Meas-Calc
Topic#2
AMSAT
Chem 1H

Meas/Calc
Topic#2

Procedure for Assignments

In WS Notebook:

1. Write your name in the right upper corner of every front facing page.
2. With each new assignment, write the date it was assigned on the lef.
3. Write name of assignment along with the date the assignment was assigned.
   i.e. WS#1: Safety Symbols (8/13/19)

Meas/Calc
Topic#2

Showing work for a problem:

1) What is the mass of $2.3cm^3$ of aluminum (Al)?
The density of aluminum is $2.70g/cm^3$.

(a) write formula: $d = m/V$

(b) create data table for variables:

$d = 2.70g/cm^3$

m= ?

$V= 2.3cm^3$

(c) Solve formula for unknown variable.

$m = d \times V$

(d) Input givens into formula and solve.

$m = (2.70g/cm^3)(2.3cm^3) = 6.21g$

(e) Write answer in correct significant figures and correct label. Highlight answer with a box, circle, or highlighter.

Ans: 6.2g Al

Meas/Calc

Topic#2

Scientific Method

quantitative (numbers and label)

observation

experiment

hypothesis - testable statement - problem

microscopic

procedure

define your system (everything else is surroundings)

control

research

variable

macroscopic

analyze data

qualitative (5 senses, no numbers)

theory (best explanation, predictive)

data **conclusion** **model**

research

Meas/Calc
Topic#2

Observations

Observations

1. Qualititative
   - Use your senses - sight, smell, taste, hear
   - Ex: clear skies, blue water
2. Quantitative
   - contains a number and a label (unit)
   - Ex. 23nm, 0.0034L

1. Direct
   - can see with your own eyes
2. Indirect
   - need to make an inference using data not seen

1. Macroscopic
   - big enough to see
2. Microsopic
   - too small to see

Topic#2 MeasCalc Sample WS#1: Qualitative vs. Quantitative

1. Identify as qualitative (a) or quantitative (b).

   a. dirty water ___ b. 24in wide ___ c. 3.000ng of U ___ d. blue jeans ___

   What is wrong with 7 tall? _____

Meas/Calc
Topic#2

SI Units

- set of standardized units used by scientists (quantity - magnitude, size, or amount).
  - length: meters (m)
    - standard: length of path traveled by light in a vacuum during a time interval of 1/299,792,458 of a second.
  - mass: kilogram (kg)
    - standard: the unit of mass equal to the mass of the international prototype of the kilogram.
  - time: second (s or sec)
    - standard: the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.
  - temperature (K): Kelvin (K = °C + 273.15) (0K absolute zero)
    - standard: the fraction 1/273.15 of the thermodynamic temperature of the triple point of water.
  - amount of substance: mole (1 mol = 6.022×10^{23} objects (Avogadro's number))
    - standard: the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilograms of carbon-12.

Meas/Calc
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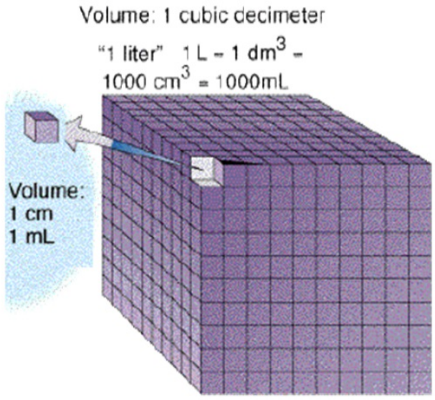
SI Units

SI Prefixes (NTK)

kilo	k	1000	10^{3}	1km = 1000m
deci	d	1/10	10^{-1}	1dm = 0.1m
centi	c	1/100	10^{-2}	1cm = 0.01m
milli	m	1/1000	10^{-3}	1mm = 0.001m
micro	μ	1/1 000 000	10^{-6}	1μm = $1x10^{-6}$m
nano	n	1/1 000 000 000	10^{-9}	1nm = $1x10^{-9}$m
*Angstrom	A	1/10 000 000 000	10^{-10}	1A = $1x10^{-10}$m

Meas/Calc
Topic#2

SI Units



Derived SI Units (Complex label, cannot be simplified)

