HONORS CHEMISTRY: SCALE READING   DATE:_____

Objectives: **SWBAT. . .**

… determine the resolution of a mechanical scale.

… read a scale correctly based on its resolution.

… explain the difference between accuracy & precision.

READING SCALES CORRECTLY IS REALLY, REALLY IMPORTANT. [REALLY.]

DETERMINE THE RESOLUTION OF A MECHANICAL SCALE *BEFORE* USING IT..

- Resolution:

- You'll want to know how far out to take your numeric values before making any measurements.

- Determine what the smallest hashmarks measure.

- The resolution is one digit beyond that. For example...

0 cm   10

- The smallest set of lines represent:

- That means the gap between the lines represents:

- The resolution of this scale is:

ONCE YOU KNOW A SCALE'S RESOLUTION, THE REST IS EASY.

- Read the hashmarks are far as you can and then "guess the gap" for the final digit.

- If you end on a hashmark and not a gap, use the appropriate amount of zeroes to get your measurement to the scale's resolution.

0 cm   10

- Practice on these two arrows...
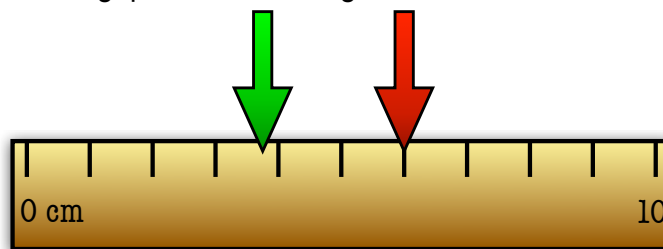
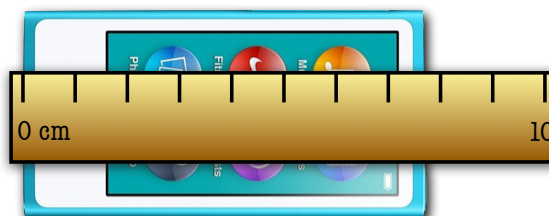- Then determine each of the following scale's resolution and then correctly measure the items:

Resolution=
Item Length=

0 cm   10

Resolution=
Item Length=

0 cm   10

Resolution=
Item Length=

0 cm   10

Other common scale reading mistakes:

**-** Remember to write down the _____!

- Never read a _____ off of a metric scale!

- Do not _____ a gap!

    - E.g., Guessing 2.75 cm instead of 2.7 or 2.8 cm

- Place your numbers in the correct locations!

    - E.g., Reading 10.65 cm instead of 16.5 cm.

- Some scales are downright confusing.

    - What is the resolution of this cylinder?
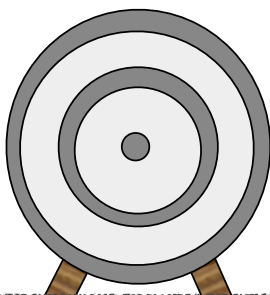
    - It can only be read to :
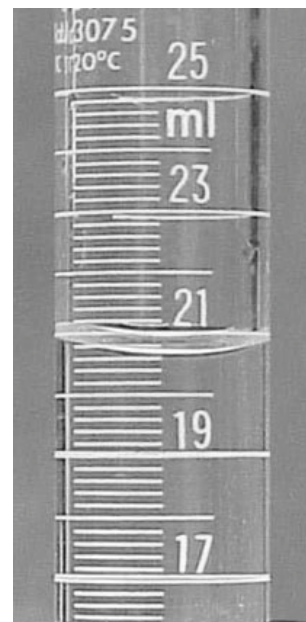
Some other scale related vocabulary....

