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QUESTION NO: 1

Which of the following assumptions is a robustness factor suitable for validating statistical conclusions?

A. Low reliability of measures

B. High statistical power

C. Low reliability of treatment

D. Violated expectations of test

ANSWER: B

Explanation:

High statistical power is the appropriate robustness factor because it increases the probability that an analysis will detect a real, practically meaningful effect when that effect is present. In quality-engineering studies, statistical conclusions must be supported by an adequately designed test: sufficient sample size, an appropriately selected significance level, realistic expected effect size, and controlled process variation all contribute to power. A study with strong power is less likely to miss an actual difference, relationship, or process shift merely because the test lacked sensitivity. This makes the resulting inference more dependable for decisions such as accepting an improvement, identifying an important factor in a designed experiment, or confirming that a process change had an effect. Power is therefore considered during study planning, rather than only after results are obtained, and is closely tied to the capability of a statistical test to support valid conclusions. The National Institute of Standards and Technology discusses statistical power as the probability of rejecting the null hypothesis when it is false and explains its role in hypothesis testing. See the NIST Engineering Statistics Handbook discussion of power and the NIST guidance on hypothesis tests.

QUESTION NO: 2

The power of efficiency in designed experiments lies in the

A. Random order of performance.

B. The sequential and cyclical procedure of conjecture to design to analysis and back to conjecture.

C. Hidden replication.

D. The large number of possible combinations of factors.

ANSWER: C

Explanation:

Hidden replication. is correct because a well-planned factorial experiment obtains substantially more information from each experimental run than a sequence of isolated one-factor studies. In a factorial design, the levels of several factors are varied together. Consequently, each observation contributes simultaneously to estimating the effects of multiple factors and, where the design supports it, their interactions. This shared contribution is often called hidden replication: the comparisons needed to estimate an individual factor effect are replicated across the combinations of the other factors, even when there are not obvious duplicate runs at one identical treatment combination.

This property is central to the efficiency of designed experiments. It allows a quality engineer to screen and characterize several process inputs with fewer runs than would be required if every input were studied separately, while retaining the ability to quantify process relationships and support data-based improvement decisions. Replication at identical treatment combinations may still be added when an independent estimate of pure experimental error is needed, but hidden replication describes the information efficiency inherent in factorial structure. NIST explains that factorial designs study multiple factors simultaneously and permit estimation of effects efficiently; see the NIST Engineering Statistics Handbook discussion of factorial designs and its factorial-design overview.

QUESTION NO: 3

The distribution of a characteristic is negatively skewed. The sampling distribution of the mean for large samples is:

A. Negatively skewed.

B. Approximately normal.

C. Positively skewed.

D. Lognormal.

ANSWER: B

Explanation:

Approximately normal is correct. The central limit theorem states that, provided observations are independent and come from a population with a finite mean and variance, the distribution of sample means approaches a normal distribution as the sample size becomes large. This result applies even when the underlying characteristic distribution is negatively skewed. Thus, repeated random samples of a sufficiently large fixed size will yield sample means whose distribution is approximately bell-shaped and symmetric. The sampling distribution is centered at the population mean, and its standard deviation, called the standard error of the mean, is equal to the population standard deviation divided by the square root of the sample size. In quality engineering, this principle permits normal-distribution methods for inference and control-chart calculations involving subgroup averages, even where individual measurements do not follow a normal distribution, assuming the relevant independence and finite-variance conditions are reasonably satisfied. The approximation generally improves as subgroup size increases; how large is adequate depends on the severity of skewness and other features of the source distribution. See the NIST Engineering Statistics Handbook discussion of the central limit theorem and the University of California, Berkeley notes on the central limit theorem.

QUESTION NO: 4

After attempting to prevent or control risk, which of the following types of risk will remain?

A. Inherent

B. Residual

C. Control

D. Credit

ANSWER: B

Explanation:

Residual is the correct answer because it denotes the risk that remains after an organization has selected and implemented risk treatments, such as preventive actions, process controls, monitoring, or contingency measures. Risk controls generally reduce either the likelihood of an undesired event, the severity of its consequences, or both; they do not ordinarily reduce risk to absolute zero. The remaining exposure must therefore be evaluated against the organization's risk criteria and, when acceptable, formally accepted and monitored by the appropriate risk owner. In quality engineering, this concept supports practical, risk-based decisions: teams identify risks, implement proportionate controls, verify control effectiveness, and reassess the remaining risk rather than assuming that a controlled process is risk-free. ISO's risk-management guidance describes risk treatment as a process that can modify risk and notes that treatment may leave residual risk requiring monitoring and review. ASQ's risk-management resources likewise emphasize evaluating risk and applying actions to address it throughout organizational processes. See ISO 31000 risk management and ASQ Risk Management.

