

SIGNIFICANT FIGURES / SCIENTIFIC NOTATION

SIGNIFICANT FIGURES

Any measurement is inaccurate to some degree. The inaccuracy stems from several factors -- the precision of the measuring device used, errors by the person doing the measurement, a faulty experimental technique, etc. In scientific investigations, communicating our uncertainty in a measurement is equally important as the measurement itself. We convey our uncertainty in measured quantities by abiding by the rules of significant figures.

1. Significant figures in a measurement include all of the digits that are known precisely plus one last digit that is estimated.
2. Non-zero digits are always significant. 103.230002
3. All final zeros after the decimal point are significant. 12.740 ; 0.0420
4. Zeros between two other significant digits are always significant. 10.0 ; 2004 ; 6.000
5. Zeros used only for spacing the decimal point are **not** significant. 100 ; .00000233
6. If you add or subtract, the answer is rounded to the same number of decimal places as the measurement with the least **number** of decimal places.
7. If you multiply or divide two numbers, the answer is rounded off to the number of significant figures in the least precise term used in the calculation (i.e. the number with the fewest sig figs).

Determine the number of significant digits in each of the following:

- | | | | |
|-------------|---------------|---------------|----------------------|
| 1. 23.30 cm | 4. 1,843.02 L | 7. 2.00012 km | 10. 0.0001010450 sec |
| 2. 3.65 kg | 5. 8.701°C | 8. 0.5 mL | |
| 3. 365 kg | 6. 2000.12 mm | 9. 704,000 h | |

Report answers to the following using proper significant figures:

11. 3.414 s + 10.02 s + 58.325 s + 0.00098 s
12. 2.326 h – 0.10408 h
13. 10.19 m x 0.013 m
14. 140.01 cm x 26.042 cm x 0.0159 cm
15. 80.23 m / 2.4 s
16. 4.301 kg / 1.9 cm³
17. An experiment calls for 16.156 g of substance A, 28.2 g of substance B, 0.0058 g of substance C, and 9.44 g of substance D.
 - a) How many significant digits are there in each measurement?
 - b) What is the total mass of substances in this experiment?
 - c) How many significant digits are there in the answer to part b?
18. Your lab partner has carefully measured out 16.50 mL of water. You accidentally tip over the graduated cylinder and spill some of the water. You stand the cylinder up, and determine that there are 8.0 mL of water left.
 - a) Which measurement is more precise – your lab partner's or yours? Explain.
 - b) How much water did you lose when you tipped over the graduated cylinder?

SCIENTIFIC NOTATION

How many significant figures does the measurement of 100 mm have? Reported in this fashion, the conservative reader needs to assume one significant figure. However, what if whoever performed the measurement was accurate to within 1 mm? In this case, three significant digits should be reported as the true value may be as low as 99 mm or as high as 101 mm. How can the experimenter report this value and maintain the proper number of significant figures? Reporting the value as 100.0 suddenly turns the term having one significant digit into a term having four. Certainly the experimenter isn't reading the meter stick to the nearest tenth of a meter as this last number implies!

To eliminate this possible confusion, the scientific and engineering communities often employ scientific notation. Without going into the details (since scientific notation should be review for you), our experimenter can report the above measurement as 1.00×10^2 mm. With this notation, it is clear that three significant digits are intended. Typically 1 number is placed to the left of the decimal, and this number is then multiplied by the appropriate power of ten. Strictly speaking, our experimenter could report the measured quantity as 10.0×10^1 mm, but the first version is more common. Note that in either case, the number of significant digits is correctly reported as three.

Write the following numbers in scientific notation and indicate the number of significant digits.

19. 156.90

21. 0.0345

20. 12,000

22. 0.00690

Solve the following, placing your answers in scientific notation with the proper number of significant digits.

23. $(6.6 \times 10^{-8}) / (3.30 \times 10^{-4}) =$

26. $(1.56 \times 10^{-7}) + (2.43 \times 10^{-8}) =$

24. $(7.4 \times 10^{10}) / (3.7 \times 10^3) =$

27. $(2.5 \times 10^{-8}) \times (3.0 \times 10^{-7}) =$

25. $(2.67 \times 10^{-3}) - (9.5 \times 10^{-4}) =$

28. $(2.3 \times 10^{-4}) \times (2.0 \times 10^{-3}) =$

ALGEBRA

And lets not forget everybody's favorite – algebra!

Solve for x in the following problems.

29. $\frac{3x}{y} = \frac{6g}{b}$

31. $\frac{2x^2}{3} = dg$

30. $d = \frac{t}{x}$

32. $\frac{2\sqrt{x}}{c} = y$

33. Solve for b (hint: you will need to use the quadratic formula) $9b - 13 + 2b^2 = 4b$

34. Solve for t in terms of n : $\sqrt{18t + 6n} = 3n$

35. Solve for t and x in this system of two equations with two unknowns: $2x + 6 = 9t$; $3t - 4 = 3x$

ANSWERS:

- | | | |
|-------------------------|---------------------------|--------------------------|
| 1. [4] | 16. 2.3 kg/cm^3 | 28. 4.6×10^{-7} |
| 2. [3] | 17a. [5, 3, 2, 3] | 29. $(2gy)/(b)$ |
| 3. [3] | 17b. 53.8 g | 30. t/d |
| 4. [6] | 17c. 3 | 31. $((3dg)/2)^{(1/2)}$ |
| 5. [4] | 18a. Lab partner's | 32. $(c^2y^2)/4$ |
| 6. [6] | 18b. 8.5 mL | 33. 1.58 or -4.09 |
| 7. [6] | 19. 1.5690×10^2 | 34. $(1/6)n(3n-2)$ |
| 8. [1] | 20. 1.2×10^4 | 35. $t=10/21$; $x=-6/7$ |
| 9. [3] | 21. 3.45×10^{-2} | |
| 10. [7] | 22. 6.90×10^{-3} | |
| 11. 71.76 sec | 23. 2.0×10^{-4} | |
| 12. 2.222 h | 24. 2.0×10^7 | |
| 13. 0.13 m^2 | 25. 1.72×10^{-3} | |
| 14. 58.0 cm^3 | 26. 1.80×10^{-7} | |
| 15. 33 m/sec | 27. 7.5×10^{-15} | |