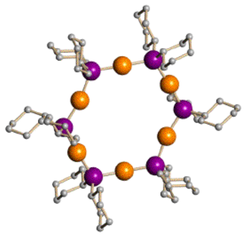
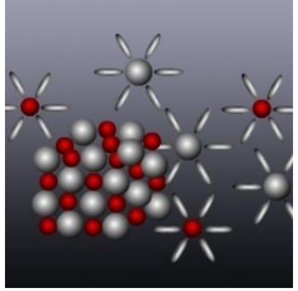
INTRODUCTION TO CHEMISTRY

Engr. Art Jared E. Eduria, LPT
Instructor 1





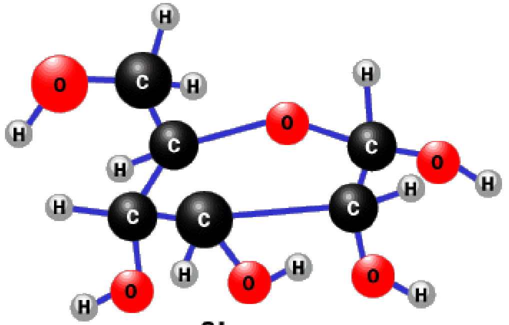
The branches of chemistry

1. Inorganic chemistry

   It deals with all elements but carbon, as well as with some carbon compounds → derived mainly from mineral sources.

2. Organic chemistry

   Concern with compounds containing the element carbon → derived from living organisms.



Glucose

Inorganic chemistry

- Inorganic matter is a **matter which is not derived from living organisms and contains no organically produced carbon**. It includes rocks, minerals, and metals. Inorganic matter can be formally defined with reference to what they are not: organic compounds

Why Study Inorganic Chemistry?

- **Medicine:** Inorganic compounds are used to make drugs, such as antibiotics, anti-cancer drugs, and heart medications. For example, the drug chloroquine is an inorganic compound that is used to treat malaria.
- **Agriculture:** Inorganic compounds are used to make fertilizers, pesticides, and other agricultural chemicals. For example, ammonia is a nitrogen fertilizer that is used to help plants grow.
- **Energy:** Inorganic compounds are used to make batteries, fuel cells, and other energy storage devices. For example, lithium batteries are used in laptops and cell phones.
- **Materials science:** Inorganic compounds are used to make materials such as glass, ceramics, and semiconductors. For example, silicon dioxide is used to make glass.
- **Environmental science:** Inorganic compounds are used to treat water, clean up pollution, and study the environment. For example, activated carbon is used to remove impurities from water.
- **Other applications:** Inorganic compounds are also used in a variety of other applications, such as food additives, cosmetics, and fireworks.

Scientific Method

It is a systematic way to answer questions about the natural world.

Steps:

- 1. A scientist makes an observation.
- 2. The observation leads to a question.
- 3. Experiment - a test of the hypothesis
- 4. Conclusion – a possible explanation of the results
- 5. Natural Law – describes how nature behaves. It can be duplicated many times

Measurement

It is a major part of science.

- 1. Every measurement needs a number. (value)
- 2. All measurements need to include units.

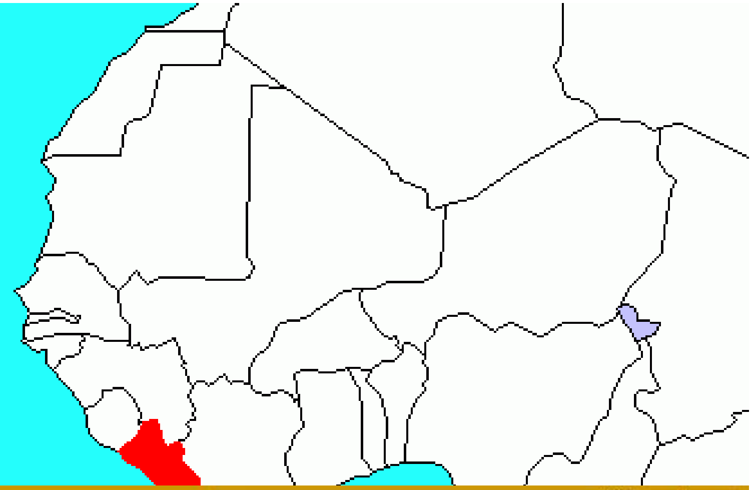
All sciences use the metric system

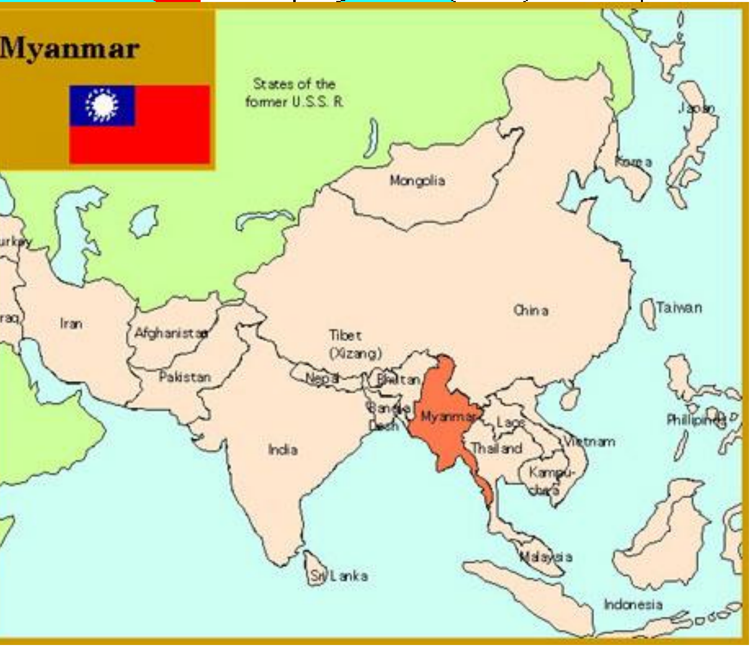
- 1. They're called the International System of Units
- 2. All scientists use it as a common unit.

