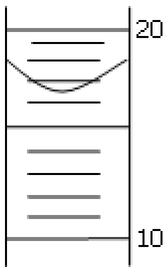
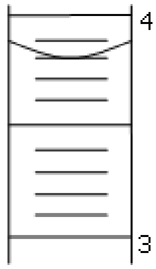
READING MEASURING DEVICES NOTES

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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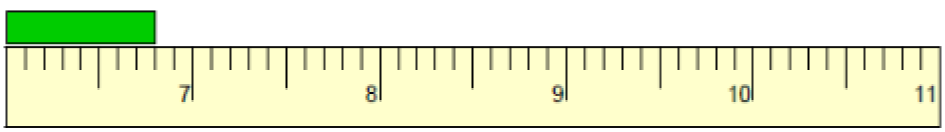
PRACTICE WITH READING MEASURING DEVICES WORKSHEET

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

1.



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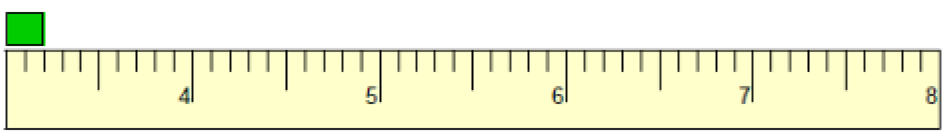

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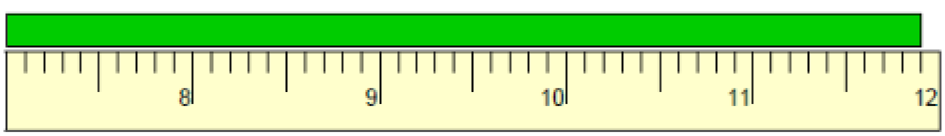

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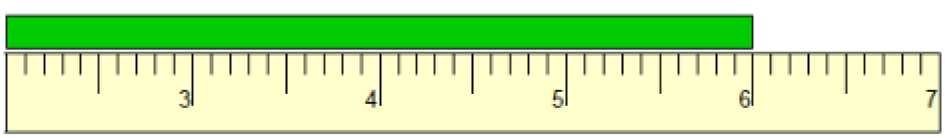

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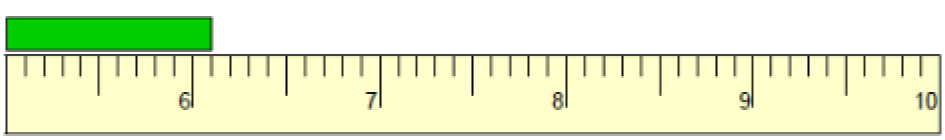
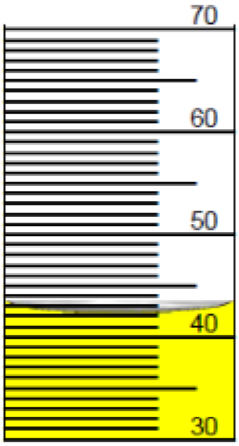


Rulers, graduated cylinders, and thermometers on "Practice With Reading Measuring Devices Worksheet" are from math-aids.com

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

6.



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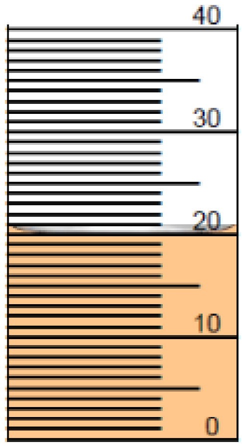

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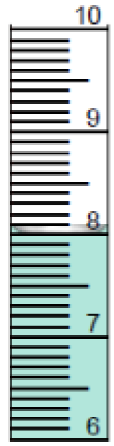

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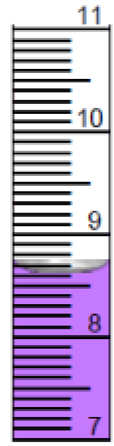
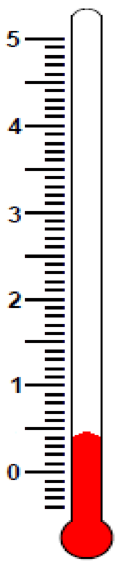


Part 3 – What are the readings on these thermometers? Be sure to include units with your answers.

