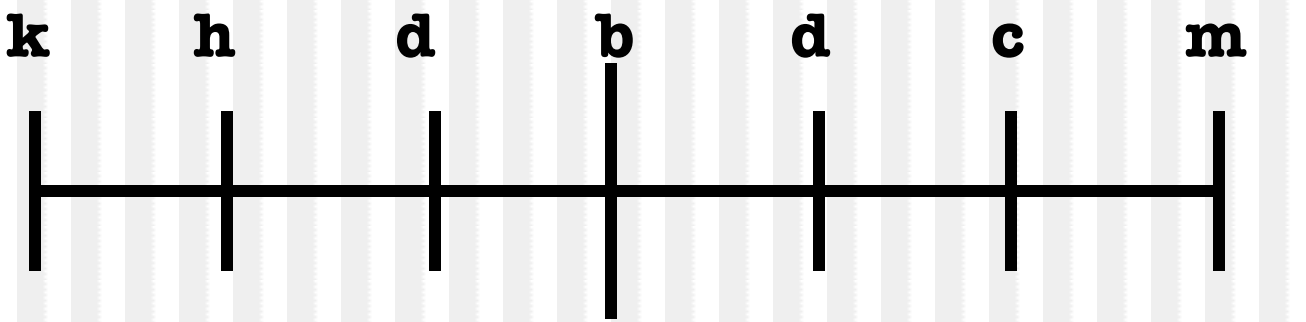
Let's add the meter line:



Let's add the liter line:



Let's add the gram line:



km	hm	dam	m	dm	cm	mm
kL	hL	daL	L	dL	cL	mL
kg	hg	dag	g	dg	cg	mg

How to use this device:

1. Look at the problem. Look at the unit that has a number. On the device put your pencil on that unit.

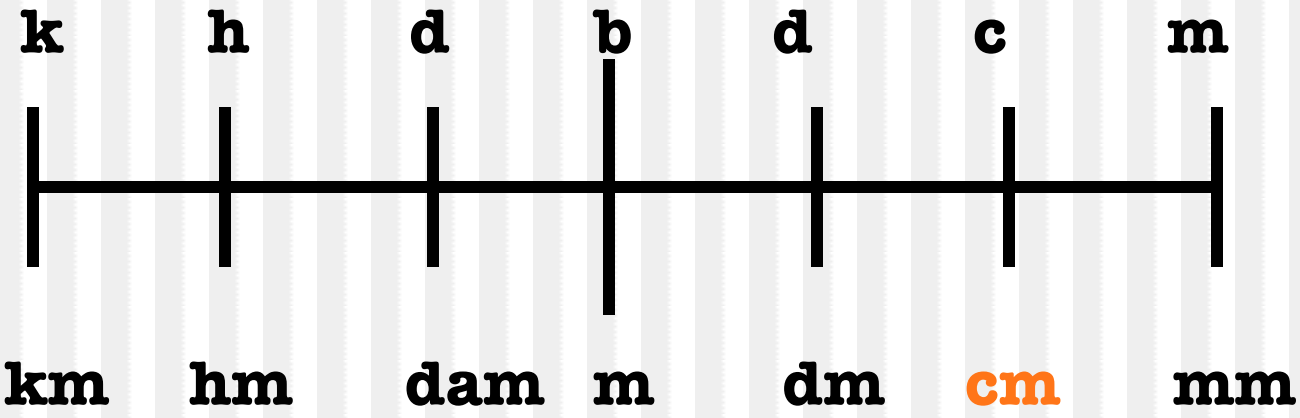
2. Move to new unit, counting jumps and noticing the direction of the jump.

3. Move decimal in original number the same # of spaces and in the same direction.

Example #1:

