

The Metric System

Mr. Hold-Key

About it...

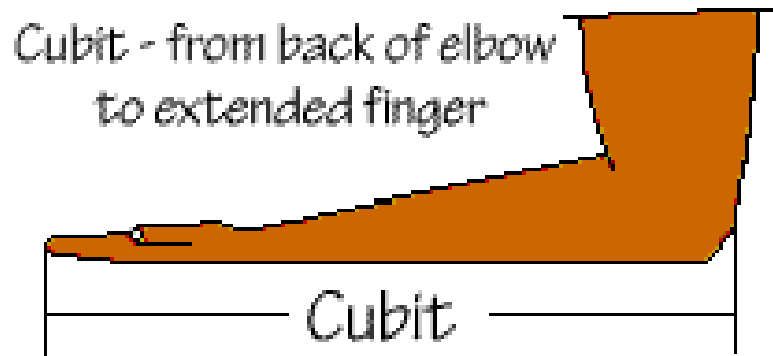
- The metric system is a universal.
 - Except for the U.S.A
- Developed in the late 18th century by French scientists
 - Until then it was a chaotic system of various measurements in place at the time.

Examples of Arbitrary Measurements

- **Distance: cubit** - A biblical unit of distance. It is the distance between a man's middle finger and his elbow. It is about 18 inches or 45 centimeters.

In Ezekiel 48: 34 it was written that the size of the New Jerusalem or heaven is 4500 cubits on each side. That translates to about 1,046 acres or 1.63 square mile - about 3/100th the size of San Francisco.

- Metric= Meter



Cont...

- **Time: moment** - If you ask someone to wait a moment, you're asking them to wait a medieval unit of time that equals to 1/40th of an hour or 1.5 minutes.
 - We use: Second
- **Mass: smidgen** - Yes, it means "small" but how small? A smidgen is exactly 1/2 a pinch or 1/32 of a teaspoon
 - Metric: Gram
- **Olympic Swimming Pool:** 660,000 US gal
 - Metric: liters

For fun...

- **googol** - The googol was invented in 1938 by mathematician Edward Kasner, who asked his then 8-year-old nephew Milton Sirotta what he would name a really, really, *really* large number. A googol is a large number indeed: it is 1 followed by 100 zeroes or 10^{100}



The U.S.A.

- The U.S. is the only industrialized nation that does not mainly use the [metric system](#) in its commercial and standards activities
- Short distance units are based on the dimensions of the human body.
 - The inch (a twelfth)
 - The foot (Henry the I)
 - The yard (three feet)

Why the Metric System?

- **The metric system, which is based on a system of 10, is simple. To change to a larger or smaller unit, you simply multiply or divide by a multiple of 10. It's easy! All metric units are changed like this.**

Metric Mania



Lesson 1: Length

km

m

Metric Units

cm

mm

The basic unit of length in the metric system is the **meter** and is represented by a lowercase **m**.

Standard: The **distance** traveled by **light** in absolute vacuum in $1/299,792,458$ of a second.

Metric Units

1 Kilometer (km) = 1000 meters

1 Meter = 100 Centimeters (cm)

1 Meter = 1000 Millimeters (mm)

Click the image to watch a short video about the meter.



0-3:25

Which is larger?

A. 1 meter or 105 centimeters

C. 12 centimeters or 102 millimeters

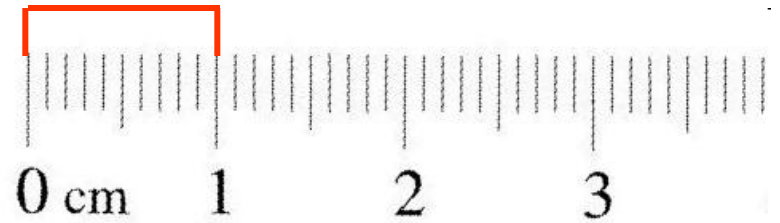
B. 4 kilometers or 4400 meters

D. 1200 millimeters or 1 meter

Measuring Length

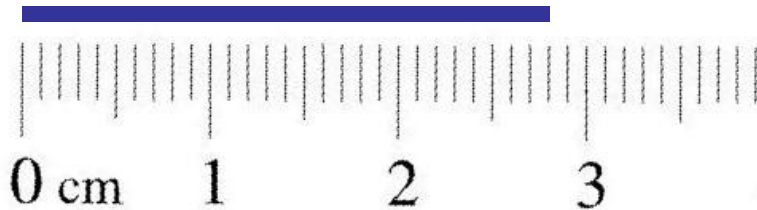
How many millimeters are in 1 centimeter?

