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Topic Break Down

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QUESTION NO: 1

A team wants to make a schedule for a project showing which tasks must be done sequentially and which may be done simultaneously. Which tool is most appropriate?

A. matrix diagram

B. cause and effect diagram

C. process decision program chart

D. affinity diagram

E. activity network diagram

F. tree diagram

G. prioritization matrix

ANSWER: E

Explanation:

An activity network diagram is the appropriate tool because it maps project activities according to their logical dependencies and execution order. The diagram uses connected activities or nodes to show predecessor and successor relationships: a task that depends on another must follow it, while tasks with no dependency between them can be scheduled in parallel. This makes the tool especially useful for constructing and communicating a project schedule, identifying the sequence of work, and determining opportunities for concurrent activity. In Lean Six Sigma project management, the same network logic supports planning improvement work by clarifying what must be completed before later phases or deliverables can begin. Network diagrams also provide the foundation for critical-path analysis, which identifies the chain of dependent activities that governs the earliest possible project completion date. The Project Management Institute describes network diagrams as graphical representations of the logical relationships among schedule activities, and the U.S. General Services Administration similarly identifies dependency relationships as a core part of schedule network development. See PMI guidance on schedule network analysis and GSA scheduling guidance.

QUESTION NO: 2

The English words used for the 5S's are __________, _____________, Shining, Standardizing and Sustaining. (Note: There are 2 correct answers).

A. Shaping

B. Sorting

C. Shifting

D. Straightening

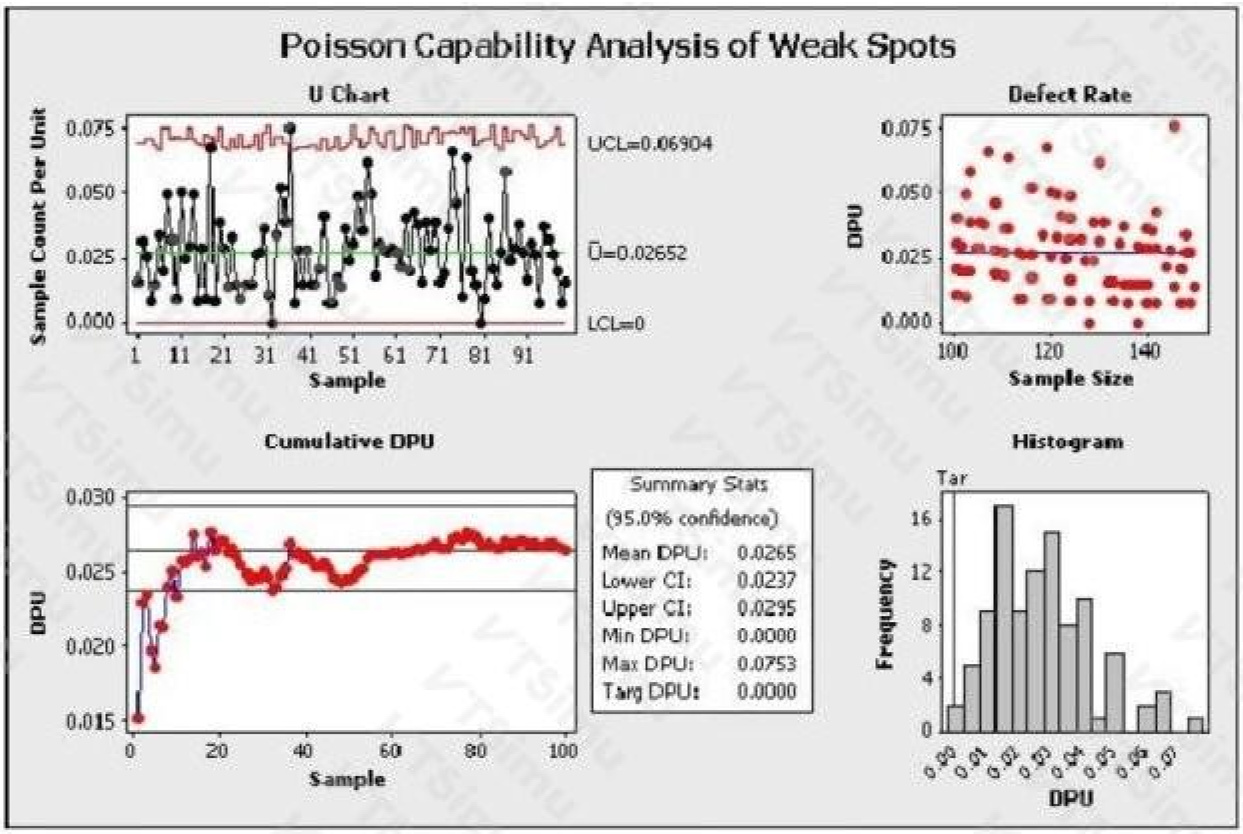
ANSWER: B D

Explanation:

The correct terms are **Sorting** and **Straightening**. They are the first two activities in the commonly taught English 5S sequence: Sort, Set in Order (also called Straighten), Shine, Standardize, and Sustain. Sorting means separating necessary items from unnecessary items in the workplace and removing what is not needed. This creates a foundation for a safer, less cluttered, and more efficient work area. Straightening follows by arranging the needed items so they are easy to find, use, and return; visual location controls and designated storage locations are common practices. The question uses "Shining," "Standardizing," and "Sustaining" for the remaining three S terms, so "Sorting" and "Straightening" complete that specific wording consistently. These practices are central to Lean workplace organization because they make abnormalities visible, reduce wasted motion and search time, and support repeatable work standards. The American Society for Quality describes 5S as Sort, Set in Order, Shine, Standardize, and Sustain, while recognizing closely related English terminology in Lean practice. See ASQ's 5S tutorial and the Lean Enterprise Institute's 5S definition.