Types of Observations and Measurements

- We make QUALITATIVE observations of reactions — changes in color and physical state.
- We also make QUANTITATIVE MEASUREMENTS, which involve numbers.
  - Use SI units — based on the metric system

SI measurement





Information from U.S. Metric Association

- Le Système international d'unités
- The only countries that have not *officially* adopted SI are Liberia (in western Africa) and Myanmar (a.k.a. Burma, in SE Asia), but now these are reportedly using metric regularly
- Metrication is a process that does not happen all at once, but is rather a process that happens over time.
- Among countries with non-metric usage, the U.S. is the *only country significantly holding out*. The U.S. officially adopted SI in 1866.

What is Scientific Notation?

- Scientific notation is a way of expressing really big numbers or really small numbers.
- For very large and very small numbers, scientific notation is more concise.

- **A number between 1 and 10**

- **A power of 10**

$$N \times 10^x$$

To change standard form to scientific notation…

- Place the decimal point so that there is one non-zero digit to the left of the decimal point.
- Count the number of decimal places the decimal point has "moved" from the original number. This will be the exponent on the 10.
- If the original number was less than 1, then the exponent is negative. If the original number was greater than 1, then the exponent is positive.

Example

- Given: 289,800,000

  Use: 2.898 (moved 8 places)

  Answer: 2.898×10^8

- Given: 0.000567

  Use: 5.67 (moved 4 places)

  Answer: ?

To change the scientific notation to standard form…

- Simply move the decimal point to the right for positive exponent 10.
- Move the decimal point to the left for negative exponent 10.

(Use zeros to fill in places.)

Example

- Given: 5.093×10^6

  Answer: 5,093,000 (moved 6 places to the right)

- Given: 1.976×10^{-4}

  Answer: ? (moved 4 places to the left)

Learning Check

- Express these numbers in Scientific Notation:

1) 3000000000
2) 2
3) 0.478260

Stating a Measurement

In every measurement, there is a

- Number *followed by a*
- Unit from a measuring device

The number should also be as precise as the measurement!

UNITS OF MEASUREMENT

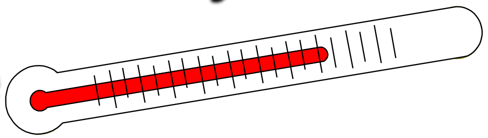
Use SI units — based on the metric system

Length	Meter, m
Mass	Kilogram, kg
Volume	Liter, L
Time	Seconds, s
Temperature	Celsius degrees, ˚C kelvins, K

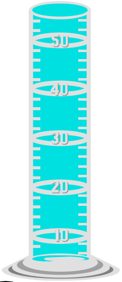
Some Tools for Measurement

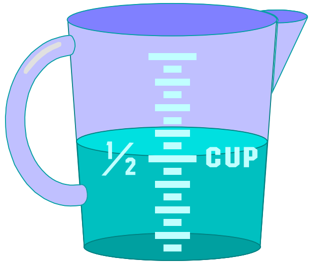
Which tool(s) would you use to measure:

A. temperature

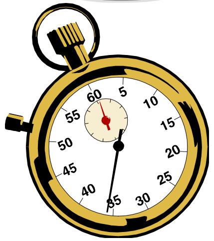


B. volume

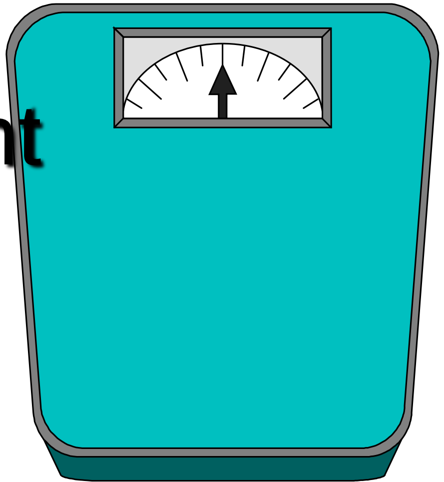




C. time



D. weight



Learning Check

Match L) length M) mass V) volume

____ A. A bag of tomatoes is 4.6 kg.

____ B. A person is 2.0 m tall.

____ C. A medication contains 0.50 g Aspirin.

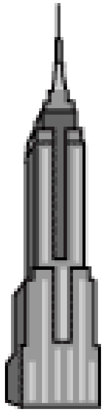
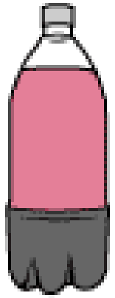
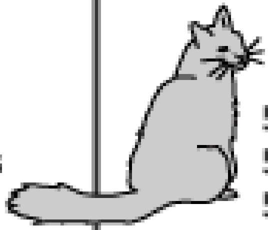
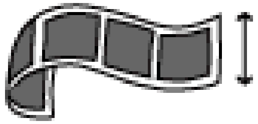
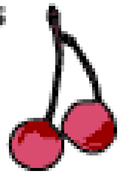
____ D. A bottle contains 1.5 L of water.

