SIGNIFICANT FIGURES

When scientists write down a measured or calculated value, they always understand that the value they write has an **implied precision**, as follows:

15.	means ± .5	(closer to 15. than to 16. or to 14.)
15.0	means ± .05	(closer to 15.0 than to 15.1 or to 14.9)
15.00	means ± .005	(closer to 15.00 than to 15.01 or to 14.99)
15.000	means ± .0005	(closer to 15.000 than to 15.001 or to 14.999)
15.0000	means ± .00005	(closer to 15.0000 than to 15.0001 or to 14.9999)
15.00000	means ± .000005	(closer to 15.00000 than to 15.00001 or to 14.99999)

We say that the digits that we trust are "significant," so the first number listed above has just two significant figures (or significant digits), while the last number listed has seven.

A. RULES FOR WRITING SIGNIFICANT FIGURES:
1. All nonzero digits are considered significant.
2. Zeroes in between nonzero digits are considered significant.
3. "Leading" zeroes, to the left of the first nonzero digit, are **never** significant.
4. Zeroes to the right of the last nonzero digit are considered significant only if a decimal point is present.

THUS:
536   has 3 significant digits (rule 1)
5036   has 4 significant digits (rule 2)
005036   still has 4 significant digits, and so does 0.000005036 (rule 3)
5360. has <u>four</u> significant digits, but 5360 has only <u>three</u> (rule 4)
1000. has <u>four</u> significant digits, meaning 1000. ± .5 (to the nearest integer),
but 1000 has only <u>one</u> significant digit, meaning 1000 ± 500 (to the nearest thousand).

B. RULE FOR ADDITION (AND SUBTRACTION):
When adding or subtracting quantities, the answer should have as many <u>decimal places</u> as the number with the fewest decimal places that was used.
    THUS: 24.5 - 23.318287 = 1.2 (rounded up to one decimal place)

C. RULE FOR MULTIPLICATION AND DIVISION:
When multiplying or dividing quantities, the answer should have as many significant figures as the number with the fewest significant figures that was used.
    THUS: 4.5 x 23.318287 = 1.0 x 10^2 (rounded to two significant figures, and
            expressed in scientific notation to show the correct number of significant figures,
            which cannot be shown for this number in ordinary decimal notation).
    NOTE:
        Numbers like 2, or ½, or π, or most conversion factors (like 1 m = 100 cm) are assumed
        to be <u>exact</u>, with an infinite number of significant figures. They do not influence the number
        of significant figures in the answer.

D. ROUNDING OFF:

Most calculators show many more digits than just the significant ones, so you need to round off.

1. Count the number of significant digits and keep them.
2. Discard any remaining (nonsignificant) digits.
3. If the first nonsignificant digit was 5 or more, add 1 to the last significant digit.
4. Remember that powers of ten (like 10^2 or 10^{-6}) are exact and have no influence on the number of significant digits.

E. SPECIAL ADVANCED RULE FOR LOGARITHMS (mostly in pH calculations):

A logarithmic quantity, such as a pH value, has as many <u>decimal places</u> as the number of <u>significant figures</u> in the original value (the concentration in a pH calculation).

THUS:

A whole-number pH corresponds to a concentration known only as a power of ten.

A pH to one decimal place (like 5.2) corresponds to
a concentration known to one significant figure.

A pH to two decimal places (like 5.22) corresponds to
a concentration known to two significant figures.

The part of the pH to the left of the decimal point has no effect on significant figures.