QUESTION NO: 3

Which statements are correct about the advanced Capability Analysis shown here? (Note: There are 3 correct answers).



A. This is a Poisson Capability Analysis.

B. The average DPU with 95% confidence is between 0.024 and 0.0295.

C. The DPU does not seem to vary depending on sample size.

D. The process shows only one instance of being out of control statistically so we have confidence in the estimated DPU of this process.

E. The maximum DPU in one observation was nearly 0.0753.

ANSWER: B C E

Explanation:

The correct statements are supported by the values and plots displayed in the advanced capability analysis. The reported average defects per unit (DPU) has a 95% confidence interval running from approximately 0.024 to 0.0295. This interval expresses the uncertainty around the process-wide DPU estimate based on the observed defect data, rather than merely describing individual observations.

The chart also indicates that the DPU has no apparent systematic relationship with sample size. In other words, observations with larger or smaller opportunity/sample counts do not show a meaningful trend in defect rate attributable to sample size; this supports use of the displayed overall DPU as the central process estimate. Finally, the individual-observation results show a largest DPU of about 0.0753. This is the maximum observed defect rate for a single observation and is distinct from the average DPU and its confidence interval.

DPU is a standard attribute-data measure calculated as total defects divided by total units. For background on attribute capability analysis and the interpretation of defect-based process measures, see [Minitab's attribute capability analysis overview] and [ASQ's DPU reference].

QUESTION NO: 4

The English words used for the 5S's are Sorting, Straightening, _____________, __________ and Sustaining. (Note: There are 2 correct answers).

A. Shaping

B. Shining

C. Standardizing

D. Signing

ANSWER: B C

Explanation:

The missing terms are **Shining** and **Standardizing**. In the common English rendering of the Lean workplace-organization method, the five steps are Sorting, Straightening (or setting in order), Shining, Standardizing, and Sustaining. Shining means cleaning the work area and equipment while also inspecting them, so abnormalities such as leaks, damage, or unsafe conditions can be detected promptly. Standardizing establishes consistent visual controls, procedures, schedules, and ownership so that the first three practices are carried out uniformly across the workplace. Together, these steps turn workplace organization from a one-time cleanup into a repeatable operating discipline. The original Japanese terms are Seiri, Seiton, Seiso, Seiketsu, and Shitsuke; English translations vary slightly, but "Shining" and "Standardizing" are widely used equivalents for Seiso and Seiketsu. Lean Enterprise Institute describes 5S as a system for organizing work that incorporates these practices, and ASQ similarly presents Shine and Standardize as core elements of 5S. See the Lean Enterprise Institute 5S definition and ASQ's 5S tutorial.

QUESTION NO: 5

Of the various types of data shown which is NOT representative of Variable Data.

A. Child's height is 4 foot 3 inches

B. Three employees wore hard hats

C. Car burned 2.7 gallons of gasoline

D. Train was going 140 kilometers per hour

ANSWER: B

Explanation:

"Three employees wore hard hats" is the correct choice because it reports a count of employees meeting a condition, rather than a measured quantity on a continuous numerical scale. In Lean Six Sigma and statistical process control, variable data are obtained by measurement and can, in principle, take any value within a range, subject to the precision of the measurement system. Typical variable measures include length, volume, time, weight, temperature, and speed. The number of employees who wore hard hats is instead attribute data: each employee is classified according to whether the hard-hat condition is met, and the resulting observations are summarized as a count. This distinction matters when selecting analytical methods and control charts. Measured, continuous process characteristics are commonly analyzed using variable-data methods, while counts or classifications are analyzed with attribute-data methods. ASQ describes attribute data as data that are counted or classified, in contrast with variable data that are measured on a continuous scale. More detail is available from ASQ's data collection and analysis resources and the NIST Engineering Statistics Handbook discussion of control-chart data types.

QUESTION NO: 6

If = 0.5, what is the critical value?

