Read pages 5-10 in textbook

Chemistry- *the study of matter and the changes that it undergoes*.

Science- the use of ____*evidence*_____ to construct testable _____*explanations*_____ and _____*predications*_____ of natural phenomena, and the ____*knowledge*_____ generated through this process.

Hypothesis- *a testable explanation of a situation or phenomena.*

Scientific Inquiry- *the nature, or essential characteristic of science, the development of new explanations.*

Theory- an explanation of a _____ *natural phenomenon* _____based on many _____ *observations* _____and _____ *investigations* _____over time. Theories can be_____ *modified* _____.

Scientific Law- *a relationship in nature that is supported by many experiments.*

Pure vs. Applied Research

Pure- *to gain knowledge for the sake of knowledge itself.*

Applied- *to solve a specific problem. Example- research a cure for cancer*.

Matter and Its Characteristics

Matter- *anything that has mass and takes up space*

Substance- *is matter that has a definite and uniform composition.*

Scientists use mass instead of weight so that scientists all over the world can compare measurements.

Mass- a *measurement that reflects the amount of matter.*

Weight- *a measure of the amount of matter and the effect of the Earth's gravitational pull on that matter*

Weight vs. Mass Across the Solar

Chemistry seeks to explain the _____ *submicroscopic* _____ events that lead to _____ *macroscopic* _____observations.

The_____ *structure* _____ *composition*_____ _____, and _____ *behavior* _____of all matter can be explained on a submicroscopic level (atomic level).

Lab- Weight vs. Mass Across the Solar System
Read pages 11-26 in textbook

Measurement

The Seven Base SI Units

Quantity	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Temperature	kelvin	K
Time	second	s
Amount of Substance	mole	mol
Luminous Intensity	candela	cd
Electric Current	ampere	a

- *There are 7 base units that scientists use to measure matter.*
- *Scientists add prefixes to these base units to describe different amounts.*

Prefixes	Value	Standard form	Symbol
Tera	1 000 000 000 000	10^{12}	T
Giga	1 000 000 000	10^{9}	G
Mega	1 000 000	10^{6}	M
Kilo	1 000	10^{3}	k
deci	0.1	10^{-1}	d
centi	0.01	10^{-2}	c
milli	0.001	10^{-3}	m
micro	0.000 001	10^{-6}	μ
nano	0.000 000 001	10^{-9}	n
pico	0.000 000 000 001	10^{-12}	p

Time-
SI base unit= *second (s).*

The physical standard used to define the second is- *the frequency of the radiation given off by a cesium-133 atom.*

Length-
SI base unit= *meter (m).*

A meter is the distance that- *light travels in a vacuum in 1/299,792,458 of a second.*

Mass-
Si Base unit= *kilogram (kg).*

A platinum and iridium- *cylinder kept in France defines the kilogram.*

Kilogram= 2.2 pounds

Temperature-
a quantitative measurement of the average kinetic energy of the particles that make up an object.

As the particle motion in an object increases… *so does the temperature of the object.*

SI base unit= *Kelvin.*
Water freezes at 273.15 K, and boils at 373.15 K
K= °C + 273

Practice ➡

1kg= ?g
1000g

2000m= ?km
2km

300cm= ?m
3m

100cm= ?d
10d

48 hr.= ?s.
172,800 s.

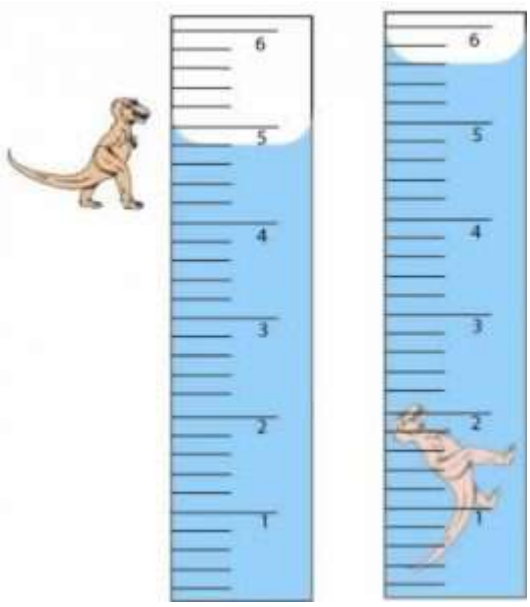
99° C = ? K
372 K

6kg= ?mg
6,000,000 mg

Metric System Task Cards
Metric Measurement Lab

Derived Units-

a unit defined by a combination of base units.
Example- speed=m/s, volume= cm^3, density= g/cm^3.



Volume-

The space occupied by an object.
The SI base unit = cubic meter.

We often see volume measured in Liters.
1 liter is equal to 1 cubic decimeter.

In the lab- *we will most often measure liquids in milliliters.*
1 mL= 1 cm^3
1 L = 1000 mL

The volume of irregularly shaped objects can be determined using the_____ *water displacement method*._____.