1 centimeter = 10 millimeters



What is the length of the line in centimeters? _____ cm

What is the length of the line in millimeters? _____ mm



What is the length of the line to the nearest centimeter? _____ cm

HINT: Round to the nearest centimeter – no decimals.

km

m Converting Units

cm

mm

Click the image to
watch a short video
about the meter.



3:26-5:20

Which is larger?

A. 1 meter or 105 centimeters

B. 4 kilometers or 4400 meters

C. 12 centimeters or 102 millimeters

D. 1200 millimeters or 1 meter

km

m Converting Units

cm

mm

Click the image to
watch a short video
about the meter.



3:26-5:20

Solving the following together

1. How many inches are in 4.7 miles?
2. How many quarts are in 2 liters?
3. How many liters are in 18 cups?

Metric Mania

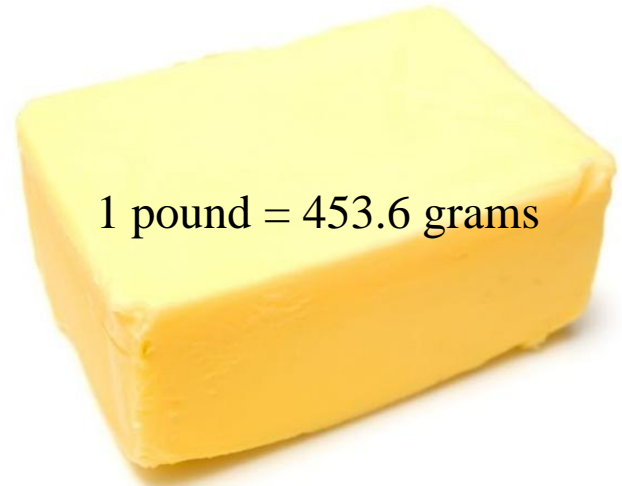


Lesson 2: Mass

English vs. Metric Units

Which is larger?

1. 1 Pound or 100 Grams
2. 1 Kilogram or 1 Pound
3. 1 Ounce or 1000 Milligrams



1 pound = 453.6 grams



1 ounce of gold =
28,349.5 milligrams



100 kilogram =
220 pounds

kg

g

Metric Units

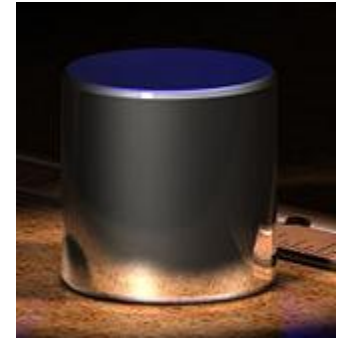
cg

mg

Mass refers to the amount of matter in an object.

The base unit of mass in the metric system is the **kilogram** and is represented by **kg**.

Standard: 1 kilogram is equal to the mass of the **International Prototype Kilogram (IPK)**, a platinum-iridium cylinder kept by the BIPM at Sèvres, France.



Kilogram Prototype

Metric Units

1 Kilogram (kg) = 1000 Grams (g)

1 Gram (g) = 1000 Milligrams (mg)

Click the image to watch a short video about mass.



Which is larger?

