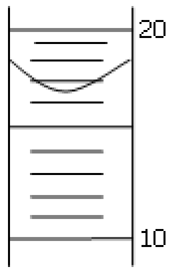
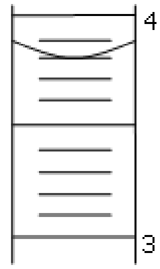
READING MEASURING DEVICES NOTES

Here are a couple of examples of graduated cylinders:



A



B

An important part of Chemistry is measurement. It is very important that you read the measuring devices we use in lab as accurately as possible. Here is how to determine how accurately a measuring device can be read:
Look at the graduation marks on the piece of equipment. (Those are the lines or marks that are not numbered.) Decide what each mark is worth using the numbers given as a guide. You should read the instrument to one more decimal place to the right than the smallest graduation mark. This last number will be an estimate on your part. This will lead us into our next topic in measurement – significant figures. A: Each of the smaller lines represents 1 mL. That means that our reading should be to one place to the right of the decimal point. To me, it looks like the bottom of the curve is about halfway between the 16 and the 17, so I would say that the reading on this graduated cylinder would be 16.5 mL.
B: Each line represents 0.1 mL. That means that our reading should be to two places to the right of the decimal point. The bottom of the curve looks to me like it is exactly on the line that would represent 3.8. My reading, however, needs to be to two places to the right of the decimal. Because it is exactly on the line, my reading will be 3.80 mL.

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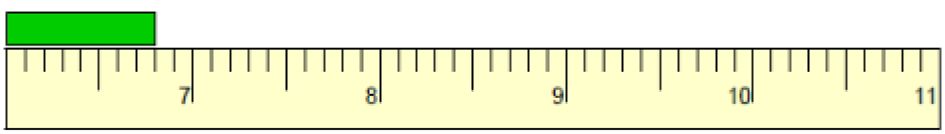
PRACTICE WITH READING MEASURING DEVICES WORKSHEET

Part 1 - What are the readings on these metric rulers? Be sure to include units with your answers.

1.)



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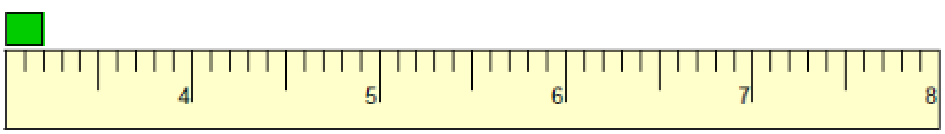

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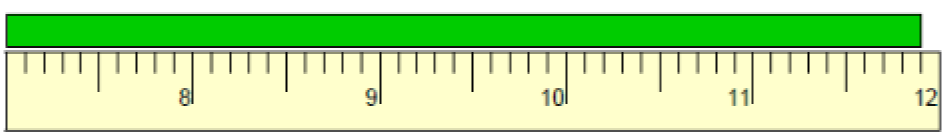

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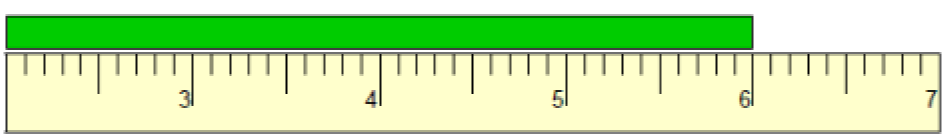

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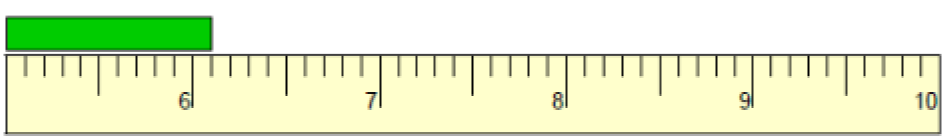
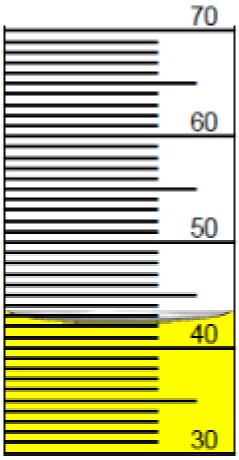


Rulers, graduated cylinders, and thermometers on "Practice With Reading Measuring Devices Worksheet" are from math-aids.com

Part 2 – What are the readings on these graduated cylinders? Be sure to include units with your answers.

