

Measurement in Chemistry

Mrs. Correia

Measurement

You are making a measurement when you:

- ◆ **Check how tall you have grown**
- ◆ **Check how many minutes until lunch**
- ◆ **Take your temperature when you sick**
- ◆ **Weigh yourself for PE class**
- ◆ **Check out the cute new girl or guy in your class**

Measurement in Chemistry

In chemistry we

- ◆ do experiments
- ◆ measure quantities
- ◆ use numbers to report measurements



Standards of Measurement

- **When we measure, we use a measuring tool to compare some dimension of an object to a standard.**
- **Someone somewhere set the standard by which we compare.**



The Cubit

The cubit was the measurement used by the Egyptians to build the pyramids.



The cubit is the measure from your elbow to the tip of your middle finger when your arm is extended.



The Fathom

The fathom is the measure from fingertip to fingertip when your arms are stretched sideways as far as they will go. You sometimes see a rope or fabric measured in this way.



The Foot

A measurement equal to the length of the king's foot.



The Mile

- "The word comes from the Latin word for 1000, *mille*, because originally a mile was the distance a Roman legion could march in 2000 steps



Common Units of Measurement

Some possible answers are

A. length inch, foot, yard, mile

B. volume cup, teaspoon, gallon, pint, quart

C. weight ounce, pound (lb), ton

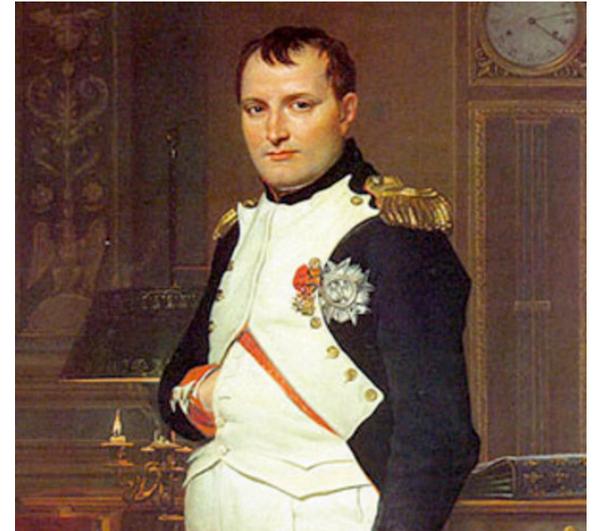
D. temperature °F



Some folks found
measuring in this fashion to
be quite challenging.

History of the Metric System

- Created at the end of the 18th Century to provide a consistent system
 - Previously, each area had its own units inherited from earlier times, that were not reproducible (standardized)
- The metric system became the legal system of measurement in France on Dec. 10, 1799, during the reign of Napoleon.
- Being reproducible, its use spread across Europe, and their colonies.



International System of Units (SI Units)

- **Internationally agreed upon choice of metric units; consists of base units from which all other units can be derived.**
 - **Based on the number 10**

TABLE 2.1 Some SI and Metric Units and Their Equivalents

QUANTITY	SI UNIT (SYMBOL)	METRIC UNIT (SYMBOL)	EQUIVALENTS
Mass	Kilogram (kg)	Gram (g)	1 kg = 1000 g = 2.205 lb
Length	Meter (m)	Meter (m)	1 m = 3.280 ft
Volume	Cubic meter (m ³)	Liter (L)	1 m ³ = 1000 L = 264.2 gal
Temperature	Kelvin (K)	Celsius degree (°C)	See Section 2.9
Time	Second (s)	Second (s)	—

Copyright © 2010 Pearson Prentice Hall, Inc.