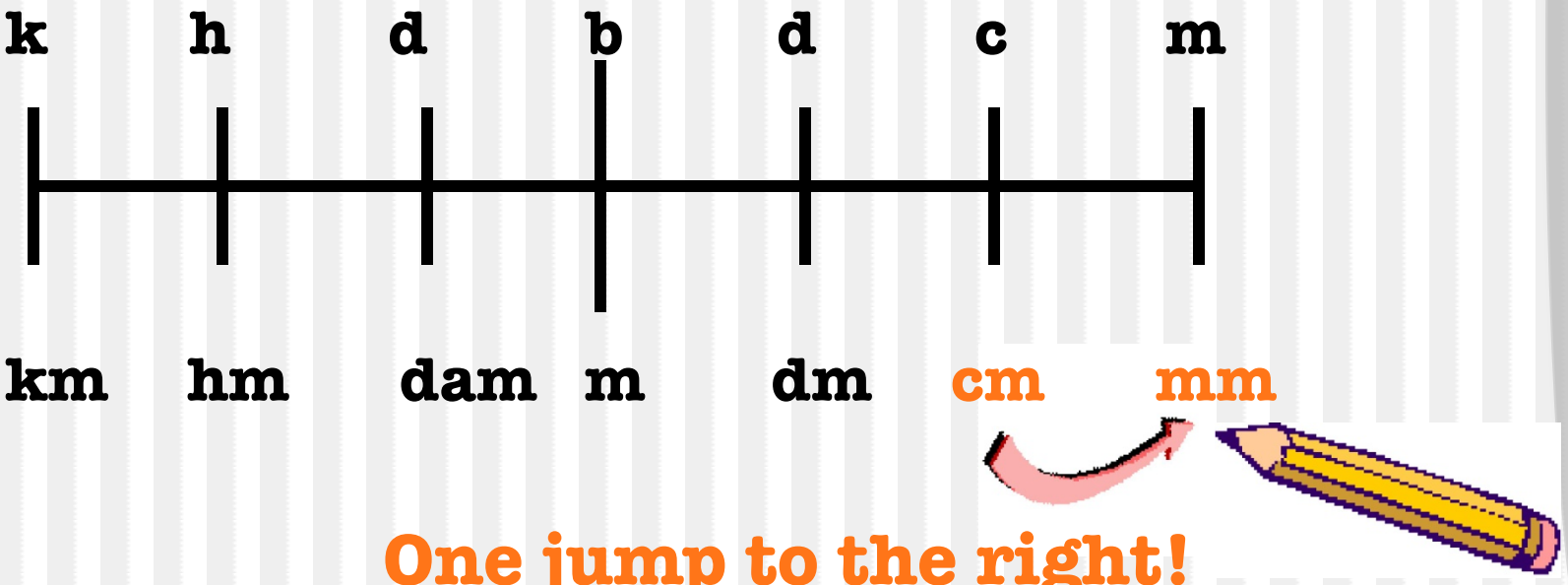
(1) Look at the problem. 56 cm = _____ mm

Look at the unit that has a number. 56 cm
On the device put your pencil on <u>that</u> unit.



Example #1:

2. Move to new unit, counting jumps and noticing the direction of the jump!



One jump to the right!

Example #1:

3. Move decimal in original number the same # of spaces and in the same direction.

56 cm = _____ mm

56.0.

One jump to the right!

Move decimal one jump to the right.
Add a zero as a placeholder.

Example #1:

56 cm = _____ mm

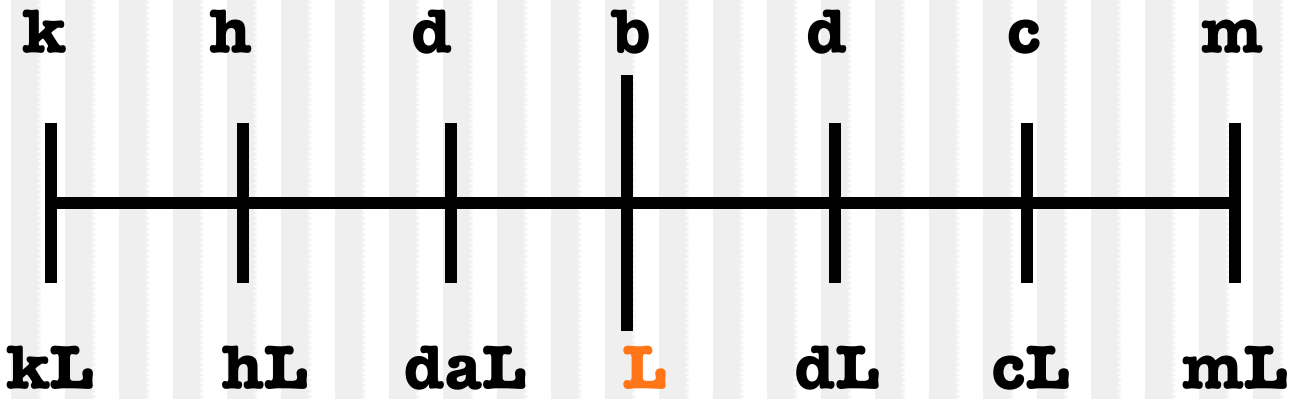
56cm = 560 mm

Example #2:

