CERTIFIED QUALITY INSPECTOR
BODY OF KNOWLEDGE

The topics in this body of knowledge 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 line of subtext refers to the maximum cognitive level at which the topic will be tested. A complete description of cognitive levels is provided at the end of this document.

Note: Approximately 20% of the questions in each exam will require calculation.

I. Technical Mathematics (19 Questions)

A. Basic Shop Math

Solve basic shop math problems using addition, subtraction, multiplication, division of fractions and decimals, squares, and square roots. Use methods such as truncating and rounding to obtain significant digits for positive and negative numbers. Demonstrate when and how to use percent change calculation (new value – original value / original value x 100). (Apply)

B. Basic Algebra

Solve or simplify first-degree and single-variable equations. (Apply)

C. Basic Geometry

Calculate general parameters for basic geometric shapes, such as area, circumference, diameter, radius, perimeter, and volume. Calculate complementary and supplementary angles. Select the minimum number of coordinate points for shapes (e.g., lines and circles). (Apply)

D. Basic Trigonometry

Solve for angles and lengths using trigonometric functions, such as sine, cosine, tangent, and the Pythagorean Theorem. (Apply)

E. Measurement Systems

Convert units within and between English and metric measurement systems (SI), such as inch to micro-inch and meter to millimeter. (Apply)

F. Numeric Conversions

Use various numbering methods, such as scientific notation, decimals, and fractions, and convert values between these methods. (Apply)

G. Basic Statistics and Applications

1. **Measures of central tendency**
   Calculate mean, median, and mode. (Apply)
2. **Measures of dispersion**
   Calculate range, standard deviation, and variance. (Apply)

3. **Measures of proportion**
   Calculate percentage and ratio measures for various data sets. (Apply)
4. **Graphical displays**
   Define, interpret, and use scatter diagrams, tally sheets, and bar charts to effectively display data in various situations. (Apply)
5. **Normal distribution**
   Explain various characteristics of a normal distribution, such as symmetry, bell curve, and central tendency. (Apply)

II. Metrology (26 Questions)

A. Common Gauges and Measurement Instruments

1. **Variable gauges**
   Identify and use variable gauges, such as micrometers, calipers, dial indicators, and Coordinate Measuring Machines (CMMs). Understand linear scales, such as steel rule and gauge blocks. Use borescopes, thermometers, and temperature probes. (Apply)
2. **Attribute gauges**
   Identify and use attribute gauges, such as thread plugs, progressive gauges, ring gauges, flush pins, pin gauges, and radius gauges. (Apply)
3. **Transfer gauges**
   Identify and use transfer gauges, such as small-hole gauges, telescoping gauges, and spring calipers. (Apply)
4. **Measurement scales**
   Identify and use measurement scales, such as dial, digital, and vernier scales. (Apply)

B. Special Gauges and Applications

Identify and describe the following tools and components. (Remember)

1. Electronic gauging tools: oscilloscopes and multimeters
2. Automatic gauging components: machine vision, ultrasonic, X-ray, and laser
3. Pneumatic gauging components: probes and rings
4. Force gauging: torque wrenches and load cells
5. Environment instrumentation: chart recorders and data loggers

C. Gauge Selection, Handling, and Use

1. **10:1 rule**
   Apply the 10:1 rule: inspection measurements require better than the tolerance of a dimension by a factor of 10, and calibration standards require better than the inspection measurements by a factor of 10. (Apply)
2. **Gauge selection**
   Select gauges according to the feature or characteristic to be measured, the applicable tolerance, and the accuracy, environment, resolution, and capability of the test instrument. Determine whether the type of measurement should be direct, differential, or transfer. (Apply)

3. **Gauge handling, preservation, and storage**
   Identify and apply various methods of cleaning, handling, and storing gauges. (Apply)
4. **Gauge correlation**
   Identify and apply methods for establishing the correlation between measurement instruments, such as gauge-to-gauge or manual-to-automated process. (Apply)

D. Surface Plate Tools and Techniques

1. **Surface plate equipment**
   Select and use height gauges, V-blocks, and other indicators to measure various types of features. Understand the care, cleaning, calibration, and lapping of a surface plate. (Apply)
2. **Angle measurement instruments**
   Identify and use protractors, sine bars, and angle blocks. (Apply)