Metric System

- Based on the decimal system, the metric system is the common system used for scientific measurements.
- Each prefix is either 10^x or $1/10^x$ of the base unit.
- A centimeter is $1/10^2$ of a meter or $1/100$ of a meter
- A kilometer is 10^3 of a meter or 1000 times a meter

TABLE 2.2 Some Prefixes for Multiples of Metric and SI Units

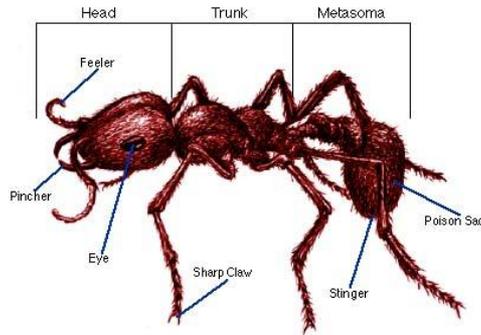
PREFIX	SYMBOL	BASE UNIT MULTIPLIED BY*	EXAMPLE
mega	M	1,000,000 = 10^6	1 megameter (Mm) = 10^6 m
kilo	k	1000 = 10^3	1 kilogram (kg) = 10^3 g
hecto	h	100 = 10^2	1 hectogram (hg) = 100 g
deka	da	10 = 10^1	1 dekaliter (daL) = 10 L
deci	d	0.1 = 10^{-1}	1 deciliter (dL) = 0.1 L
centi	c	0.01 = 10^{-2}	1 centimeter (cm) = 0.01 m
milli	m	0.001 = 10^{-3}	1 milligram (mg) = 0.001 g
micro	μ	0.000 001 = 10^{-6}	1 micrometer (μm) = 10^{-6} m
nano	n	0.000 000 001 = 10^{-9}	1 nanogram (ng) = 10^{-9} g
pico	p	0.000 000 000 001 = 10^{-12}	1 picogram (pg) = 10^{-12} g
femto	f	0.000 000 000 000 001 = 10^{-15}	1 femtogram = 10^{-15} g

*The scientific notation method of writing large and small numbers (for example, 10^6 for 1,000,000) is explained in Section 2.5.

Metric System

- Prefixes are used to make the base unit useful for measuring items of different sizes.

Would you use a meter stick to measure the length of an ant?



Would you use a meter stick to measure the distance from here to California?



Length: A measure of distance.

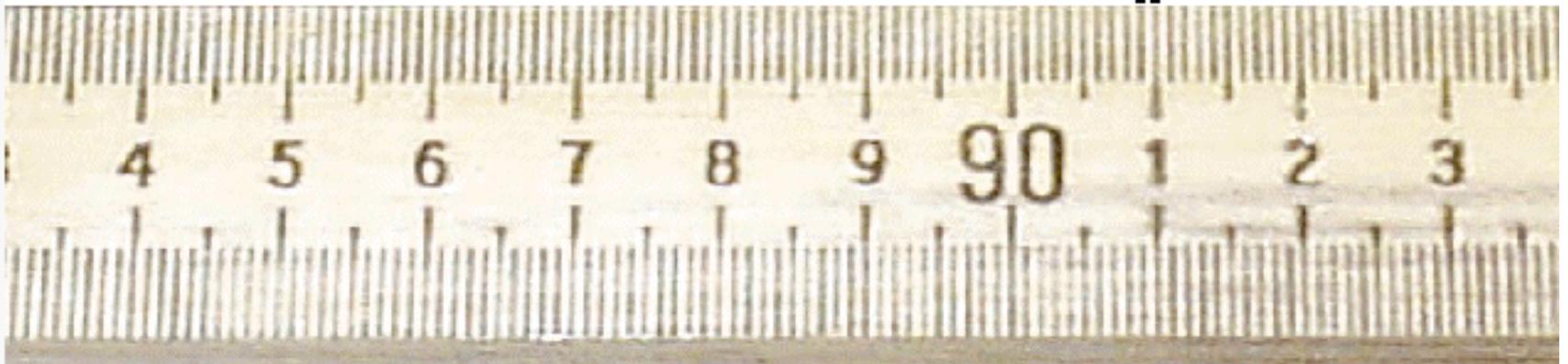
- **SI Unit:** meter (m)

- **Conversions**

$$1 \text{ in} = 2.54 \text{ cm} \quad 1 \text{ cm} = 0.0254 \text{ m} \quad 1 \text{ mi} = 1.609 \text{ km}$$
$$\text{km} = 1000 \text{ m}$$