- uses two or more SI units to formulate a new unit

- area	s x s	m^2
- volume	s x s x s	m^3
- density	mass per volume	g/mL
- molar mass	grams per mol	g/mol
- energy	joule	J

NTK

1000mL = 1L

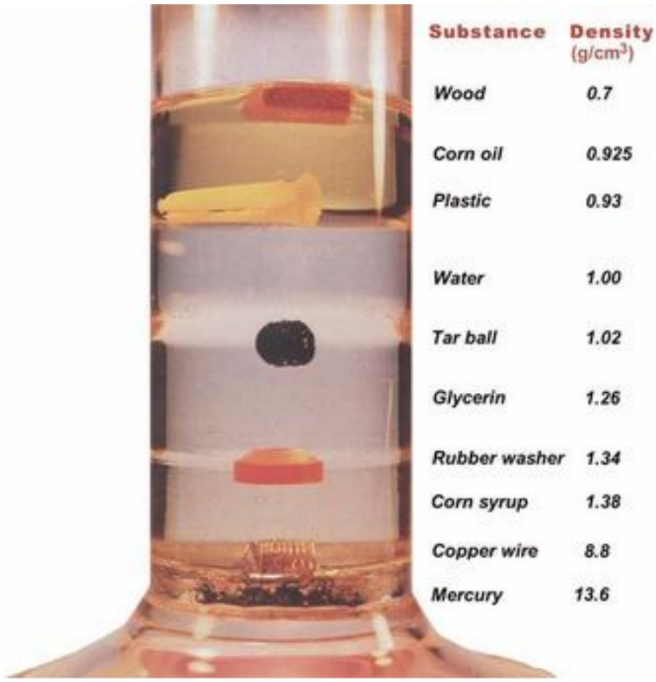
$1cm^3$ = 1mL ($1000cm^3$ = 1L)

$1dm^3$ = 1L (1dm = 10 cm; 10cm x 10cm x10cm = $1000cm^3$)

$1m^3$ = 1000L (1m = 100cm; 100cm x 100cm x 100cm = $\frac{1x10^6}{1000}cm^3$ = 1000L

Meas/Calc
Topic#2

Density



mass - amount of matter in object
volume - space object occupies
weight - gravity's affect on mass
density - ratio of mass to volume

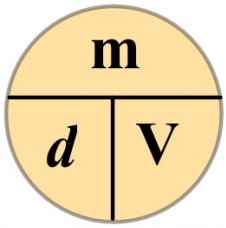
$$d = m/V$$

Memorize:
d_{H2O} = 1.00g/mL or 1.00g/cm^3

Density

Formula for Density

$d = m/V$



Topic#2 MeasCalc Sample WS#1: Density

2. A sample of aluminum metal has a mass of 8.4g. The volume of the sample is 3.1cm^3. Calculate the density of aluminum. (Ans: 2.7g/cm^3)

$d = \frac{m}{V} = \frac{8.4\text{g}}{3.1\text{cm}^3} = 2.7\text{g/cm}^3$

3. Given a density of 13.6g/cm^3, what is the volume of a sample of liquid mercury that has a mass of 76.2g? (Ans: 5.60cm^3)

Gun
$d = 13.6\text{g/cm}^3$
$m = 76.2\text{g}$

NTK
$V = \frac{m}{d}$

Solve:
$V = \frac{76.2\text{g}}{13.6\text{g/cm}^3} = 5.60\text{cm}^3$

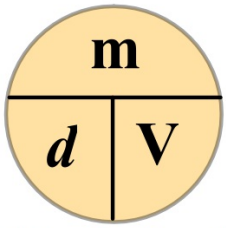
Unk
$V = 5.60\text{ cm}^3$

Meas/Calc
Topic#2

Density

Formula for Density

$d = m/V$



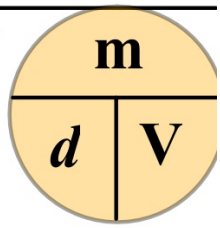
4. (OYO) Ice has a density of 0.90g/cm^3. Calculate the mass of 234.2cm^3 of ice. (Ans: 210g)

