# Analytical Metrology Frequently Asked Questions



Integrated Sciences Group answers frequently asked questions relating to the general field of analytical metrology. The answers are intended to provide clarification and dispel common misconceptions. If you have any questions or comments regarding any of our analytical metrology FAQ topics or would like us to answer additional questions, please contact us at tech@isgmax.com.

| Question | Answer |
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| What is analytical metrology? | Analytical metrology consists of the disciplines of measurement uncertainty analysis, measurement decision risk analysis and calibration interval analysis.<br>* Not to be confused with Analytical Chemistry Metrology, which is sometimes shortened to Analytical Metrology. |
| What is measurement quality assurance (MQA) and what is its importance to metrology? | When a measurement supports a decision, the validity and accuracy of the measurement carries the same importance as the decision. MQA applies analytical metrology to provide a means for assessing whether or not activities, equipment, environments and procedures involved in making a measurement produce a result that can be rigorously evaluated for validity and accuracy.<br>Validating that measuring and test equipment (MTE) parameters and attributes are within specified tolerance limits is an important element of MQA. In many instances, the validation of MTE performance is required by regulation, contract or policy directive. |
| What skills are required to implement or apply analytical metrology concepts and methods? | It depends on whether or not you start from scratch or use commercial-off-the-shelf (COTS) training and software.<br>If starting from scratch, an M.S. or Ph.D. degree in math and statistics and a B.S. or higher degree in engineering or physics would be needed to effectively implement measurement uncertainty analysis, measurement decision risk analysis and calibration interval analysis concepts and methods.<br>With appropriate COTS training and software, it would require a fundamental understanding of math and statistics and practical experience gained through testing, MTE calibration or other measurement science related activity. |

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| What is a measurement? | It is a process whereby the value of a quantity is estimated with the aid of an instrument or device. In metrology, the quantity whose value is sought is often called the subject parameter or measurand. |
| What is the difference between a subject parameter and a measurand? | In section B.2.9 of the ISO GUM, measurand is defined as "the particular quantity subject to measurement." Other sources define measurand as also including the specific conditions under which the measurement is made. These conditions may include the identification of environmental factors, ancillary equipment used, measuring personnel, etc.<br><br>To avoid confusion, the term "subject parameter" has been coined to specifically represent the quantity (or attribute) whose value we seek to determine through measurement. For example, a subject parameter may be the length of a gage block or the pressure of a tire. |
| What is measurement error? | All measurements are accompanied by error. That is, the measured value of a quantity differs from the quantity's true value by some unknown amount. Measurement error is the sign and magnitude of this difference. For given a quantity $x$, the error in $x$ is<br><br>$$\varepsilon_x = x - x_{true}$$<br><br>The error in $x$ is comprised of errors encountered during the measurement process and can be expressed as<br><br>$$\varepsilon_x = \varepsilon_1 + \varepsilon_2 + \ldots + \varepsilon_k$$<br><br>where the numbered subscripts signify the different measurement process errors. |
| What is a calibration? | It is a process in which the value of a parameter or attribute of a device or unit under test (UUT) is compared to a corresponding value of a measurement reference.<br><br>A calibration result may take the form of (1) a stated value for the measured UUT attribute or parameter and an estimate of the uncertainty in the measured value, (2) a correction in the value of the UUT parameter or attribute or (3) a declaration that the UUT parameter or attribute is in- or out-of-tolerance. |

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| What types of devices are considered to be MTE? | For the purposes of analytical metrology, MTE include artifacts (mass standards, gage blocks, etc), instruments, sensors and transducers, signal conditioners, data acquisition units, data processors and output displays. |
| Is it really necessary that I fully understand the manufacturer specifications of the MTE I use? | Manufacturer specifications are used to purchase or substitute MTE for a given measurement application, estimate bias uncertainties and establish tolerance limits for calibration and testing. Therefore, MTE users should be proficient at identifying applicable specifications and in interpreting and combining them. |