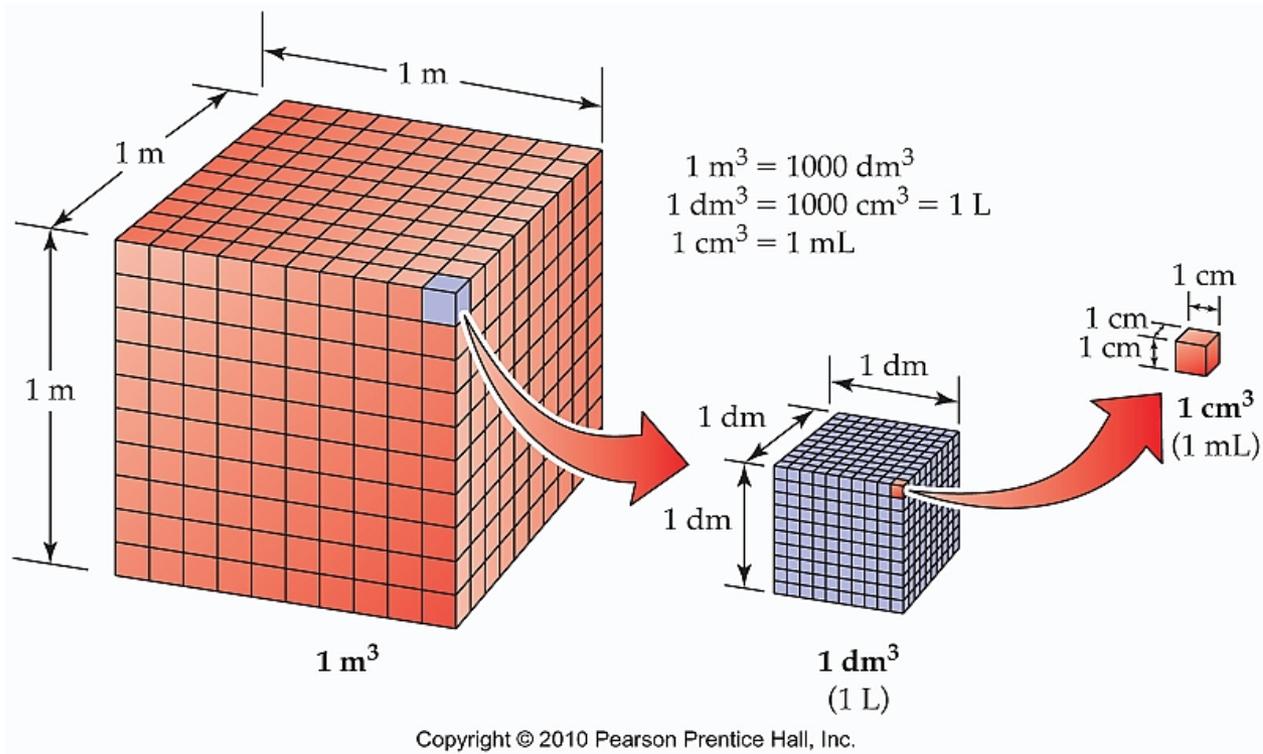
1 cm

1 mm



Volume: Amount of space occupied by a body.

- **SI Unit:** cubic meter (m^3)
- **Conversions**
 $1 \text{ m}^3 = 1000 \text{ dm}^3$ $1 \text{ dm}^3 = 1 \text{ L}$ 1 cm^3 (also written cc) = 1 mL



Temperature: The measure of how hot or cold an object is.