Density-

a physical property of matter, defined as the amount of mass per unit volume.

Units for a solid- *g/cm^3,*
Units for liquids- *g/mL.*

Calculated using mass and volume measurements.

Density= mass/volume

Substance	Density/g cm^{-3}*
Helium gas	0.000 16
Dry air	0.001 185
Gasoline	0.66 → 0.69 (varies)
Kerosene	0.82
Benzene	0.880
Water	1.000
Carbon tetrachloride	1.595
Magnesium	1.74
Salt	2.16
Aluminum	2.70
Iron	7.87
Copper	8.96
Silver	10.5
Lead	11.34
Uranium	19.05
Gold	19.32

Density Practice Problems:

An unknown metallic object has a volume of 1.50 cm^3 and mass of 2.61 g. What is the objects density? Use the table to the left to determine the objects identity.
1.74 g/cm^3, Magnesium

Aluminum has a density of 2.7 g/cm^3. What is the volume of a 4.5g piece of aluminum?
1.7 cm^3

A piece of Copper has a volume of 2.3 cm^3, what is its mass?
21 g

Scientific Notation

Scientists use this method to restate a number without_____ *changing its value*_____..

Determining the exponents to use when writing scientific notation- *count the number of places the decimal point must be moved to give a coefficient between 1 and 10.*

The exponent is __ *negative* __when the decimal moves to the ____ *left*____.

The exponent is ___ *positive*____ when the decimal moves to the ___ *right*___.

Example-
520= 5.20 x 10^2
.0005 = 5.0 x 10^{-4}

Multiplication/Division of Scientific Notation

Two step process:

Multiplication
1. *Multiply the coefficients*
2. *Add the exponents*

Division
1. *Divide the coefficients*
2. *Subtract the exponents*

Example:
2.5 x 10^2 x 2.0 x 10^3 =
5.0 x 10^5

4.2 x 10^3 / 2.1 x 10^1 =
2.0 x 10^2

Addition/Subtraction of Scientific Notation

Exponents must be the same.

Examples:
2.2 x 10^2 + 1.1 x 10^2= 3.3 x 10^2
5.4 x 10^4 - 2.2 x 10^4 = 3.2 x 10^4

If they are not the same you must rewrite them.

Example:
2.20 x 10^4 + 1.10 x 10^2=

Change the 2 to a 4 by moving the decimal point.

2.20 x 10^4 + .0110 x 10^4=2.21x10^4

Practice:

1.2 x 10^4 + 2.3 x 10^4=
3.5 x 10^4

5.3 x 10^8 – 2.2 x10^8 =
3.1 x 10^8

2.1 x 10^4 + 5.5 x 10^2 =
2.15 x 10^4

4.5 x 10^6 – 1.7 x 10^5=
4.5 x 10^6 - .17 x 10^6=
4.3 x10^6

Practice:

3.2 x 10^6 x 2.3 x 10^4 =
7.4 x 10^{10}

1.2 x 10^8 x 4.4 x 10^2=
5.3 x 10^{10}

2.5 x 10^4 x 1.2 x 10^2 =
3.0 x 10^6

3.2 x 10^6 / 2.3 x 10^4 =
1.4 x 10^2

4.4 x 10^8 / 1.2 x 10^2=
3.7 x 10^6

Dimensional Analysis

Uses conversion factors to move, or convert, from one unit to another.

Conversion factors are *derived from equality relationships.*

Example: 1 foot= 12 inches, 100 cm to 1 m.

Dimensional Analysis must accomplish two things:

1. It must cancel one unit and introduce a new one.
2. All of the units except the desired unit must cancel.

Challenge #1:

You are driving at a speed of 65 mph. If you take your eyes off the road for two seconds while you reach for your coffee, how many feet do you travel during those two seconds?

Practice:

3500 cm to m

2 km to m

3600 sec. to min.

5 m to cm

6500 g to kg

250 cm to km

Challenge #2:

If water drips from a faucet at a rate of one drop every three seconds, how many liters could be collected after one day? Assume 20 drops equal one milliliter.