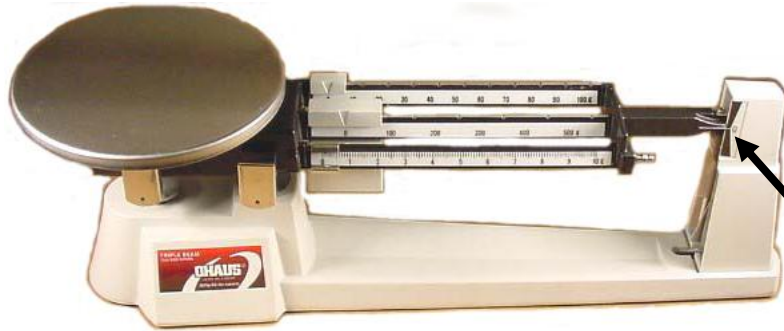
A. 1 kilogram or 1500 grams

C. 12 milligrams or 12 kilograms

B. 1200 milligrams or 1 gram

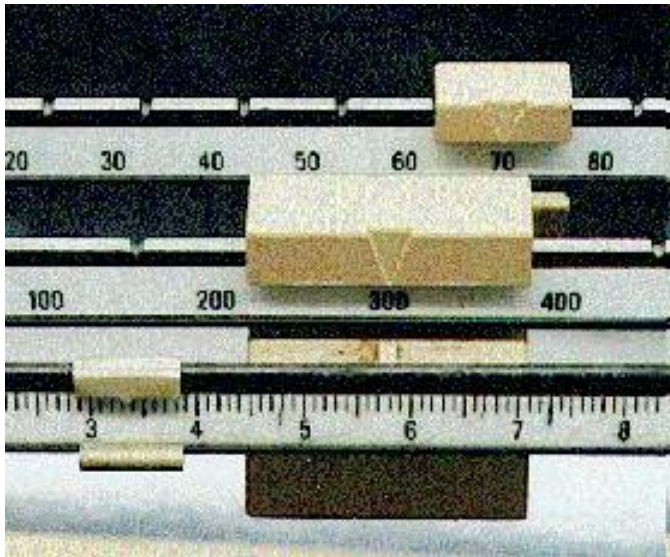
D. 4 kilograms or 4500 grams

Measuring Mass



We will be using **triple-beam balances** to find the mass of various objects.

The objects are placed on the scale and then you move the weights on the beams until you get the lines on the right-side of the scale to match up.



Once you have balanced the scale, you add up the amounts on each beam to find the total mass.

What would be the mass of the object measured in the picture?

$$\underline{\hspace{2cm}} + \underline{\hspace{2cm}} + \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ g}$$

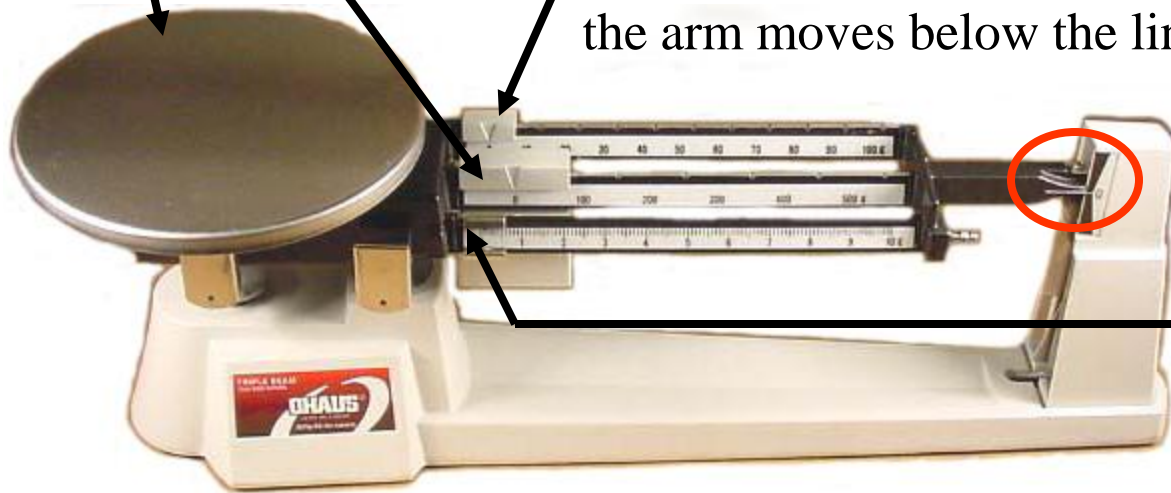
Measuring Mass – Triple-Beam Balance

1st – Place the film canister on the scale.

2nd – Slide the large weight to the right until the arm drops below the line. Move the rider back one groove. Make sure it “locks” into place.

3rd – Repeat this process with the top weight. When the arm moves below the line, back it up one groove.

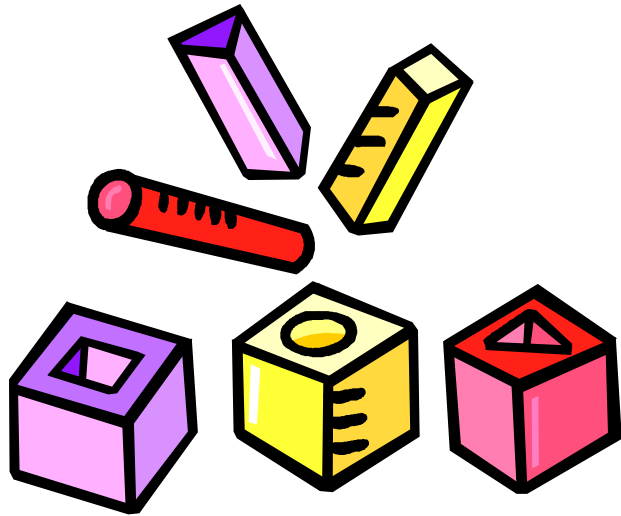
4th – Slide the small weight on the front beam until the lines match up.



5th – Add the amounts on each beam to find the total mass to the nearest tenth of a gram.

[Click here to try an online activity.](#)

Metric Mania



Lesson 3: Volume

English vs. Metric Units

Which is larger?