6.)



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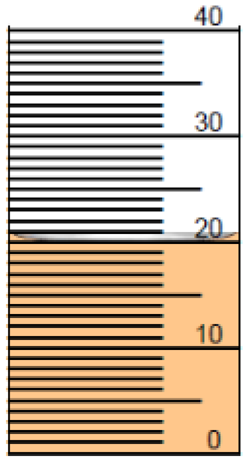

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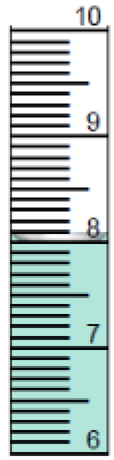

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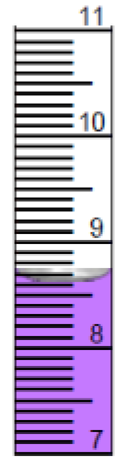

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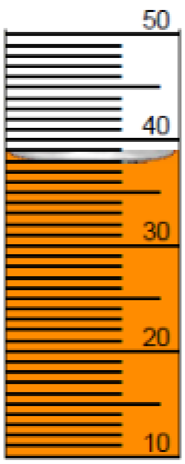

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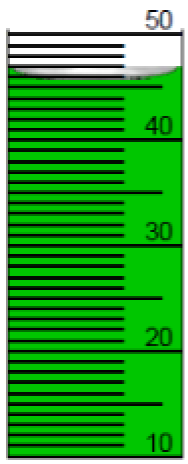

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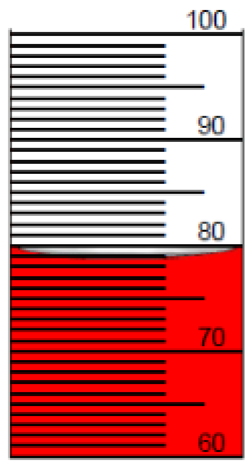

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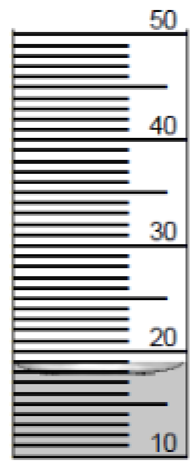
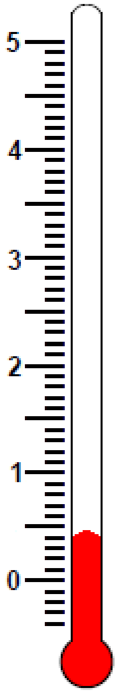
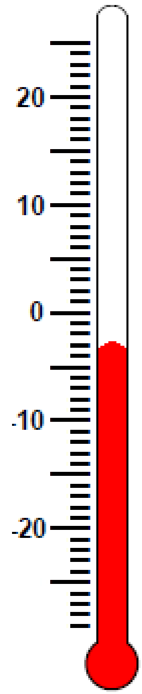
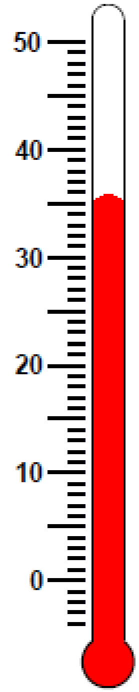


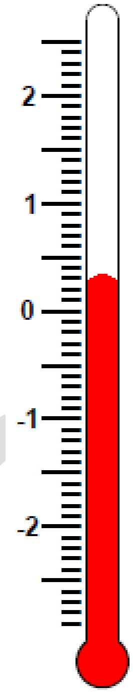
Part 3 – What are the readings on these thermometers? Be sure to include units with your answers.

14.) 15.) 16.) 17.)