Fudge Lab
Read pages 27-35 in textbook

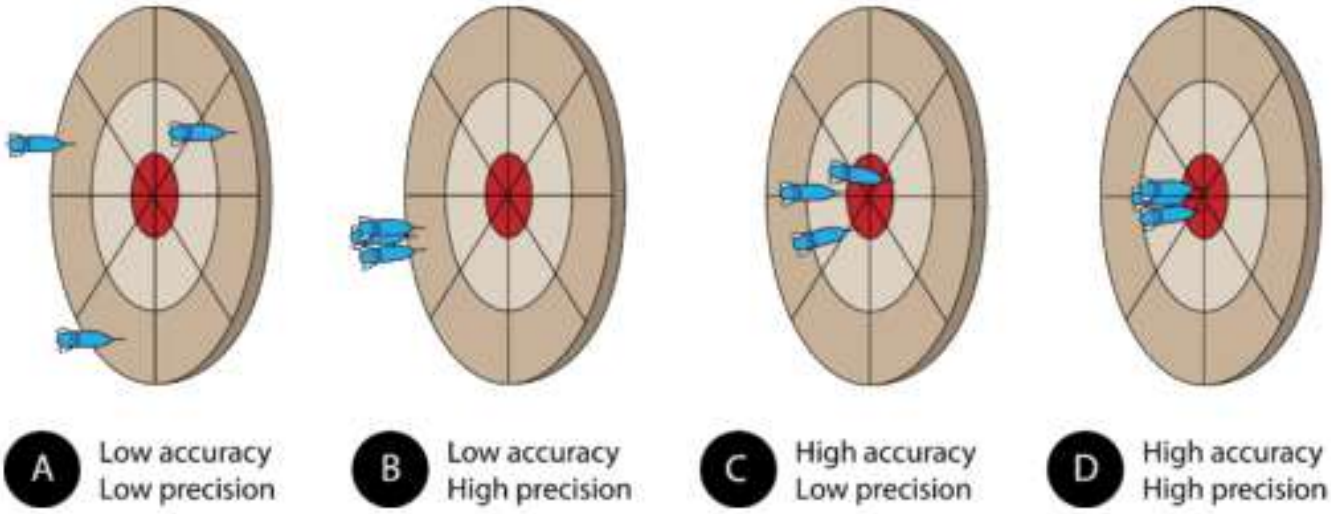
Uncertainty of Data

Accuracy-

How close a measured value is to an accepted value

Precision-

How close a series of measurements are to one another.



Precise measurements might not be __*accurate*_____.

To evaluate the accuracy of experimental data-

compare how close the experimental value is to the accepted value.

Error- *the difference between an experimental value and an accepted value.*

Error= experimental value – accepted value

Percent Error- *expresses error as a percentage of the accepted value.*

Percent Error=
error/ accepted value x 100

Practice #1-

A student calculates the density of Magnesium to be 1.9 g/cm^3. Calculate the percent error. (The density of Magnesium is 1.738 g/cm^3.)

1.9-1.738= .162

.162 / 1.738 x 100= 9.3%

Practice #2-

A student calculates the density of Copper to be 8.88 g/cm^3. Calculate the percent error. (The density of Copper is 8.96 g/cm^3.)

8.88-8.96= -.08

.08 / 8.96 x 100= .89%

Significant Figures

The precision of a measurement is indicated by_____ the number of digits reported___.

A measurement reported with a lot of significant figures might be__ precise____, but may not be__ accurate__.

Include all known digits plus one __ estimated _____digit.

Rules:

General:

Read from the left and start counting sig figs when you encounter the first non-zero digit

1. All non zero numbers are significant (meaning they count as sig figs)
   - 613 has three sig figs
   - 123456 has six sig figs
2. Zeros located between non-zero digits are significant (they count)
   - 5004 has four sig figs 602 has three sig figs
   - 6000000000000002 has 16 sig figs!
3. Trailing zeros (those at the end) are significant only if the number contains a decimal point; otherwise they are insignificant (they don't count)
   - 5.640 has four sig figs
   - 120000. has six sig figs
   - 120000 has two sig figs
4. Zeros to left of the first nonzero digit are insignificant (they don't count); they are only placeholders!
   - 0.000456 has three sig figs
   - 0.052 has two sig figs
   - 0.00000000000000000000000000000000052 also has two sig figs!

Practice:

Indicate how many significant figures there are in each of the following measured values.

_____ 246.32 *5 sig figs*

_____ 107.854 *6 sig figs*

_____ 100.3 *4 sig figs*

_____ 0.678 3 sig figs

_____ 1.008 4 sig figs

_____ 0.00340 3 sig figs

_____ 14.600 5 sig figs

_____ 0.0001 *1 sig fig*

_____ 700000 *1 sig fig*

_____ 350.670 *6 sig figs*

_____ 1.0000 *5 sig figs*

_____ 320001 *6 sig fig*

Rules for addition/subtraction problems:

1. Your calculated value cannot be more precise than the least precise quantity used in the calculation. The least precise quantity has the fewest digits to the right of the decimal point. Your calculated value will have the same number of digits to the right of the decimal point as that of the least precise quantity.

2. In practice, find the quantity with the fewest digits to the right of the decimal point. In the example below, this would be 11.1 (this is the least precise quantity).
   7.939 + 6.26 + 11.1 = 25.299 (this is what your calculator spits out)
3. In this case, your final answer is limited to one sig fig to the right of the decimal or 25.3 (rounded up).