Meas/Calc
Topic#2

Density

Formula for Density

$d = m/V$



Starter Density

1. Calculate the mass of copper in grams ($d_{Cu} = 8.94 g/cm^3$) with the same volume as 100.0grams of gold ($d_{Au} = 19.31 g/cm^3$). (Ans: 46.30g)

2. Liquid mercury has a density of 13.546g/mL. What is the volume of a 151.89g sample? (Ans: 11.213mL)

3. A spherical ball bearing has a radius of 8.50 mm and a mass of 2.315 g. What is the density of the ball bearing? (in g/cm^3)? The formula for volume of a sphere is $V = (4/3)\pi r^3$. (Ans: $0.900 g/cm^3$)

Dimensional Analysis

Converting one unit (label) to another unit (label) using dimensional analysis and factors.
A conversion factor is an equivalency between two units (lables). i.e. 10cm = 1dm

Topic#2 MeasCalc Sample WS#1: Dimensional Analysis

* fundamental relationship between the two units.

5. Length (1000 mm = 100 cm = 10 dm = 1 m)

(a) ____ cm = 0.230m (* 100cm = 1m) $\frac{1m}{100cm}$ or $\frac{100cm}{1m}$

$$0.230\,\cancel{m} \times \frac{100\,cm}{1\,\cancel{m}} = \boxed{23\ cm}$$

(b) 345 cm = ____ mm (* 1cm = 10mm)

$$345\,\cancel{cm} \times \frac{10\,mm}{1\,\cancel{cm}} = \boxed{3450\,mm}$$

Dimensional Analysis

Converting one unit (label) to another unit (label) using dimensional analysis and factors.
A conversion factor is an equivalency between two units (lables). i.e. 10cm = 1dm

Topic#2 MeasCalc Sample WS#1: Dimensional Analysis

5. Length (1000 mm = 100 cm = 10 dm = 1 m)

$\frac{1nm}{1\times10^{-9}} = \frac{1\times10^{-9}m}{1\times10^{-9}}$

(c)___ dm = 8.9 m (10dm = 1m)

$\frac{8.9\,m \mid 10dm}{1\,m} = \boxed{89\,dm}$

$1\times10^{9}nm = 1m$

$100\,cm = 1m$

(d) 760nm = __cm (1×10^{9} nm : 100 cm)

$\frac{760nm \mid 100\,cm}{1\times10^{9}\,nm} = \frac{760\times10^{2}\,cm}{1\times10^{9}} = 760\times10^{-7}\,cm = \boxed{0.0000760\,cm}$

$760\times10^{2-9}$

$7.6\times10^{-5}\,cm$

Dimensional Analysis

Converting one unit (label) to another unit (label) using dimensional analysis and factors.
A conversion factor is an equivalency between two units (lables). i.e. 10cm = 1dm

5. (OYO) (e) 323mL = __L (Ans: 0.323L)

(f) 10.05cm = __μm (Ans: 1.005×10^5cm)

Dimensional Analysis

Multi-Step Unit Conversion Problem (Time)

6. How many seconds in an hour? (Ans: 3600sec)

GVN

1 hr

NTK

60 s = 1 min

60 min = 1 hr

UNK

seconds : 3600 s

Solve: $1\ \text{hr} \times \frac{60\ \text{min}}{1\ \text{hr}} \times \frac{60\ \text{s}}{1\ \text{min}} = 3600\ \text{s}$

Dimensional Analysis

7. (OYO) How many seconds in a day? (Ans: 86,400sec; 8.64×10^4sec)

Dimensional Analysis

Derived Conversion Factors

1st to 2nd Dimension	**1st to 3rd Dimension**
100cm = 1m	**100cm = 1m**
_____cm² = ___m²	**_____cm³ = ___m³**

Topic#2 MeasCalc Sample WS#1: Derived Conversion Factors

8. How many cm^3 in $8489mm^3$?

GVN
$8489\,mm^3$

NTK
$(10\,mm)^3 = (1\,cm)^3$
$1 \times 10^3\,mm^3 = 1\,cm^3$

UNK
_____ cm^3

SOLVE:
$$8489\,mm^3 \left| \frac{1\,cm^3}{1 \times 10^3\,mm^3} \right. = 8.489\,cm^3$$