- **Accuracy:** The degree to which a measurement relates to the actual (true) value

- **Precision:** A scale's ability to show consistent results under the same conditions (i.e., repeatability)
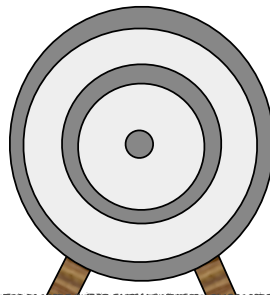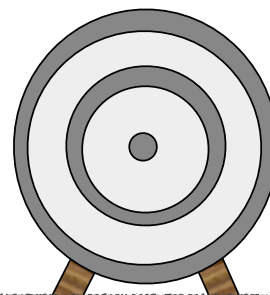
- Four possible situations:
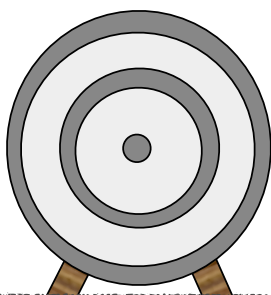
ACCURATE AND PRECISE	ACCURATE AND IMPRECISE	INACCURATE AND PRECISE	INACCURATE AND IMPRECISE

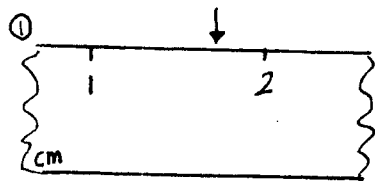AN EXCELLENT SECOND TAKE ON THIS BY TYLER DEWITT

"It takes a lot of things to prove you are smart, but only one thing to prove you are ignorant."
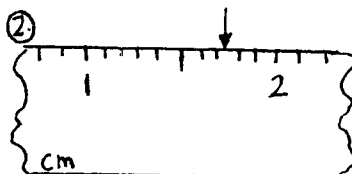*~ Don Herald*

SCALE READING PRACTICE.
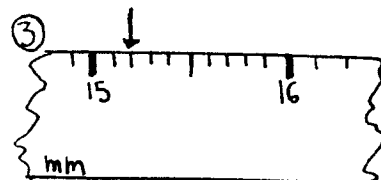
NAME :   PERIOD:

INSTRUCTIONS: READ EACH OF THE FOLLOWING SCALES TO THE CORRECT NUMBER OF SIGNIFICANT FIGURES. DO NOT FORGET UNITS!! (NOTE SCALES ARE <u>NOT</u> ACTUAL SIZE.)
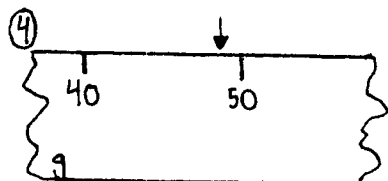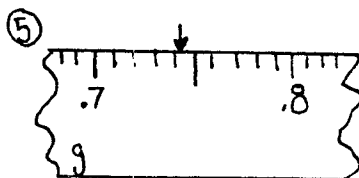
①   1   2   cm   answer: _____
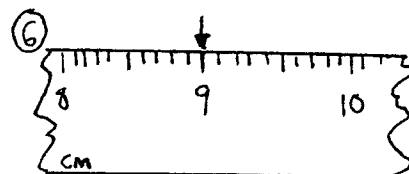
②   1   2   cm   answer: _____

