

Presenting Chemical Data

This video presentation discusses the precision of a measurement, significant figures and scientific notation. We have already discussed the accepted SI units used in scientific measurement but we have yet to explain how scientific measurements are made.

Some measurements need to be precise, and are measured with sophisticated equipment, some measurements are estimated. We use significant figures to convey the precision of a measurement when recording data or doing calculations. A large number of significant figures mean a greater precision in the measurement.

To put this idea in perspective, imagine we are doing an experiment that needs to be completed in a water bath at room temperature. We have access to two thermometers. The traditional thermometer has a precision of two significant figures, and the digital thermometer has a precision of three significant figures. Which would you use? The answer lies in the requirements of the experiment, room temperature is a general statement for approximately twenty two degrees Celsius. We would use the traditional thermometer because it has the required precision for our purposes. If the experiment required dissolving a substance in water at exactly 35.5 degrees Celsius then we would need to use the digital thermometer.

There are guidelines for determining the significant figures of a number. Exact numbers have no uncertainty, and an unlimited number of significant figures. Non-zero digits, contained zeros, and zeros after a decimal point are significant, leading zeros are not significant. Zeros placed at the end of a number, a non-decimal, are generally place holders, if however; the number is a measured quantity a period is placed at the end of the number. Detailed guidelines for determining significance are included in this section with worked examples.

When performing calculations it is important that the precision of the measurement be preserved. A calculated answer does not have a larger or smaller precision than the numbers used in the calculation. This means the calculated answer should not have a greater or fewer number of significant figures than the data used in the calculation. When multiplying or dividing significant figures, the calculated number has the same number of significant figures as the least precise number used in the calculation. For the addition or subtraction of significant figures, the calculated number will have the same decimal place as the least precise number used in the calculation. When completing a series of calculations carry extra digits through to the final answer then round to the correct amount of significant figures.

A method for clearly conveying the significance of a number is scientific notation. Scientific notation expresses large and small numbers using a coefficient, which is just a number, typically between one and ten, multiplied by a power of ten. If a value is written the significant figures can be read unambiguously from the number of digits in the coefficient. To write a value in scientific notation, move the decimal point to the left or right to reach a decimal number between one and ten. Write the number obtained, multiplied by 10. Raised to the correct power, which is number of places the decimal point was moved. If the decimal is moved to the left, the power is positive. If the decimal is moved to the right, the power is negative. For example one hundred forty thousand would become 1.4×10^5 clearly showing the two significant figures for this value.

For the addition or subtraction of numbers written in scientific notation rewrite all of the numbers in the calculation so the exponent is the same, then add or subtract the coefficient. For multiplication simply multiply the coefficients and add the exponents. When dividing numbers in scientific notation write the values out as fractions and divide the coefficients, then subtract the exponent in the denominator from the exponent in the numerator. Scientific calculators are frequently used to do chemical calculations using scientific notation. Generally scientific calculators have an EE or EXP button both buttons mean multiplied by ten to the power of n, n being the value of the exponent. For an exponent with a negative value, enter a negative sign before entering the value of the exponent. For example to enter 1.4×10^5 into a scientific calculator type the coefficient value, 1.4, press the EE or EXP button, then enter your exponent value, 5.

We have now covered the material on measurement precision, significant figures and scientific notation. You should be able to assign significance to a value or measurement and do simple calculations using significant figures and scientific notation. Please work on developing your skills in this area using the example problems provided.