Significant Digits (also known as significant figures)

Rules for deciding which digits are significant:

1. Nonzero digits are always significant.
2. All final zeros after the decimal point are significant.
3. Zeros between two other significant digits are always significant.
4. Zeros used solely for spacing the decimal point are ***not*** significant.

Examples:

Using the rules above, 0.0340 mm has 3, 960 kg has 2, and 70,080 s has 4 significant figures.

123.479 m + 35.8 m + 5.32 m = 164.599 m = 164.6 m

(In addition or subtraction, work with the numbers as they are written, but the final answer must have the same level of precision as the least precise number – in this case, precision to the tenths place.)

$$\frac{123.479 \text{ kg}}{35.8 \text{ m}^3} = 3.449134078 \frac{\text{kg}}{\text{m}^3} = \underline{3.45 \frac{\text{kg}}{\text{m}^3}}$$

(In multiplication or division, work with the numbers as they are written, but the final answer must have the same number of significant digits as the number with the least amount of digits – in this case, 3 significant digits.)

$$\frac{7.48 \text{ m}^3}{3.6 \text{ m}} = \underline{2.1 \text{ m}^2}$$

(In multiplication or division, units are multiplied and divided like numbers.)

Exercises

1. **State the number of significant digits in each of the following measurements.**

a. 32.06 kg ________ **b.** 0.02 km ________ **c.** 5400 m ________ **d.** 2006 s ________

e. 2.9910 m ________ **f.** 5600 km ________ **g.** 0.00670 kg ________ **h.** 809 g ________

2. **Solve the following problems and give the answers to the correct number of significant digits. (All numbers must be written with the correct units.)**

a. 324.54 cm - 25.6 cm = ________________

b. 28.9 g + 300.25 g + 2.945 g = ________________

c. 82.3 m x 1.254 m = ________________

d. $(1.2 \times 10^6 \text{ m})(3.25 \times 10^4 \text{ m})$ = ________________

e. $\frac{32.6 \text{ kg}}{125.4 \text{ L}}$ = ________________

f. $\frac{4.24 \times 10^{-3} \text{ kg}}{2.2 \times 10^{-4} \text{ L}}$ = ________________

g. $\frac{2.647 \text{ m}}{2.0 \text{ m}}$ = ________________

h. 5.25 cm x 1.3 cm = ________________

i. 9.0 cm + 7.66 cm + 5.44 cm = ____________

j. 10.07 g - 3.1 g = ________________

Scientific Notation

Scientific notation is a compact way of writing large or small numbers while using only significant digits and powers of ten.

Examples:

0.00265 written in scientific notation would be $\underline{2.65 \times 10^{-3}}$.
(The negative three power of ten indicates that the decimal point should be moved three places to the left.)

7.68×10^{5} expanded would be $\underline{768{,}000}$.
(The positive power of five indicates that the decimal point should be moved five places to the right. In this case, zeros are needed as placeholders.)

$$\frac{9.6 \times 10^{7}}{3.2 \times 10^{4}} = \underline{3.0 \times 10^{3}}.$$

(Divide the decimals while keeping the correct number of significant figures. When dividing powers of ten, subtract the bottom power of ten's exponent from the top power of ten's exponent. If multiplying, add powers of ten.)

$(4.5 \times 10^{-2}) + (8.2 \times 10^{-3}) = 4.5 \times 10^{-2} + 0.82 \times 10^{-2} = 5.32 \times 10^{-2} = \underline{5.3 \times 10^{-2}}$.
(Before adding or subtracting numbers in scientific notation, all numbers need to have the same power of ten)

Exercises

Write the following numbers in scientific notation.

1. 156.90 ______________________________
2. 0.0345 ______________________________
3. 0.00890 ______________________________
4. 560 ______________________________
5. 43,200 ______________________________
6. 4,320,000 ______________________________
7. 0.00065 ______________________________
8. 101.35 ______________________________

Expand the following numbers.

9. 1.54×10^{4} ______________
10. 2.5×10^{-3} ______________
11. 5.67×10^{-1} ______________

Solve the following and put your answer in scientific notation. (With the correct number of significant figures.)

