1.4 – Uncertainty in Data

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Data Terms

What's accuracy?
– How close a measurement is to an accepted value.

What's precision?
– How close measurements are to each other.

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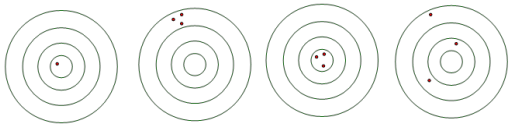
Target practice

How are these shots?



Accurate Precise Both Neither

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Error Calculations

What's error?

Difference between experimental value (the number measured in an experiment) and accepted value (number regarded to be correct).

Error = Experimental Value - Accepted Value

Error will be positive or negative: indicates whether an experimental value was high or low.

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Error Calculations

More useful to show error as a percent of the accepted value:

$$\%\,Error = \frac{|Error|}{Accepted\,Value} \cdot 100\%$$

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Ex. 1.

A student measures the mass and volume of a piece of aluminu to be 14.38g and 5.29 mL, respectively. What is the density of this sample?

$$\rho = \frac{\text{mass}}{\text{volume}} = \frac{14.38\,\text{g}}{5.29\,\text{mL}} = 2.72\,\text{g/mL}$$

If the accepted density = 2.64 g/mL:
What is the error? What is the % error?

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Ex. 1.

Error = Experimental value - Accepted Value

= 2.72 g/mL - 2.64 g/mL = 0.08 g/mL

$$\%\,Error = \frac{|Error|}{Accepted\,Value} \cdot 100\%$$

$$= \frac{|0.08\,g/mL|}{2.64\,g/mL} \cdot 100\%$$

$$= 3.03\% \rightarrow Round\ to\ hundredths\ place$$

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Yay?

Accuracy is limited to the tools we use.

What time is it exactly? Clock vs. watch.

Significant figures all known digits of a measurement plus one estimated one.

Ex 1: The balances have distinct tick marks to 0.1 g, but you determine the last 0.01 g value.

Ex 2: Measure a penny with a ruler vs. a caliper

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Significant Figure Rules!

1. Non-zero digits are significant. 4.32 =3 sig figs
2. Zeros between non-zeros are also. 409 =3 sig figs
3. Final zeros only **if a decimal is present** are too. 310.0 =4
4. Placeholders and leading zeros are insignificant.
   0.0034 and 4200 = 2
5. Numbers in the exponent don't count. 2.3 E 14 =2
6. Counting numbers & defined constants have infinite number.

Ex: 6 molecules, 60 s = 1 minute

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Terrible Significant Figure Rhyme

digits from 1 thru 9 always be [113.45]
and always zeros between them you'll see [100.32]
-
but the decimal be darned
it is slightly confusing
-
so here is my rhyme
to make it amusing
-
only zeros to the left of numbers not at all [0.0043032]
and after numbers with no decimal do fall [942,0200]
-
yet give your decimal some numbers then zeros [1.0420]
you've added significance and become a hero
-
now a digit 1-9 with decimal right on a whim
any zeros between them or after will win [1000.0]
-
i've given my rhyme and paid my penance
now study your chemistry...makes the test less a menace!

Sep 7-7:37 AM

Significant Figures

How many significant figures in the following?

0.389 = 3 All non-zero digits are significant. Leading zeros are insignificant.
0.9023 = 4 All zeros in between non-zeros are significant.
0.3890 = 4 A decimal makes all ending zeros significant.
480 = 2 If no decimal - all end zeros are placeholders.
480.0 = 4 A decimal makes all ending zeros significant.
5.20 E 4 = 3 Numbers in the exponent don't matter.

Converting numbers into scientific notation eliminates ambiguity in significant figuring.

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Rounding

Rules:
Find number to right of last sig fig in your number.

If 4 or less, drop it completely. 23.67833 = 23.678

If 5 or more, increase last sig fig by 1 before dropping.

23.678 = 23.68

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Brain Teaser Ex. 2.

How would you round 20,200 L to two significant figures?

Tricky!
Scientific notation is the best way to avoid ambiguity. → 2.0 E 4 L

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Number Manipulation.

Addition and subtraction:
Answer has same number of digits right of the decimal as the original value having the fewest.
Ex: 14.314 + 1.24

14.314
+ 1.24
15.554 → 15.55

Note: If your numbers are in scientific notation, they MUST have the same exponent.
Ex: 1.23 E 5 + 1.562 E 4

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Number Manipulation.

Multiplication and division:
Answer has same number of sig figs as the original with the fewest.

Ex: 1.24 X 14.314

$1.24 \cdot 14.314 = 17.74936 \rightarrow 17.7$

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Homework

Read 2.4 in your book
1.4 Problems in Booklet
Due: Next Class

Start Unit 1 Review (P. 24)
Due: 2nd Block Day Next Week

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