E. Specialized Inspection Equipment

1. **Measuring mass**
   Describe and apply weights, balances, and scales. (Apply)
2. **Measuring finish**
   Describe and apply profilometers (e.g., optical and stylus). (Apply)
3. **Measuring shape and profile**
   Understand and describe mechanical comparators, roundness testers, precision spindles, and profile tracers. (Understand)
4. **Optical equipment**
   Describe and apply optical comparators and microscopes. (Apply)
5. **Software-based measurement systems**
   Define and use digital cameras, vision inspection systems (white light / blue light), and other digital systems for product inspection. Recognize software limitations with regard to locating functional datums, target points and areas, hole positions, and the basic operation of the x, y, and z axes. (Apply)
6. **Measuring inclination**
   Define and describe the measurement of the slope or slant of various equipment (mechanical / laser). (Understand)

F. Calibration

1. **Calibration systems**
   Describe the principles and purpose of a calibration system, including the importance of establishing calibration intervals and uncertainty. Identify and use basic tracking and identification methods, such as logs, stickers, radio frequency identifications (RFID), barcodes, and other identification codes to control calibration equipment. (Apply)
2. **Calibration standards and equipment traceability**
   Understand and describe the hierarchy of standards, from working standards through international standards, and the documentation process of a measurement device traceable to the international standards. Recognize measurement results before and after an adjustment or repair is made. (Understand)

3. **Gauge calibration environment**
   Understand the effects that environmental conditions have on the calibration process, such as temperature, humidity, vibration, and cleanliness of the gauge. (Understand)
4. **Out-of-calibration effects**
   Describe the effects that out-of-calibration instruments can have on product acceptance and the actions to take in response to this situation. (Apply)

G. Measurement System Analysis (MSA)

Define and understand the following elements of MSA. (Understand)

1. Bias
2. Stability
3. Precision
4. Accuracy
5. Linearity
6. Repeatability and reproducibility (R&R) studies

III. Inspection and Test (32 Questions)

A. Blueprints, Drawings, Geometric Dimensioning & Tolerancing (GD&T), and Model Based Definitions

1. **Blueprints, engineering drawings, and model based definitions**
   Define and interpret various sections of technical drawings, such as title blocks, tolerances, and change or revision blocks, as well as notes, scale, and size details. Use this information to conduct inspections. (Apply)
2. **Terminology and symbols**
   Define and interpret drawing views and details for product specifications or other controlling documents. Define and use various terms and symbols from the ASME Y14.5 Standard. (Analyze)
3. **Position and bonus tolerances**
   Calculate position and bonus tolerances from various drawings. (Analyze)
4. **Part alignment and datum structure**
   Determine part alignment and setup using the datum structure. (Analyze)

B. Sampling

Define and utilize the following concepts related to sampling. (Apply)

1. Acceptance quality limit (AQL)
2. Random sampling
3. Lot and sample size
4. Acceptance number
5. Sampling plans

C. Inspection Planning and Processes

1. **Inspection types**
   Define and distinguish between inspection types, such as incoming material, first-article (first-piece), in-process, and final. (Analyze)

2. **Inspection errors**
   Identify potential inspection errors and their sources, such as bias, fatigue, flinching, distraction, poor time management, setup, and cosine error when using indicators. (Apply)
3. **Product traceability**
   Identify methods to trace products and materials, such as age control, shelf life, first-in first-out (FIFO), barcoding, date codes, and lot and part numbering. (Apply)
4. **Identification of nonconforming material**
   Describe and apply various methods of identifying nonconforming material, such as tagging, labeling, and segregating. (Apply)
5. **Levels of severity**
   Define and describe levels of severity (i.e., critical, major, and minor) and apply them to product features and defects. (Apply)
6. **Disposition of nonconforming material**
   Describe disposition methods, such as rework, reprocess, reinspect, scrap, and customer waiver as determined by a material review board (MRB) or other authority. (Understand)

D. Testing Methods

Define and use the following methods in various situations.

