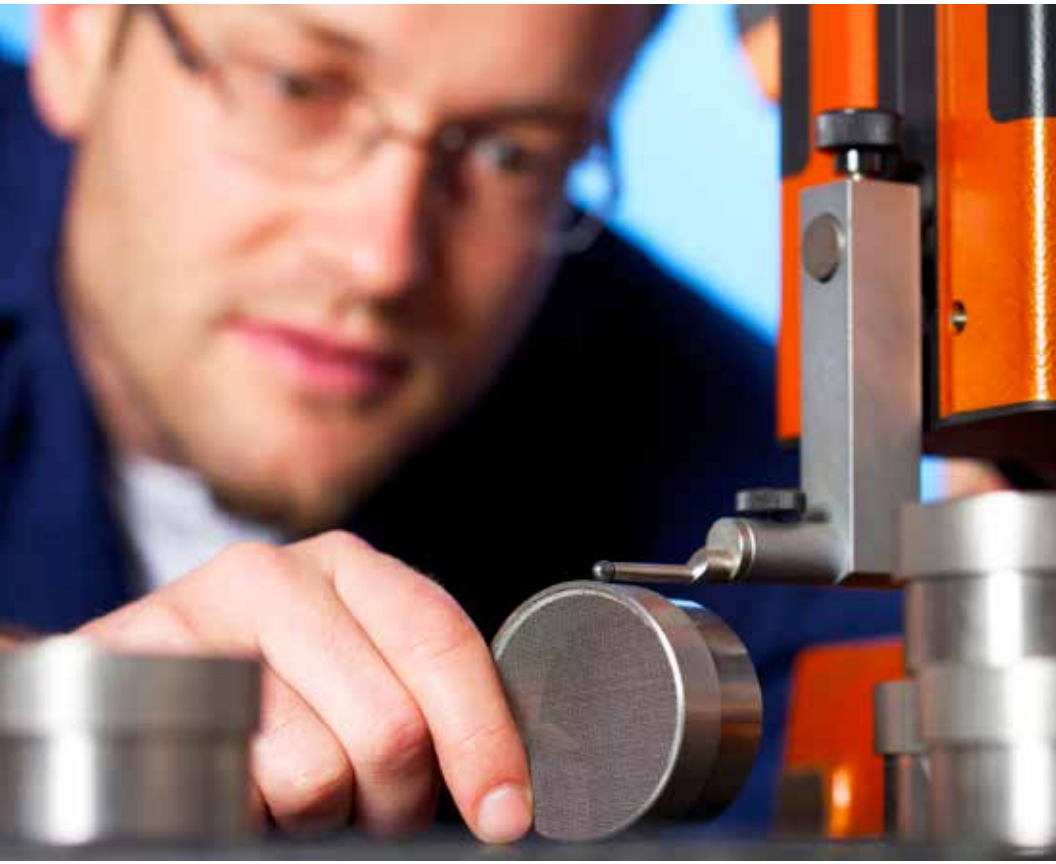
Certified Calibration Technician



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Certification from ASQ is considered a mark of quality excellence in many industries. It helps you advance your career and boosts your organization's bottom line through your mastery of quality skills. Becoming certified as a Calibration Technician confirms your commitment to quality and the positive impact it will have on your organization.

Information

Certified Calibration Technician

The Certified Calibration Technician is a professional who tests, calibrates, maintains, and repairs electrical, mechanical, electromechanical, analytical, and electronic measuring, recording, and indicating instruments and equipment for conformance to established standards.

Examination

Each certification candidate is required to pass a written examination that consists of multiple-choice questions that measure comprehension of the Body of Knowledge. The Calibration Technician examination is a one-part, 125-question, four-hour exam and is offered in English.

Education and/or Experience

You must have five years of on-the-job experience in one or more of the areas of the Certified Calibration Technician Body of Knowledge.

If you have completed a degree from a college, university, technical or trade school with accreditation accepted by ASQ, part of the five-year experience requirement will be waived, as follows (only one of these waivers may be claimed):

- Diploma from a technical, military, or trade school—two years waived
- Associate degree—two years waived
- Bachelor's degree—two years waived
- Master's or doctorate—two years waived

Degrees/diplomas from educational institutions outside the United States must be equivalent to degrees from U.S. educational institutions.