Dimensional Analysis

Converting Complex Units

9. Convert 5.87m/s to km/hr. (Ans: 21.1km/hr)

GVN
5.87 m/s

NTK
1×10^3 m = 1 km
3600 s = 1 hr

UNK
21.1 km/hr

SOLVE: $\frac{5.87\ \text{m}}{\text{s}} \left| \frac{1\ \text{km}}{1 \times 10^3\ \text{m}} \right| \frac{3600\ \text{s}}{1\ \text{hr}} = 21.13\ \text{km/hr}$

Dimensional Analysis

10. (OYO) Convert 0.0712kg/m^3 to g per cm^3. (Ans: 7.1x10^{-5}g/cm^3)

Dimensional Analysis

11. Using density as a conversion factor, determine the volume of 56.2g of aluminum.
($d_{Al} = 2.70 g/cm^3$) (Ans: $20.8 cm^3$)

Given
56.2g Al
$d_{Al} = 2.70 g/cm^3$

NTK
$2.70 g = 1 cm^3$

Unk

Solve: $\frac{56.2 g\ Al}{\frac{1 cm^3}{2.70 g}} = 20.8\ cm^3\ Al$

Dimensional Analysis

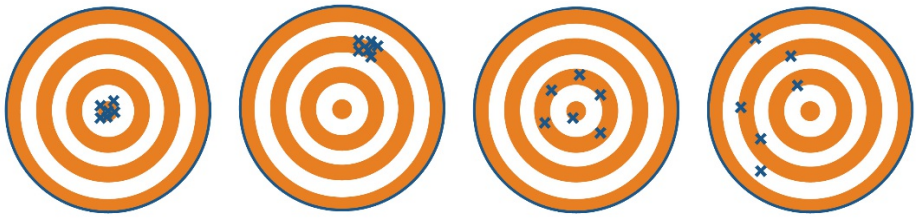
Dimensional Analysis Starter

1. Convert $1x10^8$ mm to meters.
2. Convert 0.00931km to mm.
3. How many square centimeters in 85 dm^2?
4. How many mm^3 in $45cm^3$?

Accuracy vs Precision

Meas/Calc
Topic#2

(Calc) d_{Al} = 2.60 g/cm³
(Acc) d_{Al} = 2.70 g/cm³



High Accuracy
High Precision

Low Accuracy
High Precision

High Accuracy
Low Precision

Low Accuracy
Low Precision

Precision - getting the same value for a measurement multiple times

e.g. - Rick used a scale to measure the mass of a beaker three times: 100.2 g, 100.1g, and 100.2. His measurements were precise.

Accuracy - close to the real value of the measurement

e.g - The real value of the beaker was 100.1g. So, Rick's measurement was accurate.

Accuracy and Precision

Trial #1	1.00g	0.99g	1.00g
Trial #2	0.93g	1.05g	0.87g
Trial #3	0.94g	0.93g	0.95g

Accepted value is 0.93g

Topic#2 MeasCalc Sample WS#2: Accuracy and Precision

1. Using the chart above, which of the three trials is the most precise? Accurate? Precise and accurate?

Percent Error

Meas/Calc
Topic#2

All measurements have error. Scientists collect data for analysis. During analysis, error is taken into account by calculating the uncertainty. When data is known, scientists can show the error in their measurement with percent error.

$$\% \text{ error} = \frac{\text{actual (known) value - experimental value}}{\text{actual (known) value}} \times 100\%$$

Topic#2 MeasCalc Sample WS#2: Percent Error

2. A student measures the mass and volume of a substance and calculates its density as 1.40g/mL. The correct, or accepted, value of the density is 1.30g/mL. What is the percent error of the student's measurement? (Ans: -7.7%)

GUN

experimental: 1.40 g/mL

accepted: 1.30 g/mL

NTK

$\% \text{ error} = \frac{\text{act - exp}}{\text{act}} \times 100\%$

Solve:

$\frac{1.30 - 1.40}{1.40} \times 100\% = -7.7\%$

UNK

% error: -7.7%

Q

Meas/Calc
Topic#2

Percent Error

All measurements have error. Scientists collect data for analysis. During analysis, error is taken into account by calculating the uncertainty. When data is known, scientists can show the error in their measurement with percent error.

$$\% \text{ error} = \frac{\text{actual (known) value - experimental value}}{\text{actual (known) value}} \times 100\%$$

3. (OYO) A volume is measured experimentally as 4.06mL. What is the percent error, given the correct value is 4.15mL? (Ans: 2.2%)

Meas/Calc
Topic#2

Percent Error

All measurements have error. Scientists collect data for analysis. During analysis, error is taken into account by calculating the uncertainty. When data is known, scientists can show the error in their measurement with percent error.