A. 2.365

B. 2.306

C. 1.860

D. 1.895

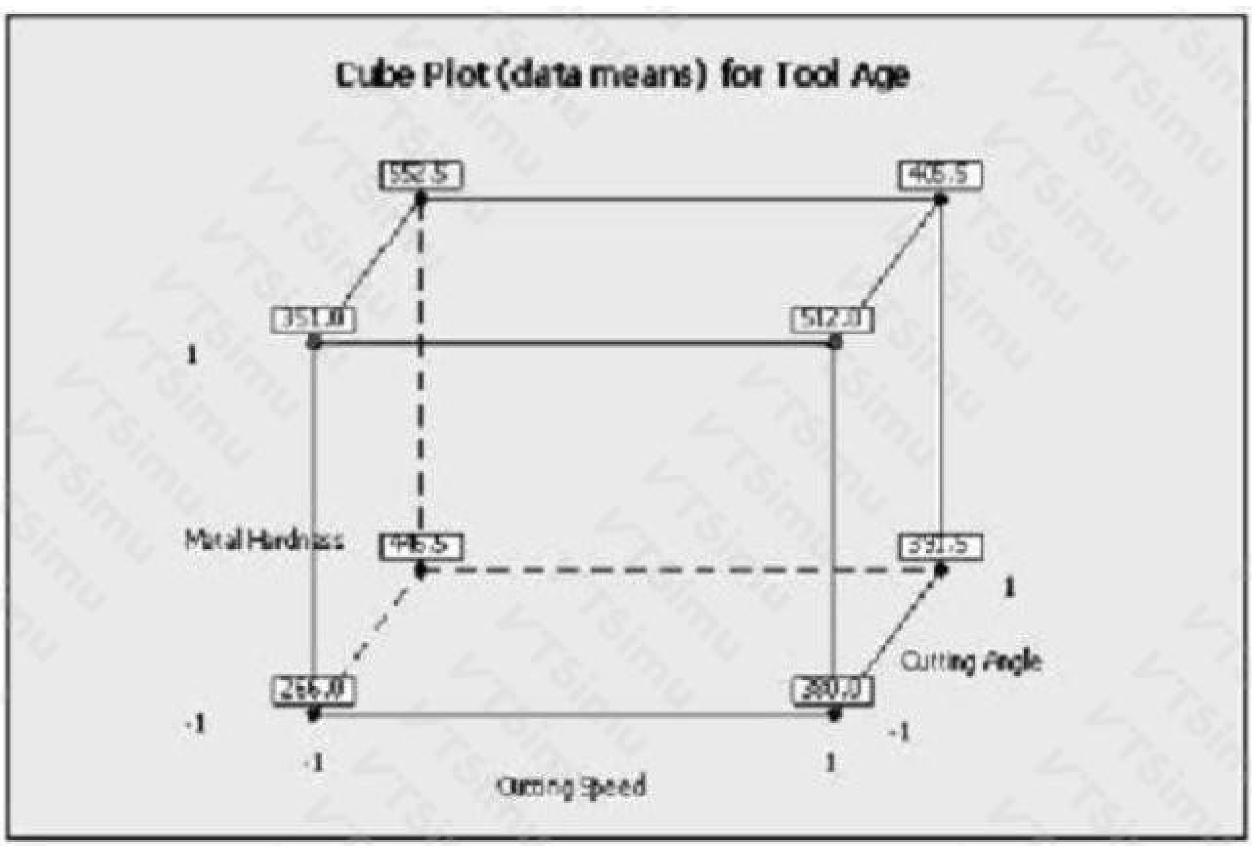
ANSWER: D

Explanation:

The critical value is **1.895**. In an F-distribution critical-value lookup, the required value is the upper-tail quantile selected using the stated significance probability and the numerator and denominator degrees of freedom defined by the exercise or its accompanying table. The supplied explanation identifies the intended lookup as an F critical-values table for $P = 0.05$; at the relevant row-and-column intersection, the tabulated critical value is 1.895. An F critical value establishes the threshold against which an observed F statistic is compared in variance-ratio tests, regression ANOVA, and related hypothesis tests. For a right-tailed test at the stated probability, the critical value is chosen so that the specified probability remains to its right under the F distribution. This is why using the table's designated degrees-of-freedom combination and probability column yields 1.895. The general definition and use of F-distribution quantiles are described by the NIST Engineering Statistics Handbook; NIST's F-distribution reference also explains the distribution's dependence on two degrees-of-freedom parameters.

QUESTION NO: 7

Which statement(s) are correct about the Factorial Plot shown here? (Note: There are 3 correct answers).



A. When the cutting speed increased from low to high level, the tool age increases

B. The coefficient of the metal hardness is positively related to the output of tool age

C. The coded coefficient is lower for cutting speed than the cutting angle related to the output of tool age

D. These plots prove a statistically significance factor with 95% confidence

E. These plots are an example of interaction plots

ANSWER: A B C

Explanation:

A factorial main-effects plot shows the estimated average response at each factor level while averaging over the levels of the other factors. In the displayed plot, the tool-age response is higher at the high cutting-speed setting than at the low setting; therefore, “When the cutting speed increased from low to high level, the tool age increases” correctly describes the direction of that main effect. The metal-hardness trend also rises from its low to high level. Thus, “The coefficient of the metal hardness is positively related to the output of tool age” is correct: its coded-factor coefficient has a positive sign, indicating an increase in the fitted response when moving from the low coded level to the high coded level.

The plotted change associated with cutting angle is larger than the change associated with cutting speed. Accordingly, “The coded coefficient is lower for cutting speed than the cutting angle related to the output of tool age” is also correct. For a two-level factorial model using coded factor settings, the magnitude of a main-effect coefficient is proportional to the response change between the factor’s low and high levels, so the steeper displayed main-effect trend corresponds to the larger coefficient magnitude. Factorial plotting and interpretation of main effects are discussed in the NIST Engineering Statistics Handbook and in Minitab’s main-effects plot guidance.

QUESTION NO: 8

During the _______________ phase of 5S is when we might implement a Red Tag program.

A. Straightening

B. Standardizing

C. Shining

D. Sorting

ANSWER: D

Explanation:

Sorting is correct because the first 5S activity focuses on separating necessary workplace items from unnecessary ones. A Red Tag program provides a visible, controlled method for identifying items whose purpose, ownership, frequency of use, or need is uncertain. Team members attach red tags to suspect materials, tools, equipment, documents, or inventory and place them in a designated holding area while a decision is made to retain, relocate, dispose of, or otherwise address each item. This directly supports Sorting by removing clutter and freeing workspace for items that are genuinely needed for the process. The practice also makes abnormalities and excess inventory easier to see, creating a more organized and efficient work area before the remaining 5S practices are established. Lean Enterprise Institute describes red-tagging as a process for identifying and evaluating unnecessary items during workplace organization; see Lean Enterprise Institute: Red Tagging. ASQ’s overview of 5S likewise identifies Sort as the step concerned with eliminating unnecessary items: ASQ: 5S Tutorial.

QUESTION NO: 9

For the data shown here which statement(s) are true? (Note: There are 2 correct answers).

