SIGNIFICANT FIGURES

What are significant figures/digits and what are they used for?

Significant figures are numbers that carry a contribution to a measurement and are useful as a rough method to round a final calculation. For more complex systems such as the uncertainty of a dosimetry system, or estimating the bioburden of a product, more accurate methods should be used, such as those found in NIST Technical Note 1297 (TN1297), “Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results”

What makes a number “significant” or not significant?

All numbers which are not leading or trailing zeros are considered significant unless the trailing zero comes after a decimal point (i.e. 3.00 would have 3 significant figures, while 300 would only have 1 significant figure). In the case of a measurement instrument, if the instrument is only calibrated to a certain decimal place, any digit after that calibration range is not considered significant. For example, if a weight scale is calibrated to the tenths place (0.0), but provides a reading to the hundredths place (0.00), only an estimate of the tenths place may be accurately reported using traditional rounding methods.

Example: A weight scale calibrated to the tenths place reads a weight of 11.35 lbs. The reading would be rounded to the tenths place and reported as 11.4 lbs.

What rules about significant figures should be followed when adding and subtracting numbers?

For addition and subtraction, the final result may only have the result reported to the same decimal place as the least precise measurement.

Example: The length of a building is 372.71 ft. measured using a tape measure calibrated to the hundredths place. The width of the same building is 174.2 ft measured using a ruler calibrated to the tenths place. What is the perimeter of the building?

The perimeter is:

$$P = 372.71 + 174.2 + 372.71 + 174.2$$

$$P = 1093.82 \text{ ft.}$$

However, since the width of the building is only known to the tenths place, our result can only be reported to the tenths place. The final result is:

$$P = 1093.8 \text{ ft.}$$

What rules about significant figures should be followed when multiplying and dividing numbers?

For multiplication and division, the final result may only have the same number of significant figures as the least precise measurement.

Example: If the mass of a box is measured to be 6.817 kg, and the volume is measured to be 18.39 cm^3 what is the density of the box?

We calculate density (p) by dividing the mass of the box by the volume of the box. So:

$$p = \frac{6.817\text{kg}}{18.39\text{cm}^3}$$

$$p = 0.370\ldots\ldots\text{kg/cm}^3$$

Since the volume only has significant digits to the hundredths place while mass has significant digits to the thousandths place, we report the final density to the hundredths place as:

$$p = 0.37\text{kg/cm}^3$$

FOR MORE INFORMATION

STERIS Applied Sterilization Technologies
Web: www.steris-ast.com // Email: ast_info@steris.com
(EMEAA) +44 (0) 8456 88 99 70
(Americas) 877.783.7479

STERIS

SIGNIFICANT FIGURES

How are constants handled when performing calculations with significant figures?

Recall the formula for the circumference of a circle is:

$$C = 2\pi r$$

In this equation, the r represents a measurable quantity, the radius of the circle, and π is a constant. In the case of π, we know infinitely many digits beyond the decimal place, so the least accurate reading would be from our measurement of the radius. However, this is not the case for all constants.

In general, when performing calculations with constants, it is best to use one more digit than the least precise measurement. So if we calculate the circumference of a circle with a radius of 4.2 in., we would use 3.14 as a minimum estimate of π (the radius is significant to the tenths place, so for π, we go out one more digit to the hundredths place).

When calculating a value with multiple steps, when do we make the significant figures estimate?

Significant figures estimates should be made at the final step of the calculation. Going back to our density example, if our mass is now 5.312 kg, and we have a box measuring 2.54 cm x 2.54 cm x 2.54 cm, we would calculate the volume as:

$$V = (2.54\text{cm}) \times ((2.54\text{cm})) \text{ x } (2.54\text{cm})$$

$$V = 16.3871\ldots\text{cm}^3$$

And to calculate the density, we would use:

$$p = \frac{5.312\text{kg}}{16.3871\ldots\text{cm}^3}$$

$$p = 0.3242\ldots\text{kg}/\text{cm}^3$$

And our final density is reported to the hundredths place based on the accuracy of the length, width, and height of the box:

$$p = 0.32\text{kg} / \text{cm}^3$$

FOR MORE INFORMATION

STERIS Applied Sterilization Technologies
Web: www.steris-ast.com // Email: ast_info@steris.com
(EMEAA) +44 (0) 8456 88 99 70
(Americas) 877.783.7479

STERIS