Rules for Counting Significant Figures

1. **Nonzero Digits.** Nonzero digits always count as significant figures. For example, the number 33.45 has four nonzero digits, all of which count as significant, it has four significant figures.
2. **Zeros.** There are three classes of zeros.
    a. *Leading zeros* are zeros that precede all of the nonzero digits. They never count as significant. For example, the number 0.0034 has three leading zeros and two nonzero digits; it has 2 significant figures, since the leading zeros do not count.
    b. *Captive zeros* are zeros that fall between nonzero digits. They always count as significant figures. For example, the number 2003 has four significant figures.
    c. *Trailing zeros* are zeros at the right end of the number. They are significant only if the number is written with a decimal point. The number one hundred written as 100. has three significant figures. One hundred written as 100.0 has four significant figures. However the number 100 has one significant figure.
3. **Exact numbers.** Often calculations involve numbers that were not obtained using measuring devices but were determined by counting. For example, 10 experiments, 3 apples, 8 molecules, these are exact numbers. We assume that exact numbers have unlimited significant figures. In addition, factors for converting between units of measurement (like 2.54 cm/in) are considered exact numbers.

Rules for rounding off.

When doing calculations on your calculator, the number of digits displayed is usually greater than the number of significant figures that the result can reasonably have. In this case, you figure out how many significant figures you should have, and round off.

1. If the digit to be removed is
    a. less than 5, the preceding digit stays the same. For example, if 1.33 is rounded to have two significant figures, it would become 1.3. If 1.632 is rounded to have three significant figures, it would become 1.63.
    b. is equal or greater than 5, the preceding digit is increased by 1. For example, 1.666 rounded to two significant figures becomes 1.7. The number 1.666 rounded to three significant figures is 1.67.
2. In a series of calculations, carry the extra digits through to the final result and then round off, using the procedure in Rule (1).

Rules for significant figures in calculations.

1. For multiplication or division, the number of significant figures in the result is the same as that in the measurement with the smallest number of significant figures.

For example:

4.560 x 1.04 = 6.348 (calculator answer)

4.560 has four significant figures.

1.04 has three significant figures.

When we multiply the two numbers, the result will have three significant figures (three is the least number of significant figures of numbers in this calculations).

So the correct answer is 6.35.

2. For addition or subtraction, we use the position of uncertainty rather than the number of significant figures to govern how we round off our results. The position of uncertainty is the decimal place of the last significant digit in a number. For example, in the number 1.23, the position of uncertainty is in the hundredth's place. For the number 120, the position of uncertainty is in the tens place (remember the trailing 0 is not significant).

   The rule is that for addition or subtraction, the position of uncertainty of the result is in the same position as that of the most uncertain measurement. In other words, the result will have the same number of decimal places as the measurement with the least decimal places in the calculation.

   For example:

   0.04+4.560=4.6 (calculator answer)

   The position of uncertainty of 0.04 is in the hundredths place. The position of uncertainty of 4.560 is in the thousandths place. The result will have position of uncertainty in the hundredths place.

   So the correct answer is 5.60.

   Notice that though the number 0.04 has one significant figure (leading zeros do not count as significant), the answer has three significant figures. The numbers of significant figures of the measurements do not play a role in the number of significant figures in the result. Only the positions of uncertainty matter in addition and subtraction.