③   15   16   mm   answer: _____

④   40   50   g   answer: _____

⑤   .7   .8   g   answer: _____

⑥   8   9   10   cm   answer: _____

⑦   10   20   g   answer: _____

⑧   100   200   mm   answer: _____

⑨   6   7   8   cm   answer: _____

⑩   29   30   mm   answer: _____

⑪   4   5   m   answer: _____

⑫   .3   .4   mg   answer: _____

⑬   40   30   ml   answer: _____

⑭   0.2   0.1   mL   answer: _____

⑮   70   60   ml   answer: _____

⑯   3   2   ml   answer: _____
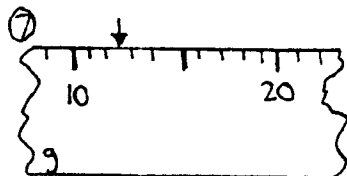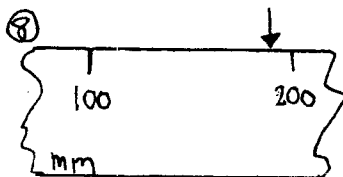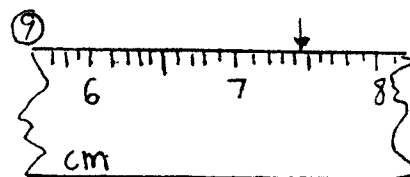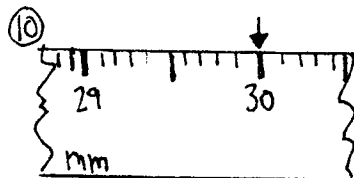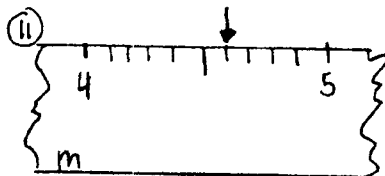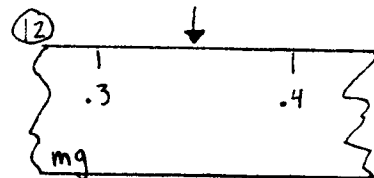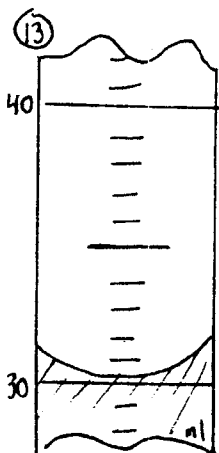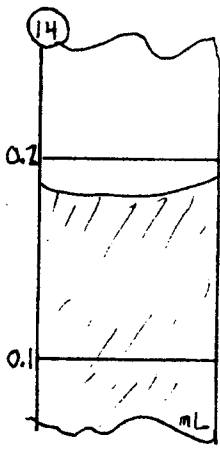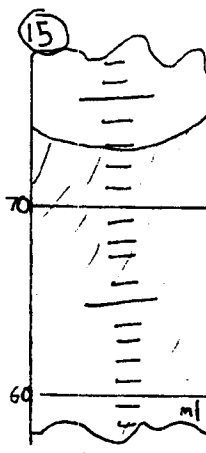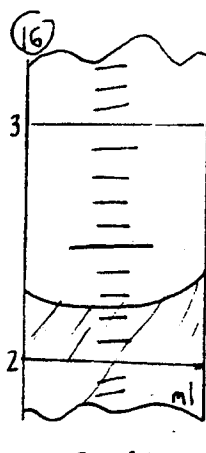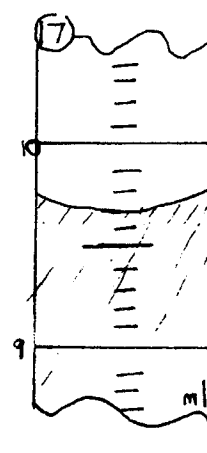
⑰   10   9   ml   answer: _____

HONORS CHEMISTRY: significant figures!　　　DATE:_____

Objectives: **SWBAT. . .**

　　…explain what significant measurements are.

　　... correlate the resolution of an instrument to the significance of its measurements.

　　... count the number of sig figs in a measurement.

　　... explain why some zeros are significant and some are not.

　　... properly manage sig figs in a variety of math problems.

GREAT RESOLUTION IN YOUR EQUIPMENT IS GOING TO COST YOU MONEY.

- All other things being equal, the price _____ as the resolution increases.

　　- E.g., It is going to cost more to measure something to 12.014 grams vs. 12.01 grams.

- Measurements must reflect _____. Each scale can only be read so precisely.

　　- E.g., a measurement of 6.732 cm did NOT come from :

Significant Figures/Digits:

　　- Counted items are NOT 'significant' since they were not _____. (E.g., 15 cows)

　　- Metric/metric conversions (100 cm = 1 m) or English/English conversions (12 inches = 1 foot) are

　　　　NOT 'significant' since _____.

　　- Metric/English conversions ARE significant since _____.

WHEN YOU LOOK AT A MEASUREMENT, WHAT IS SIGNIFICANT AND WHAT ISN'T?

- All non-zero numbers in a measurement are significant.

- Some zeros are significant, some are not.

IN A PRIMAL WAY, YOU PROBABLY ALREADY KNOW THIS...

　　- Which measurement feels more precise? 4.0 cm or 4.000 cm?

　　- Are 68,000,000 years old dinosaur bones EXACTLY 68 million years?

THE RULES FOR ZEROS!

1. Zeroes between non-zeros ('snuggle zeros') are always significant.

　　ex.) 6056 L (___ s.f.), 7.7001 min (___ s.f.)