Metric Prefixes

Prefix	Symbol	Multiplier	
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
deka	da	10^{1}	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 micro micro	p $\mu\mu$	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

- **Kilo- means 1000 of that unit**
  - 1 kilometer (km) = 1000 meters (m)
- **Centi- means 1/100 of that unit**
  - 1 meter (m) = 100 centimeters (cm)
  - 1 dollar = 100 cents
- **Milli- means 1/1000 of that unit**
  - 1 Liter (L) = 1000 milliliters (mL)

Metric Prefixes

Height	Volume	Weight
skyscraper  0.35 kilometers 3.5 hectometers 35 dekameters 350 meters 3500 decimeters 35000 centimeters 350000 millimeters	bottle  0.002 kiloliters 0.02 hectoliters 0.2 dekaliters 2 liters 20 deciliters 200 centiliters 2000 milliliters	cat  5 kilograms 50 hectograms 500 dekagrams 5000 grams 50000 decigrams 500000 centigrams 5000000 milligrams
film  0.000035 kilometers 0.00035 hectometers 0.0035 dekameters 0.035 meters 0.35 decimeters 3.5 centimeters 35 millimeters	medicine  0.00002 kiloliters 0.0002 hectoliters 0.002 dekaliters 0.02 liters 0.2 deciliters 2 centiliters 20 milliliters	cherries  0.005 kilograms 0.05 hectograms 0.5 dekagrams 5 grams 50 decigrams 500 centigrams 5000 milligrams

Learning Check

Select the unit you would use to measure

1. Your height

   a) millimeters b) meters c) kilometers

2. Your mass

   a) milligrams b) grams c) kilograms

3. The distance between two cities

   a) millimeters b) meters c) kilometers

4. The width of an artery

   a) millimeters b) meters c) kilometers

Conversion Factors

Fractions in which the numerator and denominator are EQUAL quantities expressed in different units

Example: 1 in. = 2.54 cm

Factors: $\dfrac{1\text{ in.}}{2.54\text{ cm}}$ and $\dfrac{2.54\text{ cm}}{1\text{ in.}}$

set up:

$$\text{known value with unit} \times \frac{\text{unknown unit}}{\text{known unit}}$$

Steps to Problem Solving

1. Write down the given amount. Don't forget the units!
2. Multiply by a fraction.
3. Use the fraction as a conversion factor. Determine if the top or the bottom should be the same unit as the given so that it will cancel.
4. Put a unit on the opposite side that will be the new unit. If you don't know a conversion between those units directly, use one that you do know that is a step toward the one you want at the end.
5. Insert the numbers on the conversion so that the top and the bottom amounts are EQUAL, but in different units.
6. Multiply and divide the units (Cancel).
7. If the units are not the ones you want for your answer, make more conversions until you reach that point.
8. Multiply and divide the numbers. Don't forget "Please Excuse My Dear Aunt Sally"! (order of operations)

Units of Length

- ? kilometer (km) = 500 meters (m)
- 2.5 meter (m) = ? centimeters (cm)
- 1 centimeter (cm) = ? millimeter (mm)

Learning Check

1. 1000 m = 1 ___ a) mm b) km c) dm

2. 0.001 g = 1 ___ a) mg b) kg c) dg

3. 0.1 L = 1 ___ a) mL b) cL c) dL

Learning Check

A rattlesnake is 2.44 m long. How long is the snake in cm?

a) 2440 cm

b) 244 cm

c) 24.4 cm

Units of Time

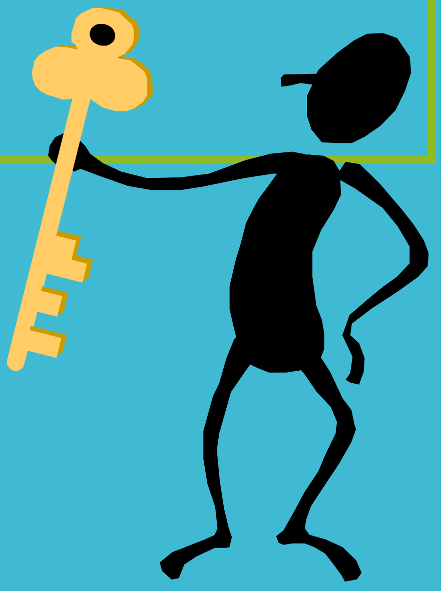
How many minutes are in 2.5 hours?

Conversion factor

$$2.5\ \cancel{hr} \times \frac{60\ min}{1\ \cancel{hr}} = 150\ min$$

By using the dimensional analysis / factor-label method, the UNITS ensure that you have the conversion right side up, and the UNITS are calculated as well as the numbers!

Learning Check



How many seconds are in 1.4 days?

Unit plan: $\rightarrow$ days $\rightarrow$ hr $\rightarrow$ min $\rightarrow$ seconds

$$1.4\ \cancel{\text{days}} \times \frac{24\ \text{hr}}{1\ \cancel{\text{day}}} \times ??$$

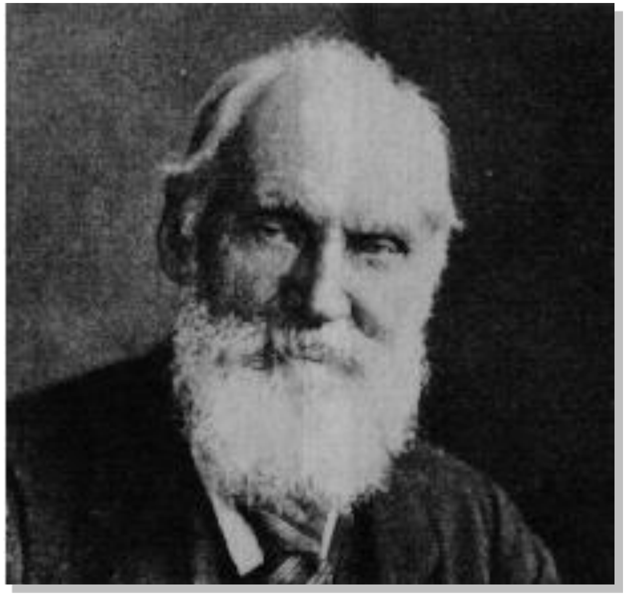
English and Metric Conversions

- If you know ONE conversion for each type of measurement, you can convert anything!
- You must memorize and use these conversions:
  - Mass: 454 grams = 1 pound
  - Length: 2.54 cm = 1 inch
  - Volume: 0.946 L = 1 quart