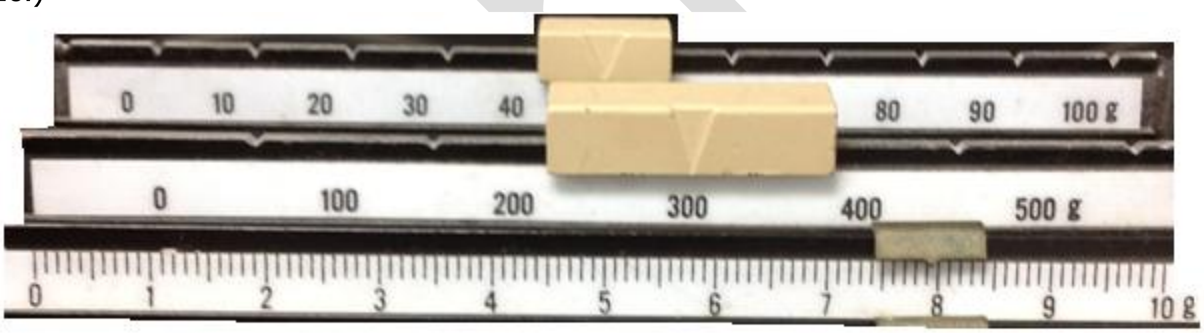




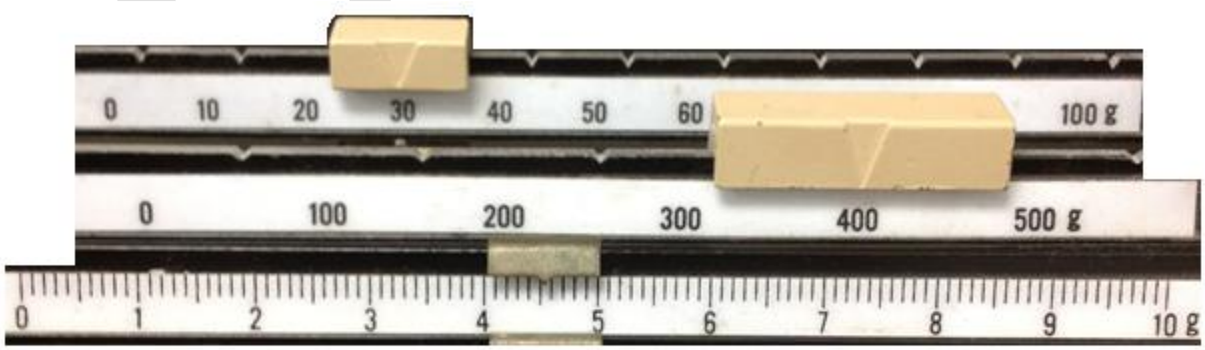


Part 4 – What are the readings on these triple beam balances? Be sure to include units with your answers.

18.)



19.)



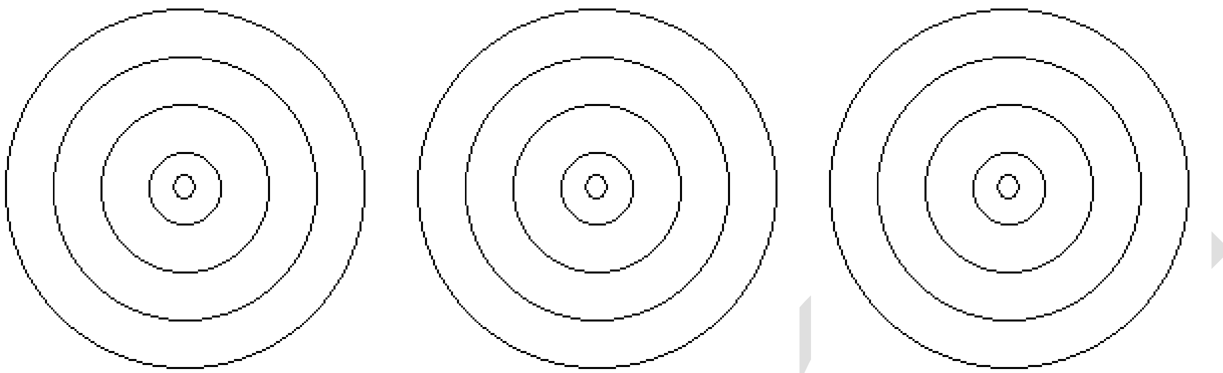
ACCURACY & PRECISION NOTES

Up until now, you probably thought of accuracy and precision as the same thing. I know I did until I got to Chemistry class in high school. There is actually a difference between the two.