2. Zeroes to the left of all non-zero numbers (a.k.a. 'leading zeros') are never significant.

　　ex.) 0027 g (___ s.f.), 0.000124 cm (___ s.f.)

3. Zeros to the right of all non-zero numbers (a.k.a. 'trailing zeros') are significant if there is a decimal somewhere in the number.
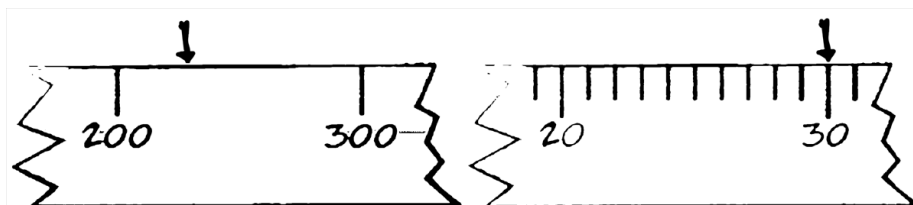
　　ex.) 1200 in. (___ s.f.), 120.0 kg (___ s.f.), 0.020 sec (___ s.f.)

A zero with a bar above it is the last significant digit in a series of zeros.

　　ex.) 54̇000 seconds (___ s.f.)

WHY ALL ZEROS ARE *IMPORTANT*, BUT ONLY SOME ARE *SIGNIFICANT*....

So what was the difference between these readings?

- In ...

      - That zero was not read against the scale ∴ it is not _____

- In...

      - Those zeros were read against the scale ∴ they are _____

SIG FIGS IN MULTIPLICATION/DIVISION PROBLEMS:

1. Count the number of significant figures in each number.

2. The answer cannot have more sig figs than your least significant piece of data.

3. Determine the answer normally, but then round your answer to the appropriate number of sig figs.

      Ex) 23 cm x 1.0246 cm = 23.5888 cm^2 =

SIG FIGS IN ADDITION/SUBTRACTION PROBLEMS:

1. Line up the numbers old school and determine the answer normally.

2. DON'T COUNT SIG FIGS! (No need!)

3. Starting from the left, find the first column to run out of resolution. Draw a vertical line after that column.

4. Round your answer to the left of that line.

Your answer cannot exceed the resolution of your weakest data source!

      Ex) 52.0 g + 100.258 g + 71 g =

SIG FIGS WHEN DETERMINING AN AVERAGE:

- Like addition/subtraction, an average cannot exceed the resolution of your weakest data source.

      Ex) Find the average of 2.05 cm, 51.2 cm & 705 cm. =

SIG FIGS AND CASCADING ROUNDING ERRORS IN LARGE PROBLEMS:

- You should only determine sig figs ONCE no matter how involved a math problem is.

- This is only tricky if you have both multiplication/division and addition/subtraction the same problem.

- When you transition between the two, note what the sig figs would be if the problem ended there.

- Account for those transitional sig figs at the end of the problem.

      Ex) Solve this: (47.25 g – 46 g) / 50.2 mL =

"Curious that we spend more time congratulating people who have succeeded than encouraging people who have not." ~ Neil deGrasse Tyson

Scientific Notation

Useful for keeping track of very big or very small numbers. An exponential expression.

For numbers greater than one:

Move the decimal point *left* until there is only one number to the left of it. Indicate the number of moves of the decimal point as an exponent of ten.

ex. $3{,}673{,}000 = 3.673 \times 10^6$ $456 = 4.56 \times 10^2$

For numbers less than one:

Move the decimal point *right* until there is only one number to the left of it. Indicate the number of moves of the decimal point as a *negative* exponent of ten.

ex. $0.00034 = 3.4 \times 10^{-4}$ $0.000000304 = 3.04 \times 10^{-7}$

Significant Figures

Those digits in a measurement that have actually been measured by comparison to a scale, plus one estimated digit.

How to determine which digits are significant:

All non zero-digits are significant. ex) 3456.7 five sig. figs.

How about zeros?

1. Zeros *between* non-zero numbers are significant.
2. Zeros *to the left* of non-zero numbers (*a.k.a. leading zeros*) are not significant.
3. Zeros *to the right* of non-zero numbers (*a.k.a. trailing zeros*) are significant if they are in a number with a decimal point.

