

Astronomy 11 review guide for significant figures

Good for you, for reviewing your significant figures!

Below I have some worked math examples...make sure you understand why the significant figures and rounding steps are done the way they are.

STEP 1

When conducting calculations in laboratory work, it is important to first determine the number of significant figures ("sig. figs.") your answer should have. This number is set by the input parameter in your calculations that has the fewest sig. figs.: *the weakest link in your input values sets the number of significant figures in your answer.*

Make sure you understand how to count the sig. figs. in your input values—see the rules on sig. figs. given in Lab 41, and also on our astronomy lab web site.

STEP 2

Complete your calculation, retaining all the figures in your calculator. If you have to stop at some intermediate step, record your intermediate value with at least two more sig. figs. than your final answer will have.

STEP 3

When you are done, and are presenting your final answer, round your answer to the number of sig. figs. you counted in Step 1. And of course, don't forget to include your units.

A note to the dedicated student

This astronomy lab treats only the basics of "laboratory precision." As you continue your science studies, you may learn about more complete, sophisticated treatments of laboratory precision such as "propagation of errors" or "error analysis."

Rounding examples...do all these make sense to you?

<u>Number</u>	<u>4 sig. figs.</u>	<u>3 sig. figs.</u>	<u>2 sig. figs.</u>	<u>1 sig. fig.</u>
37,431	37,430	37,400	37,000	40,000
445,542	445,500	446,000	450,000	400,000 ^A
0.0034955	0.003496	0.00350 ^B	0.0035	0.003
51.568	51.57	51.6	52	50
39.678	39.68	39.7	40.	40 ^C
49,980.1	49,980	5.00 x 10 ⁴	5.0 x 10 ⁴	50,000 ^D
5.8965 x 10 ¹¹	5.897 x 10 ¹¹	5.90 x 10 ¹¹	5.9 x 10 ¹¹	6 x 10 ¹¹ ^E

Notes

A: When rounding 445,542 to one sig. fig., it is closer to 400,000 than 500,000.

B: The following zero here, after a decimal point, adds a third sig. fig.

C: Because of the decimal point "40." has 2 sig. figs., while "40" only has 1 sig. fig.

D: To express 50000 with more than 1 sig. fig., you must use scientific notation.

E: The "x 10¹¹" does not contribute to the sig. figs.

Practice problems to review significant figures

Calculate the volume of a rectangular block, using $V = \text{Length} \times \text{Width} \times \text{Height}$

1) $L = 15 \text{ cm}$, $W = 14 \text{ cm}$, $H = 18 \text{ cm}$

Step 1: You see that all three input values have 2 sig. figs.

Step 2: $15 \times 14 \times 18 = 3780$

Step 3: Round to 2 sig. figs., and include units: 3800 cm^3

2) $L = 150.0 \text{ cm}$, $W = 140.00 \text{ cm}$, $H = 180 \text{ cm}$

Step 1: The input values have the following numbers of sig. figs.: 4, 5, and 2.

(There is no decimal point in "180")

Step 2: $150.0 \times 140.00 \times 180 = 3,780,000$

Step 3: Round to 2 sig. figs., and include units: $3,800,000 \text{ cm}^3$, or $3.8 \times 10^6 \text{ cm}^3$.

3) $L = 150 \text{ cm}$, $W = 140 \text{ cm}$, $H = 190 \text{ cm}$

Step 1: The input values all have 2 sig. figs.

Step 2: $150 \times 140 \times 180 = 3,990,000$

Step 3: Currently, that answer has 3 sig. figs., but you must round it to 2 sig. figs. In this case, it is a little tricky. The last "9" must be rounded up...but if you write your final answer as 4,000,000, that only has one sig. fig. If you write it as 3,900,000, that has 2 sig. figs. but is not correctly rounded. The only way around it is to use scientific notation: $4.0 \times 10^6 \text{ cm}^3$.

Calculate the speed of an object, $\text{Speed} = \text{distance}/\text{time}$

4) An object travels 5000 meters in 30. seconds. $D = 5000 \text{ m}$, $t = 30. \text{ sec}$

Step 1: The input values have the following numbers of sig. figs.: 1, 2.

Step 2: $5000/30. = 166.666$

Step 3: Round the number to 1 sig. fig., and include units: 200 m/sec .

5) An object travels 5000. meters in 30. seconds. $D = 5000. \text{ m}$, $t = 30. \text{ sec}$

Step 1: The input values have the following numbers of sig. figs.: 4, 2.

Step 2: $5000./30. = 166.666$

Step 3: Round the number to 2 sig. figs., and include units: 170 m/sec .

6) An object travels 5.00×10^4 meters in 30.0 seconds. $D = 5.00 \times 10^4 \text{ m}$, $t = 30.0 \text{ sec}$

Step 1: The input values both have 3 significant figures.

Step 2: $5.00 \times 10^4 / 30.0 = 1666.666$

Step 3: Round the number to 3 sig. figs., and include units: 1670 m/sec .

Significant figures and exact numbers in conversions or formulae

Remember that exact conversions do not reduce sig. figs. Examples of exact numbers are:

- 1) There are exactly 24 hours in a day;
- 2) There are exactly 60 minutes in an hour;
- 3) There are exactly 1000 meters in a km;
- 4) In the equation, " $A=4\pi R^2$ ", the "4" is an exact number.

If a conversion or a constant in an equation is not exact, you must use a version of the number with enough sig. figs. so your conversion does not affect the precision of your calculations. Examples of inexact numbers are:

- 1) There are approximately 365.25636 days in a year;
- 2) One km is approximately 0.6213711922 mile;
- 3) The speed of light is approximately 2.99792458×10^8 m/sec;
- 4) The mathematical constant π is approximately 3.14159265358979.

7) You measure an event to take 6.32 days. How long is this in seconds?

Step 1: The input value has 3 sig. figs.

Step 2: $6.32 \text{ days} \times (24 \text{ hrs} / \text{day}) \times (60 \text{ min} / \text{hr}) \times (60 \text{ sec} / \text{min}) = 546,048$

Step 3: Round the number to 3 sig. figs., and include units: 546,000 sec.

Remember, the 24 and 60s in the above conversions are perfect, and do not reduce the sig. figs. of your answer.

8) You measure the radius of a circle to be 454.48 cm. Use the equation $C = 2\pi R$ to calculate its circumference.

Step 1: The input value has 5 sig. figs.

Step 2: In the equation " $C = 2\pi R$ ", the "2" is exact. You must look up the value of the inexact number pi to 5 sig. figs. so it will not limit the precision of your final value.

$$C = 2 \times 3.1416 \times 454.48 = 2855.5887$$

Step 3: Round the number to 5 sig. figs., and include units: 2855.6 cm.

Note: It is perfectly fine to use the extremely precise value of π that is already stored on your calculator.