(1) Look at the problem. 7.25 L = ____ kL

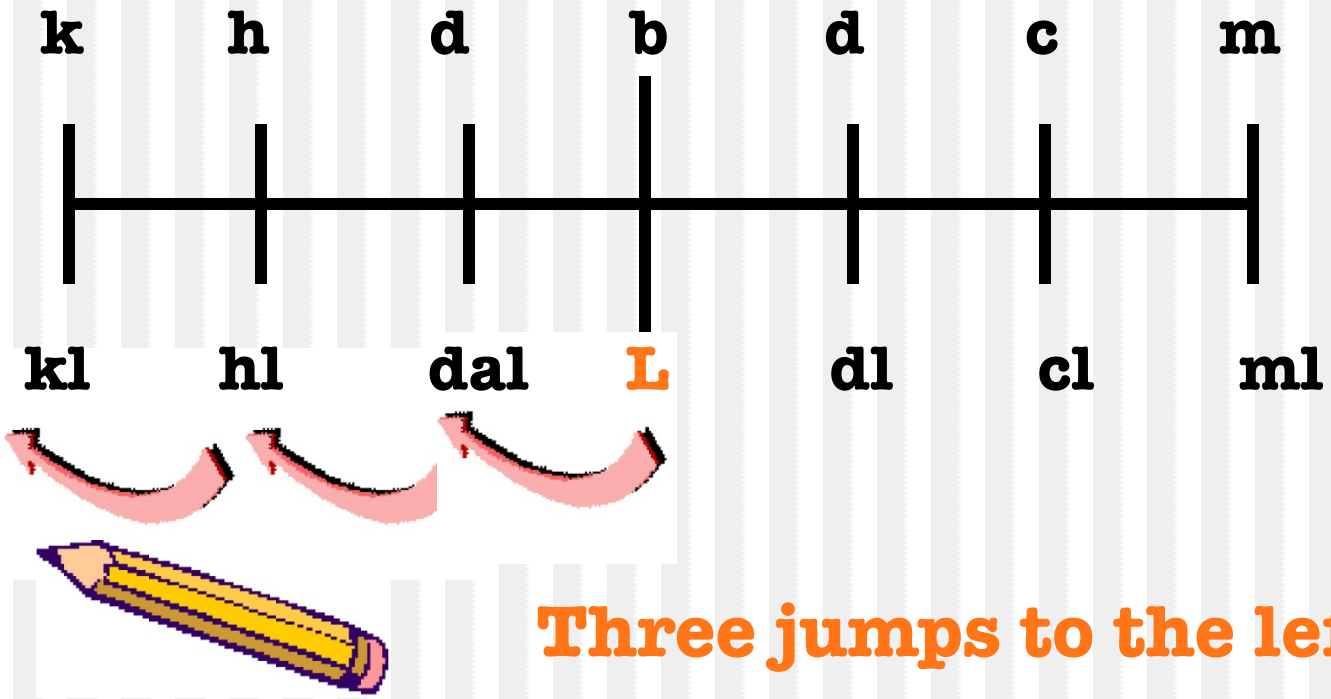
Look at the unit that has a number. 7.25 L

On the device put your pencil on <u>that</u> unit.



Example #2:

2. Move to new unit, counting jumps and noticing the direction of the jump!



Three jumps to the left!

Example #2:

(3) Move decimal in original number the same # of spaces and in the same direction.

7.25 L = ____ kL

.007.25

Three jumps to the left!

Move decimal to the left three jumps.
Add two zeros as placeholders.

Example #2:

7.25 L = ____ kL

7.25 L = .00725 kL

Examples #5-9:

(5) 35 mm = _____ cm

(6) 14,443 L = _____ kL

(7) 0.00056 kg = _____ g

(8) 35.4 L = _____ mL

(9) 16 mm = _____ km

One last caution:

Be careful NOT to count the spot you start from, where you put your pencil point.

Only count the jumps!

- Now try these problems:

a) 1 liter = ____ deciliters = ____ centiliters

b) 2 grams = ____ dekagrams = ____ hectograms = ____ kilograms

kilo	hecto	deca	meter liter gram	deci	**centi**	**milli**

- An easy way to move within the metric system is by moving the decimal point one place for each "step" desired.