   (4. Zeros that have *a bar* above them are the last significant zero.)

For example. . .

0.0021   NOT SIG! (2 s.f.)

1.0021   SIG! (5 s.f.)

50,000   NOT SIG! (1 s.f.)

50,000.   ALL SIG.! (5 s.f.)

10   NOT SIG! (1 s.f.)

10.   SIG! (2 s.f.)

10.0   SIG! (3 s.f.)

10.00   ALL SIG! (4 s.f.)

1,001,000   (4 s.f.)   SIG! NOT SIG!

1,001,000.   (7 s.f.)   SIG! SIG!

1,001,002   (7 s.f.)   SIG! SIG!

Note: Leave out insignificant zeros when putting a number in scientific notation.

How to use significant figures in calculations:

Adding / subtracting?
1. Line up the numbers and add or subtract as you would normally.
2. From left to right, determine which number (excluding the answer) runs out of significant figures first.
3. Draw a vertical line right after the last significant digit in that number. Draw the line all the way down until it bisects the answer.
4. Round off the answer to the left of the line.

For example. . .

* (SINCE YOU DON'T KNOW WHAT NUMBERS ARE HERE YOU CAN'T TRUST THOSE COLUMNS!)

SET UP THE NUMBERS...

```
    52.0
  100.258
 +  71.
 ─────────
  223.258
```

...AND SOLVE ...

... FIND THE LAST SIGNIFICANT COLUMN...

```
    52.0 ? ?*
  100.258
 +  71.????
 ─────────
  223.258
```

...AND DRAW A LINE...

... ROUND TO THE LEFT OF YOUR LINE!

223.258   '2' ROUNDS DOWN...

CORRECT ANSWER = 223

(3 s.f.)

Multiplying / dividing?
1. Determine significant digits in each number.
2. Determine the smallest number of significant digits present. That is how many significant digits the answer must have.
3. Multiply or divide as you normally would.
4. Round the answer to the number of significant figures determined in step 2.

For example. . .

COUNT THE # OF SIG FIGS IN EACH NUMBER ...

2 s.f.!   5 s.f.!
   23 x 1.0256

...SINCE 2 IS THE SMALLEST # OF SIG FIGS, IT LIMITS YOUR ANSWER TO 2 SIG FIGS!

(THINK WEAK LINK!)

... THEN DO THE MATH AND ROUND ANSWER TO PROPER # OF SIG FIGS!

23 x 1.0256 = 23.5888

TO 2 SIG FIGS...

24   CORRECT ANSWER!

Another note: *Significant figures are only needed when things are measured!! Counting numbers (3 birds) or definitions (1 foot = 12 inches) are not measured against a scale, so they do not have to deal with significant figures. If present, ignore such numbers when figuring out how many significant digits an answer should have!!*

For each of the following numbers determine the number of significant figures and then convert the number to scientific notation or back to normal notation if needed.

1. 0.02   _____   7.   0.0200   _____   13. 2.0002   _____

2. 5000   _____   8.   5000.   _____   14. 5001   _____

3. 920,000   _____   9. 8.72×10^7 _____ 15. 1.2×10^3 _____

4. 5.4×10^{-3} _____   10. 0.0200   _____   16. 10,000.2   _____

5. 6×10^{-1} _____   11. 1.24×10^3 _____ 17. 9.90×10^6 _____

6. 2.000×10^2 _____   12. 0.23001   _____   18. 3.14×10^0 _____

Perform the following operations expressing the answer in the correct number of significant figures. Show necessary work and pay attention to units!

