Significant Figures

Physics and **Chemistry** courses require students to round their final answers to the correct number of significant figures. Whenever we measure something, there is a margin of error, and we communicate the margin of error by clearly indicating the number of significant figures - ie, how many decimal places are important to the question.

Only apply significant figures to your *final answer*. If a question has multiple parts (a, b, c, etc.), round the final answer of each section to the correct number of significant figures. However, if you are using an answer from an earlier part in later calculations,, use the *unrounded* value in calculations.

When are digits significant?

- Non-zero numbers are always significant. 22 has two significant figures.
- Zeroes placed in between nonzero digits are significant. 7006 has four significant figures.
- Zeroes to the left of a number are non-significant. 0.0076 only has two significant figures (7 and 6).
- Zeroes to the right of a number *if there is a decimal point* are significant. 76.000 has 5 significant figures.
- Zeroes to the right of a number *without a decimal point* are non-significant; these are called trailing zeroes. 8200 only has two significant figures, 8 and 2.
- If you use an assumed value (such as acceleration due to gravity), this must be included in significant figures calculations.
- An exact whole number, like a quantity of items, can be considered infinitely significant. This means that we count the significant digits as-is. "5 apples" has an infinite number of significant figures, but "5 metres" has just one significant figure. There are exactly 5 apples, but approximately 5 metres.
- When examining a number in scientific notation, ignore the 10 multiplier when counting significant digits. Only the decimal portion is considered when determining significant figures. 1.234×10^8 has 4 significant figures (1.234).

Calculating Significant Figures in answers

Generally, if there are a lot of calculations occurring in a question, round your final answer to the *least number of significant figures* found in the question.

Multiplying and Dividing

When multiplying and dividing values, round the final answer to the least number of significant figures found in the original question.

Example:

What is the speed of a car if it moved 220.0m {four significant figures} in 15.0 {three significant figures} seconds?

$v = \frac{d}{t}$

$v = \frac{220.0m}{15.0s}$

$v = 14.6666...7\ (unrounded - use\ this\ value\ if\ you\ have\ a\ second\ part\ to\ the\ question)$

$v = 14.7m/s$ {rounded to three significant figures because three is the lowest count of significant figures in the question}

Adding and Subtracting

When adding and subtracting values *only*, round the final answer to the least number of decimal points found in the original question.

Example:

0.067 {three decimal places} + 1.23 {two decimal places} = 1.30 {two decimal places - a zero was added to fill the second decimal place}

Examples

1. A car moving at 32 *(2 sf)* m/s sounds a 480 *(3 sf)* Hz horn. A person at the side of the highway hears the horn as the car is approaching and while it is moving away. The temperature is 24°C *(2 sf)*. Calculate the two frequencies.

A:

$f_1 = 530\ Hz$

$f_2 = 440\ Hz$

The answers are rounded to 2 significant figures because the given values have 2, 3, and 2 significant figures. The lowest of those values is 2, so our solution has two significant figures.

2. A golfer can drive a ball with a velocity of 80.0 m/s *(3 sf)* [10° from the horizontal] (ignore the angle for sf). Assume no air resistance and g = -9.8 m/s^2.

A: $\Delta t = 2.8\ s$

In this question, you need to use the acceleration value of $-9.8 m/s^2$ *this has two significant figures. The final answer will therefore have 2 significant figures.*

b. How far will the ball travel horizontally before it hits the ground?

A: $\Delta d_x = 223\ m$

In this question, the values of 80.0 m/s, $10°$ and 2.835 seconds (*unrounded*) are used. In addition, g = -9.8 with two signfiicant digits was used to find that time. We *ignore the angle*, and instead look to the other two values. Both have at least three significant figures, and therefore our final answer has three significant figures.

3. A $2.00 \times 10^2 kg$ satellite is in circular orbit at a height of $6.00 \times 10^2 km$ above the earth's surface

a. Find the speed of the satellite.

A: $7560\ m/s$ or $7.56 \times 10^3 m/s$

For this question, all given values are to three significant figures, so our final answer needs to be calculated to three significant figures. Two possibilities are provided - the second, in scientific notation, is preferred as the original question is given in scientific notation.

4. If a sample of copper (I) chloride has 5.98×10^{22} molecules, what is the mass of the sample?

Given:

$\#\ molecules = 5.98 \times 10^{22}$ (3 significant figures)
$Molar\ Mass\ of\ CuCl = 99.00 g/mol$ (4 significant figures - ignore when calculating final answer)

Answer: 9.83 g, rounded to 3 significant figures.