

Significant Figures

Significant figures ("sig figs") are the digits in a value that are known with some degree of confidence. As the number of significant figures increases, the more certain the measurement.

Counting significant figures:

- 1) all non zero digits are significant
- 2) zeros between non zero digits are significant
- 3) zeros to the left of the first non-zero digit are not significant
- 4) zeros that fall at the end of the number and to the right of the decimal are significant
- 5) a number which ends in zero and has no decimal point *is* ambiguous - to clarify the number of sig figs, the number must be written in scientific notation
- 6) only digits in the coefficient of a number written in scientific notation count towards significant figures (does not depend on the power often/the exponent)

Propagating significant figures when adding and subtracting:

The result has uncertainty in the same digit (tenths, ones, etc.) as the number with the largest uncertainty being added/subtracted.

Propagating significant figures when multiplying & dividing:

The result has the same number of significant figures as the number with the least number of significant figures being multiplied or divided.

Rounding: reporting a result with the correct # of sig. figs

Final results must be reported with the correct number of significant figures.

The value of the right-most significant figure to be reported is based on the insignificant digit immediately to its right:

If this digit is 5, then the right most significant digit is rounded up.

If this digit is < 5, then the right-most significant digit is reported as *is*.

Problems containing both addition/subtraction and multiplication/division:

- 1) Do operations in parentheses first. Then do multiplication/division. Then addition/subtraction.
- 2) Keep all digits (even those which are insignificant) until the final result is reported.
[This requires you to keep track of which digits are significant as you go along.]

Numbers which are exact and do not limit the uncertainty in a calculation:

numbers that are defined to have a certain value have no uncertainty and should be treated as though they have infinite significant figures

1 ft = 12 inches (both the 1 and the 12 are exact)

1 kg = 1×10^3 g = 1000 (all numbers are exact)

for a value such as the density below:

3.02 g/ml → the denominator has an implied 1, which is exact (the numerator has 3 sig figs)

Proper Form

$$\text{Result} = (A \pm \delta A) \times 10^{\text{exponent}} \text{ units}$$

- δA must be written to **1 significant figure!!!!!!**
(You don't generally know the uncertainty with a great degree of certainty.)
- A and δA must have
 1. common exponent outside the parentheses.
 2. common units outside the parentheses.
 3. same number of **decimal places** inside the parentheses.

Bad

A) $(3.023 \pm 0.07) \times 10^3 \text{ m}$

B) $(1.12 \pm 0.21) \text{ s}$

C) $(4.34 \pm 0.004) \times 10^{-2} \text{ kg}$

D) $(510 \pm 70) \text{ kg}$

Corrected

$(3.02 \pm 0.07) \times 10^3 \text{ m}$

$(1.1 \pm 0.2) \text{ s}$

$(4.340 \pm 0.004) \times 10^{-2} \text{ kg}$

$(5.1 \pm 0.7) \times 10^2 \text{ kg}$

Why are the bad ones bad?

- A) A has three decimal places (i.e. places past the decimal point), not matching the two decimal places for δA .
- B) δA has two significant figures instead of just one.
- C) A has only two decimal places, not matching the three decimal places for δA .
- D) Some people might say that this one is actually acceptable...but technically, it's ambiguous whether δA has one or two significant figures here. The only way that this can be remedied is by using scientific notation.