Grade A	Grade B	Grade C
0.917	1.1	0.63
0.68	0.173	4.17
1.74	0.24	0.6
0.3	0.67	0.84
0.33	6.94	0.22
4.13		

A. With 95% confidence, we cannot conclude if the samples are from three Normal Distributions.

B. With greater than 95% confidence, we conclude the samples are from Non-normal Distributions.

C. If we wanted to compare the Central Tendencies of these three samples we would use the one-way ANOVA test.

D. If we wanted to compare the Central Tendencies of these three samples we could use Mood's Median test.

ANSWER: B D

Explanation:

The displayed normality-analysis results support the conclusion that the samples do not meet the normal-distribution assumption at the 95% confidence level. In hypothesis-test terms, the reported evidence has a p-value below the usual significance level of 0.05; therefore, there is greater than 95% confidence for rejecting normality for the applicable samples. This finding matters because comparing group centers with a conventional one-way ANOVA relies on residuals being approximately normally distributed (along with the other model assumptions).

For three independent samples whose distributions are non-normal, Mood's Median test is an appropriate nonparametric procedure for assessing whether the population medians, a measure of central tendency, differ among groups. The test evaluates how observations are distributed above and below the overall median and does not require the data in each group to follow a normal distribution. Thus it provides a suitable robust approach for the comparison indicated by the data. Minitab's guidance describes normality testing and interpretation of its p-value at Minitab Support; its documentation also describes Mood's Median test for comparing group medians at Minitab Support.

QUESTION NO: 10

In a Failure Modes and Effects Analysis, which actions are appropriate after a high-risk failure mode has been identified? (Note: There are 3 correct answers).

A. Identify actions that reduce severity, occurrence, or improve detection

B. Assign an owner and completion date for the action

C. Reassess the risk after actions are completed

D. Reduce the occurrence rating without changing the process

E. Remove the failure mode from the analysis after it is documented

ANSWER: A B C

Explanation:

Identify actions that reduce severity, occurrence, or improve detection is correct because FMEA is intended to prioritize preventive and detection controls for failure risks. **Assign an owner and completion date for the action** is correct because recommended actions must have accountability to be implemented. **Reassess the risk after actions are completed** is correct because the team must verify whether the implemented controls changed the relevant risk ratings.

Changing a rating solely to improve the apparent risk priority is not valid; ratings must reflect the actual condition of the process. FMEA is a living risk-analysis document and should be updated when the design or process changes. See ASQ’s FMEA resource.

QUESTION NO: 11

To assess the significance of factors in either a fractional- or a full-factorial experiment structure, a black belt can use

A. analysis of variance (ANOVA)

B. fault tree analysis (FTA)

C. failure mode and effects analysis (FMEA)

D. evolutionary operation (EVOP)

ANSWER: A

Explanation:

Analysis of variance (ANOVA) is the appropriate method for assessing which experimental factors have statistically significant effects in full-factorial and fractional-factorial designs. In a factorial experiment, the response variation is partitioned into components attributable to the main effects of factors, interaction effects, and random experimental error. ANOVA then compares the estimated variation associated with each modeled effect to the residual error variation using an F statistic and corresponding p-value. This enables a Black Belt to determine, at a selected significance level, whether observed factor or interaction effects are likely to represent real process influences rather than ordinary sampling variation. The same fundamental approach applies to fractional-factorial designs, although the design’s alias structure must be considered when interpreting estimated effects because some effects can be confounded with one another. ANOVA also provides a structured model summary and supports residual analysis, helping verify that the assumptions used for inference are reasonably appropriate. NIST’s Engineering Statistics Handbook describes factorial designs and the use of analysis of variance to estimate and test factor effects: NIST: Full Factorial Designs. For the underlying ANOVA methodology, see NIST: Analysis of Variance.

QUESTION NO: 12

When constructing a Cause-and-Effect Diagram to investigate recurring invoice errors, which practices are appropriate? (Note: There are 3 correct answers).

A. Define the effect or problem clearly

B. Use cross-functional process knowledge

C. Validate suspected causes with data

D. Treat every listed cause as a verified root cause

E. Exclude causes outside the selected category labels

ANSWER: A B C

Explanation:

A Cause-and-Effect Diagram, also known as a fishbone or Ishikawa diagram, helps a team organize potential causes of a defined problem before the causes are validated with data. The effect should be stated clearly and specifically so that the team is investigating one measurable problem. Cross-functional participation is valuable because people who perform, receive, or support the work can identify different potential causes. The categories and individual causes should then be investigated with process evidence rather than accepted as proven merely because they appear on the diagram.

The diagram is not a substitute for data collection or root-cause verification. It provides a structured way to generate and organize hypotheses for further analysis. See ASQ's overview of the fishbone diagram.

QUESTION NO: 13

A set of data from a process has 8 readings per sample and 50 samples. The mean of the 50 sample means is 12.62. The mean of the 50 ranges is 0.18. Find the control limits for the xbar chart.

A. 12.55 and 12.69

B. 12.11 and 13.13

C. 12.54 and 12.70

D. none of the above

ANSWER: A

Explanation:

12.55 and 12.69 is correct. An X-bar chart monitors variation in subgroup averages, and, when the within-subgroup variation is estimated from ranges, its limits are calculated using the X-bar-and-R chart formulas: UCL = X-double-bar + A2 × R-bar and LCL = X-double-bar − A2 × R-bar. The subgroup size is eight readings, so the applicable standard control-chart constant is A2 = 0.373. Using the supplied grand mean of 12.62 and average range of 0.18 gives a margin of 0.373 × 0.18 = 0.06714. Therefore, the upper control limit is 12.62 + 0.06714 = 12.68714, which rounds to 12.69. The lower control limit is 12.62 − 0.06714 = 12.55286, which rounds to 12.55. The 50 subgroups provide the data used to estimate the overall center line and average range; the limit calculation itself uses the grand mean, average range, and the constant associated with subgroup size eight. This is the standard range-based method for constructing an X-bar chart, as described in the NIST/SEMATECH control-chart guidance and summarized by the American Society for Quality.