Example: change liters to centiliters

1 liter = 10 deciliters = 100 centiliters

(so you move the decimal 2 times to the right)

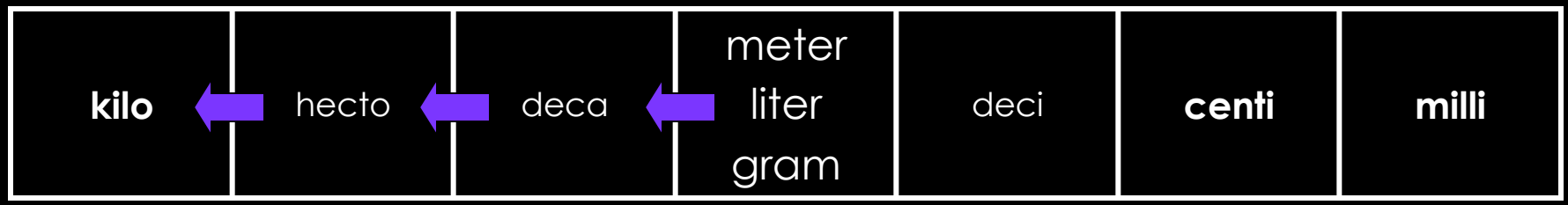
kilo	hecto	deca	meter liter gram	→ deci →	**centi**	**milli**

- Now let's try the second example this time moving the decimal to the left.

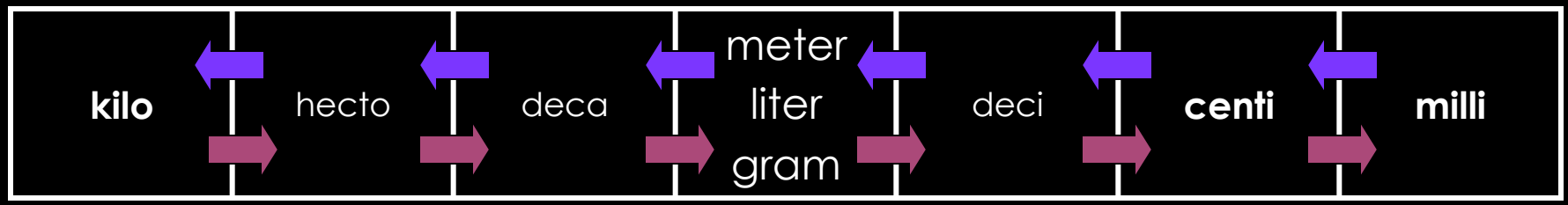
Example: change grams to kilograms

2 grams = 0.2 dekagrams = 0.02 hectograms = 0.002 kilograms

(so you move the decimal 3 times to the left)



- If you move to the left in the diagram, move the decimal to the left
- If you move to the right in the diagram, move the decimal to the right



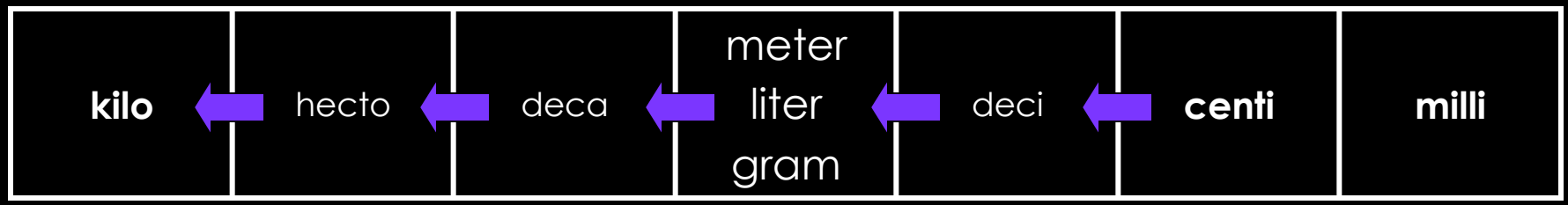
Why Metric?

- The metric system is a system of measurement that is used by scientists all over the world.
- The metric system is simpler and easier to use and understand than traditional measurement systems
- Most countries only use the metric system.
- In the United States, we use the **English or Standard measurement System**.

- Now try another one.

Example: change centimeters to kilometers.

400,000 centimeters = **4** kilometers



Metric Summary

- Base units in the metric system are the meter, liter, gram
- Prefixes can be used with many of the base units
- The Metric system is based on the power of 10
- For conversions within the metric system, each "step" is 1 decimal place to the right or left

kilo	hecto	deca	meter liter gram	deci	**centi**	**milli**

III. Other Conversions

- Sometimes we have to convert from "other" units to metric units and vice versa.