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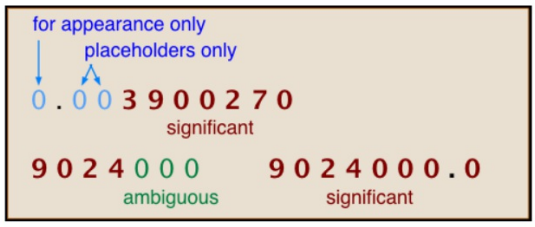
3. (OYO) A volume is measured experimentally as 4.06mL. What is the percent error, given the correct value is 4.15mL? (Ans: 2.2%)

Significant Figures



Significant figures represent the precision and accuracy of a measurement and a calculated measurement. Scientists must represent their data correctly using significant figures. All non-zero numbers are significant. So, we only need to determine when a zero is significant.

- all zeros between numbers are significant (567 8**0**9; 6 sig figs)
- when a decimal IS present all numbers at the END of the number are significant (12 3**00.00**; 7 sig figs).
- When Decimal IS NOT present, zeros at end are NOT significant (12 3**00**; 3 sig figs)
- zeros at the BEGINNING are never significant (**0.0000**123; 3 sig figs)

Topic#2 MeasCalc Sample WS#2: Significant Figures

4. (a) 28.6g (b) 3440.cm (c) 910m (d) 0.046 04 (e) 0.006 700kg

Significant Figures - Rounding

Rounding in Chemistry

We round like math for numbers <4 and >6. Scientists round 5 differently. When rounding always round to the EVEN value when deciding on a 5, 50, 500, 5000, etc.

1.5|5 1.6

1.4|5 1.4

Topic#2 MeasCalc Sample WS#2: Rounding

5. (a) 0.105 to hundreth

0.10

(b) 1.23 to the tenth

1.2

(c) 1055 to the tens

1060

(d) 1.03855 to thousandth

1.039

1.038|50

1.038

Significant Figures - Calculations

Start Here Per 5/6 Monday 8/27

How do you decide the number of significant figures are in your calculated unknown?
Like a team, your unknown can only reflect the least accurate of your data points (given). For example, find the average of 2.2987g, 2.29g, 2.3g, and 2.299g. Your answer can only have 2 sig figs because the data point (given) 2.3g has only 2 sig figs.

Topic#2 MeasCalc Sample WS#2: Significant Figures in Calculations

Carry out the following calculations. Express each answer to the correct number of significant figures

6. (a) 5.44m – 2.6103m (Ans: 2.83m)

(b) 2.4g/mL x 15.82mL (Ans: 38g)

(a) 5.44 − 2.6103 = 2.8297 → 2.83m

(b) 37.968 (g/mL × mL) → 38 g

Significant Figures - Calculations

How do you decide the number of significant figures are in your calculated unknown?
Like a team, your unknown can only reflect the least accurate of your data points (given). For example, find the average of 2.2987g, 2.29g, 2.3g, and 2.299g. Your answer can only have 2 sig figs because the data point (given) 2.3g has only 2 sig figs.

7. (OYO) What is the sum of 2.009g and 0.05681g? (Ans: 2.066g)

8. (OYO) Calculate the area of a crystal surface that measures 1.34μm by 0.7488 μm. (Ans: 1.00μm

Significant Figures - Calculations

How do you decide the number of significant figures are in your calculated unknown?
Like a team, your unknown can only reflect the least accurate of your data points (given). For example, find the average of 2.2987g, 2.29g, 2.3g, and 2.299g. Your answer can only have 2 sig figs because the data point (given) 2.3g has only 2 sig figs.