QUESTION NO: 14

A Belt is analyzing data and upon creation of the graphical analysis sees multiple modes. One of the primary reasons this could occur is because the process has experienced a ____________________.

A. Significant change from one shift to another

B. Sizable Measurement System error

C. Catastrophic failure of some sort

D. Any one of these

ANSWER: D

Explanation:

Any one of these is correct because multiple modes in a graphical display, such as a histogram, commonly indicate that the plotted observations may come from more than one underlying condition or population. A significant change between shifts can create distinct centers in the data when operators, machines, materials, settings, or environmental conditions differ. A sizable measurement-system error can similarly produce separate groupings when measurement bias, resolution, instruments, or measurement methods are inconsistent. A catastrophic failure can introduce a distinct set of observations associated with the failure state, separate from normal-process observations. In Lean Six Sigma analysis, multimodality is therefore an important signal to stratify the data and investigate potential sources of variation rather than treating all observations as a single homogeneous process. The analyst should examine relevant factors such as shift, machine, operator, material lot, measurement device, and time period to identify the source of the separate peaks. NIST's guidance on histograms notes that multiple peaks can indicate different populations or process conditions, supporting this interpretation. See NIST: Histogram and NIST: Multimodal Distributions.

QUESTION NO: 15

Customer segmentation refers to:

A. dividing a particular customer into parts that are more easily understood

B. grouping customers by one or more criteria

C. maintaining secure customer listings to minimize communication among them

D. eliminating or “cutting off” customers with poor credit history

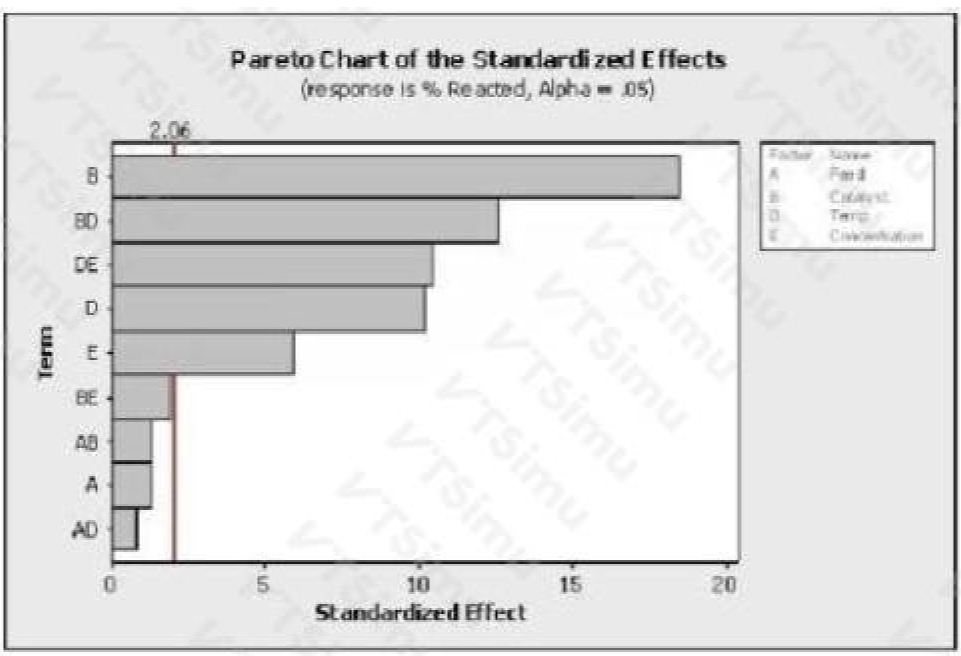
ANSWER: B

Explanation:

Customer segmentation is correctly defined as **grouping customers by one or more criteria**. In Lean Six Sigma and customer-focused process improvement, segmentation organizes a broad customer population into meaningful groups that share relevant characteristics, needs, behaviors, or value expectations. Criteria may include demographics, geography, buying behavior, product usage, service requirements, profitability, or the critical-to-quality requirements that customers express. This makes customer data more actionable: teams can identify which needs matter most to each group, prioritize improvement opportunities, and tailor process outputs, communications, and service levels appropriately. Segmentation is especially useful during Voice of the Customer analysis because it prevents a large and diverse customer base from being treated as though every customer has identical requirements. The American Marketing Association describes market segmentation as dividing a market into distinct subsets of customers with similar needs or characteristics, while ASQ emphasizes understanding customer requirements as a foundation for quality improvement. These principles support using defined criteria to form customer groups for analysis and action. See the American Marketing Association overview of market segmentation and ASQ’s Voice of the Customer resource.

QUESTION NO: 16

Which statement(s) are correct about the Pareto Chart shown here for the DOE analysis? (Note: There are 2 correct answers).