10.



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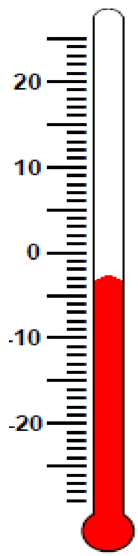

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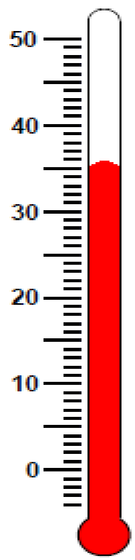
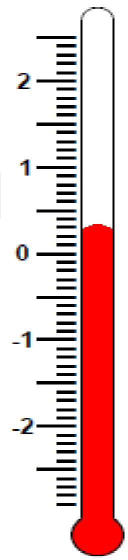
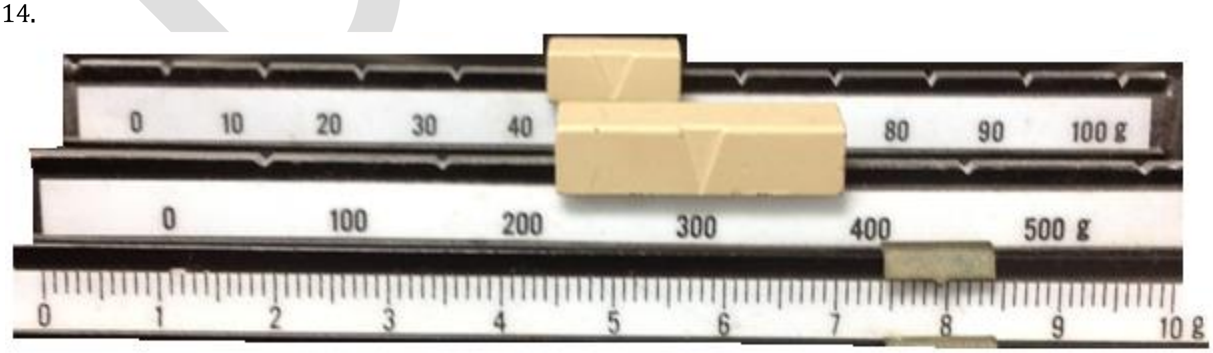


13.

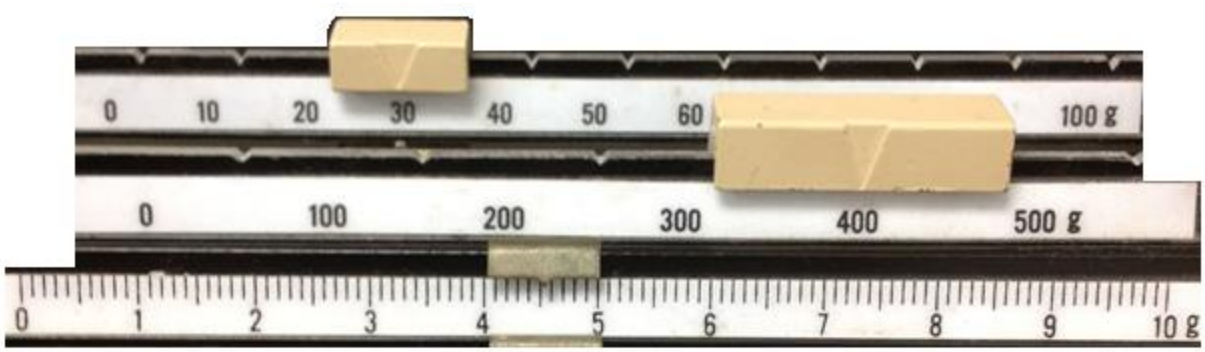


Part 4 – What are the readings on these triple beam balances? Be sure to include units with your answers.