9. Polycarbonate plastic has a density of 1.2g/cm^3. A photo frame is constructed from two 3.0mm sheets of polycarbonate. Each sheet measures 28cm by 22cm. What is the mass of the photo frame? (Ans: 440g)

(2) (2) (2)

Given
$d = 1.2\ g/cm^3$
2 sheets @ 3.0 mm (0.30 cm)
$l = 28$ cm
$w = 22$ cm

NTK
$V = l \times w \times h$
$h = 2(0.30\ cm)$

Unk
mass: _____ g

Solve: $V = (28\ cm)(22\ cm)(0.60\ cm)$
$= 369.6\ cm^3$

$$369.6\ cm^3 \left| \frac{1.2\ g}{cm^3} \right. = 443.52\ g = \boxed{440\ g}$$

Meas/Calc
Topic#2

Scientific Notation

11. Operations Involving Exponents

a. $(8^4)^{1/2}$ = $\sqrt{8^4} = \sqrt{4096} = 64$

Or $8^{4 \cdot 2} = 8^2 = 64$

b. $8^{1/3}$ = $\sqrt[3]{8} = 2$

c. $7^{-3}/7^{-4}$ = $7^{-3} \times 7^4 = 7^1 = 7$

d. $6^3 \times 6^{-2}$ = $6^{3-2} = 6^1 = 6$

12. Converting Numbers to Scientific Notation

a. 2,918,000,000 2.918×10^9

b. 0.000 000 2918 2.918×10^{-7}

13. Dividing/Multiplying Scientific Notation

a. $\frac{6.02 \times 10^{23}}{3.00 \times 10^{19}} = \frac{6.02}{3.00} \times \frac{10^{23}}{10^{19}}$

$= 2.01 \times 10^4$

b. $6.02 \times 10^{23} \times 3.00 \times 10^{19} =$

$(6.02 \times 3.00) \times (10^{23} \times 10^{19})$

$18.06 \times 10^{42+1}$

1.806×10^{43}

14. Adding/Subtracting Scientific Notation

a. $2.98 \times 10^2 + 6.78 \times 10^1 + 5.02 =$

29.8
6.78
0.502
37.082

$29.8 \times 10^1 + 6.78 \times 10^1 + 0.502 \times 10^1$

$= 37.082 \times 10^1 = 3.71 \times 10^{1+1}$

$= 3.71 \times 10^2$

b. $1.58 \times 10^{-2} - 4.99 \times 10^{-1} + 9.78 \times 10^{-3} =$

$1.58 \times 10^{-2} - 49.9 \times 10^{-2} + 0.978 \times 10^{-2}$

-47.342×10^{-2}

-47.3×10^{-2}

-4.73×10^{-1}

Meas/Calc
Topic#2

Proportions

Start Here Per EB Friday 8/27

Direct vs. Inverse Proportion

direct - quotient of variables equals a constant (k = m/V)
- density

Inverse - product between variables equals a constant (k = PV)
- gas pressure and volume

Meas/Calc
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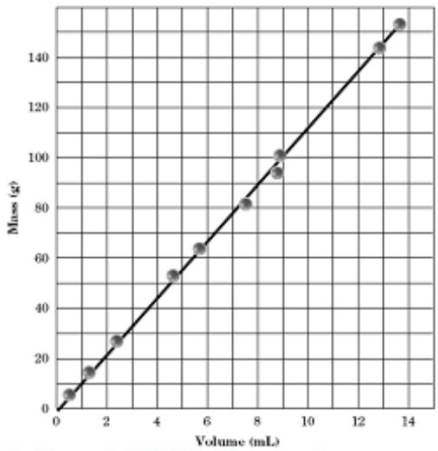
Direct Proportions

$y = mx + b$

$m = \frac{y_2 - y_1}{x_2 - x_1}$



Mass and Volume Data for Samples of Lead

Sample number	Mass (g)	Volume (mL)
1	5.00	0.443
2	15.0	1.33
3	24.0	2.12
4	52.0	4.60
5	64.0	5.66
6	81.0	7.17
7	95.0	8.41
8	101	8.94
9	142	12.6
10	153	13.5

$\frac{153 - 5}{13.5 - 0.443}$

$m = 11.3\ g/mL$

m = slope

11.3
11.3
11.3
11.3
11.3
11.3
11.3
11.3
11.3
11.3
11.3

Topic#2 MeasCalc Sample WS#2: Proportions

15. Using the above graph and data table, answer the following questions.

a. Using the above data for lead, calculate the density for each of the data points. Calculate the average value for the densities.

b. Pick two data points and find the slope of the line.