A. It is unknown from this graph how many factors were in the Experimental Design

B. The factors to keep in the mathematical model are E, D, DE, BD and B with an alpha risk equal to 2.06

C. The effects to keep in the mathematical model are E, D, DE, BD and B with an alpha risk equal to 0.05

D. The factors to keep in the mathematical model with a 5% alpha risk are BE, AB, A and AD

ANSWER: A C

Explanation:

It is unknown from this graph how many factors were in the Experimental Design because a Pareto chart of standardized effects displays the effects that were estimated and plotted, rather than a complete specification of the original design. The labels reveal that factors such as B, D, and E, and interactions such as BD and DE, were evaluated, but they do not by themselves establish the total number of factors originally included. For example, additional factors may have been screened out, omitted from the displayed terms, or not represented among the effects shown.

The effects to keep in the mathematical model are E, D, DE, BD and B with an alpha risk equal to 0.05 because these displayed standardized effects extend beyond the chart's reference line. In DOE Pareto charts, the reference line is the critical value used to identify statistically significant effects at the selected significance level. Here, 0.05 is the alpha risk (significance level), while the displayed cutoff value of 2.06 is the corresponding critical standardized-effect threshold, not an alpha value. Retaining the effects that exceed this threshold provides a statistically supported starting model for subsequent model fitting and validation. See Minitab's guidance on Pareto charts of standardized effects and the NIST discussion of factorial-design effect analysis.

QUESTION NO: 17

A medicine with efficacy of .52 is given to five patients. Find the approximate probability that at least one of the patients is cured. (Hint: Use the binomial formula.)

A. .975

B. .480

C. .531

D. .416

E. none of the above

ANSWER: A

Explanation:

The correct answer is **.975**. Treat efficacy as the probability that an individual patient is cured, so the cure probability for each patient is 0.52. Assuming the outcomes for the five patients are independent and the medicine has the same efficacy for each, the most direct binomial calculation uses the complement event: first find the probability that no patient is cured, then subtract that value from 1. The probability that one patient is not cured is 1 − 0.52 = 0.48. Therefore, the probability that all five patients are not cured is $(0.48)^5$, which is approximately 0.02548. Consequently, the probability that at least one patient is cured is 1 − 0.02548 = 0.97452. Rounding to three decimal places gives 0.975. This is an application of the binomial model's complement rule, which is especially efficient for an "at least one" probability. The binomial distribution and its assumptions are described by the NIST/SEMATECH Engineering Statistics Handbook; the complement approach for binomial probabilities is also explained in OpenStax Introductory Statistics.

QUESTION NO: 18

Which statement(s) are incorrect for the Regression Analysis shown here? (Note: There are 2 correct answers).

Regression Analysis: Turbine Output versus Air-Fuel Ratio, % stream, ...

```
The Regression Equation is
TurbineOutput = 16.5 + 3.21 Air-Fuel Ratio + 0.386 % methane + 0.0166
SteamExitTemp

Predictor         Coef       SE Coef       T       P
Constant          16.488     2.918         5.65    0.000
Air-Fuel Ratio    3.2148     0.2377        13.52   0.000
%methane          0.38637    0.07278       5.31    0.004
SteamExitTemp     0.016576   0.004273      3.88    0.004

S = 0.508616    R-Sq = 98.6%      R-Sq(adj) = 98.2%
Analysis of Variance
Source            DF         SS        MS        P         F
Regression        3          170.003   56.668    219.06    0.000
Residual Error    9          2.328     0.259
Total             12         172.331

Source            DF         Seq SS
Air-Fuel Ratio    1          159.048
% methane         1          7.062
SteamExitTemp     1          3.892
```

A. The air-fuel ratio explains most of the TurbineOutput variation

B. The Regression explains over 98% of the process variation

C. This Multiple Linear Regression has three statistically significant independent variables

D. If the air-fuel ratio increases by 1, the TurbineOutput more than triples

E. The SteamExitTemp explains the most variation of the TurbineOutput

ANSWER: D E

Explanation:

“If the air-fuel ratio increases by 1, the TurbineOutput more than triples” is incorrect because the fitted multiple linear regression is expressed on the original response scale. A coefficient for air-fuel ratio represents the estimated *additive* change in TurbineOutput associated with a one-unit increase in that predictor, while holding the other predictors constant. It does not represent a multiplicative factor or a tripling of the response. Multiplicative interpretations require an appropriately transformed response model, such as a log-linear model, and then require back-transformation.

“The SteamExitTemp explains the most variation of the TurbineOutput” is also incorrect. The regression results identify the air-fuel ratio as the predictor with the largest contribution to explaining the modeled TurbineOutput variation, rather than SteamExitTemp. In multiple regression, this conclusion should be based on the reported predictor contribution measures in the analysis, interpreted in the context of the other variables in the fitted model. Coefficient magnitude alone is not generally sufficient when predictors have different units or scales. Guidance on interpreting regression coefficients and model variation measures is available from the NIST regression handbook and the Minitab model-summary documentation.

QUESTION NO: 19

An important aspect of data collection is that the data collector should

A. Determine the dispersion of the data

B. Know how the data are to be used

C. use a control chart to analyze the data

D. use a stratified sampling plan

ANSWER: B

Explanation:

Know how the data are to be used is correct because a sound data-collection process begins with a clear purpose. In Lean Six Sigma, the intended use of the data determines what characteristic must be measured, the operational definition to apply, the appropriate unit and time frame, the needed level of accuracy, and the method for recording observations. When collectors understand the decision, analysis, or improvement question the data will support, they can collect relevant, consistent, and usable information rather than simply accumulating measurements. This understanding also helps ensure that definitions are applied uniformly by different people and that the data can validly support subsequent analysis and process decisions. NIST describes planning data collection as identifying the objective and defining the measurements needed to meet that objective; it also emphasizes documenting measurement procedures so data are collected consistently. ASQ similarly identifies a data-collection plan as a structured approach that specifies what data are needed and how they will be gathered. These principles make knowledge of the data's intended use a foundational responsibility for a data collector. See the NIST/SEMATECH e-Handbook guidance on data collection and ASQ's data collection and analysis resource.