Unit of Temperature Scales

- Fahrenheit
- Celsius
- Kelvin

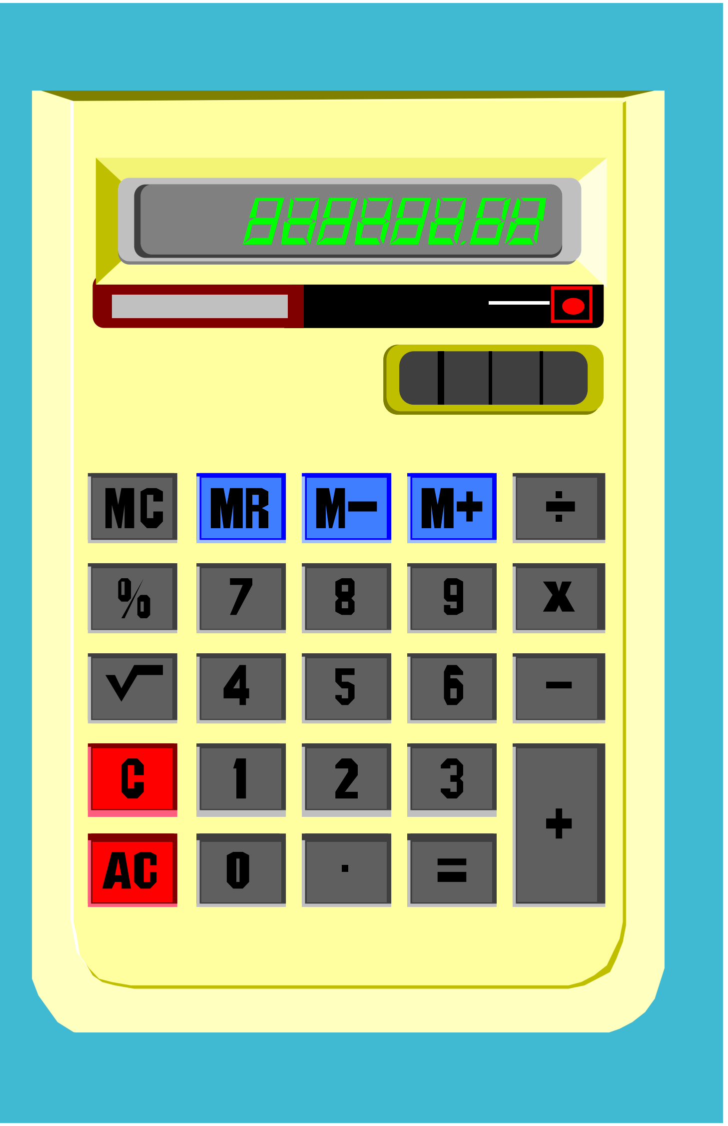
Anders Celsius
1701-1744



Lord Kelvin
(William Thomson)
1824-1907

Temperature Scales

	Fahrenheit	Celsius	Kelvin
Boiling point of water	212 °F	100 °C	373 K
	180°F	100°C	100 K
Freezing point of water	32 °F	0 °C	273 K



Kelvin Formula

- Generally require temp's in **kelvins**
- $T\ (K) = t\ (^\circ C) + 273.15$
- Body temp = 37 ˚C + 273 = 310 K
- Liquid nitrogen = -196 ˚C + 273 = 77 K

Fahrenheit Formula

Zero point: $0°C = 32°F$

$°F = (9/5 \times °C) + 32$

$°C = (°F - 32) \times 5/9$

Celsius Formula

Rearrange to find T°C

$$°F = 9/5\,°C + 32$$

$$°F - 32 = 9/5\,°C\ (+32 - 32)$$

$$\frac{°F - 32}{9/5} = \frac{\cancel{9/5}\,°C}{\cancel{9/5}}$$

$$(°F - 32) * 5/9 = °C$$

Temperature Conversions

A person with hypothermia has a body temperature of 29.1°C. What is the body temperature in °F?