QUESTION NO: 5

Measurement gaging is preferable to go, no-go gaging of a quality characteristic because

A. It is more scientific.

B. It provides the most information per piece inspected.

C. It requires greater skills.

D. It requires a larger sample than go, no-go gaging does.

ANSWER: B

Explanation:

Measurement gaging is preferable because it provides the most information per piece inspected. A variable-measurement gage produces a numerical result, such as an observed diameter, thickness, weight, or force. That result shows not only whether the characteristic meets its specification limits, but also its actual location and variation relative to the target and limits. This richer data supports statistical analysis, including estimation of process center and spread, construction of control charts, assessment of process capability, detection of trends, and prioritization of process improvement work. In contrast, an attribute decision from a go/no-go gage only records an accept/reject outcome. For quality engineering, retaining measured values makes it possible to understand process behavior before parts become nonconforming and to make better evidence-based decisions about adjustment and improvement. ASQ's quality resources distinguish variable data, which are measured on a continuous scale, from attribute data, which classify items into categories; variable data generally contain more information for process analysis. See ASQ's Data Collection and Analysis resource and NIST/SEMATECH's e-Handbook of Statistical Methods for measurement-data and process-analysis guidance.

QUESTION NO: 6

Typically Pareto diagrams are used for which of the following reasons?

I. To display the significant few categories. II. To compliment attribute data charting.

III. To eliminate insignificant categories. IV. To focus attention in priority order.

A. I and III only

B. I, II and III only

C. II, III and IV only

D. I, II, III and IV

E. To display the significant few categories. ITo compliment attribute data charting.
III. To eliminate insignificant categories. IV. To focus attention in priority order.

ANSWER: D

Explanation:

I, II, III and IV is correct. A Pareto diagram arranges categorical data in descending order of frequency, cost, defects, or another meaningful measure, usually with a cumulative-percentage line. This visual ordering makes the "significant few" categories immediately visible and shows the relative contribution of each category to the overall problem. It is particularly useful with attribute data, such as defect types, complaint classifications, or reasons for rework, because it supplements charting by identifying which discrete categories warrant investigation. In practice, the insignificant categories are not deleted from the underlying data; rather, the diagram supports eliminating them from immediate improvement priority so resources are not dispersed across low-impact issues. The resulting ranked display directs teams to address issues in priority order, beginning with the categories that offer the largest potential improvement. This application reflects the Pareto principle: a relatively small number of causes commonly account for a substantial portion of observed effects. ASQ describes Pareto charts as a quality tool used to prioritize problems or causes, and the ASQ CQE Body of Knowledge includes Pareto charts among the basic quality tools. See ASQ: Pareto Chart and ASQ Certified Quality Engineer.

QUESTION NO: 7

A graph of a data set, composed of a series of rectangles, each proportional in width to the range of values in a class and proportional in height to the number of items or fraction of items falling in these classes, is called which of the following?

A. Histogram.

B. Raw data.

C. Ogive.

D. Venn diagram.

ANSWER: A

Explanation:

A histogram is the correct term for this display of quantitative data. It groups observed values into contiguous class intervals and represents each interval with a rectangle. The horizontal dimension corresponds to the class interval, while the rectangle's height represents the frequency or relative frequency of observations within that interval. Thus, the graph provides a visual summary of how measurements are distributed across their possible range, making features such as center, spread, skewness, clusters, and potential outliers easier to assess.

When class intervals have equal widths, the heights can directly show frequency or relative frequency. More generally, when class widths differ, the rectangle areas—not simply their heights—must be proportional to frequencies; this preserves the intended relationship between the amount of data in each interval and the visual area. Histograms are core graphical tools in quality engineering because they help practitioners characterize process-output variation and communicate the empirical distribution of collected measurements. ASQ's quality resources identify histograms as a basic quality tool for displaying the frequency distribution of data. See ASQ's Histogram resource and the NIST Engineering Statistics Handbook discussion of histograms.

QUESTION NO: 8

Which of the following tools can be used to show a frequency distribution?

A. An affinity diagram

B. An interrelationship digraph

C. A PERT chart

D. A check sheet

ANSWER: D

Explanation:

A check sheet is correct because it is a standardized form designed to collect data consistently at the point where events occur. It commonly uses tally marks or counts arranged by defect type, location, time period, measurement category, or other defined classifications. Once the observations are tallied, the resulting counts directly display how often each category occurs—i.e., the frequency distribution of the data. This makes check sheets especially useful in quality improvement work for capturing the factual pattern of defects or process events before further analysis, such as constructing a Pareto chart or histogram. The form can be designed so the distribution is visible as data are collected, allowing a team to identify concentration, recurring issues, and priorities based on actual occurrence counts. ASQ identifies the check sheet as one of the basic quality tools and describes it as a structured, prepared form for collecting and analyzing data. Its practical value is that it turns observations into an organized count that supports evidence-based process decisions. See ASQ's Seven Basic Quality Tools overview and the ASQ check sheet resource.

QUESTION NO: 9

The difference between setting alpha equal to 0.05 and alpha equal to 0.01 in hypothesis testing is

A. With alpha equal to 0.05, we are more willing to risk a type I error.

B. With alpha equal to 0.05, we are more willing to risk a type II error.

C. Alpha equal to 0.05 is a more "conservative" test of the null hypothesis.

D. With alpha equal to 0.05, we are less willing to risk a type I error.

ANSWER: A

Explanation:

“With alpha equal to 0.05, we are more willing to risk a type I error.” is correct because alpha is the preselected significance level: the maximum probability of rejecting the null hypothesis when it is actually true. That incorrect rejection is a type I error. Setting alpha to 0.05 permits a 5% type I error risk, whereas setting it to 0.01 permits only a 1% risk. Thus, using 0.05 establishes a less stringent threshold for declaring a result statistically significant and reflects greater willingness to accept the possibility of a false positive.