Practice:

Calculate the answers to the appropriate number of significant figures.

```
  32.567          658.0
  135.0             23.5478
+   1.4567      + 1345.29
  169.0           2026.8
```

2.1 +2 = *4*

2.3 + 1.23 + 5.222 = *8.7*

```
  246.24          22.0
  238.278        111.3312
+  98.3        + 2222.1
  582.8           2355.4
```

6.23 – 1.1 – 2.366= *2.8*

8.82 – 4.444 – 2.5= *1.9*

Rules for multiplication/division problems:

1. The number of sig figs in the final calculated value will be the same as that of the quantity with the fewest number of sig figs used in the calculation.
2. In practice, find the quantity with the fewest number of sig figs. In the example below, the quantity with the fewest number of sig figs is 27.2 (three sig figs). Your final answer is therefore limited to three sig figs.
   (27.2 x 15.63) ÷ 1.846 = 230.3011918 (this is what you calculator spits out)
3. In this case, since your final answer it limited to three sig figs, the answer is 230. (rounded down)

Practice:

Calculate the answers to the appropriate number of significant figures.

a) 23.7 x 3.8 = *90.*

b) 45.76 x 0.25 = *11*

c) 81.04 g x0.010 = *0.81*

d) 6.47 x 64.5 = *417*

e) 43.678 x 64.1 = 2.80×10^3

f) 1.678 / 0.42 = *4.0*

g) 28.367 / 3.74 = *7.58*

h) 4278 / 1.006 = *4252*

Rules for combined addition/subtraction and multiplication/division problems:

1. Use the order of mathematical operations to determine which order to apply the rules for addition/subtraction (determine the number of sig figs for that step) or the rules for multiplication/division.
   (23 + 7) ÷ 10.0 = 3 (this is what your calculator spits out)
2. In this case, your answer should have 2 significant figures, 3.0.

Example:

137.3 s + 2(35.45 s) =

Perform multiplication first.

2(35.45 s *4 sig figs*) = **70.90 s** *4 sig figs*

The number with the least number of significant figures is 35.45; *the number 2 is an exact number and therefore has an infinite number of significant figures.*

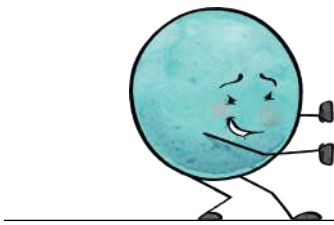
Then, perform the addition.

137.3 s *tenths place (least precise)* + **70.90 s** *hundredths place* = 208.20 s

Round the final answer.

Round the final answer to the tenths place based on 137.3 s.

208.2



Practice:

5(1.008 s) - 10.66 s
-5.62 s

2.12 m + 4(552 cm)
24.2 m

99.0 cm+ 2(5.56 cm)
110.1 cm

3.23 km – 2(1.2 km)
.83 km

Read pages 36-41 in textbook
Sig Fig Lab

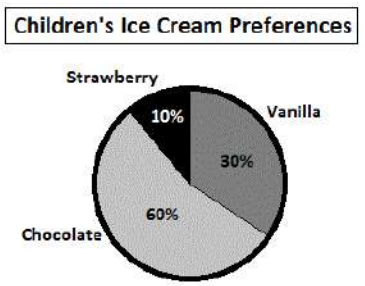
Representing Data

When collecting data you are often times looking for patterns in your results.

A powerful tool in looking for patterns is graphing (circle, bar, and line graphs)

Circle Graphs

-Useful for showing parts of a fixed whole.



-Parts are usually labeled as percent's with the whole circle representing 100%

Independent and Dependent Variables

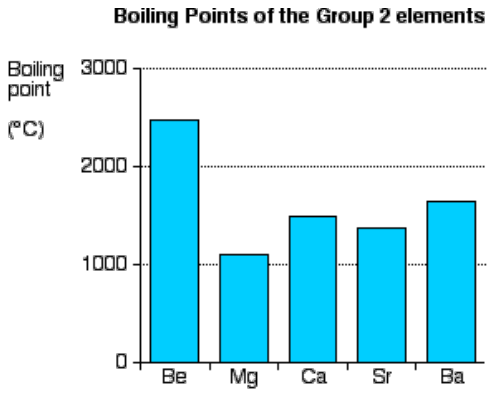
Independent Variable- *the variable that is deliberately changed during an experiment (plotted on the x-axis).*

Dependent Variable- *the variable whose value depends on or changes in response to the independent variable (plotted on the y-axis).*

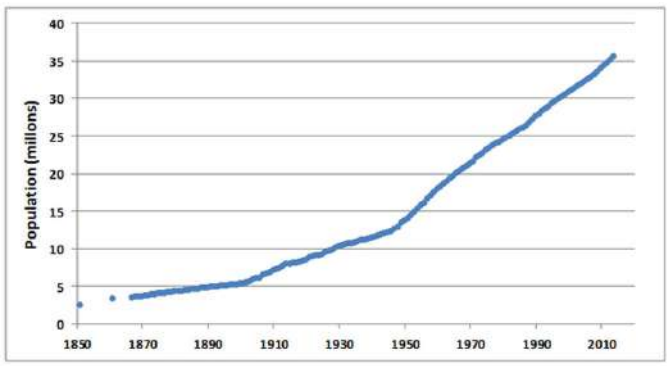
Example:
In a study to determine whether how long a student sleeps affects test scores, the independent variable is the length of time spent sleeping while the dependent variable is the test score.