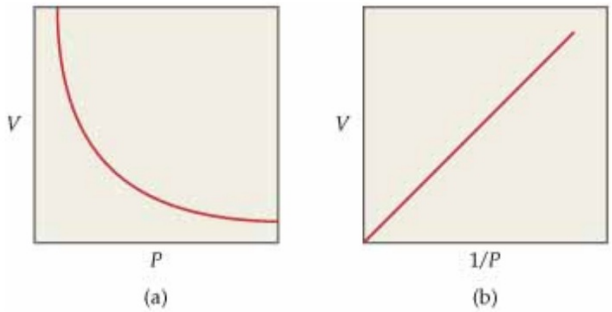
c. Compare the average densities to the slope of the line.

Meas/Calc
Topic#2

Inverse Proportions

Pressure-Volume Data for Nitrogen
@ Constant Temperature

Pressure(kPa)	Volume(cm^3)	P x V
100	500	50,000
150	333	49,950
200	250	50,000
250	200	50,000
300	166	"
350	143	"
400	125	"
450	110	"

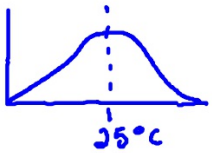


Temperature

273.15

Formulas: 273 + °C = K and °F = (1.8)°C + 32

Temperature - is the average kinetic energy of all the parts in a sample of matter. For science, temperature is measured in Celsius or Kelvin. Increments: 1°C = 1K



Topic#2 MeasCalc Sample WS#2: Temperature

16. Convert the following temperatures

a. 30°C = 303 K b. ____°C = 323K c. 98.6°F = ____°C d. ____ °F = 100°C

K = °C + 273
K = 30 + 273
= 303 K

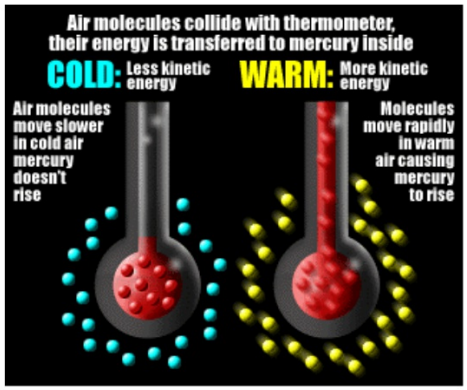
°C = K - 273
°C = 323 - 273
= 50. °C

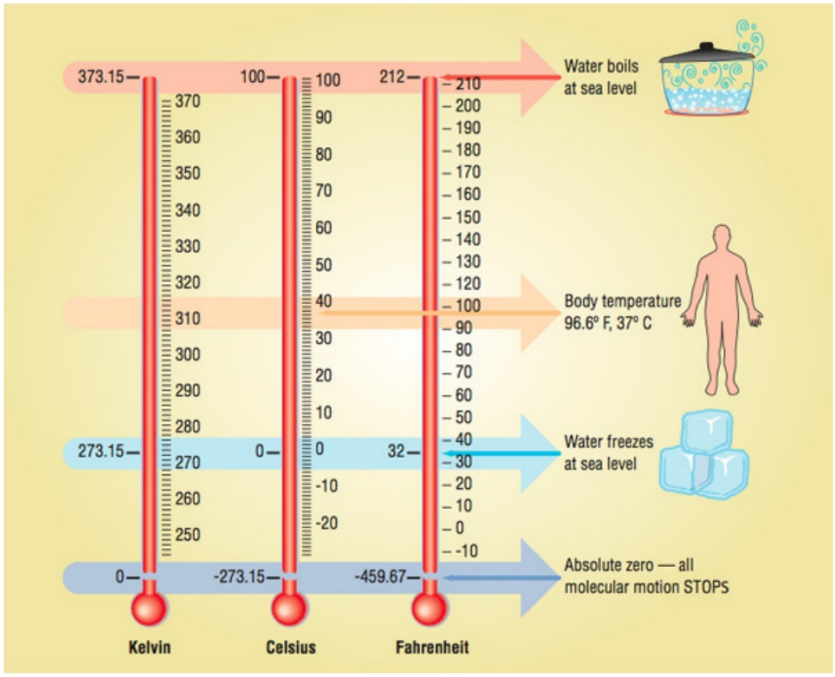
°F = (1.8)°C + 32
°C = (°F - 32) / 1.8
°C = (98.6 - 32) / 1.8
°C = 37°C