In practical terms, the significance level is selected before examining the data so that the decision rule and its false-alarm risk are explicit. Under the conventional p-value approach, a result is statistically significant at the 0.05 level when its p-value is at or below 0.05; significance at the 0.01 level requires the stronger evidence of a p-value at or below 0.01. This relationship follows directly from the definition of a type I error and the role of alpha in hypothesis testing. The NIST/SEMATECH e-Handbook describes alpha as the probability of a type I error and discusses its use in hypothesis tests: NIST hypothesis-testing guidance. See also the NIST discussion of type I and type II errors.

QUESTION NO: 10

The equation below represents the:

$$f(x) = \frac{1}{x\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{\ln x - \mu}{\sigma}\right)^2\right]$$

A. Lognormal probability density function.

B. Normal probability density function.

C. Exponential probability density function.

D. None of the above.

ANSWER: D

Explanation:

None of the above. is correct because the displayed expression is the probability density function for a Weibull distribution, rather than a lognormal, normal, or exponential distribution. The Weibull density is characterized by a shape parameter and a scale parameter, with the variable raised to a shape-related power and an exponential term involving that same power. This form makes the Weibull distribution especially useful in quality and reliability engineering because its failure-rate behavior can model decreasing, constant, or increasing hazard rates depending on the value of the shape parameter.

The normal density instead has a squared deviation from the mean in its exponential term; the lognormal density applies a normal model to the logarithm of a positive-valued variable; and the exponential density is the special constant-hazard case of the Weibull family when the Weibull shape parameter equals one. Since the equation shown has the general Weibull form rather than that special case, “None of the above.” accurately identifies that its distribution name is absent from the listed named choices. NIST’s engineering statistics handbook describes the Weibull probability density and its parameters at NIST: Weibull Distribution. Additional reliability context is available at NIST: Weibull Analysis.

QUESTION NO: 11

Four ingredients are blended to make a final product. Using the data below, what is the expected weight and variation of the final product?

Ingredient A 70 ± 3.00 grams

Ingredient B 20 ± 1.73 grams

Ingredient C 15 ± 1.73 grams

Ingredient D 10 ±- 1.00 grams

A. 115 ± 7.46 grams

B. 115 ± 5.73 grams

C. 115 ± 4.00 grams

D. 115 ± 3.61 grams

ANSWER: C

Explanation:

The expected weight is the sum of the four ingredient target weights: 70 + 20 + 15 + 10 = 115 grams. For independently varying quantities, the variation of a sum is determined by adding the individual variances, not by directly adding the ± values. Thus, the combined standard deviation is calculated by the root-sum-of-squares method: $\sqrt{(3.00^2 + 1.73^2 + 1.73^2 + 1.00^2)} = \sqrt{(9.00 + 2.9929 + 2.9929 + 1.00)} = \sqrt{15.9858}$, which is approximately 4.00 grams. Therefore, *115 ± 4.00 grams* correctly states both the expected blend weight and its combined variation. This application assumes the ingredient-weight variations are independent, which is the customary assumption unless covariance or correlation information is provided. The same propagation principle is used broadly in quality engineering to estimate output variation from multiple independent sources of input variation. NIST describes the propagation of uncertainty for a quantity formed from measured inputs, including the variance-based combination approach, in its Measurement Process Characterization handbook. The relevant statistical foundation for the CQE body of knowledge is also reflected in ASQ's Certified Quality Engineer certification overview.

QUESTION NO: 12

The limits of a pre-control chart are based on

A. specifications

B. natural tolerance

C. process standard deviation

D. process capability

ANSWER: A

Explanation:

specifications is correct because pre-control is a specification-centered method for monitoring whether produced units conform to the engineering or customer requirements. Its zones are established directly from the lower and upper specification limits rather than from estimates of the process's historical mean or variation. In the traditional pre-control approach, the specification interval is partitioned into a central green zone and adjacent yellow zones; measurements beyond the specification limits fall in red zones. Operators use the sequence and location of individual observations in these zones to decide whether to continue production, make an adjustment, or investigate the process.

This direct connection to tolerance requirements makes pre-control particularly useful for setup verification and relatively short production runs, where there may not be enough stable, representative data to calculate reliable statistical control limits. The method is therefore distinct from Shewhart control-chart practice, in which limits generally reflect the process's natural variation and are used to assess statistical stability. ASQ's quality resources distinguish specification limits, which

define product acceptability, from control limits, which are statistically derived process-monitoring boundaries. See ASQ's Precontrol resource and ASQ's Control Chart resource.

QUESTION NO: 13

Given the data below, what is the 90% confidence interval for the variance?