$$°F = 9/5\,(29.1°C) + 32$$

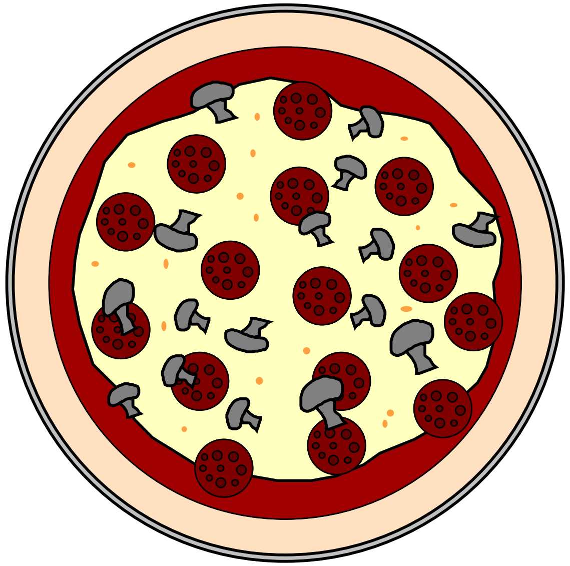
$$= 52.4 + 32$$

$$= 84.4°F$$

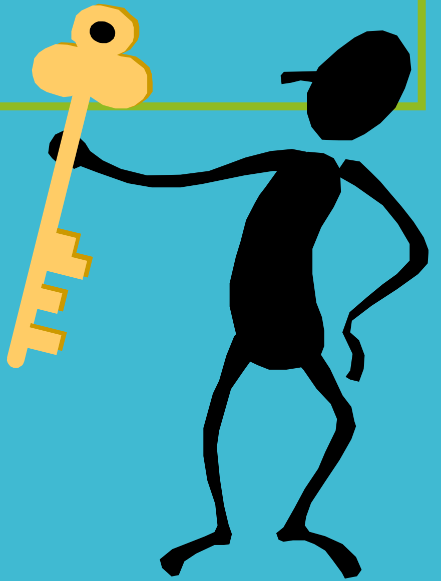
Learning Check

Pizza is baked at 455°F. What is that in °C?

1) 437 °C
2) 235°C
3) 221°C



Learning Check

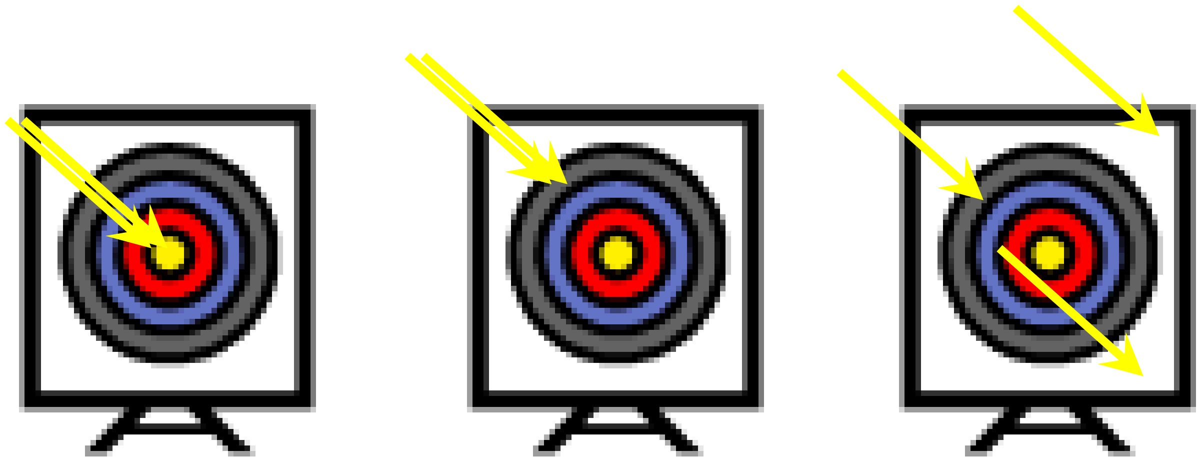


The normal temperature of a chickadee is 105.8°F. What is that temperature in °C?

1) 73.8 °C
2) 58.8 °C
3) 41.0 °C

Can you hit the bull's-eye?

Three targets with three arrows each to shoot.



How do they compare?

Both accurate and precise

Precise but not accurate

Neither accurate nor precise

Can you define accuracy and precision?

Significant Figures

- The numbers reported in a measurement are limited by the measuring tool
- Significant figures in a measurement include the known digits plus one estimated digit

EX: 31.7, the 3 and 1 are certain digits and 7 is the estimated digit

YOU CANNOT REPORT DATA THAT IS MORE PRECISE THAN YOUR LEAST PRECISE MEASURMENT

“Rules” of Significant Figures

Zero - As a “place keeper” it tells where the decimal point goes and is NOT significant. If it is after the decimal than it is significant.

EX: If a balance measures to the nearest 10 grams and measures 1060 grams then the number has 3 significant figures, 1, 0, 6. The last 0 only shows where the decimal goes.

Try this: 7,006,500

Atlantic Pacific Rule

a. Measurements with a decimal point use the Pacific rule, count from the left using the first non-zero number, and go to the end.

b. Measurements without a decimal point use the Atlantic rule, count from the right using the first non-zero number, and go to the end.

c. Start counting with the first non-zero number then count all the way to the end.

Counting Significant Figures

RULE 1. All non-zero digits in a measured number are significant. Only a zero could indicate that rounding occurred.

	Number of Significant Figures
38.15 cm	4
5.6 ft	2
65.6 lb	___
122.55 m	___

Leading Zeros

RULE 2. Leading zeros in decimal numbers are NOT significant.

	Number of Significant Figures
0.008 mm	1
0.0156 oz	3
0.0042 lb	____
0.000262 mL	____

Sandwiched Zeros

RULE 3. Zeros between nonzero numbers are significant. (They can not be rounded unless they are on the end of a number.)

	Number of Significant Figures
50.8 mm	3
2001 min	4
0.702 lb	____
0.00405 m	____

Trailing Zeros

RULE 4. Trailing zeros in numbers without decimals are NOT significant. They are only serving as placeholders.

	Number of Significant Figures
25,000 in.	2
200. yr	3
48,600 gal	____
25,005,000 g	____

Learning Check

A. Which answers contain 3 significant figures?

1) 0.4760 2) 0.00476 3) 4760

B. All the zeros are significant in

1) 0.00307 2) 25.300 3) 2.050×10^3

In which set(s) do both numbers contain the *same* number of significant figures?

1) 22.0 and 22.00

2) 400.0 and 40

3) 0.000015 and 150,000

Learning Check

State the number of significant figures in each of the following:

A. 0.030 m	1	2	3
B. 4.050 L	2	3	4
C. 0.0008 g	1	2	4
D. 3.00 m	1	2	3
E. 2,080,000 bees	3	5	7

Significant Numbers in Calculations

- A calculated answer cannot be more precise than the measuring tool.
- A calculated answer must match the least precise measurement.
- Significant figures are needed for final answers from

    1) adding or subtracting

    2) multiplying or dividing

Adding and Subtracting

The answer has the same number of decimal places as the measurement with the fewest decimal places.