ACCURACY: how close a measurement is to the actual (accepted) value

PRECISION: how close measurements are to each other

Let's use a dart board as an example...



bad accuracy, bad precision	bad accuracy, good precision	good accuracy, good precision

EXAMPLE: Describe the accuracy and precision of each group's measurements, given the following data and that the actual mass of the object is 7.00 grams.

Trial	Group A	Group B	Group C
1	7.62 g	6.98 g	7.72 g
2	8.94 g	7.00 g	7.75 g
3	6.21 g	6.99 g	7.71 g

===

SIGNIFICANT FIGURES (SFs or Sig Figs) NOTES

<u>How to Determine the Number of Significant Figures (SF) a Measurement Has</u>...

** Any non-zero number (1, 2, 3, 4, 5, 6, 7, 8, 9) is <u>ALWAYS</u> significant. **

1. "Sandwiched" zeroes (zeroes in between two non-zero numbers) are ALWAYS significant.
   EXAMPLE: 103 has 3 SFs 5007 has 4 SFs
2. "Leading" zeroes (zeroes to the left of a non-zero number) are NEVER significant.
   EXAMPLE: 0.000375 has 3 SFs
3. "Trailing" zeroes (zeroes to the right of non-zero numbers) are significant ONLY if a decimal point is written in the number. (Note: The decimal point can be located anywhere in the measurement.)
   EXAMPLES: 50 has 1 SF 50. has 2 SFs 50.0 has 3 SFs

PRACTICE EXAMPLES:

a. 25 cm b. 30015 cm
c. 0.00123 in d. 400 g
e. 400. m f. 0.94600 mL
g. $2.70 \times 10_{25}$ atoms h. 0.070500 km

<u>Rules For Deciding How Many SFs an Answer Should Have...</u>

<u>** When multiplying or dividing...</u>

<u>Your answer must have as many SFs as the number in the problem with the fewest (lowest) number of SFs.</u>

EXAMPLE: 9.34 cm x 4.5 cm = calculator says 42.03
(3 SF) (2 SF) Must round to 2 SFs --> so, answer is 42 cm^2.

EXAMPLE: 2.494 m x 3.02 m x 5.125 m = calculator says 38.60085
(4 SF) (3 SF) (4 SF) Must round to 3 SF --> 38.6 m^3

** When adding or subtracting... Your answer must have as many places to the right of the decimal point as the number in the problem with the fewest number of places to the right of the decimal.

EXAMPLE: 2.194 g + 25.84 g + 5.7210 g = calculator says 33.755
(3 places) (2 places) (4 places) Must round to 2 places --> 33.76 g

==

SIGNIFICANT FIGURES WORKSHEET

PART 1 - Determine the number of significant figures in the following numbers.

1.) 0.02 ____ 2.) 0.020 ____ 3.) 501 ____ 4.) 501.0 ____

5.) 5,000 ____ 6.) 5,000. ____ 7.) 6,051.00 ____

8.) 0.0005 ____ 9.) 0.1020 ____ 10.) 10,001 ____

PART 2 – Rewrite/round each of the following numbers so that it has 3 significant figures.

1.) 0.03006 __________________ 2.) 0.00041193 __________________

3.) 10,800,000. __________________ 4.) 0.90149 __________________

5.) 2.195×10^2 __________________ 6.) 2.998×10^{21} __________________

7.) 0.007997 __________________ 8.) 8048 __________________

9.) 90,185 __________________ 10.) 699.5 __________________

ROUNDING & SIGNIFICANT FIGURES WORKSHEET

Perform the following operations expressing the answer with the correct number of significant figures.

1.) 1.35 m x 2.467 m =

2.) $\dfrac{1{,}035\ m^2}{42\ m}$ =

3.) 0.021 cm x 3.2 cm x 100.1 cm =

4.) $\dfrac{150\ km^3}{4\ km^2}$ =

5.) 1.252 mm x 0.115 mm x 0.012 mm =

6.) $\dfrac{1.278 \times 10^3\ m^2}{1.4267 \times 10^2\ m}$ =

7.) 55.46 g - 28.9 g =

8.) 12.01 mL + 35.2 mL + 6 mL =

9.) 0.15 cm + 1.15 cm + 2.051 cm =

10.) 505 kg - 450.25 kg =

==

DENSITY NOTES

The formula for density is: $D = \frac{\text{mass}}{\text{volume}}$

Remember... volume of a rectangular solid is (length x width x height)

EXAMPLE: A cube-shaped sample of gold has a mass of 65.78 grams. If each side of the cube measures 1.50 cm, what is the density of gold?