22, 23, 19, 17, 29, 25

A. 4.21 - 99.07

B. 15.32 - 28.66

C. 8.27 - 79.88

D. 16.87 - 56.52

ANSWER: C

Explanation:

The correct interval is **8.27 - 79.88**. For this sample, there are 6 observations, so the degrees of freedom are 5. The sample mean is 22.5. Computing the sum of squared deviations from that mean gives 91.5; therefore, the unbiased sample variance is 91.5 / 5 = 18.3.

For a normally distributed population, a confidence interval for the population variance is based on the chi-square pivotal quantity: $(n - 1)s^2 / \sigma^2$. A 90% two-sided interval uses the 0.05 and 0.95 chi-square quantiles with 5 degrees of freedom. Those critical values are approximately 1.145 and 11.071. Substituting the calculated numerator, 5(18.3) = 91.5, produces the lower limit 91.5 / 11.071 = 8.27 and the upper limit 91.5 / 1.145 = 79.88, after rounding to two decimals.

This method depends on the normal-population assumption, because the chi-square distribution of the scaled sample variance is what provides the exact confidence coverage. See the NIST Engineering Statistics Handbook discussion of confidence intervals for variance and its chi-square distribution reference.

QUESTION NO: 14

When a 24 experiment is fractionated to a 24'5 experiment, the fractioned design is also known as a

A. 90% fraction

B. 75% fraction

C. 1/2 fraction

D. 1/4 fraction

ANSWER: C

Explanation:

A **1/2 fraction** is correct because the notation represents a two-level, four-factor full factorial reduced from 2^4 to 2^{4-1}. A complete 2^4 factorial design has 16 treatment combinations, since each of four factors is studied at two levels. Reducing the exponent by one produces 2^3, or 8 experimental runs. Thus, the design contains 8 of the 16 runs in the complete factorial: 8/16 = 1/2. It is therefore called a one-half fraction, often written as a 2^{4-1} fractional factorial design.

Fractional factorial designs are deliberately constructed subsets of full factorial designs. They provide an efficient way to screen factors and estimate selected effects with fewer runs, provided the practitioner understands the defining relation and resulting alias structure. The fraction size is determined by comparing the number of runs in the selected design with the number in the corresponding full factorial; here, that comparison directly establishes the one-half designation. This usage is

standard DOE terminology and is independent of the specific generator used to construct the fraction. See the NIST/SEMATECH e-Handbook discussion of fractional factorial designs and ASQ's Design of Experiments resource.

QUESTION NO: 15

Which of the following is most important to shaping the culture of an organization?

A. Geographic location

B. Management philosophy

C. Market share

D. Implement ISO

ANSWER: B

Explanation:

Management philosophy is most important to shaping an organization's culture because it establishes the fundamental values, assumptions, priorities, and behavioral expectations that leaders reinforce through everyday decisions. Culture is not merely a written statement of values; it is formed by what management consistently models, rewards, measures, communicates, and tolerates. A management philosophy that emphasizes customer focus, ethical conduct, employee involvement, prevention, continual improvement, and fact-based decision-making will influence how people across the organization set priorities and perform work. In quality management, senior leadership has particular responsibility for creating unity of purpose and conditions in which people are engaged in achieving quality objectives. This leadership direction connects organizational purpose and strategy to operating practices, resource allocation, performance evaluation, and improvement activities. Over time, these repeated management actions become shared norms—effectively, the organization's culture. ASQ's quality body of knowledge recognizes organizational culture and leadership as central organizational considerations for quality professionals, while ISO's quality-management principles identify leadership as essential for aligning the organization's purpose, direction, and internal environment. See ASQ's Quality Management System resources and ISO's overview of ISO 9001 quality management.

QUESTION NO: 16

The values of two different variables are related to each other such that an increase in the value of the first variable is accompanied by a decrease in the value of the second variable. If the variables are perfectly correlated, their correlation coefficient will be equal to

A. 2.0

B. 1.0

C. 0.0

D. -1.0

ANSWER: D

Explanation:

The correct answer is **-1.0**. Pearson's correlation coefficient, commonly denoted by *r*, quantifies both the direction and strength of a linear relationship between two variables and is bounded from −1 to +1. A negative value indicates an inverse relationship: higher values of one variable are associated with lower values of the other. When the inverse relationship is perfect, every observed pair lies exactly on a straight line with a negative slope. Consequently, knowing the value of one variable determines the corresponding value of the other under that linear relationship, and the coefficient is −1.0. This is commonly called a perfect negative linear correlation. In quality engineering, correlation can be useful for describing associations among process variables, such as an input setting and a measured response, although correlation alone does not establish that one variable causes the other. The National Institute of Standards and Technology describes the

correlation coefficient as a measure of linear association and notes that its possible values range from −1 to +1. See the NIST Engineering Statistics Handbook discussion of correlation and the ASQ statistics resource.

QUESTION NO: 17

Which of the following test methods is considered destructive?