25.2	*one decimal place*
+ 1.34	*two decimal places*
26.54	

answer 26.5 *one decimal place*

Learning Check

In each calculation, round the answer to the correct number of significant figures.

A. 235.05 + 19.6 + 2.1 =

1) 256.75 2) 256.8 3) 257

B. 58.925 - 18.2 =

1) 40.725 2) 40.73 3) 40.7

Multiplying and Dividing

Round (or add zeros) to the calculated answer until you have the same number of significant figures as the measurement with the fewest significant figures.

Learning Check

A. $2.19 \times 4.2 =$

1) 9 2) 9.2 3) 9.198

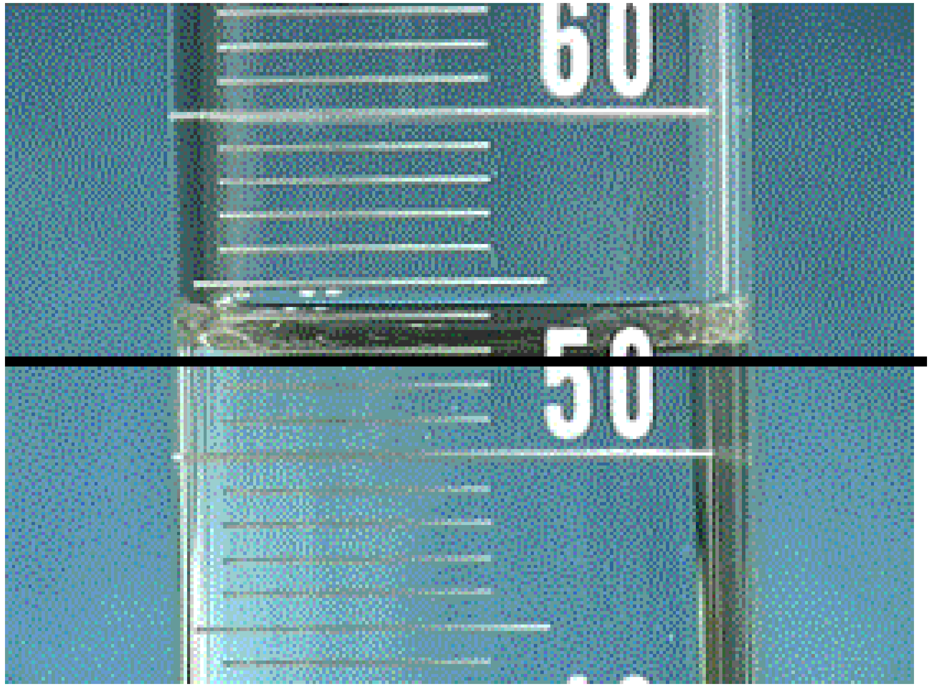
B. $4.311 \div 0.07 =$

1) 61.58 2) 62 3) 60

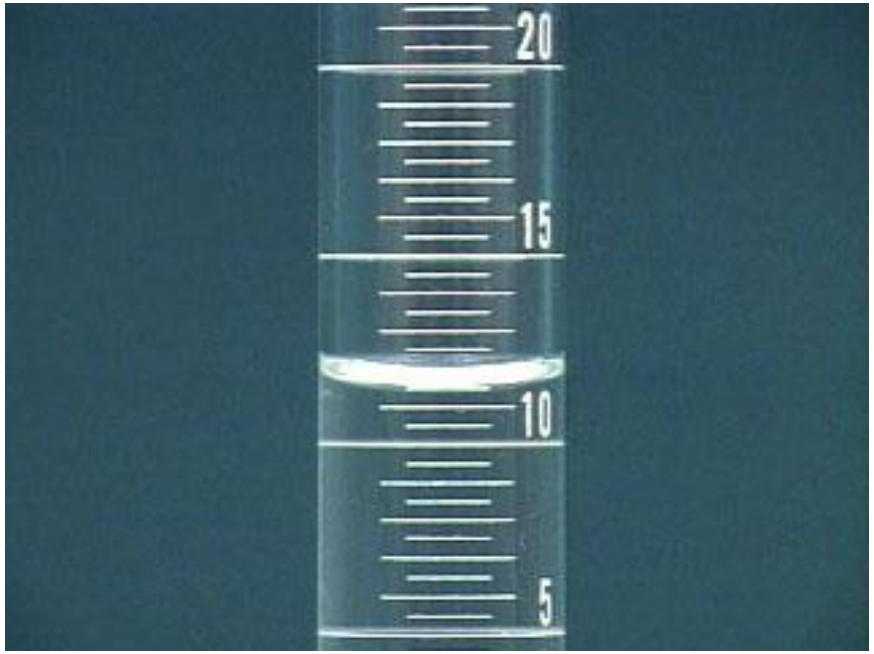
C. $\dfrac{2.54 \times 0.0028}{0.0105 \times 0.060} =$

1) 11.3 2) 11 3) 0.041

Always estimate ONE place past the smallest mark!