1.   1.20023 m x 52 m =   2. $150 \ L^3 / 4 \ L =$

3. $8.901 \times 10^2 \ g / 36.0023 \ mL =$ 4. $67.2 \times 10^{-3} \ cm$ x 231 sec =

5.   (346 mL x 200 K) / 237.12 K =   6.   23.0 cm x 0.0967 cm x 333 cm =

7.   12.01 mL + 35.274 mL =   8.   55.69 g – 2.1111 g – 34.1 g =

9. $2.3456 \times 10^{-2} \ kg + 9.02 \times 10^{-3} \ kg =$ 10.   1.000 m – 23.2 cm =

11.   (12.02 kg + 0.00034 kg + 381 kg)   12.   (12.011 L - 0.099 daL)
            (0.34 m x 12.090 m) $5.020 \times 10^2 \ mol$

HONORS CHEMISTRY   THE FACTOR-LABEL METHOD

A brand, new way to solve math problems (a.k.a.   )

1. Write what you have and what you need.

2. Set up conversions (a.k.a.   )

   ~ Top and bottom of each conversion should be equal.

   ~ (HELPFUL HINT: when setting up conversions, ask yourself "Which unit is bigger?" Make that unit equal to 'one' and then determine how many of the smaller units are equivalent.)

   ~ ex.) 1 inch =   cm   1 foot =   inches

   ~ Can flip either way, whichever is needed.

3. Cancel out units, leaving behind only units desired.

4. Do the math.

5. ▷ USE COMMON SENSE. . . DOES ANSWER MAKE SENSE?!?

Metric - metric conversions are usually two - step problems.

   - Go to base unit, then to prefix sought (less to memorize)

ex.) How many micrometers are there in 26 millimeters?

Other conversions can have variable number of steps.

ex.) A building has 79 lightbulbs burning at 60W each. How many MW is that?

ex.) How many inches is 678 meters? How many feet is that? Miles?

   (note: 5280. feet in one mile.)

Note: these are multiplication/division problems. Significance rules apply!

Conversions that are defined <u>never</u> limit significance.

   ~ ex.) 12 inches in a foot, 100 centimeters in a meter

Conversions that are measured can limit significance.

   ~ ex.) 2.54 cm in one inch, 454 grams in a pound.

HONORS CHEMISTRY   FACTOR-LABEL PRACTICE

Try out these problems. Show all intermediate steps and all work! Remember, metric-metric conversions should be two steps. Other conversions can vary.

1. .045Mm = ? hm

2. 52.4 mL = ? daL

3. 960 µg = ? cg

4. .0034 GW = ? dW

5. 14 nm = ? pm

6. 2.54 hL = ? cm^3

7. exactly 2 hours = ? ms

8. 1.0 mile = ? cm

9. WELCOME TO THE FARMER'S MARKET. YOU HAVE 50 APPLES AND YOU'D LIKE SOME EGGS, BUT YOU'LL HAVE TO BARTER FOR THEM! AFTER TRADING WITH ALL THE FARMERS, HOW MANY EGGS CAN YOU GET? INFORMATION: FARMER A WILL TRADE 1 PIG FOR 2 CHICKENS. FARMER B WILL TRADE 3 CAKES FOR ONE SACK OF POTATOES. FARMER C WILL TRADE 1 CHICKEN FOR 25 APPLES. FARMER D WILL TRADE 1 DOZEN EGGS FOR 1 CAKE. FINALLY, FARMER E WILL TRADE 1 PIG FOR 3 SACKS OF POTATOES. ALL THE FARMERS WILL TRADE EITHER WAY (I.E. FARMER A WILL TRADE FOR CHICKENS OR APPLES.) GOOD LUCK!

"Eggs must not quarrel with stones." ~ Chinese Proverb

HONORS CHEMISTRY   MATHEMATICS REVIEW SHEET

Metric conversions **(show all work!)**

1) 16.8 GW to ? cW

2) 34.50 mm to ? dm

3) 106 nl to ? dal

4) 0.67 μm to ? Mm

5) .007 ps to ? minutes

6) 75.6 kg to ? Mg

Scientific Notation
Write the answers to the top six answers in scientific notation.

1)

2)

3)

4)

5)

6)

Significant Figures
Perform the following calculations, using the proper number of significant figures.

1) $45.0 + 34 - 0.0006$

2) $8.2 \times 10^{-4} + 9.02 \times 10^{-4}$

3) $7.89 \times 10^{5} \times 1.4 \times 10^{4}$

4) $326.3 \times 123 \times 45.0066701$

And finally
Count and write down the number of significant figures next to <u>each</u> number on this sheet.

"True knowledge lies in knowing how to live."

~ Gracian