A. 1 liter or 1 gallon

B. 1 liter or 1 quart

C. 1 milliliter or 1 fluid ounce



1 fl oz = 29.573 ml

1 12-oz can of soda
would equal
approximately 355 ml.

1 gallon = 3.79 liters



It would take approximately $3 \frac{3}{4}$
1-liter bottles to equal a gallon.

1 quart = 0.946 liters



KL**L**

Metric Units

CL**mL**

Volume is the amount of space an object takes up.

The base unit of volume in the metric system is the **liter** and is represented by **L** or **l**.

Standard: 1 liter is equal to one cubic **decimeter**

Metric Units

1 liter (L) = 1000 milliliters (mL)

1 milliliter (mL) = 1 cm³ (or cc) = 1 gram*

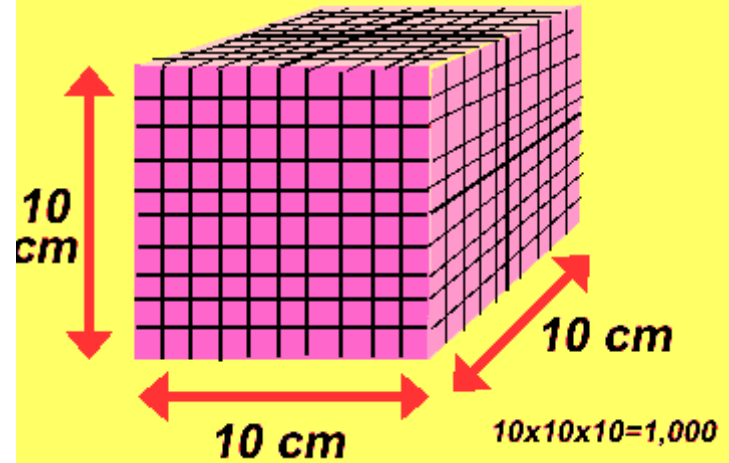
Which is larger?

A. 1 liter or 1500 milliliters

B. 200 milliliters or 1.2 liters

C. 12 cm³ or 1.2 milliliters*

A liter is the volume of a cube 10 cm on each side.



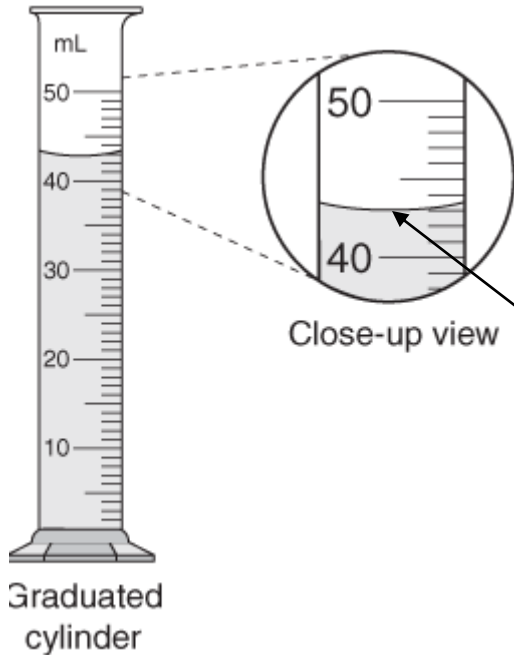
Click the image to watch a short video about volume.



* When referring to water

Liter Image: <http://www.dmtturner.org/Teacher/Pictures/liter.gif>

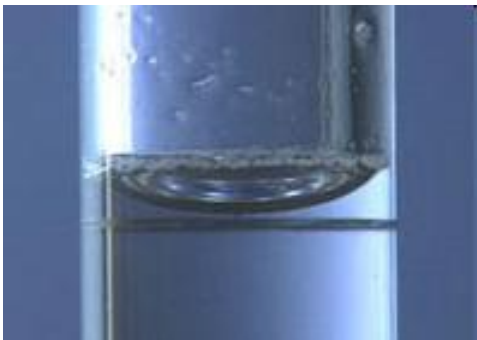
Measuring Volume



We will be using **graduated cylinders** to find the volume of liquids and other objects.

Read the measurement based on the bottom of the **meniscus** or curve. When using a real cylinder, make sure you are eye-level with the level of the water.