- **SI Unit:** Kelvin (K)
- **Common Units:** Celsius (°C) or Fahrenheit (°F)

Converting between K and °C:

$$K = °C + 273$$

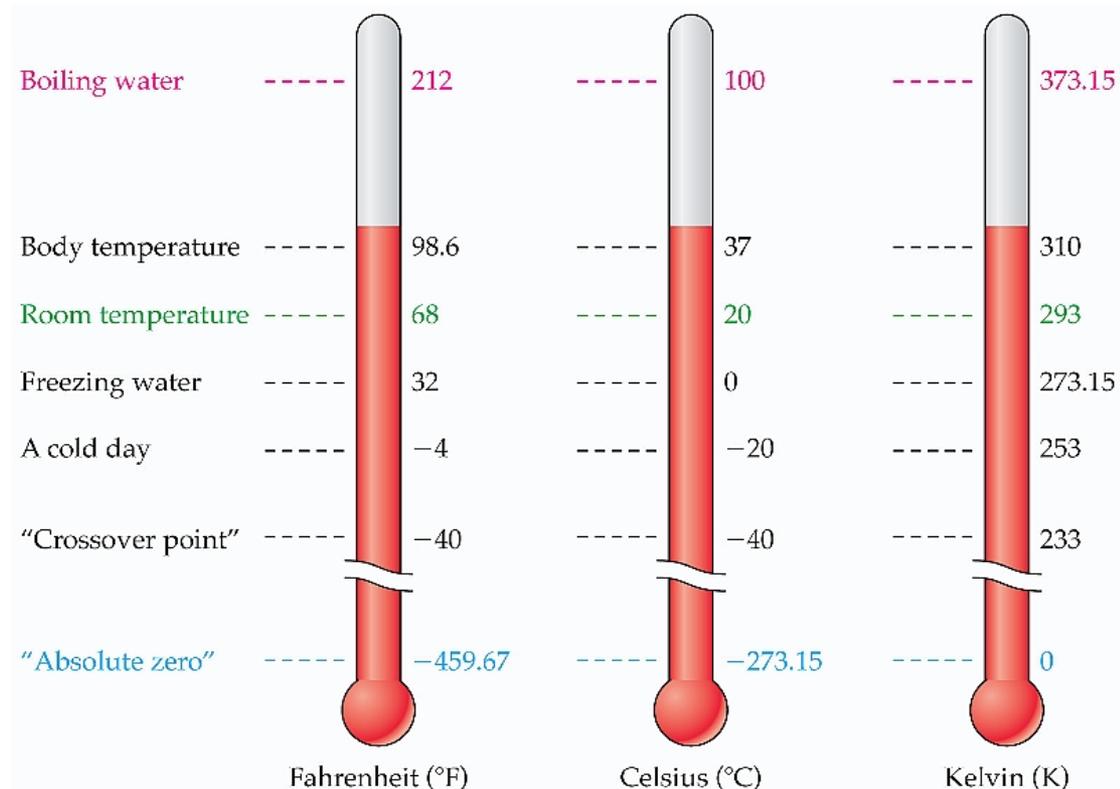
$$°C = K - 273$$

Examples:

$$0 °C = 273 K$$

$$25 °C = 298 K$$

$$200 K = -73 °C$$



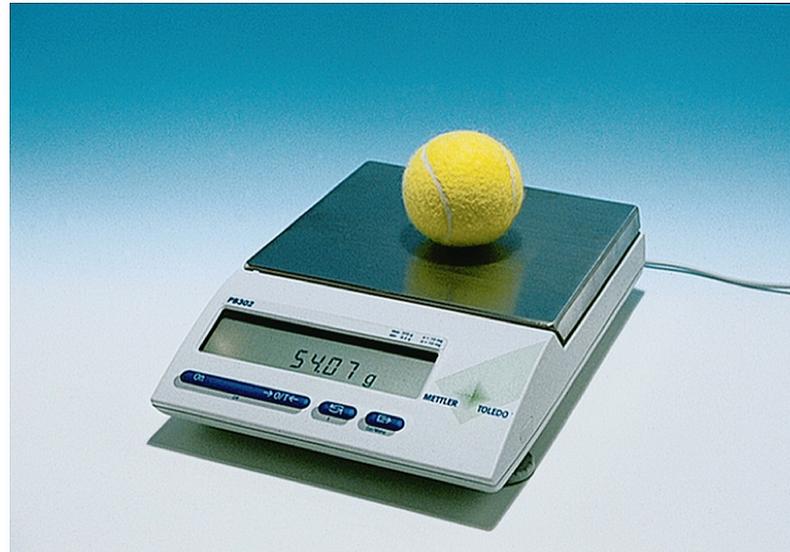
Copyright © 2010 Pearson Prentice Hall, Inc.