==

DENSITY PROBLEMS WORKSHEET (round your answers to the correct # of SFs)

1.) Determine the density of a rectangular piece of concrete that measures 3.7 cm by 2.1 cm by 5.8 cm and has a mass of 43.8 grams.

2.) Determine the density of a piece of granite that measures 5.02 cm by 1.35 cm by 2.78 cm and has a mass of 30.64 grams.

3.) Determine the density of a brick in which 49.92 grams occupies 4.01 cm^3.

4.) Gold has a density of 19.32 g/cm^3. Find the mass of 6.39 cm^3 of gold.

5.) Determine the volume of 6.37 grams of magnesium if its density is 1.29 g/cm^3.

6.) Determine the volume of 15.64 grams of iron if its density is 2.27 g/cm^3.

7.) A graduated cylinder contains 30.0 mL of water. An object is placed in the cylinder and the water level moves to 46.7 mL. Find the density if the mass of the object is 121.3 grams.

8.) A ball has a mass of 6.03 kilograms and a volume of 10.57 cm^3. Find the density of the ball.

9.) A piece of wood has a mass of 5.75 grams and a volume of 0.95 cm^3. Find its density.

==

PERCENT ERROR NOTES

Formula for % error: $\frac{|\text{accepted value - experimental value}|}{\text{accepted value}} \times 100$

EXAMPLE: A student measures a sample of matter to be 9.67 grams. The teacher tells the class that the actual mass of the sample is 9.82 grams. What is the student's percent error?

UNIT CONVERSIONS NOTES

BIGGER	< -----	------	------	------	------	B	------	------	------	----- >	smaller
prefix	Giga-	Mega-	kilo-	hect-	deca-	A	deci-	centi-	milli-	micro-	nano-
abbrev.	G-	M-	k-	h-	da-	S	d-	c-	m-	μ-	n-
# of times base unit	1×10^{9}	1×10^{6}	1×10^{3}	1×10^{2}	1×10^{1}	E	1×10^{-1}	1×10^{-2}	1×10^{-3}	1×10^{-6}	1×10^{-9}

EXAMPLES OF BASE UNITS ARE:

How to set up a unit conversion:

number and unit you are given | appropriate # and unit you're converting to / appropriate # and unit you're given =

These numbers and units are referred to as a CONVERSION FACTOR.

The numbers and units in a conversion factor must be equal to each other.

There will be different numbers and units, but the amounts must represent the same thing.

An example of a conversion factor: 12 eggs = 1 dozen (difft. #s and difft. units, but values are =)

To solve a unit conversion problem:

~ Multiply the *numbers* across the top of the set up.

~ Then, divide by the *number* on the bottom of the set up.

To set up conversion factors for metric system unit conversions:

1.) Decide on the units for the numerator and denominator of the conversion factor.

Example: Problem asks to convert 4.5 grams (g) to milligrams (mg)

Set up: $4.5\text{ g} \left| \dfrac{\text{mg}}{\text{g}} \right. =$ The unit on the bottom right side of the set-up should be the same as the given unit– always!!!

2.) To set up conversions between metric prefixes, look at the units in the conversion factor. The unit with a prefix will have a "1" next to it.

Example: grams are larger than milligrams, so "g" will have a "1" in front of it.

Set up: $4.5\text{ g} \left| \dfrac{1\ \text{mg}}{\text{g}} \right. =$

3.) The number in front of the other unit will correspond to the number associated with the prefix.

Example: milli- corresponds to 1×10^{-3} (milli- = lowercase m in "mg")

Set up: $4.5\text{ g} \left| \dfrac{1\ \text{mg}}{1 \times 10^{-3}\ \text{g}} \right. =$

4.) Multiply 4.5 by 1. Then, divide by 1×10^{-3}. Answer is 4500 or 4.5×10^{3} mg.

For volume conversions, remember that 1 cm^3 = 1 mL and 1 dm^3 = 1 L (These are also conversion factors.)