What is the volume of water in the cylinder? _____mL

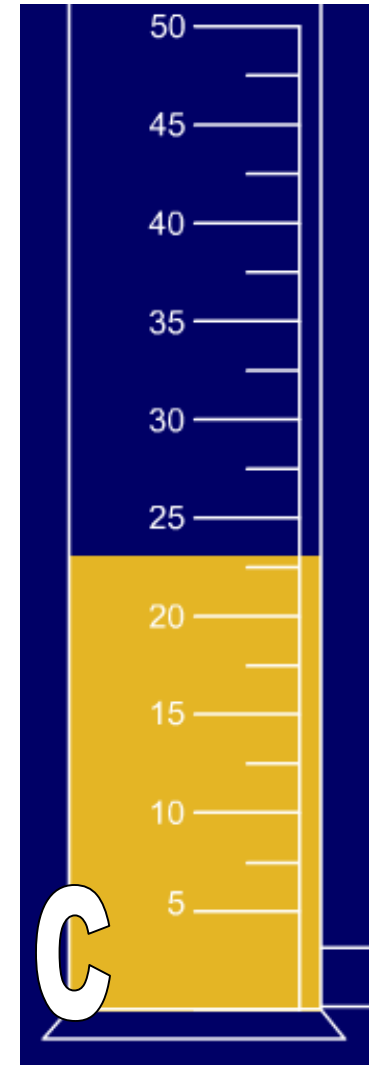
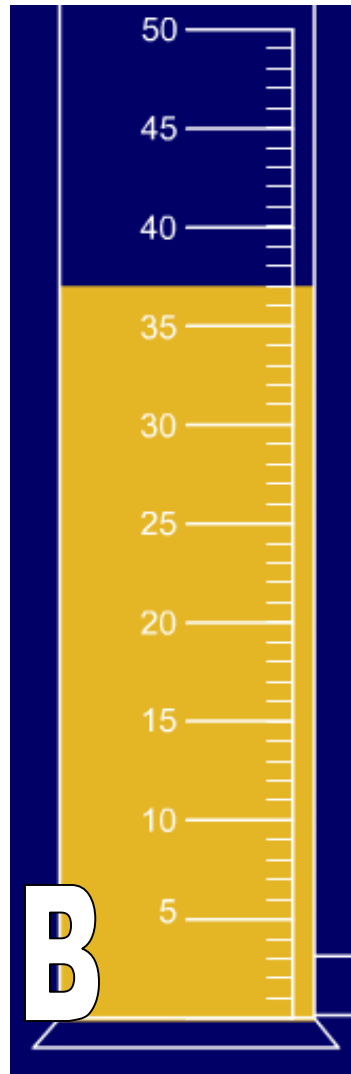
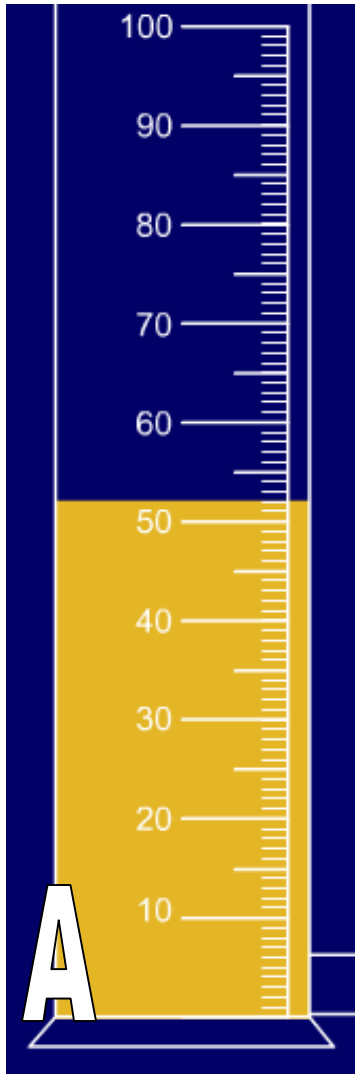


What causes the meniscus?

A concave meniscus occurs when the molecules of the liquid attract those of the container. The glass attracts the water on the sides.

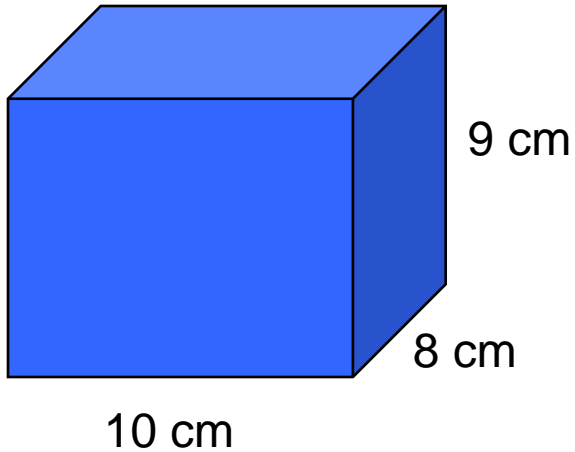
Measuring Liquid Volume

What is the volume of water in each cylinder?



Pay attention to the scales for each cylinder.