QUESTION NO: 20

There are 14 different defects that can occur on a completed time card. The payroll department collects 328 cards and finds a total of 87 defects. DPMO =:

A. 87 ÷ 328

B. 87 ÷ (328 × 14)

C. 14 ÷ 87

D. 87 ÷ 14 × 1,000,000

E. 328 ÷ 87

F. 87 × 1,000,000 ÷ (14 × 328)

ANSWER: F

Explanation:

87 × 1,000,000 ÷ (14 × 328) is correct because defects per million opportunities (DPMO) standardizes the observed number of defects against every possible defect opportunity in the sample. Each completed time card has 14 possible opportunities for a defect, and 328 cards were examined; therefore, the total opportunity count is 14 × 328 = 4,592. The process produced 87 observed defects, so the defects-per-opportunity rate is 87 ÷ 4,592. Multiplying that rate by 1,000,000 expresses the result on the conventional per-million-opportunities scale: (87 ÷ 4,592) × 1,000,000 = approximately 18,946 DPMO. This metric is useful in Lean Six Sigma because it accounts for the number of defect opportunities per unit, allowing meaningful comparison between processes or products even when they have different complexity levels. ASQ describes DPMO as a Six Sigma performance metric based on defects relative to opportunities, and iSixSigma provides the corresponding calculation structure and terminology. See ASQ's Six Sigma resources and iSixSigma's DPMO definition.

QUESTION NO: 21

Which statement(s) correctly describe Type I Error, Type II Error, and statistical power? (Note: There are 3 correct answers).

A. Type I Error is rejecting a true Null Hypothesis

B. Type II Error is failing to reject a false Null Hypothesis

C. Statistical Power equals 1 minus Beta risk

D. Alpha is the probability of a Type II Error

E. Increasing sample size always increases Alpha

ANSWER: A B C

Explanation:

A Type I Error occurs when a true null hypothesis is rejected. Its probability is controlled by the selected significance level, alpha. A Type II Error occurs when the analysis fails to reject a false null hypothesis. Statistical power is the probability of detecting an effect when a real effect of the specified size exists, and is equal to 1 minus beta.

For a fixed sample size and effect size, reducing alpha generally makes rejection of the null more difficult and can reduce power. Sample-size planning therefore considers alpha, power, the meaningful effect size, and process variation together. NIST discusses Type I and Type II errors in its hypothesis-testing guidance.

QUESTION NO: 22

Which of the following techniques is NOT effective when a team leader is giving feedback to the team?

A. Describing the behavior in context

B. Describing the reasons for giving feedback

C. Giving feedback when it is convenient

D. Providing actionable guidance

ANSWER: C

Explanation:

Giving feedback when it is convenient is not an effective feedback technique because useful feedback should be delivered as close as reasonably possible to the observed behavior, performance, or event. Timely delivery helps team members recall the relevant facts, understand the relationship between their actions and the outcome, and apply any needed adjustment to current work. Waiting solely until it suits the leader can make the information less specific, less actionable, and less relevant to the team's immediate improvement efforts. In Lean Six Sigma environments, feedback supports continuous improvement by helping people recognize performance conditions and take prompt, practical corrective action. Effective feedback is therefore planned around the recipient's ability to receive and use it, while also being sufficiently prompt to preserve context. The Center for Creative Leadership notes that feedback is most useful when it is timely, specific, and focused on observable behavior; see CCL guidance on feedback and impact. Similarly, the U.S. Office of Personnel Management emphasizes timely, constructive performance feedback as a core management practice; see OPM's performance-management guidance.

QUESTION NO: 23

A process shows the following number of defects. Each sample size for this process is

85. 3 8 2 7 7 6 8 8 9 5.

What control chart should be used?

A. x-bar and R

B. median

C. individual and moving range

D. p

E. np

F. c

G. u

ANSWER: F

Explanation:

The **c** chart is appropriate because the data are counts of defects (nonconformities) observed in each sample, and every sample has the same size: 85. A c chart monitors the number of nonconformities per inspection unit when the opportunity for defects is constant from sample to sample. Here, the successive defect counts—3, 8, 2, 7, 7, 6, 8, 8, 9, and 5—are attribute data expressed as defect counts, rather than measurements on a continuous scale or counts of defective units. The chart center line is the average number of defects per sample, $\bar{c}$, and the conventional three-sigma control limits are based on the Poisson model: $\bar{c} \pm 3\sqrt{\bar{c}}$, with a negative lower limit treated as zero. This makes the c chart useful for detecting unusual variation in the defect count while the inspected sample size remains fixed. The American Society for Quality describes c charts as charts for the number of defects when the sample size is constant; see ASQ's control-chart resource. NIST also documents c charts as Poisson-based charts for counts of nonconformities per unit under constant inspection conditions: NIST/SEMATECH e-Handbook.

QUESTION NO: 24

Which item(s) listed would impact the Process Capability for a process with a continuous output? (Note: There are 4 correct answers).

A. Shape of process data distribution (e.g. Normal Distribution)

B. Process Technology

C. Process Standard Deviation

D. Presence of Special Causes or solely Common Causes

E. Seasonal variation in process

ANSWER: A C D E

Explanation:

For continuous-process output, capability is evaluated by comparing the process's natural variation and centering with the applicable specification limits. The **Shape of process data distribution (e.g. Normal Distribution)** matters because standard capability indices such as Cp and Cpk rely on distributional assumptions or require an appropriate non-normal capability method when those assumptions are not met. **Process Standard Deviation** directly determines the spread used in capability calculations: lower within-process variation, with specifications and centering held constant, produces greater capability.