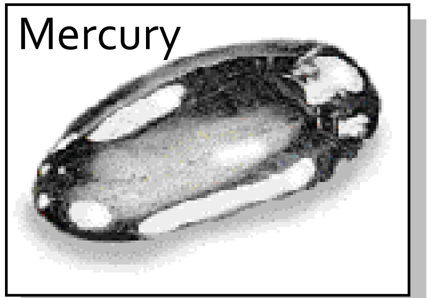
52.9



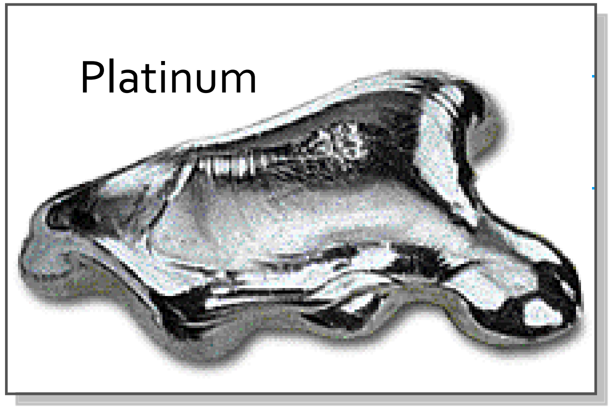
DENSITY

- an important and useful physical property

$$\text{Density} = \frac{\text{mass (g)}}{\text{volume (cm}^3\text{)}}$$



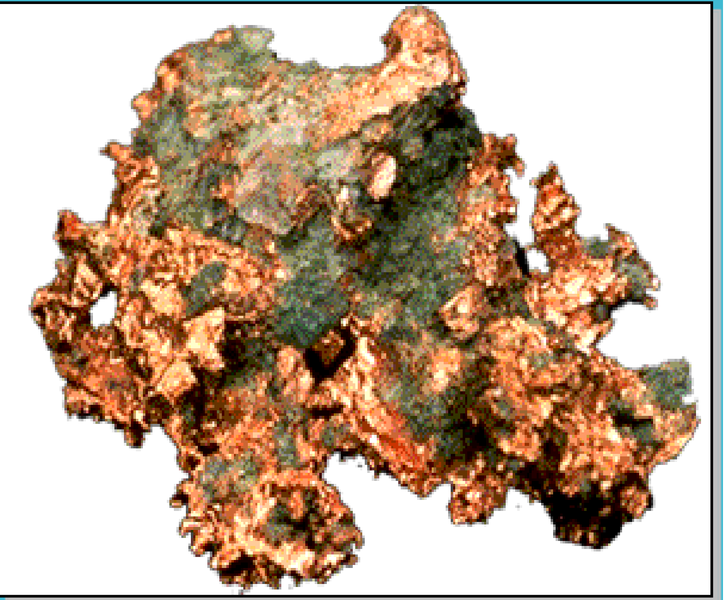
$13.6\ g/cm^3$



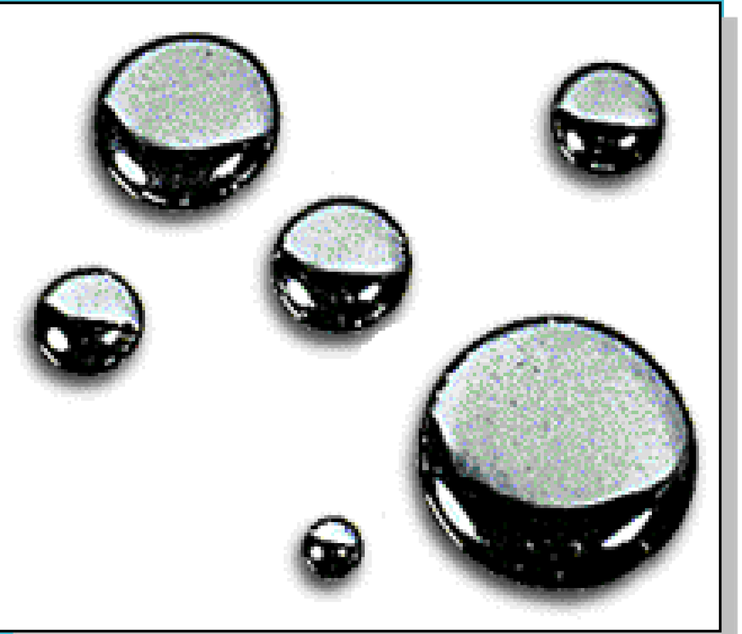
$21.5\ g/cm^3$

$2.7\ g/cm^3$

$$\text{Density} = \frac{\text{mass (g)}}{\text{volume (cm}^3\text{)}}$$



Problem A piece of copper has a mass of 57.54 g. It is 9.36 cm long, 7.23 cm wide, and 0.95 mm thick. Calculate density (g/cm^3).



PROBLEM: Mercury (Hg) has a density of 13.6 g/cm^3. What is the mass of 95 mL of Hg in grams? In pounds?

1. Convert volume to mass

$$95 \text{ cm}^3 \cdot \frac{13.6 \text{ g}}{\text{cm}^3} = 1.3 \times 10^3 \text{ g}$$

2. Convert mass (g) to mass (lb)

$$1.3 \times 10^3 \text{ g} \cdot \frac{1 \text{ lb}}{454 \text{ g}} = 2.8 \text{ lb}$$