Mass: The amount of matter in a body.

- **SI Units:** kilogram (kg)

- **Conversions**

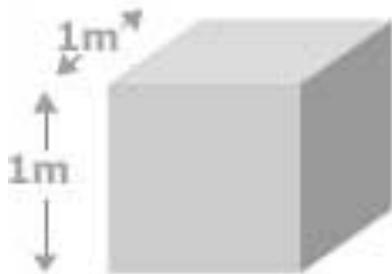
1 kg = 2.2 lbs 1 kg = 1000 g 1 oz = 28.35 g



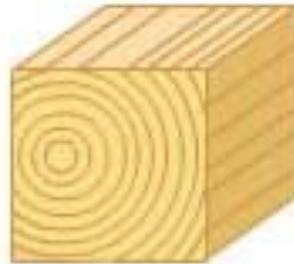
Copyright © 2010 Pearson Prentice Hall, Inc.

Density: Amount of mass per unit volume of a substance.

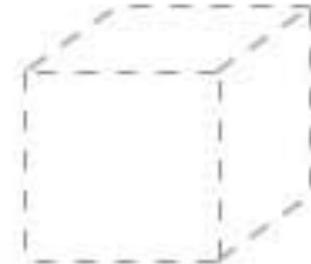
- **SI Units:** kg/m^3
- **Common Units:** g/cm^3 or g/mL



steel 7800 kg/m^3



wood 500 kg/m^3



air 1.2 kg/m^3

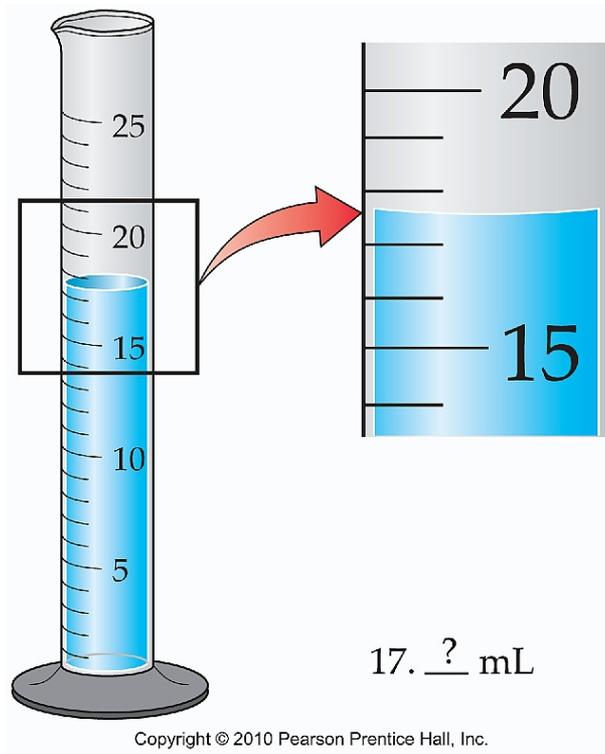
The units of density are units of mass divided by units of volume

Uncertainty in Measurements

- **Exact numbers:** numbers that have a definite value.
- **Examples of exact numbers:**
 - If you buy a dozen eggs you have bought exactly 12 eggs
 - 1 kg is equal to exactly 1000 g
 - Any counted number such as number of people in a room or number of skittles in a bag
- **Inexact numbers:** numbers that do not have a definite value and contain some uncertainty. There is always uncertainty in measured quantities!