°F = 1.8°C + 32
= 1.8(100) + 32
= 212°F

Meas/Calc
Topic#2

Temperature





Density Lab

Meas/Calc
Topic#2

Note: (Volume Through Water Displacement)
When using a graduated cylinder to determine volume of an object through water displacement, tip the graduated cylinder about 45° (from upright position) and then insert the rectangular prism or cubes so they GENTLY slide to the bottom of the graduated cylinder. When starting a NEW volume measurement, pou out the water and start anew. For each new trial, start with a DIFFERING volume of initial water, but th water should still COMPLETELY cover the object when place in water (submerged)

Note: Volume through Measuring Length, Width, and Heigh
Depending on the number of trials you have decided to do, you will need the same number of independent volume calculations. To do this use the following example:

1. Using a ruler or caliper, silently measure the length, width, and height (or three sides of the cube).
2. Write your individual measurements on a small piece of paper.
3. Depending on the number of trials, a new lab member measures the *l,* w, and *h* (or sides of a cube) and writes his/her data on a small sheet of paper.
4. When all of the volume measurements for each trial have been measured, then each lab member silently calculates the volume from his/her measurements.
5. The lab team now has independent volume calculations for the number of trials indicated in the procedure.

Meas/Calc
Topic#2

Density Lab

- Brainstorm within your groups on procedure
- Collaborate - agree on duties
- One typed report per group
- Conclusion - done AFTER the lab

Question: What is the density of an object?

1. Write a lab procedure.
   a. What data do you need to collect?
   b. What materials do you need?
   c. Develop two methods of finding the volume of your object.
   d. How many trials do you want to perform? Be reasonable.
2. Be as specific as possible where another lab group could follow your procedure and finish the lab.

Format

1. Name of Lab
2. Objective
3. Materials needed
4. Procedure
5. Data table (2; one for data and one for calculations
   a. calculate density
   b. calculate percent error
6. Calculations (leave space in your document).Hand write very NEAT or use the equation editor in Word. Show work for calculated volumes and density.
7. Conclusion - reflect on any parts you would change to better the lab. Comment on the percent error and how you can use this to better your lab.

Meas/Calc
Topic#2

Density Lab

Report

Title: Some Students are Very Dense.

Objective or **Question:** The teacher will determine the density of a student.

Materials:

one student
extremely large graduated cylinder (industrial scale)
water
electronic scale

Data Table:

Data (mass and volume) Calculations (density and percent error)

Calculations:

Conclusion:

Meas/Calc
Topic#2

Density Lab

Report

Water displacement: $V_f - V_i = V_{object}$
(where V_i is initial volume and V_f is the final volume (after the object is added))

Data Tables:

Data (Mass/Volume)

Trial	Mass (g)	Volume Water Displacement (mL)		Caliper (or Ruler) (cm)
		V_i	V_f	
#1				*h* = *w* = *l* =
#2				*h* = *w* = *l* =
#3				*h* = *w* = *l* =

Calculations (Volume/Density)

Trial	V_{object} (water) (mL)	V_{object} (Caliper/Ruler) (cm^3)	Density	
			(water) g/mL	(sides) g/cm^3
#1				
#2				
#3				

Meas/Calc
Topic#2

Density Lab

Report

Data Table:

Calculations (Average Density/ Percent Error)

Volume Method	Average Density	% Error
Water Displacement	~g/mL	~%
Caliper or Ruler	~g/cm^3	~%

$$\% \text{ error} = \frac{|\text{actual} - \text{average density}|}{\text{actual}} \times 100\%$$