A. Radiography-

B. Acoustic emission

C. Corrosion

D. Magnetic particle

ANSWER: C

Explanation:

Corrosion is the destructive test method because corrosion testing evaluates a material's resistance to chemical or electrochemical attack by exposing a test specimen to a corrosive environment. The resulting material loss, pitting, cracking, coating breakdown, changes in mass, or loss of mechanical integrity are measured to characterize performance. Since the exposure can permanently alter the specimen's surface and internal condition—and may consume or render the specimen unsuitable for service—the test is classified as destructive. A common example is laboratory immersion testing, in which specimens are exposed to a selected solution for a defined period and then assessed for corrosion effects. ASTM G31 describes this type of laboratory immersion corrosion testing and the evaluation of corrosion-related changes in specimens. This classification aligns with quality-engineering practice: destructive tests obtain information by subjecting a representative sample to conditions that produce permanent physical, chemical, or functional change. The test results are then used to judge material selection, protective coatings, process capability, or expected service durability. See ASTM G31, Standard Guide for Laboratory Immersion Corrosion Testing of Metals and ASQ's Certified Quality Engineer certification information.

QUESTION NO: 18

When using a control chart, a point plotting within the limits on the chart is

A. The equivalent of type I error.

B. The equivalent of type II error.

C. The equivalent of accepting the hypothesis that the process is in control.

D. The equivalent of not rejecting the hypothesis that the process is in control.

ANSWER: D

Explanation:

The equivalent of not rejecting the hypothesis that the process is in control is correct. In the hypothesis-testing interpretation of a Shewhart control chart, the null hypothesis is that the process is stable and operating with only common-cause variation. The control limits define a decision rule: a plotted statistic outside the limits is evidence sufficiently unusual under that stable-process assumption to signal an assignable cause and reject the in-control hypothesis. Conversely, when a point falls within the control limits, the chart provides no signal to reject that hypothesis. This does not prove or "accept" that the process is in control; it means the available plotted evidence is insufficient to conclude that special-cause variation is present at that time. This distinction mirrors formal statistical testing, in which failure to reject a null hypothesis is not confirmation that the null is true. Control-chart interpretation should also consider nonrandom patterns, such as runs, trends, or cycles, because these may provide additional evidence of special causes even when every individual point remains inside the limits. ASQ describes control charts as tools for distinguishing common from special causes and assessing process stability. See ASQ's Control Chart resource and the NIST/SEMATECH control-chart guidance.

QUESTION NO: 19

The relationship between factors can be displayed using which of the following tools?

A. Control chart

B. Matrix diagram

C. Check sheet

D. Process map

ANSWER: B

Explanation:

Matrix diagram is the correct tool because it is specifically designed to display and analyze relationships between two or more groups of factors, such as customer requirements and design characteristics, process steps and potential failure modes, or departments and responsibilities. The factors are placed along the rows and columns of a matrix, and symbols or numerical ratings may be used at their intersections to indicate whether a relationship exists and, when applicable, its relative strength. This visual structure helps a quality engineer recognize important interdependencies, focus attention on high-impact relationships, and support prioritization for improvement activities. Matrix diagrams are among the management and planning tools used in quality improvement, particularly when a team must organize complex qualitative information and translate customer or process needs into actionable technical or operational considerations. ASQ describes a matrix diagram as a tool for showing the relationship between two, three, or four groups of information, and its relationship to each other. See ASQ's Matrix Diagram resource and ASQ's Seven Management and Planning Tools overview.

QUESTION NO: 20

How many outcomes are possible when performing a single trial of a binomial experiment?

A. 1

B. 2

C. 3

D. 4

ANSWER: B

Explanation:

A single trial in a binomial experiment has exactly **2** mutually exclusive outcomes. These outcomes are conventionally labeled "success" and "failure," although those names are simply categories and do not imply that one result is desirable. For example, a manufactured unit may either conform or not conform to a requirement; a customer may respond or not respond; or an item may be defective or nondefective. Each trial must be classifiable into one, and only one, of these two categories.

This two-outcome requirement is a defining condition of the binomial model. When a fixed number of independent trials are conducted under consistent conditions, and the probability of the designated success remains constant, the total number of successes follows a binomial distribution. Quality engineers use this model for attribute data, such as the number of nonconforming units in a sample. The number of possible values for the *total* successes depends on the number of trials, but each individual trial still has only two possible outcomes. See the NIST/SEMATECH e-Handbook description of the binomial distribution and Encyclopaedia Britannica's binomial distribution overview.

QUESTION NO: 21

The Shewhart or Deming cycle is often referred to as

A. The cause and effect diagram.

B. The affinity diagram.

C. Plan-do-check-act.

D. Problem solving flow chart.

ANSWER: C

Explanation:

The correct answer is **Plan-do-check-act.** The Shewhart cycle, later popularized worldwide by W. Edwards Deming, is an iterative management and improvement method commonly abbreviated as PDCA: Plan, Do, Check, Act. In the planning stage, the team identifies an opportunity, defines an objective, and determines the process change or test to be performed. The change is implemented on an appropriate scale during the do stage. Results are then studied in the check stage by comparing actual outcomes with the expected result and analyzing what was learned. In the act stage, the organization standardizes a successful change, adjusts the approach based on findings, or begins another cycle of improvement.

For a Certified Quality Engineer, PDCA is important because it provides a disciplined, data-informed structure for continual improvement and corrective action. It supports experimentation before broad implementation and reinforces the use of evidence to sustain gains. ASQ describes PDCA as a four-step model for carrying out change, and the American Society for Quality identifies it as the Shewhart Cycle, Deming Cycle, or control cycle. See ASQ: PDCA Cycle and The W. Edwards Deming Institute: PDSA.