Measuring Solid Volume



We can measure the volume of regular object using the formula **length x width x height**.

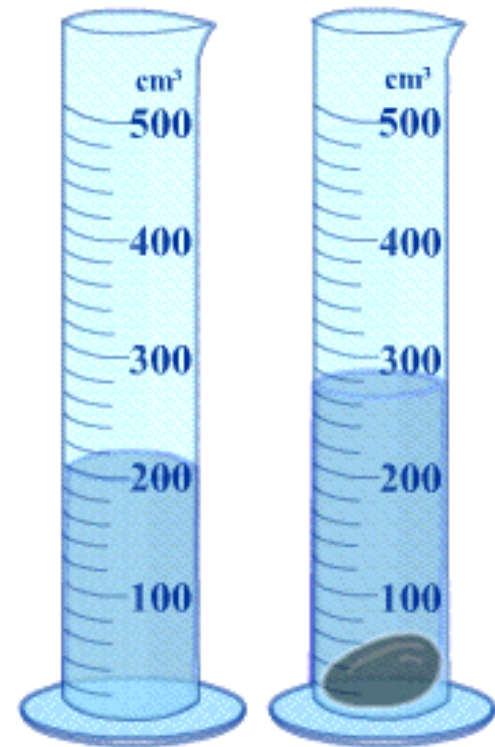
$$\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

We can measure the volume of irregular object using **water displacement**.

Amount of H₂O with object = _____

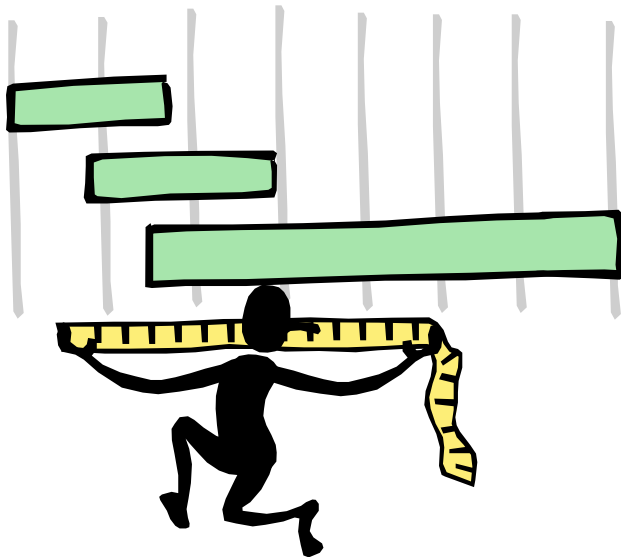
About of H₂O without object = _____

Difference = Volume = _____



[Click here for an online activity about volume.](http://resources.edb.gov.hk/~s1sci/R_S1Science/sp/en/syllabus/unit14/new/testingmain1.htm)
Choose Lessons → Volume & Displacement

Metric Mania



Metric Conversions Ladder Method

when you know	multiply by	to find
length		
millimeters	0.04	inches
centimeters	0.39	inches
meters	3.28	feet
meters	1.09	yards
kilometers	0.62	miles
inches	25.40	millimeters
inches	2.54	centimeters
feet	30.48	centimeters
yards	0.91	meters
miles	1.61	kilometers

speed		
miles per hour	1.61	kilometers per hour
kilometers per hour	0.62	miles per hour