Bar Graphs

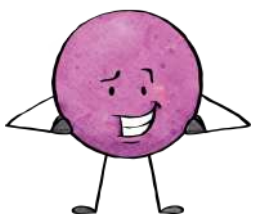
- *Often used to show how a quantity varies across categories.*
- *The quantity being measured appears on the vertical axis (y-axis)*
- *The independent variable appears on the horizontal axis (x- axis).*



Line Graphs

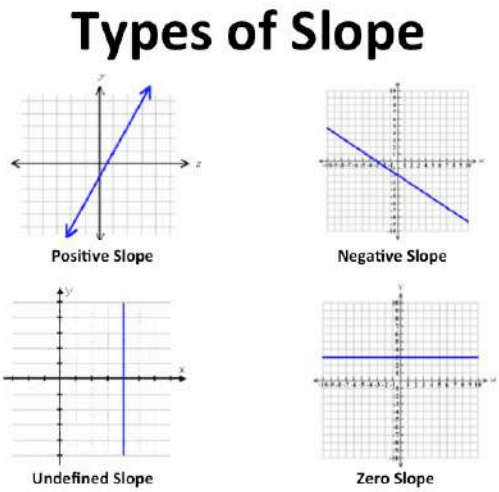


- *The points on the line represent the interaction of data for the independent and dependent variables.*
- *The line must be drawn so that about as many points fall above the line as below the line-best fit line.*



Graph Interpretation

Slope = rise over run



- *If the best fit line is straight= the variables are directly related.*

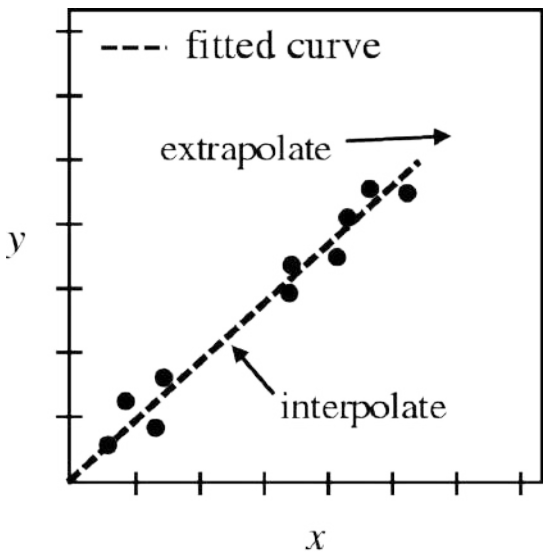
- *If the best fit line rises to the right- the slope of the line is positive. The dependent variable increases as the independent variable increases.*

- *If the best fit line sinks to the right- the slope of the line is negative. The dependent variable decreases as the independent variable increases.*

Interpolation and Extrapolation

Reading the value from any point that falls between recorded data points

Extending a line beyond the plotted points in order to estimate values.



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Theory- an explanation of a _____based on many _____and _____over time. Theories can be_____.

Scientific Law-

Pure vs. Applied Research

Pure-

Applied-

Matter and Its Characteristics

Matter-

Substance-

Mass-

Weight-

Weight vs. Mass Across the Solar System

Chemistry seeks to explain the _____ events that lead to _____observations.

The_____, _____, and _____of all matter can be explained on a submicroscopic level (atomic level).

Lab- Weight vs. Mass Across the Solar System
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Measurement

The Seven Base SI Units

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-
-

Prefixes	Value	Standard form	Symbol
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Time-
SI base unit=

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Mass-
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Kilogram= 2.2 pounds

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Water freezes at 273.15 K, and boils at 373.15 K
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Practice ➡

1kg= ?g

2000m= ? km

300cm= ? m

100cm= ? d

48 hr.= ? s.

99° C = ? K

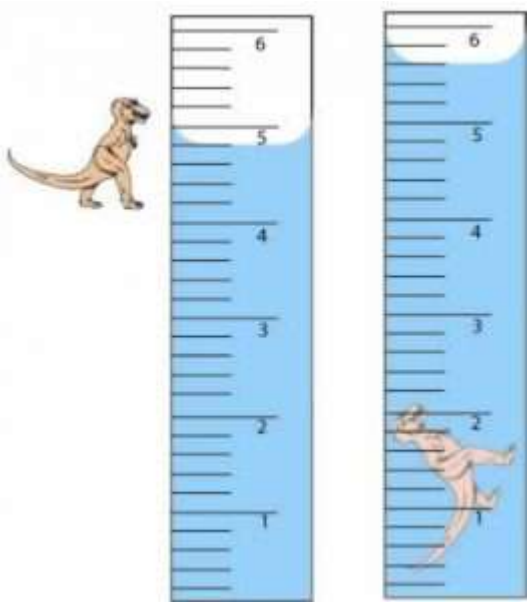
6kg= ? mg

Metric System Task Cards
Metric Measurement Lab

Derived Units-

-

Volume-



The SI base unit =

We often see volume measured in Liters.
1 liter is equal to 1 cubic decimeter.