For comprehensive exam information on Calibration Technician certification, visit **asq.org/cert.**

Body of Knowledge
Certified Calibration Technician

The topics in this Body of Knowledge (BoK) include additional detail in the form of subtext explanations and the cognitive level at which the questions will be written. This information will provide useful guidance for both the Exam Development Committee and the candidate preparing to take the exam. The subtext is not intended to limit the subject matter or be all-inclusive of what might be covered in an exam. It is meant to clarify the type of content to be included in the exam. The descriptor in parentheses at the end of each entry refers to the maximum cognitive level at which the topic will be tested. A more complete description of cognitive levels is provided at the end of this document.

Note Regarding IM&TE (inspection, measurement, and test equipment)
The Test Specification Committee that created this BoK recognizes that different industries and branches of the military use various descriptors and abbreviations to refer to the units being calibrated. To avoid confusion, the committee decided to use the term IM&TE as the most globally descriptive term. This term will be used in both the BoK and the CCT exam itself.

I. General Metrology
(35 Questions)

A. Base SI Units
Describe and define the seven base units: 1) meter, 2) kilogram, 3) second, 4) ampere, 5) kelvin, 6) candela, 7) mole. (Understand)

NOTE: The application of these units is covered in I.B., I.C., and I.E.

B. Derived SI Units
Define and calculate various derived units, including: 1) degree, 2) ohm, 3) pascal, 4) newton, 5) joule, 6) coulomb, 7) hertz, etc. (Apply)

C. SI Multipliers and Conversions
Define various multipliers, including: kilo, deci, centi, milli, and calculate converted values such as mega to kilo, micro to milli, etc. (Apply)

D. Fundamental Constants
Identify the fundamental constants of: 1) c–velocity or speed of light in a vacuum, 2) g–gravitational constant, 3) R–universal gas constant, 4) their standard symbols and common applications. (Remember)

*NOTE: The values of these constants and the formulas for calculating them will **not** be tested.*

E. Common Measurements
Describe and apply IM&TE in measuring: 1) temperature, 2) humidity, 3) pressure, 4) torque, 5) force, 6) mass, 7) voltage/current/resistance, 8) time/frequency, 9) linear displacement. (Evaluate)

F. Traceability Standards and Hierarchy
Identify various aspects of traceability, including traceability through commercial and national laboratories and international metrology organizations. (Understand)

G. Measurement Standards
Define and distinguish between various types of standards, including: 1) primary, 2) reference, 3) working, 4) intrinsic, 5) derived, 6) consensus, 7) transfer, and identify when to use them in various situations. (Apply)

H. Substitution of Standards
Determine when and how calibration standards can be substituted based on: 1) measurement requirements, 2) equipment availability, 3) equipment specifications, etc. (Analyze)

II Measurement Systems
(22 Questions)

A. Measurement Methods
Describe and use various measurement methods, including: 1) direct, 2) indirect, 3) ratio, 4) transfer, 5) differential, 6) substitution by unit under test (UUT). (Evaluate)

B. Measurement Characteristics
Define and distinguish between various measurement characteristics as they are used for basic measurements, including: 1) variability, 2) sensitivity, 3) repeatability, 4) reproducibility, 5) bias, 6) linearity, 7) stability, 8) measurand, etc. (Understand)

NOTE: The use of these characteristics in uncertainty measurements is covered in IV.