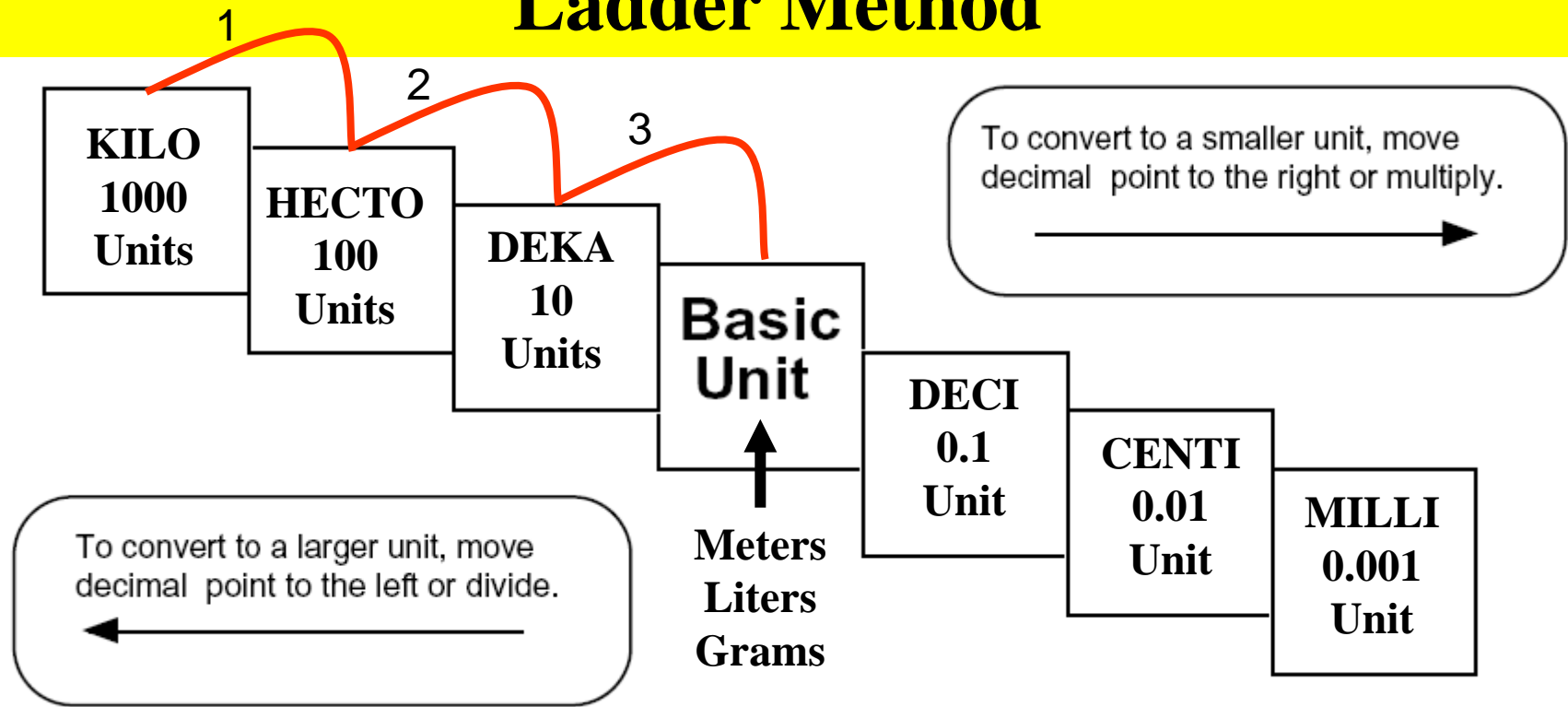
volume		
milliliters	0.20	teaspoons
milliliters	0.07	tablespoons
milliliters	0.03	fluid ounces
liters	4.23	cups
liters	2.11	pints
liters	1.06	quarts
liters	0.26	gallons
cubic meters	35.31	cubic feet
cubic meters	1.31	cubic yards
teaspoons	4.93	milliliters
tablespoons	14.79	milliliters
fluid ounces	29.57	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.79	liters
cubic feet	0.03	cubic meters
cubic yards	0.76	cubic meters

when you know	multiply by	to find
mass and weight		
grams	0.035	ounce
grams	0.032	ounce (apoth.)
kilograms	2.20	pounds
kilograms	2.68	pounds (apoth.)
tons (1,000 kg)	1.10	short tons
ounces	28.35	grams
ounces (apoth.)	31.10	grams
pounds	0.45	kilograms
pounds (apoth.)	0.37	kilograms
short tons (2,000 lb)	0.91	metric tons

temperature		
degrees Fahrenheit	$(^{\circ}\text{F} - 32) \div 1.8$	degrees Celsius
degrees Celsius	$(^{\circ}\text{C} \times 1.8) + 32$	degrees Fahrenheit

metric prefixes					
prefix	symbol	factor			
exa-	E	10^{18}	=	1,000,000,000,000,000,000	
peta-	P	10^{15}	=	1,000,000,000,000,000	
tera-	T	10^{12}	=	1,000,000,000,000	
giga-	G	10^9	=	1,000,000,000	
mega-	M	10^6	=	1,000,000	
kilo-	k	10^3	=	1,000	
hecto-	h	10^2	=	100	
deca-	da	10	=	10	
deci-	d	10^{-1}	=	0.1	
centi-	c	10^{-2}	=	0.01	
milli-	m	10^{-3}	=	0.001	
micro-	μ	10^{-6}	=	0.000,001	
nano-	n	10^{-9}	=	0.000,000,001	
pico-	p	10^{-12}	=	0.000,000,000,001	
femto-	f	10^{-15}	=	0.000,000,000,000,001	
atto-	a	10^{-18}	=	0.000,000,000,000,000,001	

Ladder Method



How do you use the “ladder” method?

1st – Determine your starting point.

2nd – Count the “jumps” to your ending point.