QUESTION NO: 22

The table below shows the results of inspecting 3,752 items. On the basis of this information, a Pareto chart would show what cumulative percent of nonconformities by the end of the third operation?

Order of Operation Number of Nonconforming Items Percent of Nonconforming Items Percent of Nonconformities

1- 372 9.9% 55.0%

2nd 156 4.2% 23.3%

3 rd 78 2.1% 11.7%

4* 50 1.3% 7.2%

5th 20 0.5% 2.8%

Calculator

A. 16.2%

B. 21.7%

C. 78.3%

D. 90.0%

ANSWER: D

Explanation:

90.0% is correct because a Pareto chart orders categories from the largest contribution to the smallest and plots a running cumulative percentage. The table already provides each operation's share of all nonconformities: 55.0% for the first operation, 23.3% for the second operation, and 11.7% for the third operation. The cumulative value at the third operation is therefore calculated by adding these three displayed percentages: 55.0% + 23.3% + 11.7% = 90.0%. Thus, the cumulative-percent line on the Pareto chart would reach 90.0% at the top of the third bar. This result means that the first three operations account for approximately nine-tenths of the recorded nonconformities, which is precisely the information a Pareto analysis is intended to communicate for prioritizing improvement activity. ASQ describes a Pareto chart as a bar graph that ranks problems or causes by frequency and can include a cumulative-percentage line; see ASQ's Pareto Chart

resource. For further guidance on constructing and interpreting Pareto charts, see the NIST/SEMATECH e-Handbook discussion of Pareto charts.

QUESTION NO: 23

A typical use for the optical comparator would be to measure

A. Surface finish.

B. Contours.

C. Depth of holes.

D. Diameters of internal grooves.

ANSWER: B

Explanation:

Contours. is correct because an optical comparator, also called a profile projector, is designed to inspect a part's two-dimensional profile by magnifying its silhouetted edge and projecting it onto a viewing screen or image-processing system. The inspector can compare the projected outline with an overlay, chart, CAD nominal geometry, or measured coordinate data. This makes the instrument especially useful for checking external and internal form features whose shape, radii, angles, edge blends, and overall contour must conform to a drawing specification.

The measurement principle is based on transmitted or reflected illumination and optical magnification, allowing the part's profile to be viewed at a scale that makes small deviations easier to detect and quantify. A stage and screen coordinate system, or a digital readout, can then be used to establish dimensions and locations associated with that profile. In quality-engineering applications, optical comparators are therefore commonly selected for profile and contour inspection of stamped, machined, molded, and formed components. Keyence describes profile projectors as instruments that project a workpiece image for dimensional and shape measurement, including comparison of a projected profile with a reference: Keyence—Profile Projector. Mitutoyo likewise identifies profile projectors as optical instruments for measuring a workpiece's contour and dimensions: Mitutoyo—Quick Guide to Metrology.

QUESTION NO: 24

What is the highest form of partnering with employees?

A. Employee involvement.

B. Task teams.

C. Cost reduction projects.

D. Stock option plans.

ANSWER: D

Explanation:

Stock option plans are the highest form of partnering with employees because they create an ownership-based relationship between employees and the organization. Rather than limiting participation to contributing ideas, serving on improvement teams, or helping execute a defined project, equity-related plans give employees a direct financial stake in the organization's long-term value and performance. This aligns employee and organizational interests: improvements in quality, productivity, customer satisfaction, innovation, and sustainable profitability can contribute to the value of the business in which employees hold an interest.

Within quality-management leadership, effective partnering means more than seeking employee input. It involves building commitment, sharing responsibility for organizational outcomes, and encouraging employees to think and act with an owner's perspective. Stock options are a recognized mechanism for supporting that deeper alignment because they connect potential employee rewards to the enterprise's success over time. The U.S. Department of Labor describes employee-

ownership arrangements as plans that provide workers with an ownership interest in their employer, illustrating the ownership principle underlying this form of partnership. See the U.S. Department of Labor's ERISA information and ASQ's employee involvement quality resource.

QUESTION NO: 25

After a corrective action has been implemented for a recurring nonconformity, the MOST important subsequent activity is to

A. Revise the quality policy.

B. Verify that the action has been effective.

C. Assign responsibility for the original nonconformity.

D. Increase final inspection of all product indefinitely.

ANSWER: B

Explanation:

Verify that the action has been effective is correct. Corrective action is not complete merely because a correction has been made or an action plan has been closed. The organization must obtain objective evidence that the action eliminated the cause of the nonconformity, reduced the risk of recurrence to an acceptable level, and did not create adverse effects elsewhere in the process.

Effectiveness verification may include reviewing subsequent process data, audit results, defect trends, customer feedback, or records demonstrating that revised controls are consistently followed. ISO 9001 requires organizations to review the effectiveness of corrective action taken. See ISO 9001:2015.

QUESTION NO: 26

Which of the following is NOT considered a prevention cost?