In the lab-

The volume of irregularly shaped objects can be determined using the _____.

Density-

Units for a solid-
Units for liquids-

Density= mass/volume

Substance	Density/g cm^{-3}*
Helium gas	0.000 16
Dry air	0.001 185
Gasoline	0.66 → 0.69 (varies)
Kerosene	0.82
Benzene	0.880
Water	1.000
Carbon tetrachloride	1.595
Magnesium	1.74
Salt	2.16
Aluminum	2.70
Iron	7.87
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Silver	10.5
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The exponent is _____ when the decimal moves to the _____.

Example-
520= 5.20 x 10^2
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Multiplication/Division of Scientific Notation

Two step process:

Multiplication
1

2

Division
1

2

Example:
2.5 x 10^2 x 2.0 x 10^3 =
5.0 x 10^5

4.2 x 10^3 / 2.1 x 10^1 =
2.0 x 10^2

Addition/Subtraction of Scientific Notation

Exponents must be the same.

Examples:
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If they are not the same you must rewrite them.

Example:
2.20 x 10^4 + 1.10 x 10^2=
Change the 2 to a 4 by moving the decimal point.
2.20 x 10^4 + .0110 x 10^4=2.21x10^4

Practice:

1.2 x 10^4 + 2.3 x 10^4=

5.3 x 10^8 – 2.2 x10^8 =

2.1 x 10^4 + 5.5 x 10^2 =

4.5 x 10^6 – 1.7 x 10^5=

Practice:

3.2 x 10^6 x 2.3 x 10^4 =

1.2 x 10^8 x 4.4 x 10^2=

2.5 x 10^4 x 1.2 x 10^2 =

3.2 x 10^6 / 2.3 x 10^4 =

4.4 x 10^8 / 1.2 x 10^2=

Dimensional Analysis

•

Conversion factors are _____ _____.

Example: 1 foot= 12 inches, 100 cm to 1 m.

Dimensional Analysis must accomplish two things:
1

2

Challenge #1:

You are driving at a speed of 65 mph. If you take your eyes off the road for two seconds while you reach for your coffee, how many feet do you travel during those two seconds?

Practice:

3500 cm to m

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Fudge Lab
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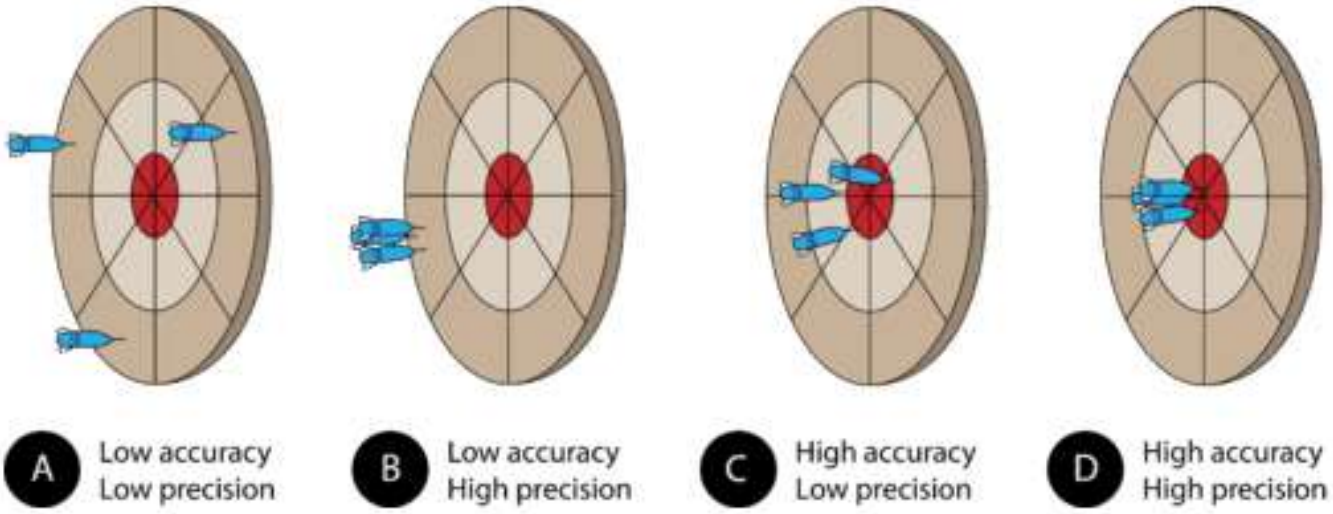
Uncertainty of Data

Accuracy-

Precision-



Precise measurements might not be _____.