3rd – Move the decimal the same number of jumps in the same direction.

$$4 \text{ km} = \underline{\hspace{2cm}} \text{ m}$$

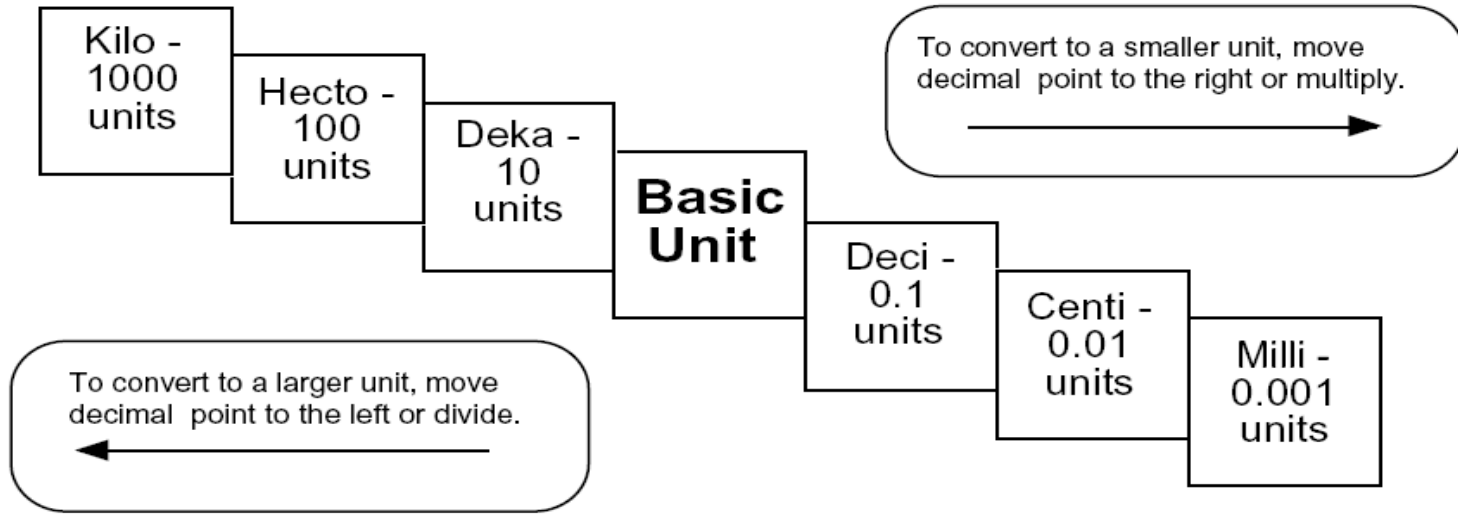
↑ Starting Point ↑ Ending Point

How many jumps does it take?

$$4.\underline{\hspace{0.5cm}}\underline{\hspace{0.5cm}}\underline{\hspace{0.5cm}} = 4000 \text{ m}$$

1 2 3

Conversion Practice



Try these conversions using the ladder method.

$1000 \text{ mg} = \underline{\hspace{2cm}} \text{ g}$

$1 \text{ L} = \underline{\hspace{2cm}} \text{ mL}$

$160 \text{ cm} = \underline{\hspace{2cm}} \text{ mm}$

$14 \text{ km} = \underline{\hspace{2cm}} \text{ m}$

$109 \text{ g} = \underline{\hspace{2cm}} \text{ kg}$

$250 \text{ m} = \underline{\hspace{2cm}} \text{ km}$

Compare using $<$, $>$, or $=$.

$56 \text{ cm} \bigcirc 6 \text{ m}$

$7 \text{ g} \bigcirc 698 \text{ mg}$

Metric Conversion Challenge

Write the correct abbreviation for each metric unit.

1) Kilogram _____

4) Milliliter _____

7) Kilometer _____

2) Meter _____

5) Millimeter _____

8) Centimeter _____

3) Gram _____

6) Liter _____

9) Milligram _____

Try these conversions, using the ladder method.

10) 2000 mg = _____ g

15) 5 L = _____ mL

20) 16 cm = _____ mm

11) 104 km = _____ m

16) 198 g = _____ kg

21) 2500 m = _____ km

12) 480 cm = _____ m

17) 75 mL = _____ L

22) 65 g = _____ mg

13) 5.6 kg = _____ g

18) 50 cm = _____ m

23) 6.3 cm = _____ mm

14) 8 mm = _____ cm

19) 5.6 m = _____ cm

24) 120 mg = _____ g

Compare using <, >, or =.

25) 63 cm ○ 6 m

27) 5 g ○ 508 mg

29) 1,500 mL ○ 1.5 L

26) 536 cm ○ 53.6 dm

28) 43 mg ○ 5 g

30) 3.6 m ○ 36 cm