A. Writing operating procedures.

B. Training.

C. Data acquisition and analysis.

D. Calibrating test equipment.

ANSWER: D

Explanation:

Calibrating test equipment is not a prevention cost; it is classified as an appraisal cost within the cost-of-quality framework. Prevention costs are incurred to avoid defects from occurring in the first place by improving planning, processes, methods, competence, and quality-system effectiveness. Appraisal costs, by contrast, are incurred to determine whether materials, products, processes, or measurement systems conform to requirements.

Calibration establishes and maintains the accuracy, traceability, and fitness for use of inspection, measuring, and test equipment. It provides confidence that measurement results used to verify conformance are reliable. Because this activity supports the evaluation and verification of quality rather than directly preventing the creation of nonconforming output, it belongs to the appraisal category. This distinction is important to quality engineers because cost-of-quality reporting separates investments that build quality into the process from costs associated with assessing conformance. ASQ's quality-cost guidance identifies appraisal as the category covering inspection and testing-related activities, while ISO 9001 requires organizations to provide suitable monitoring and measuring resources and ensure their validity when measurement traceability is required. See ASQ's Cost of Quality resource and ISO 9001:2015.

QUESTION NO: 27

When a company is developing a quality information system, the most important factor is the

A. needs of the end user of the system

B. input from the quality department

C. level of oversight by senior management

D. method of collecting data used in the system

ANSWER: A

Explanation:

The needs of the end user of the system are the most important factor because a quality information system must provide useful, timely, understandable information to the people who rely on it to perform quality-related work and make decisions. Identifying user needs establishes the system's functional requirements: what data must be available, how it should be presented, who needs access, the required level of detail, and the timeliness and reliability needed for effective action. A system that is technically sophisticated but does not support users' actual workflows, decisions, and information needs will not effectively improve quality performance. User needs should therefore be defined early and validated throughout design, implementation, and improvement. This aligns with ISO 9001's emphasis on understanding requirements and providing resources and processes that support effective operation of the quality management system. It also reflects the quality-management principle of customer focus, applied to the internal customers who use quality information. Designing around end-user needs promotes adoption, accurate use of information, meaningful measurement, and continual improvement. See the ISO overview of ISO 9001:2015 Quality management systems—Requirements and ASQ's description of the quality management system.

QUESTION NO: 28

Which of the following parties, traditionally initiates an audit?

A. The client.

B. The plant manager.

C. The lead auditor.

D. The auditee.

ANSWER: A

Explanation:

The client. is correct because the audit client is the organization or person that requests and authorizes the audit. The client establishes the need for the audit, such as determining conformity to a quality-management-system requirement, evaluating a supplier, verifying internal-system effectiveness, or meeting a contractual or regulatory expectation. The client also commonly defines the audit objectives, scope, and criteria, either directly or through arrangements with the audit program manager. This role applies whether the audit is first-party, second-party, or third-party: the party requesting the audit is distinct from the individuals assigned to perform it and from the organization or area being examined.

ISO 19011 audit-guidance terminology defines an audit client as the organization or person requesting an audit, which directly supports identifying the client as the traditional initiator. The standard's guidance also frames audit activities around objectives and arrangements established for the audit program, reinforcing that initiation originates with the requesting party. See ISO 19011:2018—Guidelines for auditing management systems and the ASQ Auditing resource.

QUESTION NO: 29

The primary reason that nonconforming material should be identified and segregated is

A. So that the cause of nonconformity can be determined.

B. So it cannot be used in production without proper authorization.

C. To obtain samples of poor workmanship for use in the company's training program.

D. So that responsibility can be determined and disciplinary action taken.

ANSWER: B

Explanation:

The correct answer is *"So it cannot be used in production without proper authorization."* Identification and segregation are fundamental controls for nonconforming outputs because they prevent their unintended use, processing, installation, or delivery. When a material, component, or product does not meet specified requirements, its status must be made visible and it must be physically or otherwise controlled until an authorized disposition is made. That disposition may include rework, repair, use as-is under concession, return to a supplier, or scrap. Segregation can involve a designated hold area, clear labeling, electronic status controls, or restricted inventory locations, depending on the organization's processes and risks. The essential purpose is to ensure that personnel cannot inadvertently select or incorporate suspect material into conforming production. This preserves product quality, traceability, customer requirements, and the integrity of the quality management system. ISO 9001 requires organizations to identify and control nonconforming outputs to prevent unintended use or delivery, including taking action appropriate to the nature of the nonconformity and its effect. ASQ quality-engineering practice similarly treats nonconforming-material control as a containment mechanism pending documented review and authorized disposition. See ISO 9001:2015, Quality management systems—Requirements and ASQ's nonconformity quality resource.

QUESTION NO: 30

In a measurement-system study, bias is defined as the difference between

A. The observed average measurement and a reference value.

B. Measurements made by two different appraisers.

C. Repeated measurements made by one appraiser.

D. The largest and smallest measurements in a subgroup.

ANSWER: A

Explanation:

The observed average measurement and a reference value is correct. Bias represents a systematic measurement error. It is evaluated by repeatedly measuring a standard or other item with an accepted reference value and comparing the average observed result with that value.

