NS A2 (pg 1 of 2) **Significant Figures** Name_____

Using the measuring device correctly: Rulers & Cylinders

When making measurements, the measuring device controls the "exactness" of the number that can be recorded i.e. the number of digits that can be written down.

	arrow X	arrow Y
Record the length of the line above and below ruler A	_____	_____
Record the length of the line above and below ruler B	_____	_____
Record the length of the line above and below ruler C	_____	_____

Which ruler, A, B, or C must have been used to make the following measurements?

4.23 cm 17 cm 9.3 cm 5.00 cm 2.0 cm

The measuring device determines how many decimal places you can record.

Look at the cylinder closely and determine the value of the smallest increment (line), and then always record the measurement one decimal place beyond that value, even if the last place is a zero. If the measured value falls exactly on a scale marking, the estimated digit must be a zero. (Sometimes there will be more than one zero if the marked line you are estimating to be on is a 1, 10, or 100's line.)

Record the amount of liquid in each of the three graduated cylinders at your table:

_____ 10 ml cylinder

_____ 100 ml cylinder

_____ 1000 ml cylinder

Significant Figures

The numbers that are written down using the measuring device to the *proper degree of uncertainty* are known as significant figures – these are the numbers in a measurement that are known for certain plus the last estimated number.

Remember each measuring device has a particular number of significant figures that can be recorded. We'll call this the "exactness". Whenever you use a measurement that someone else recorded, you must assume that they used the measuring device properly and recorded their measurement to the appropriate number of significant figures (exactness).

So when you look at a measurement, which numbers are significant figures?

1. All nonzero digits are SF.
2. So what about zeros: *Let's check out ruler D & E*
   a. Captive zeros are sig figs (wedged between sig figs).
   b. Leading zeros are NOT sig figs
   c. Trailing zeros are sig figs if there's a decimal.
3. Exact numbers are "infinitely" significant:
   - counting numbers
   - defined conversion factors e.g. 1 lb = 0.454 kg $\frac{1lb}{0.452kg} = \frac{0.454kg}{1lb}$

Why do we care about significant figures?

The reason we need to be able to identify which digits in a measurement are significant is because when we use these numbers in calculations we need to decide how we will round off the answers. Our computations can not be any more or less exact than the measurements that went into the calculation.

Use the 10 ml cylinder to determine the volume of one drop from eye dropper. Since a drop is so tiny, perhaps you would do better making several drops and taking an average.

Now that you know the volume of one drop add one drop to the 1000 ml cylinder and determine the new volume. Since clearly you can not even see that drop that was added, you can see why we need to worry about the significant figures when we calculate using measurements. It is necessary to be concerned with the SF in measurements and not compute answers that are any more accurate than the original measurements allow.

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  256      large cylinder
+ 0.05     one drop
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  256      (mathematically
           256.05, but
           not valid with the
           measuring devices.)
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Answers to Ruler question at the top of page one: Which ruler was used? Ruler C, A, B, C, B

The rules for rounding off answers after making calculations:

We must use two separate rules for rounding off since there are two distinct arithmetic :

4. Multiplication/division: Txshe result must be rounded to the same number of significant figures as the measurement with the fewest significant figures.
   *"**How Many**"*

5. Addition/subtraction: The result must be rounded to the same place (1's, 10's, 10ths, etc) as the measurement with the sig figs that are least far to the right.
   "**Where**"

12.3 "**Where**"	
+ 456.78	

~~469.08~~	(not 469 which would result if
469.1	you incorrectly applied the multiply/divide rule)

12.38 "**How Many**"	
x 5.6	

~~69.328~~	(not 69.3 which would result if
69	you incorrectly applied the add/subtract rule)

Practice:

1. Underline the significant figures in the following measurements: ***ANSWERS***
   a. 234 m — 234 m
   b. 204 ml — 204 ml
   c. 230 min — 230 min not the 0, it's to the right of a digit, but not to the right of a decimal
   d. 230.0 g — 230.0 g
   e. 2.9˚C — 2.9˚C
   f. 2.09 kg — 2.09 kg
   g. 20.9 mph — 20.9 mph
   h. 2.90 cg — 2.90 cg
   i. 0.56 cm^3 — 0.56 cm^3 not the 0 in front since they are not to the right of a digit
   j. 0.056 g/ml — 0.056 g/ml neither 0's in front since they are not to the right of a digit
   k. 0.0506 mm — 0.0506 mm neither 0's in front since they are not to the right of a digit
   l. 0.0560 m^2 — 0.0560 m^2 neither 0's in front since they are not to the right of a digit
   m. 0.05060 mg — 0.05060 mg neither 0's in front since they are not to the right of a digit
   n. 1.056 dm^2 — 1.056 dm^2
   o. 1.05060 L — 1.05060 L

2. Round the following computations to 3 significant figures:
   a. 163.8 g — 164 g
   b. 16.065 ml — 16.1 ml
   c. 1.0694 L — 1.07 L
   d. 1.10275 cm^2 — 1.10 cm^2
   e. 1.10875˚C — 1.11˚C
   f. 9.99840 g/ml — 10.0 g/ml
   g. 3.465 kg — 3.46 kg or 3.47 kg your choice

3. Round the answers off to the appropriate number of significant figures and put on the appropriate unit label.
   a. 6.4 m × 8.03 m = (51.392) — 51 m^2 (2 sf)
   b. 6.4 g/ml × 8.11 ml = (51.904) — 52 g (2 sf)
   c. 4.18 J/g˚C × 6.527 g × 2.5˚C = (68.20715) — 68 J (2 sf)
   d. $\frac{8.307g}{9.65ml}$ = (0.860829015) — 0.861 g/ml (3 sf)
   e. $\frac{1.27m^2}{0.036m}$ = (35.27777778) — 35 m (2 sf)
   f. $\frac{12.000g}{8.56g/ml}$ = (1.401869159) — 1.40 ml (3 sf)
   g. 6.73 g + 3.2 g = (9.93) — 9.9 (to the 10ths place)
   h. 3740 m – 96.275 m = (3643.725) — 3640 m (to the 10s place)
   i. $\frac{38{,}670miles}{73.0hours}$ = (529.726027) — 530. or 5.30×10^2 (which are both 530, but the zero would not be significant, and you need to show 3 sf)