1. Nondestructive testing: X-ray, eddy current, ultrasonic, dye penetrant, magnetic particle, optical, visual, and profile (Understand)
2. Destructive testing: tensile, force testing, and drop test (Apply)
3. Functionality testing: tension, torque, leak testing, and compression (Apply)
4. Hardness testing: Brinell, Rockwell, durometer, and micro-hardness scales (Apply)

E. Software for test equipment

Identify and describe basic tools (e.g., safeguarding, functional checks, comparison of test results, and identification of attributes and parameters) used to ensure that the software for test equipment adequately and correctly performs its intended functions. Recognize various software validation methods. (Remember)

IV. Quality Assurance and Improvement (23 Questions)

A. Quality Improvement

1. **Terms and concepts**
   Define basic quality improvement concepts, such as defect detection and prevention, the cost of poor quality, total quality management (TQM), and the importance of customer satisfaction. (Understand)
2. **Products and processes**
   Define and distinguish between products and processes. Describe the interrelationships of product design, materials used, manufacturing processes, and final output, and how individual steps in a process can affect the final product or the system as a whole. (Understand)

B. Quality Audits

1. Types of audits
Define and describe various types of audits, such as internal, external, system, product, and process. (Understand)

2. Audit process
Explain various stages of the audit process (planning, performance, and closure), such as audit scope and purpose, resources needed, audit schedule, opening meeting, interviewing, data gathering, document and record review, analysis of results, closing meeting, audit documentation (reporting), recordkeeping, and verification of corrective actions. (Understand)

3. Audit tools
Define and describe the purpose of checklists, log sheets, sampling plans, record reviews, document reviews, and forward-and backward-tracing. (Understand)

4. Communication tools and techniques
Define and describe the use of graphs, charts, diagrams, and other aids for written and oral presentations, including interview techniques and listening skills. (Understand)

5. Corrective action requests (CARs)
Describe how CARs from audits can support quality improvement. (Understand)

C. Quality Tools and Techniques

Apply the following quality tools and techniques. (Apply)

1. Pareto charts
2. Cause and effect diagrams
3. Flowcharts
4. Check sheets
5. Scatter diagrams
6. Histograms

D. Statistical Process Control (SPC)

1. Common and special cause variation
Explain the difference between these causes of variation. Illustrate whether a process is in statistical control by monitoring data patterns (e.g., runs, trends, and hugging), and identify what actions should be taken in response. (Apply)

2. Control limits and specification limits
Define, describe, and illustrate the differences between these limits as used in SPC. (Apply)

3. Variables charts
Identify characteristics of and apply $\overline{X} - R$ and $\overline{X} - s$ charts. (Apply)

4. Attributes charts
Identify characteristics of and apply p, np, c, and u charts. (Apply)

5. Process capability analysis
Define and describe the differences between C_p, C_{pk}, P_p, and P_{pk} studies, and identify their application to various types of data. (Understand)

E. Problem-solving Tools and Continuous Improvement Techniques

Define and describe the following tools and techniques in various situations.

1. Plan-do-check-act (PDCA) or plan-do-study-act (PDSA) cycles (Understand)
2. Lean tools for eliminating waste (e.g., error-proofing and value-stream mapping) and lean concepts (e.g., kaizen, flow, and pull) (Understand)
3. 5S / 6S (Apply)
4. Six sigma phases: define, measure, analyze, improve, control (DMAIC) (Understand)
5. Failure mode and effects analysis (FMEA) (Understand)
6. 8D Methodology (Understand)
7. 5 Whys (Understand)
8. Fault tree analysis (Understand)
9. Corrective and preventive action (CAPA) (Understand)

F. Resources

1. **Environmental and safety support**
   Define and use various resources related to personal and environmental safety, such as safety data sheets (SDS), material data sheets (MDS), and personal protective equipment (PPE). (Apply)
2. **Reference documents**
   Identify and use national and international standards (e.g., ISO, ANSI, ASTM, QS, and NIST) and customer requirements as authorities that support processes and procedures used to assure quality products. (Apply)
3. **Employees as resources**
   Describe how employees can be empowered and the value they add to project teams or quality improvement teams. Describe typical team roles and responsibilities, such as facilitator, ground rules, and project or team charter. Describe the stages of team development: forming, storming, norming, performing, and adjourning. (Remember)
4. **Quality documentation**
   Identify and apply basic quality documentation, including the correct form / revision for the process (e.g., ISO 9001, First Article Inspection Report, ISIR, PPAPs). Demonstrate proper usage of policy, procedure, work instructions, and forms, and proper documentation practices, such as document control, filling out forms completely, correcting misspellings, and initialing changes. (Apply)

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.