14.



15.



SIGNIFICANT FIGURES (SFs or Sig Figs) NOTES

How to Determine the Number of Significant Figures (SF) a Measurement Has...

** Any non-zero number (1, 2, 3, 4, 5, 6, 7, 8, 9) is ALWAYS 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. 2.70×10^{25} atoms
h. 0.070500 km

Rules For Deciding How Many SFs an Answer Should Have...

** When multiplying or dividing...

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

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

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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 ___

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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. $\dfrac{1{,}035\ \text{m}^2}{42\ \text{m}}$ =
3. 0.021 cm x 3.2 cm x 100.1 cm =
4. $\dfrac{150\ \text{km}^3}{4\ \text{km}^2}$ =
5. 1.252 mm x 0.115 mm x 0.012 mm =
6. $\dfrac{1.278 \times 10^{8}\ \text{m}^2}{1.4267 \times 10^{6}\ \text{m}}$ =
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 =

==

UNIT CONVERSIONS NOTES

What do you get when you multiply a number by one? The same number, right? Using this same idea, if we are going to be performing unit conversions. We're going to start with some easy ones…

For example, how many quarters are in one dollar? There are four quarters in $1. Ok, so how many quarters are in $2? You can probably easily answer that there are 8 quarters in $2, but we are going to use the idea that there are 4 quarters in one dollar to show an easy unit conversion. This is how we are going to set up unit conversions problems.

$$2\ \text{dollars} \times \boxed{\dfrac{4\ \text{quarters}}{1\ \text{dollar}}} =$$

given amt x conversion factor = same amount as given, but with different units

$$2\ \cancel{\text{dollars}} \times \dfrac{4\ \text{quarters}}{1\ \cancel{\text{dollar}}} = 2 \times 4 = 8$$

8 divided by 1 = 8
remaining unit is quarters

Example 2: How many eggs are in 2.5 dozen?

$$2.5\ \text{dozen} \times \dfrac{12\ \text{eggs}}{1\ \text{dozen}} = 30\ \text{eggs}$$

Example 3: How many pounds are equal to 75 oz? (Reminder: 16 oz in a pound)

75 oz x _______________ =

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The amount that you multiply/divide by (such as 12 eggs/1 dozen) is called a **CONVERSION FACTOR.** The numbers and units in a conversion factor must be equal to each other. There might be different numbers, and there will be different units, but the same amount is represented. (Thus, multiplying by one and getting the same answer, but with a different unit.)

Now, let's expand this idea to the metric system and some of its prefixes…

<--------	---------	---------	---------	---------		---------	---------	---------	---------	-------->
Giga-	Mega-	kilo-	hecta-	deca-	base unit	deci-	centi-	milli-	micro-	nano-
G-	M-	k-	h-	da-		d-	c-	m-	µ-	n-
1×10^{9}	1×10^{6}	1×10^{3}	1×10^{2}	1×10^{1}		1×10^{-1}	1×10^{-2}	1×10^{-3}	1×10^{-6}	1×10^{-9}

EXAMPLES OF BASE UNITS ARE:

Any of the prefixes above can be used in combination with a base unit to represent an amount that is some number of times as many base units. For example, centi- is 1×10^{-2} (or 0.01) times as big as a base unit. So a centimeter (cm) is 0.01 (one hundredth) times as big as a meter (m).

Here is the general set up of a problem involving unit conversions:

$$\text{given \# and unit} \times \frac{\text{\# and associated unit you're converting to}}{\text{\# and associated unit you were given}} = \text{answer}$$

To set up conversion factors in the metric system, start by writing the unit you are given in the denominator of the conversion factor. Write the unit you will be converting to in the numerator. You will always put the number "1" in front of the unit that has a prefix (which means there are two letters). The number that goes in front of the base unit will be the number associated with the prefix in the chart above.