C. Measurement Data Considerations
Identify and analyze various aspects of measurement data, including: 1) format, 2) readability, 3) resolution, 4) suitability for use, 5) confidentiality, etc. (Analyze)

D. IM&TE Specification Terms and Characteristics
Define and use common specification descriptions, including percent of full scale (FS), percent of range, percent of reading, and number of counts. Describe and distinguish between characteristics of specifications, including tolerance and specifications, baseline modifiers and qualifiers, output, scale, and floor terms, etc. (Analyze)

E. Error Sources
Identify and correct for error sources that can affect measurement results, including 1) drift, 2) bias, 3) operator error, 4) environment, etc. (Evaluate)

F. Measurement Assurance Program (MAP)
Define and describe basic MAP concepts, including 1) interlaboratory comparisons and testing schemes, 2) proficiency tests, 3) gage R&R studies, etc. (Understand)

III Calibration Systems
(33 Questions)

A. Calibration Procedures
Identify and define common elements of calibration procedures such as: 1) required equipment, 2) revisions, 3) equipment listing, 4) environmental considerations and restraints, 5) common procedures, etc. (Understand)

B. Standardization and Adjustment Methods
Use methods such as: 1) spanning, 2) nulling, 3) zeroing, 4) linearization, etc., to adjust and standardize IM&TE, and analyze the outcomes. (Analyze)

C. Industry Practices and Regulations

1. Industry practices
Identify various sources of industry-accepted metrology and calibration practices, including published resources, manufacturer recommendations, ANSI standards, etc. (Understand)

2. Regulations, mandates, and guidances
Define and distinguish between government regulations, traceability and other legally mandated metrology requirements, national or international guidances, etc., and identify which rules or conventions take precedence in various situations. (Apply)

D. Environmental Control
Define and describe various environmental parameters for: 1) humidity, 2) dust levels, 3) electrostatic discharge (ESD), 4) temperature, 5) vibration, etc., and analyze their influence on calibration activities. (Analyze)

E. Calibration Processes for IM&TE

1. Process flow
Describe the basic flow of IM&TE through the calibration process. (Understand)

2. **Logistical information**
   Identify IM&TE logistical information such as equipment identification, ownership, service history, process tracking systems, etc. (Understand)
3. **Roles and responsibilities**
   Identify roles and responsibilities of calibration staff members, including laboratory manager, technical manager, scheduler, quality manager, technician, etc. (Understand)
4. **Scheduling**
   Describe IM&TE scheduling considerations, including planned calibration intervals, product or equipment recalls, steps in the notification process, overdue lists, staff workloads, etc., and analyze their impact. (Analyze)

F. Validation Processes
Identify issues related to validating manual and automated calibration systems, and identify unique validation considerations for software or firmware that is part of IM&TE or calibration processes. (Understand)

G. Records Management
Define and describe document control in terms of maintaining the integrity and confidentiality of various calibration records, including audit results, staff training, uncertainty budgets, customer data, etc., in both electronic and paper formats. (Apply)

H. Official Reports
Describe and distinguish between various types of formal results reporting, including calibration labels, test reports, nonconforming calibration reports, calibration certificates, etc. (Apply)

IV Measurement Uncertainty and Applied Math (20 Questions)

A. Uncertainty Terminology
Define basic terms such as: 1) guardbanding, 2) test uncertainty ratio (TUR), 3) test accuracy ratio (TAR), 4) bias, 5) error, 6) percent of tolerance, etc. (Remember)

B. Uncertainty Budget Components
Identify various type A and type B uncertainty components, including 1) environment, 2) human factors, 3) methods and equipment, 4) item under test, 5) reference standards, 6) materials, and 7) identify the key elements and steps of developing an uncertainty budget. (Apply)

C. Uncertainty Determination and Reporting
Identify and use various methods to determine and report measurement uncertainty, including: 1) combined and expanded uncertainty, 2) weighted factors, 3) explanatory graphics, 4) coverage factors, 5) confidence levels, 6) effective degrees of freedom, 7) uncertainty calculation elements including mean, standard deviation, root sum square (RSS), variance, etc. (Analyze)

D. Technical and Applied Mathematics (Apply)

1. **Scientific and engineering notation**
   Express a floating point number in scientific and engineering notation.
2. **English/Metric conversions**
   Convert various units of measurement between English and metric units, including length, area, volume, capacity, and weight.
3. **Ratios**
   Express ratios in terms of percentage, decibels (dB), etc.
4. **Linear interpolation and extrapolation**
   Interpret tables and graphs to determine intermediate and extrapolated values.
5. **Rounding, truncation, and significant figures**
   Round and truncate a given number to a specified number of digits.
6. **Order of mathematical operations**
   Identify the correct order for performing mathematical operations and solve equations that contain multiple operations.
7. **Algebraic equations**
   Use basic algebra to solve for the unknown.