- This can be more difficult because it requires very specific conversion factors.

Approximate Conversions Between Metric & Customary Length Units

- A meter is about the same length as a yard
- A meter is about three feet long
- A decimeter is about four inches long
- An inch is about 25 millimeters
- A foot contains about 30 centimeters
- A foot contains about 3 decimeters

Some Common Conversion Factors

Below are some metric units and their English equivalents.

- 2.54 centimeters = 1 inch
- 1 kilometer = 0.62 miles
- 28.3 grams = 1 ounce
- 1 kilogram = 2.2 pounds
- 1 liter = 1.06 quarts

Converting from Standard to Metric

Convert from:	To:	Multiply by:
mile	kilometer (km)	1.609347
inch	millimeter (mm)	25.4
inch	centimeter (cm)	2.54
foot	meter (m)	0.3048
yard	meter (m)	0.9144

Converting from Metric to Standard

Convert from:	To:	Multiply by:
kilometer (km)	mile	0.6214
millimeter (mm)	inch	0.0394
centimeter (cm)	inch	0.3937
meter (m)	foot	3.281
meter (m)	yard	1.094

THE METRIC SYSTEM

Even though the metric system is not the official system of measurement in the United States, it is used in science, medicine, and some other fields.

The metric system is a simple form of measurement. It is based on the decimal system (units of ten), so there are no fractions. The table below lists the basic measurements in the metric system.

Linear Measure

1 centimeter	=	10 millimeters	=	0.3937 inch
1 decimeter	=	10 centimeters	=	3.937 inches
1 meter	=	10 decimeters	=	39.37 inches or 3.28 feet
1 dekameter	=	10 meters	=	393.7 inches
1 kilometer	=	1,000 meters	=	0.621 mile

Square Measure

1 square centimeter	=	100 square millimeters	=	0.155 square inch
1 square decimeter	=	100 square centimeters	=	15.5 square inches
1 square meter	=	100 square decimeters	=	1,549.9 sq. inches or 1.196 sq. yards
1 square dekameter	=	100 square meters	=	119.6 square yards
1 square kilometer	=	100 square hectometers	=	0.386 square mile

Capacity Measure

1 centiliter	=	10 milliliters	=	0.338 fluid ounce
1 deciliter	=	10 centiliters	=	3.38 fluid ounces
1 liter	=	10 deciliters	=	1.057 liquid qts. or 0.908 dry qt.
1 kiloliter	=	1,000 liters	=	264.18 gallons or 35.315 cubic feet

Land Measure

1 centare	=	1 square meter	=	1,549.9 square inches
1 hectare	=	100 ares	=	2.471 acres
1 square kilometer	=	100 hectares	=	0.386 square mile

Volume Measure

1 cubic centimeter	=	1,000 cubic millimeters	=	0.061 cubic inch
1 cubic decimeter	=	1,000 cubic centimeters	=	61.023 cubic inches
1 cubic meter	=	1,000 cubic decimeters	=	35.314 cubic feet

Weights

1 centigram	=	10 milligrams	=	0.1543 grain
1 decigram	=	10 centigrams	=	1.5432 grains
1 gram	=	10 decigrams	=	15.432 grains
1 dekagram	=	10 grams	=	0.3527 ounce
1 kilogram	=	1,000 grams	=	2.2046 pounds

A. Tools for Problem Solving

Converting Units of Measure

2.85 cm = ? in.

2.85 cm × conversion factor = ? in.