To evaluate the accuracy of experimental data-

-

Error-

Error= experimental value – accepted value

Percent Error-

Percent Error=
error/ accepted value x 100

Practice #1-

A student calculates the density of Magnesium to be 1.9 g/cm^3. Calculate the percent error. (The density of Magnesium is 1.738 g/cm^3.)

Practice #2-

A student calculates the density of Copper to be 8.88 g/cm^3. Calculate the percent error. (The density of Copper is 8.96 g/cm^3.)

Significant Figures

The precision of a measurement is indicated by_____.

A measurement reported with a lot of significant figures might be _____, but may not be_____.

Include all known digits plus one _____digit.

Rules:

General:

Read from the left and start counting sig figs when you encounter the first non-zero digit

1. All non zero numbers are significant (meaning they count as sig figs)
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   - 5004 has four sig figs 602 has three sig figs
   - 6000000000000002 has 16 sig figs!
3. Trailing zeros (those at the end) are significant only if the number contains a decimal point; otherwise they are insignificant (they don't count)
   - 5.640 has four sig figs
   - 120000. has six sig figs
   - 120000 has two sig figs
4. Zeros to left of the first nonzero digit are insignificant (they don't count); they are only placeholders!
   - 0.000456 has three sig figs
   - 0.052 has two sig figs
   - 0.00000000000000000000000000000000052 also has two sig figs!

Practice:

Indicate how many significant figures there are in each of the following measured values.

_____ 246.32

_____ 107.854

_____ 100.3

_____ 0.678

_____ 1.008

_____ 0.00340

_____ 14.600

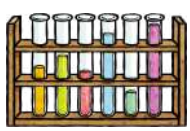
_____ 0.0001

_____ 700000

_____ 350.670

_____ 1.0000

_____ 320001



Rules for addition/subtraction problems:

1. Your calculated value cannot be more precise than the least precise quantity used in the calculation. The least precise quantity has the fewest digits to the right of the decimal point. Your calculated value will have the same number of digits to the right of the decimal point as that of the least precise quantity.

2. In practice, find the quantity with the fewest digits to the right of the decimal point. In the example below, this would be 11.1 (this is the least precise quantity).
   7.939 + 6.26 + 11.1 = 25.299 (this is what your calculator spits out)
3. In this case, your final answer is limited to one sig fig to the right of the decimal or 25.3 (rounded up).

Practice:

Calculate the answers to the appropriate number of significant figures.

```
  32.567        658.0
  135.0           23.5478
+   1.4567    + 1345.29
```

2.1 +2 =

2.3 + 1.23 + 5.222 =

6.23 – 1.1 – 2.366=

8.82 – 4.444 – 2.5=

```
  246.24          22.0
  238.278        111.3312
+  98.3       + 2222.1
```

Rules for multiplication/division problems:

1. The number of sig figs in the final calculated value will be the same as that of the quantity with the fewest number of sig figs used in the calculation.
2. In practice, find the quantity with the fewest number of sig figs. In the example below, the quantity with the fewest number of sig figs is 27.2 (three sig figs). Your final answer is therefore limited to three sig figs.
   (27.2 x 15.63) ÷ 1.846 = 230.3011918 (this is what you calculator spits out)
3. In this case, since your final answer it limited to three sig figs, the answer is 230. (rounded down)

Practice:

Calculate the answers to the appropriate number of significant figures.

a) 23.7 x 3.8 =

b) 45.76 x 0.25 =

c) 81.04 g x0.010 =

d) 6.47 x 64.5 =

e) 43.678 x 64.1 =

f) 1.678 / 0.42 =

g) 28.367 / 3.74 =

h) 4278 / 1.006 =

Rules for combined addition/subtraction and multiplication/division problems:

1. Use the order of mathematical operations to determine which order to apply the rules for addition/subtraction (determine the number of sig figs for that step) or the rules for multiplication/division.
   (23 + 7) ÷ 10.0 = 3 (this is what your calculator spits out)
2. In this case, your answer should have 2 significant figures, 3.0.

Example:

137.3 s + 2(35.45 s) =

Perform multiplication first.

2(35.45 s *4 sig figs*) = **70.90 s** *4 sig figs*

The number with the least number of significant figures is 35.45; *the number 2 is an exact number and therefore has an infinite number of significant figures.*

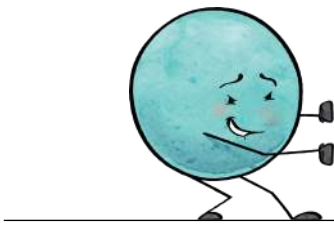
Then, perform the addition.