12. $\frac{6.6\text{x}10^{-8}}{3.3\text{x}10^{-4}}$ = ______________
13. $\frac{7.4\text{x}10^{10}}{3.7\text{x}10^{3}}$ = ______________
14. $\frac{2.5\text{x}10^{8}}{7.5\text{x}10^{2}}$ = ______________
15. $(2.67 \times 10^{-3}) - (9.5 \times 10^{-4})$ = ____
16. $(1.56 \times 10^{-7}) + (2.43 \times 10^{-8})$ = ____
17. $(2.5 \times 10^{-6})(3.0 \times 10^{-7})$ = ____
18. $(1.2 \times 10^{-9})(1.2 \times 10^{7})$ = ____
19. $(2.3 \times 10^{4})(2.0 \times 10^{-3})$ = ____

Factor-Label Unit Conversion

Common Prefixes:
nano has the symbol, n, and means 10^{-9} (or 0.000000001)
micro has the symbol, μ, and means 10^{-6} (or 0.000001)
milli has the symbol, m, and means 10^{-3} (or 0.001)
centi has the symbol, c, and means 10^{-2} (or 0.01)
kilo has the symbol, k, and means 10^{3} (or 1000)

Making Unit Conversions
250 µm = ______________ m

$$(250\ \mu m)\left(\frac{10^{-6}\ m}{1\ \mu m}\right) = 2.5 \times 10^{-4}\ m$$

or $$(250\ \mu m)\left(\frac{1\ m}{10^{6}\ \mu m}\right) = 2.5 \times 10^{-4}\ m$$

FACTOR-LABEL UNIT CONVERSION

An easy way to change from one unit to another is by using conversion factors. To convert a speed given in km/h to m/s, you must first change kilometers to meters, then hours to seconds. The value of a quantity does not change when it is multiplied by 1. Any quantity divided by its equivalent equals one. Since 1000 m = 1 km and 3600 s = 1 h, we can make the following conversion factors.

$$\left(\frac{1000\ m}{1\ km}\right) = 1 \quad \text{and} \quad \left(\frac{1\ h}{3600\ s}\right) = 1$$

Therefore, to change a speed in km/h to m/s, first multiply it by an appropriate distance conversion factor and then by a time conversion factor. For example, 120 km/h becomes

$$\left(\frac{120\ km}{1\ h}\right)\left(\frac{1000\ m}{1\ km}\right) = 120{,}000\ \frac{m}{h}$$

Then, $$\left(120{,}000\ \frac{m}{h}\right)\left(\frac{1\ h}{3600\ s}\right) = 33\ \frac{m}{s}$$ (The converted number should have the same number of significant digits as the original number.)

For the problems below, show <u>all</u> conversion factors. Show all work. Do <u>*not*</u> use the conversion factor feature on your calculator to do these problems.

1. Carry out the following conversions using the prefix information shown above.

a. 35 nm $\left(\frac{\quad}{\quad}\right)$ = ______________ m

b. 450 cm $\left(\frac{\quad}{\quad}\right)$ = ______________ mm

c. 1500 µg $\left(\frac{\quad}{\quad}\right)$ = ______________ g

d. 250 km $\left(\frac{\quad}{\quad}\right)\left(\frac{\quad}{\quad}\right)$ = ______________ cm

e. 346 ms $\left(\frac{\quad}{\quad}\right)$ = ______________ s

f. 543 mg $\left(\frac{\quad}{\quad}\right)\left(\frac{\quad}{\quad}\right)$ = ______________ kg

g. 4008 g $\left(\frac{\quad}{\quad}\right)$ = ______________ mg

h. 239 mm $\left(\frac{\quad}{\quad}\right)\left(\frac{\quad}{\quad}\right)$ = ______________ cm

i. 48 mL $\left(\frac{\quad}{\quad}\right)$ = ______________ L

j. 38 kg $\left(\frac{\quad}{\quad}\right)\left(\frac{\quad}{\quad}\right)$ = ______________ mg