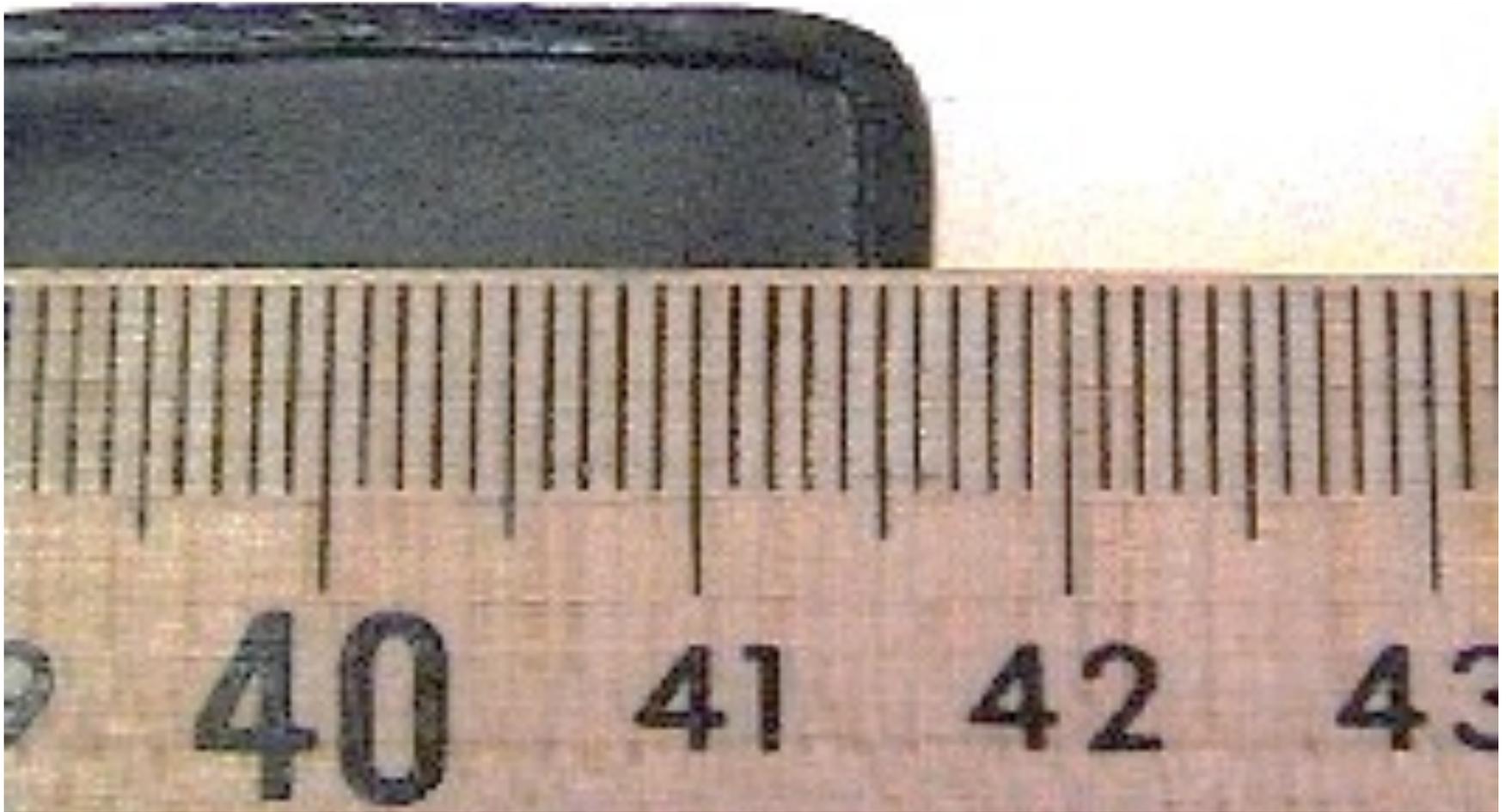
The Importance of Significant Figures in Measurements

All digits in a measured quantity are considered significant. The last digit of a measured quantity contains uncertainty (estimate)



- The level of liquid in this graduated cylinder is between the 17 and 18 mL marks.
- I would record my measurement as 17.4 mL
- The 4 in the tenths place is an estimated digit.
-

You Try



Units of Measurement in Chemistry

Some possible answers are

A. length meter, centimeter, millimeter

B. volume liters, milliliters

C. weight grams, milligrams, kilograms

D. temperature °C, K