137.3 s *tenths place (least precise)* + **70.90 s** *hundredths place* = 208.20 s

Round the final answer.

Round the final answer to the tenths place based on 137.3 s.

208.2



Practice:

5(1.008 s) - 10.66 s

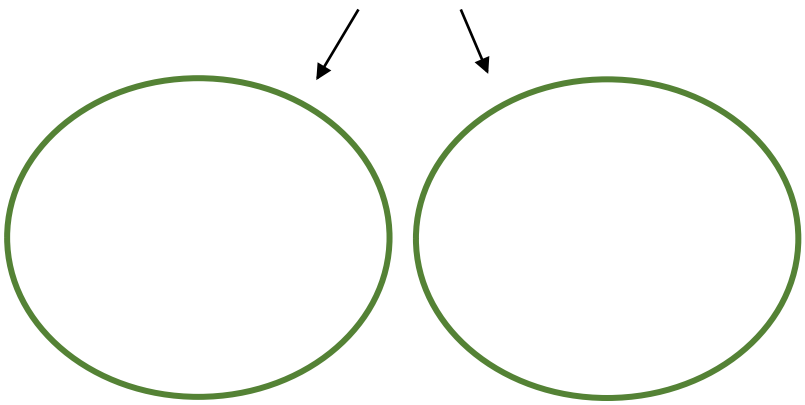
2.12 m + 4(552 cm)

99.0 cm+ 2(5.56 cm)

3.23 km – 2(1.2 km)

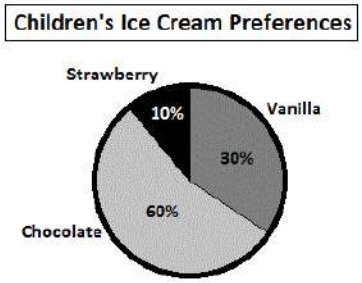
Read pages 36-41 in textbook
Sig Fig Lab

Representing Data



Circle Graphs

-
-



Independent and Dependent Variables

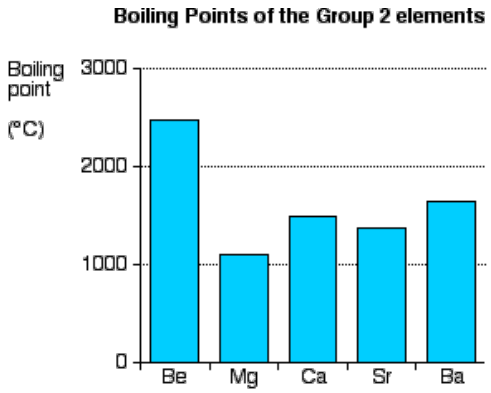
Independent Variable-

Dependent Variable-

Example:
In a study to determine whether how long a student sleeps affects test scores, the independent variable is the length of time spent sleeping while the dependent variable is the test score.

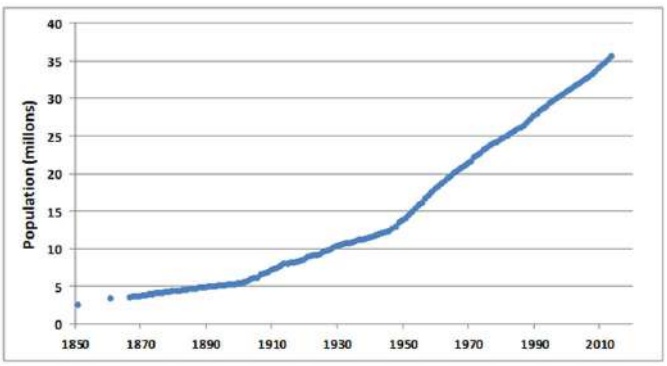
Bar Graphs

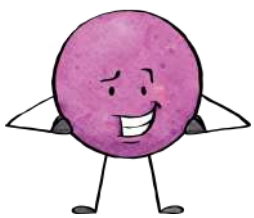
-
-
-



Line Graphs

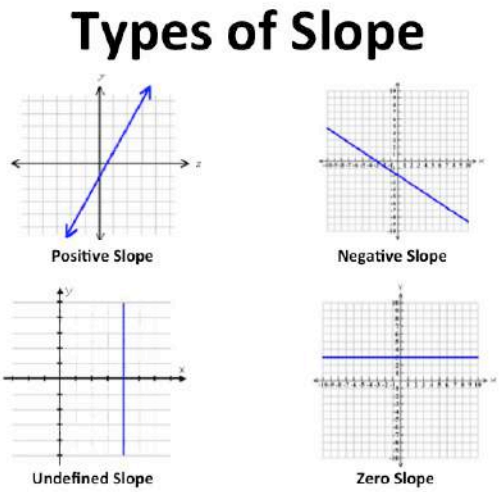
-
-





Graph Interpretation

Slope = rise over run



Interpolation and Extrapolation