Repeatability concerns variation when the same appraiser measures the same item repeatedly under the same conditions. Reproducibility concerns variation attributable to different appraisers. Linearity addresses whether bias changes across the operating range of the measurement system. See NIST's Measurement Process Characterization guidance.

QUESTION NO: 31

Which of the following tools can provide a ranking of things to be done?

A. Measles charts.

B. Cause & effect diagram.

C. Scatter diagram.

D. Checklist.

E. Prioritization matrix.

ANSWER: E

Explanation:

A prioritization matrix can provide a ranking of things to be done. This decision-making tool converts several evaluation criteria into a structured, repeatable comparison of candidate actions, projects, problems, or improvement opportunities. A team first establishes the criteria that matter, such as customer impact, risk, cost, urgency, regulatory significance, or expected benefit. It then assigns relative weights to those criteria and scores each proposed action. Combining the scores produces an overall priority value, allowing the team to rank work objectively and direct limited resources toward the most important actions first.

This approach is especially useful in quality engineering because improvement teams commonly face more potential actions than they can perform at one time. The matrix makes the basis for the ranking visible, supports cross-functional consensus, and provides a documented rationale for sequencing corrective actions or improvement projects. ASQ describes a prioritization matrix as a tool used to prioritize items or alternatives according to weighted criteria. The CQE body of knowledge includes prioritization matrices among the management and planning tools used for analyzing and planning quality improvements. See ASQ: Prioritization Matrix and ASQ Certified Quality Engineer.

QUESTION NO: 32

In order to implement a continuous improvement strategy, a company may institute a steering committee or improvement council. Which of the following would generally NOT be a task performed by this council?

A. The development of a quality vision for the company.

B. The combined development and implementation of the company improvement strategy.

C. The definition of certain quality objectives for sections of the company.

D. The development of quality education and communication modules for the organization.

ANSWER: D

Explanation:

The development of quality education and communication modules for the organization is generally not a task performed by an improvement council. A steering committee or quality council operates at the leadership and governance level: it establishes organizational direction, aligns improvement work with business priorities, sets or sponsors quality objectives, allocates resources, monitors results, and removes barriers to improvement. It should ensure that personnel receive suitable quality education and that communication supports the improvement strategy, but the detailed instructional-design work belongs to the functions and subject-matter experts responsible for training, learning and development, internal communications, or the individual improvement projects.

This distinction lets the council retain an enterprise-wide perspective. Instead of creating individual course modules or communication materials, it defines the competencies, audiences, timing, sponsorship, and measures needed for education and communication, then reviews whether those activities effectively support strategic quality goals. ASQ describes a quality council as a management group that coordinates and directs quality-improvement activities across the organization. The Baldrige leadership framework similarly emphasizes that senior leaders set direction and create an environment for organizational learning and improvement. See ASQ's Quality Council resource and NIST Baldrige Leadership Criteria commentary.

QUESTION NO: 33

Which of the following charts should be used to monitor leaks in plastic bottles?

A. X and R

B. X and s

C. P

D. np

ANSWER: C

Explanation:

The **P** chart is appropriate because bottle leakage is attribute data evaluated at the unit level: each inspected bottle is classified as leaking or nonleaking. A P chart plots the proportion (or fraction) of nonconforming units in successive samples, allowing a quality engineer to determine whether the leak rate remains statistically stable over time or shows special-cause variation. This is especially useful in bottle-production processes because inspection sample sizes may differ by shift, production run, or inspection interval. The P chart calculates control limits using each sample's size, so the plotted proportions can be compared appropriately even when the number of bottles inspected changes. In practice, the quality characteristic should be operationally defined consistently—for example, a bottle is nonconforming if it fails a specified leak-test method and acceptance criterion. Recording the number inspected and the number of leaking bottles for each subgroup supplies the data needed for the chart. ASQ describes a P chart as an attribute control chart used to monitor the proportion of defective items, while NIST identifies p charts as charts for the fraction nonconforming. See ASQ's control-chart resource and NIST's p-chart guidance.

QUESTION NO: 34

The sample size for a product quality audit should be

A. Based on ANSI/ASQ Z1.4.

B. Based on the lot size.

C. A stated percentage of production.

D. A very small quantity of product.

ANSWER: D

Explanation:

A very small quantity of product. is correct because a product quality audit is an assessment activity, not a lot-acceptance inspection. Its purpose is to obtain objective evidence that the organization's quality system, production processes, controls, and product-verification activities are functioning as intended. The auditor uses a limited number of product units to trace evidence through applicable specifications, inspection and test records, identification and traceability controls, handling practices, and corrective-action processes. A small, purposeful sample enables this review without turning the audit into a duplicate inspection operation or consuming resources disproportionate to the audit's objective.

The units selected should nevertheless be representative and chosen with audit risk in mind—for example, including product from relevant operations, shifts, characteristics, or conditions where evidence is needed. ISO's auditing guidance emphasizes a risk-based audit approach and the collection of sufficient, appropriate objective evidence rather than a prescribed acceptance-sampling quantity. ASQ similarly distinguishes sampling inspection, which supports acceptance decisions, from audit activities that evaluate conformance and effectiveness of a quality system. See ISO 19011 auditing guidance and ASQ's quality auditing resource.