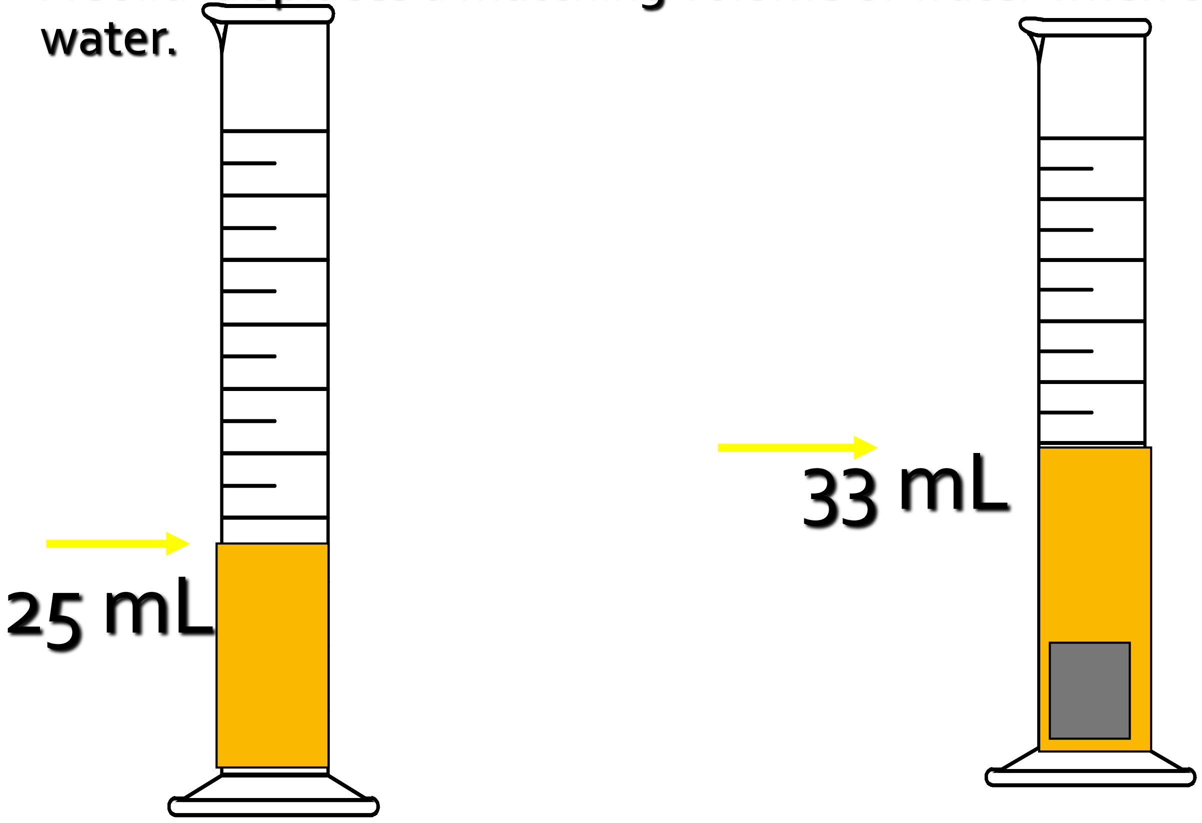
Learning Check

Osmium is a very dense metal. What is its density in g/cm^3 if 50.00 g of the metal occupies a volume of $2.22 cm^3$?

1) 2.25 g/cm^3
2) 22.5 g/cm^3
3) 111 g/cm^3

Volume Displacement

A solid displaces a matching volume of water when the solid is placed in water.

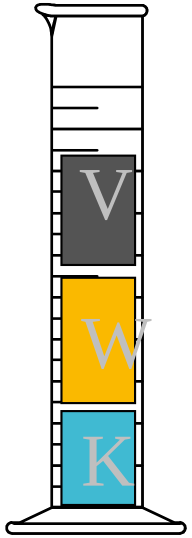


Learning Check

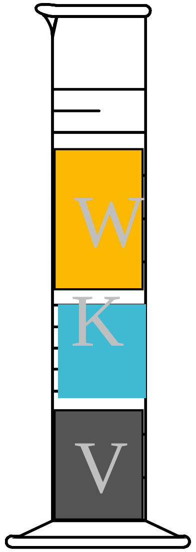
Which diagram represents the liquid layers in the cylinder?

(K) Karo syrup (1.4 g/mL), (V) vegetable oil (0.91 g/mL,) (W) water (1.0 g/mL)

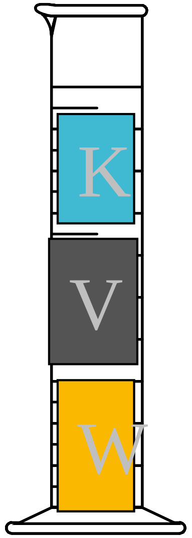
1)



2)



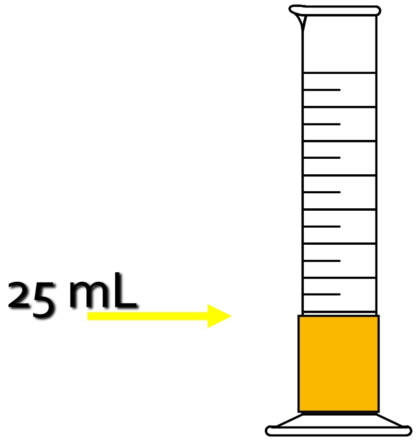
3)

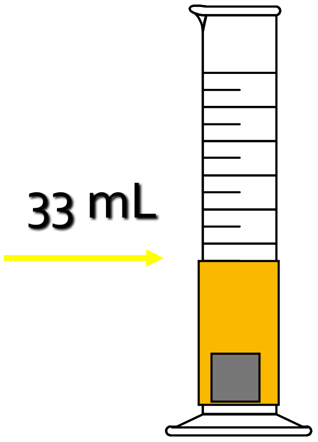


Learning Check

What is the density (g/cm³) of 48 g of a metal if the metal raises the level of water in a graduated cylinder from 25 mL to 33 mL?

1) $0.2\ g/cm^3$ 2) $6\ g/m^3$ 3) $252\ g/cm^3$





Learning Check

If blood has a density of 1.05 g/mL, how many liters of blood are donated if 575 g of blood are given?

1) 0.548 L
2) 1.25 L
3) 1.83 L

Questions?

Let’s have our Quiz 2