Significant Figures

a.k.a. how to round numbers

...or why an 89.5% should be an A

Why Rounding Rules?

- So the precision of measurement is not over-represented in an answer
  - Adding more decimals may sound smart, but without precise measurements supporting an answer, those don't matter.
  - A number is only as precise as the least precise measurement involved with it

A few notes

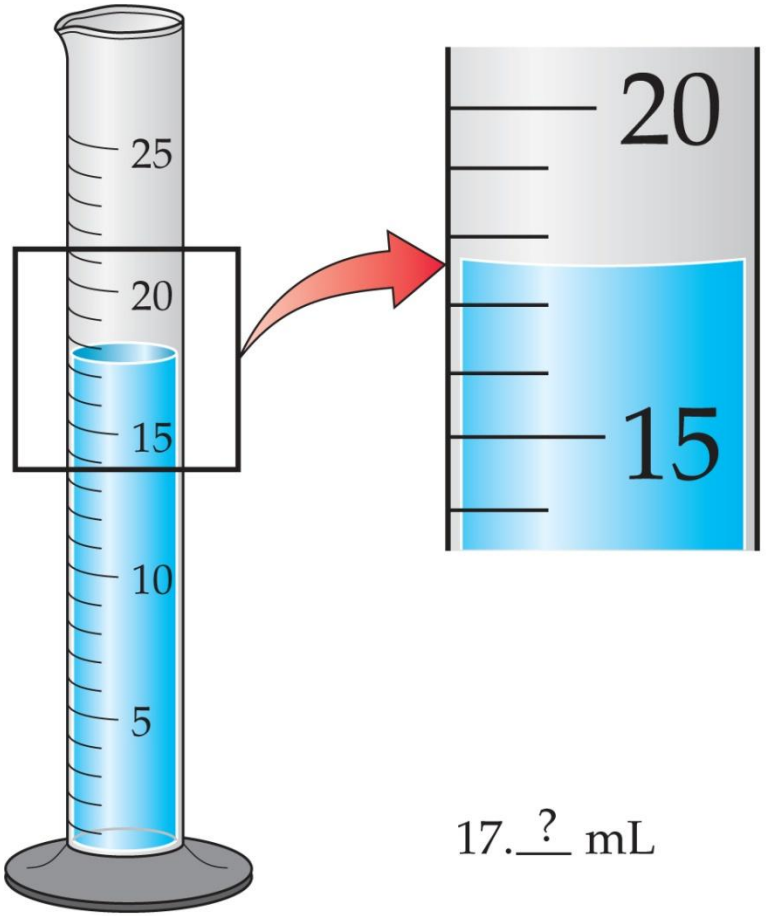
- When measuring with a **mechanical instrument** (ruler, triple beam balance etc), record all the digits that are marked on the instrument's scale and estimate (and only one) more digit.

- When measuring with an **electronic instrument**, record all the digits on the readout. Consider the last digit to be approximate.

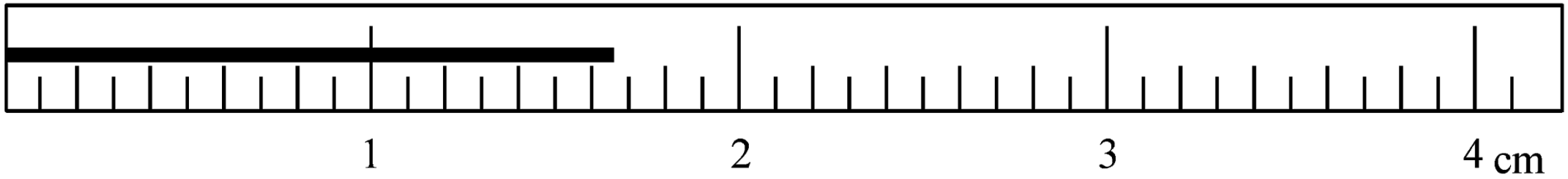
- Round calculated answers only once, at the end of the calculation, so that the number of significant digits reflects the precision of the original measurements.

Measurement and Significant Figures

- Every experimental measurement has a degree of uncertainty.
- The volume, V, at right is certain in the 10's place, 10mL<V<20mL
- The 1's digit is also certain, 17mL<V<18mL
- A best guess is needed for the tenths place.



What is the Length?



- We can see the markings between 1.6–1.7cm
- We can't see the markings between the .6–.7
- We must guess between .6 & .7
- We record 1.67 cm as our measurement
- The last digit an 7 was our guess…stop there

Measured Numbers

- Do you see why Measured Numbers have error…you have to make that Guess!
- All but one of the significant figures are known with certainty. The last significant figure is only the best possible estimate.
- To indicate the precision of a measurement, the value recorded should use all the digits known with certainty.

Significant Figures: RULES

1) All non– zero digits are significant
   Ex. (34 cm ––– 2 sig fig)

2) Zeros in zero sandwiches are significant
   Ex. (2009 ––– 4 sig fig)

3) In order for zeros at the end of a measurement to be significant, there must be a decimal point.
   Ex. (23.000 –– 5 sig fig but 2300 –––2 sig fig)

4) Zeros to the left of the first non–zero are NOT significant. They are just place holders.
   Ex. (0.00124 –––3 sig fig)

Measurement	# of Sig Figs
1) 1400.0	5 significant figures
2) 300	1 significant figure
3) 0.0050	2 sig figs
4) 6001.30	6 sig figs
5) 11232.0	6 sig figs
6) 5.00	3 sig figs

Sig. Figs.

- When we are using measurements in different calculations in Chemistry and Physics and even Biology, we need to account for the level of precision. To do so, scientists use ***significant figures***.

- The last sig fig in a measurement is always the doubtful digit. But that is not always clear. For example

- 12340cm or 12340.cm or 12340.0cm

QUESTIONS

- If Jenn measures a line to be 12.0 cm, what number is she doubtful about and how many sig. figs. are there?

- If Darren measures a mass to be 1300 g, what number is he doubtful about and how many sig. figs. are there?

Scientific Notation

- Scientists use ***scientific notation*** as a method to show the proper amount of sig. figs.
- 300 km can be written as 3×10^2 km.
  (10^2 is 100 – so 3 x 100 =300)
- 300 km (with 2 sig. figs) can be written as 3.0×10^2 km. Notice we clearly have 2 sig. figs.

Rules for + and -

- When adding or subtracting, use "columns"

"Measured to the nearest ___ " is the rule.

examples:

1.52 cm	450	1505.0
+ .02 cm	+14.5	+ 40
1.54 cm	464.5	1545.0
No rounding	rounds to 465	round to 1545

Rules for × & ÷

- Count sig figs in each measurement used.
- Use lowest number of sig figs to round **final** answer.

- Example: 45.0cm x 30cm = 1350 cm^2
  rounds to 1000 cm^2
- Ex: 4.5123g ÷ 250 cm^3 = .0180492
  rounds to 0.018 g/cm^3