==

UNIT CONVERSIONS WORKSHEET

1.) 360 g to µg

2.) 0.00238 cg to g

3.) 13.52 cm^3 to mL

4.) 0.014 g to cg

5.) 2.85×10^4 L to dm^3

6.) 41.5 mL to L

7.) 281 cm^3 to L

8.) 4.305 L to dL

9.) 61.2 mL to dm^3

10.) 1.832 L to mL

11.) 18.05 m to Mm

12.) 3.80 dL to L

13.) 1.428×10^7 m to km

14.) 30.2 µL to L

15.) 4.06×10^{12} nm to m

16.) 1.05 dm^3 to cm^3

17.) 35.85 Mm to m

18.) 4.32 L to cm^3

19.) 6.643×10^{-5} km to m

20.) 6.58 m to nm

===

UNIT 1 REVIEW WORKSHEET

Part 1 - Unit Conversions

1.) 0.9785 kg to g

2.) 2830 mm to m

3.) 19.3 L to cL

4.) 3.4 g to Mg

5.) 6.75×10^5 cm^3 to dm^3

Part 2 - Tell the number of significant figures in each of the following measurements.

6.) 48 cm

7.) 306.2 g

8.) 0.329 m

9.) 83.952 K

10.) 3700 mm

11.) 400. cm^3

12.) 71.60 g

13.) 82.000 g

Part 3 - Perform each of the following calculations, expressing the answer to the correct number of significant figures.

14.) 3.482 cm + 8.51 cm + 16.324 cm =

15.) 8.3 m x 4.0 m x 0.9823 m =

16.) $\frac{4.93\ mm^2}{18.71\ mm}$ =

17.) 106.5 mL - 32 mL =

Part 4 - Percent Error

18.) Experimental value = 1.24 g, Accepted value = 1.30 g

19.) Experimental value = 22.2 L, Accepted value = 22.4 L

20.) A person attempting to lose weight on a diet weighed 175 lb on a bathroom scale at home. An hour later at the doctor's office, on a more accurate scale, this person's weight is recorded as 178 lb. Assuming that there was no real weight change in that hour, what is the percent error between these readings?

Part 5 – Density

21.) What is the mass of a sample of material that has a volume of 55.1 cm^3 and a density of 6.72 g/cm^3?

22.) A sample of a substance that has a density of 0.824 g/mL has a mass of 0.451 g. Calculate the volume of the sample.

Thickness of Aluminum Foil

INTRODUCTION

The density of a material is given by the formula D = m/V (Density = mass divided by Volume). From Geometry, it is known that the volume of a rectangular solid is length times width times height (V = l·w·h). It can be assumed that the thickness of the aluminum foil is the height. The density of aluminum can be looked up in a table. Therefore, using substitution and then rearranging the equation, one can solve for the height.

PROCEDURE

1. Select four (4) rectangular pieces of aluminum foil. Each piece should be a different size.
2. Determine the mass of each piece of foil (in grams). Record these measurements in the data table below.
3. Carefully measure the length and the width of each piece of aluminum foil. (Make sure you use the metric side of the ruler!) Record these measurements in the data table also.
4. The accepted thickness of aluminum foil is **0.00254 cm** for heavy duty aluminum foil. The density of aluminum is **2.702 g/cm^3**.

DATA TABLE

Trial	Mass (g)	Length (cm)	Width (cm)	Thickness (cm)	Error (cm)	Percent Error
1						
2						
3						
4						
Average						

CALCULATIONS

You must show sample calculations (in detail - for only one of your trials) for (A) thickness, (B) error, and (C) percent error.

NOTE: error = | accepted value – experimental value |

ANALYSIS

Under your sample calculations, write out one potential source of error* in the lab. * Errors in the measuring device or the reading of the measuring device are not acceptable. For example, "we read the ruler incorrectly." would NOT be an acceptable source of error. Your source of error should come from the lab procedure that you followed or assumptions that were made about the materials used.

THIS LAB IS DUE ON:

**CRITERIA IN ORDER TO RECEIVE CREDIT FOR THIS ASSIGNMENT:

* All numbers are clear & legible.
* All numbers are labeled with their correct units.
* Calculations are shown in detail.
* Calculations are shown in a neat and logical order.
* No messy cross-outs or eraser marks.

* Failure to follow these criteria will result in your having to re-submit your lab. It will be considered a late grade when you re-submit.