8. **Angular conversions**
   Convert between various angular units such as degrees, minutes, seconds, grads, radians, etc.
9. **Graphs and plots**
   Calculate the slope, intercept, and linearity of data sets, and interpret graphs and plots that illustrate these aspects of data.

V Quality Systems and Standards (15 Questions)

A. Quality Management Systems

1. **System components**
   Define and distinguish between various components of a quality system, including management and customer focus, employee training and development, continuous process improvement, etc. (Apply)
2. **Strategic and tactical processes**
   Identify various methods used to develop, improve, and review quality systems, including mission and goals, planning and deployment, cross-functional teams, etc. (Understand)

B. Quality Control Tools
Select and apply the seven basic quality tools: 1) flowcharts/process maps, 2) check sheets, 3) Pareto diagrams, 4) cause and effect diagrams, 5) scatter diagrams, 6) control charts, 7) histograms. (Analyze)

C. Quality Audits
Define and describe the following elements of quality audits. (Understand)

1. **Types of audits: internal, external, product, process, etc.**
2. **Roles and responsibilities of auditor, auditee, and client.**
3. **Audit components: audit plan, audit purpose, audit standard, etc.**
4. **Auditing tools: checklist, final report, etc.**

D. Corrective Action for Nonconformances

1. **Nonconforming material identification**
   Determine conformance status and apply various methods of identifying and segregating nonconforming IM&TE materials. (Evaluate)

2. **Impact assessment**
   Define and use various tools (e.g., reverse traceability, customer notification, product recall, calibration standard evaluation, root cause analysis) in response to out-of-tolerance conditions for IM&TE. (Apply)

E. Professional Conduct and Ethics
Identify appropriate behaviors that are aligned with the ASQ Code of Ethics, for various situations. (Apply)

F. Occupational Safety Requirements

1. **Hazards and safety equipment**
   Identify potential hazards in the work environment, including improper ventilation, mercury vapors, soldering fumes, suboptimal workplace lighting, etc., and identify appropriate personal protective equipment (PPE) for various situations. (Understand)
2. **Hazardous communication (HazCom) standard**
   Identify and interpret various elements of the HazCom standard (also known as the OSHA Right-to-Know Law) including material safety data sheet (MSDS) terms, material labeling requirements, etc. (Understand)
3. **Housekeeping**
   Describe housekeeping methods in the calibration environment including, maintenance, 5S, IM&TE, and cleaning. (Remember)

G. Quality Standards and Guides
Explain the benefits and importance of the following documents in relation to calibration. (Understand)

1. **Quality standards and guides such as ANSI/ISO/IEC 17025-2005, ANSI/NCSL Z540.3-2006, ISO 10012:2003(E), ISO 9001-2008, ANSI/NCSL Z540-2-1997, Guide 99:2007, VIM etc.**
2. **Accreditation and registration boards such as NVLAP, A2LA, IAS, LAB, RABQSA, IRCA, etc.**

Levels of Cognition

Based on Bloom's Taxonomy—Revised (2001)

In addition to **content** specifics, the subtext for each topic in this BoK also indicates the intended **complexity level** of the test questions for that topic. These levels are based on "Levels of Cognition" (from Bloom's Taxonomy – Revised, 2001) and are presented below in rank order, from least complex to most complex.

Remember
Recall or recognize terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc.

Understand
Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.

Apply
Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc.

Analyze
Break down information into its constituent parts and recognize their relationship to one another and how they are organized; identify sublevel factors or salient data from a complex scenario.

Evaluate
Make judgments about the value of proposed ideas, solutions, etc., by comparing the proposal to specific criteria or standards.

Create
Put parts or elements together in such a way as to reveal a pattern or structure not clearly there before; identify which data or information from a complex set is appropriate to examine further or from which supported conclusions can be drawn.

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