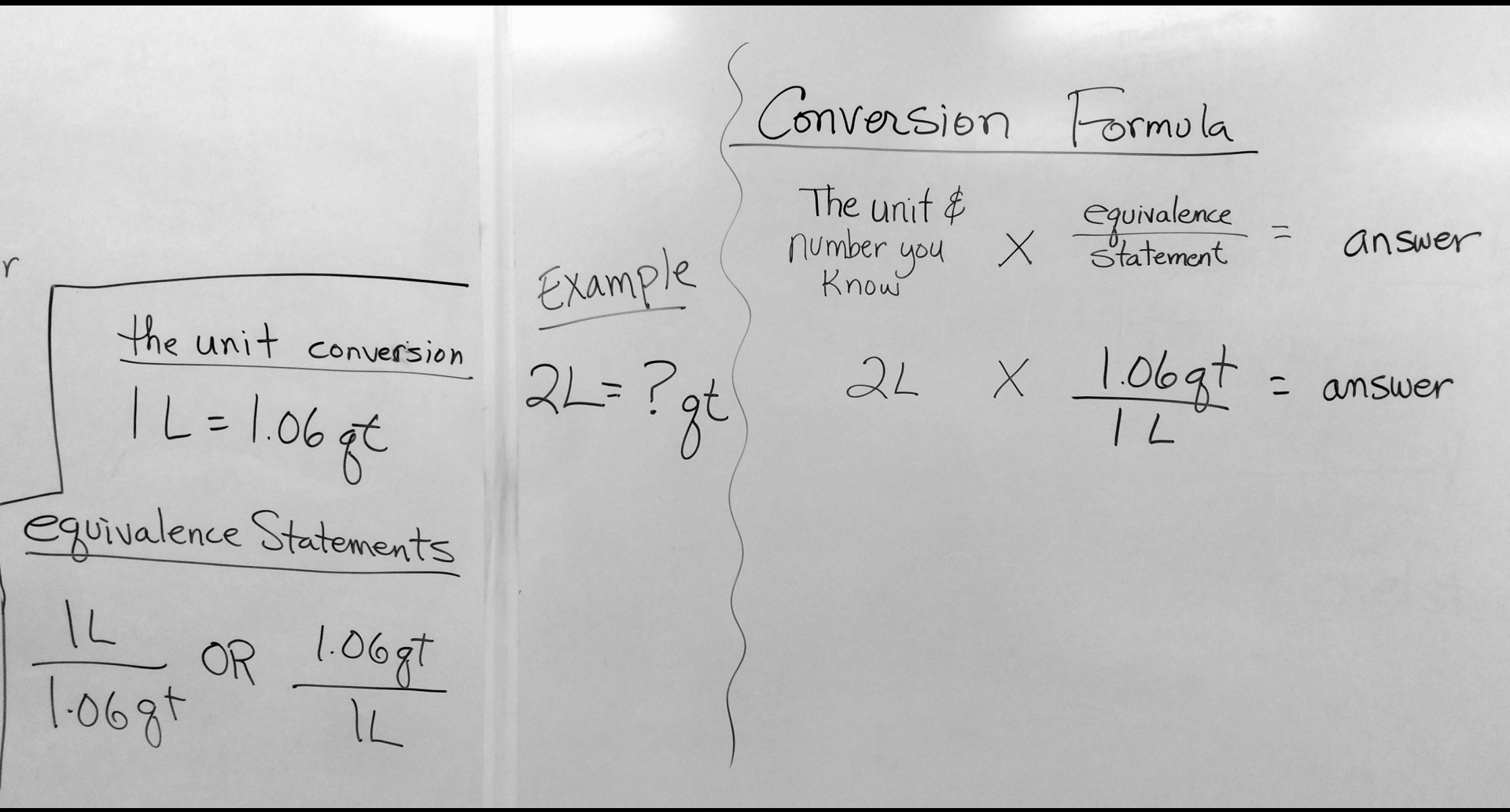
Equivalence statement 2.54 cm = 1 in.

Possible conversion factors $\frac{2.54\text{ cm}}{1\text{ in.}}$ or $\frac{1\text{ in.}}{2.54\text{ cm}}$

$$2.85\text{ cm} \times \frac{1\text{ in.}}{2.54\text{ cm}} = \frac{2.85\text{ in.}}{2.54} = 1.12\text{ in.}$$

Does this answer make sense?

How to Use Equivalence Statements to Convert Customary & Metric Units



A. Tools for Problem Solving

Tools for Converting from One Unit to Another

Step 1 Find an equivalence statement that relates the 2 units.

Step 2 Choose the conversion factor by looking at the direction of the required change (cancel the unwanted units).

Step 3 Multiply the original quantity by the conversion factor.

Step 4 Make sure you have the correct number of significant figures.

- Try these other conversion problems:

a) 8 inches = ____ centimeters

b) 36 centimeters = ____ inches

Conversion Ratio: 1 inch = 2.54 centimeters

a) 8 inches x $\frac{2.54 \text{ centimeters}}{1 \text{ inch}}$ = 20.32 cm

b) 36 centimeters x $\frac{1 \text{ inch}}{2.54 \text{cm}}$ = 14.17 in

- Try this last conversion problem:

  c) 38 miles = ____ kilometers

Conversion Ratio: 1 kilometer = 0.62 miles

c) 38 miles x $\frac{1 \text{ kilometer}}{0.62 \text{ miles}}$ = 61.29