Example 4: Convert 4.5 g (grams) to mg (milligrams)
(~Shown in steps~)

$$4.5\text{ g} \times \frac{\text{mg}}{\text{g}} =$$

mg ← unit the problem asks for
g ← unit given in the problem

Now to determine where the numbers go… Which unit (mg or g) has a prefix? What number should go next to that unit (regardless of whether the unit is in the numerator or denominator)?
What number should go next to the other unit? How do you determine that number?

$$4.5\text{ g} \times \frac{1\ \text{mg}}{1 \times 10^{-3}\ \text{g}} =$$

In this case, there is a unit of grams on the top and a unit of grams on the bottom, so those will cancel-leaving just mg as the unit. To solve mathematically, multiply the numbers across the top and divide by the number on the bottom.

More examples to practice:
Example 5: 0.0375 km to m

Example 6: 2.94×10^{-8} µL to L

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There are two more conversion factors you need to know for volumes:

$1\ cm^3 = 1\ mL$ $\qquad$ $1\ dm^3 = 1\ L$

Example 7: 7.72×10^5 mL to dm^3

==

UNIT CONVERSIONS WORKSHEET

1. 360 g to µg	2. 18.05 m to Mm
3. 0.00238 cg to g	4. 3.80 dL to L
5. 13.52 cm^3 to mL	6. 1.428×10^7 m to km
7. 0.014 g to cg	8. 30.2 µL to L
9. 2.85×10^4 L to dm^3	10. 4.06×10^{12} nm to m
11. 41.5 mL to L	12. 1.05 dm^3 to cm^3
13. 281 cm^3 to L	14. 35.85 Mm to m
15. 4.305 L to dL	16. 4.32 L to cm^3
17. 61.2 mL to dm^3	18. 6.643×10^{-5} km to m
19. 1.832 L to mL	20. 6.58 m to nm

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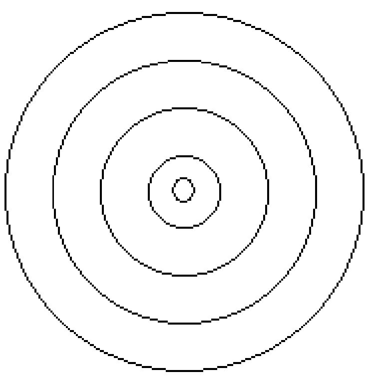
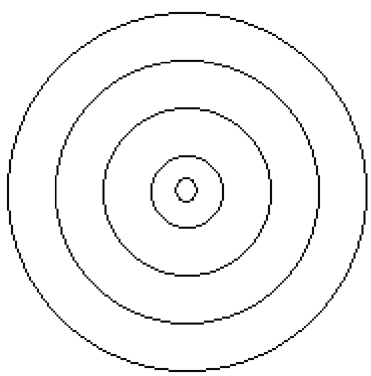
ACCURACY & PRECISION NOTES

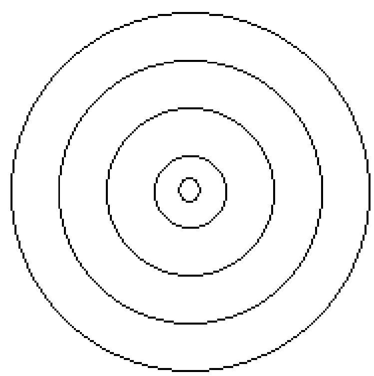
ACCURACY: how close a measurement is to the actual (accepted) value

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

==

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?

===

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.

Density Problems Worksheet Answers: 1) 0.97 g/cm^3, 2) 1.63 g/cm^3, 3) 12.4 g/cm^3, 4) 123 g, 5) 4.94 cm^3, 6) 6.89 cm^3, 7) 7.26 g/mL, 8) 0.570 kg/cm^3, 9) 6.1 g/cm^3

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

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