Presence of Special Causes or solely Common Causes is essential because a capability analysis should represent a statistically stable, predictable process. Special-cause variation means the observed performance does not reliably describe a consistent process capability. **Seasonal variation in process** can create time-dependent shifts in location or variation. Unless that source of variation is accounted for, such as by stratifying data or modeling the seasonal effect, the calculated capability may not represent performance throughout the full operating period. These factors determine whether the variation estimate is valid and whether calculated capability is meaningful for the process. See the NIST guidance on process capability analysis and the NIST discussion of process stability.

QUESTION NO: 25

Find the upper control limit for a range chart if n = 4 and the average range is 2.282.

A. 2.282

B. 4.564

C. 5.208

D. 3.423

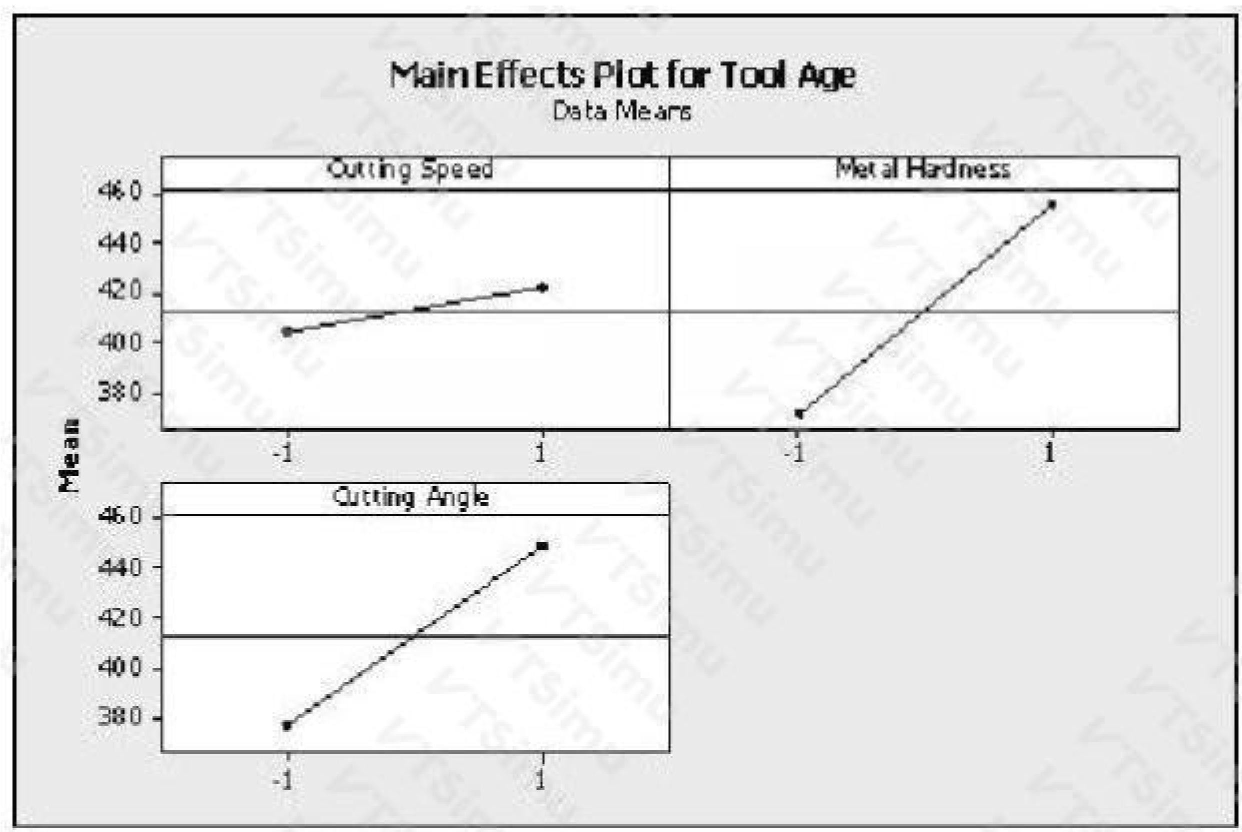
ANSWER: C

Explanation:

5.208 is the upper control limit because an R (range) chart uses the subgroup average range, denoted $\bar{R}$, multiplied by the tabulated *D4* control-chart constant for the subgroup size. The calculation is $UCL_R = D4 \times \bar{R}$. For a subgroup size of 4, the applicable D4 constant is 2.282. Using the stated average range of 2.282 gives $UCL_R = 2.282 \times 2.282 = 5.207524$. Control limits are normally reported to three decimal places in this context, so the result rounds to 5.208. This upper limit represents the expected upper boundary of routine within-subgroup variation when the process is stable; ranges beyond it warrant investigation for a potential special cause. The use of D4 accounts for the fact that the distribution and expected magnitude of a sample range depend on subgroup size, rather than treating all subgroup sizes identically. NIST's control-chart reference describes R charts and the use of control-chart constants: NIST/SEMATECH e-Handbook: R Control Charts. A published constants table confirms the D4 value for a subgroup size of four: NIST control-chart constants.

QUESTION NO: 26

Which statement(s) are correct about the DOE Factorial plot output here? (Note: There are 3 correct answers).



A. Two factors were operated at 3 levels each

B. The highest tool age was achieved with metal hardness at high level while keeping the cutting speed at the low level

C. The design indicated above is a 32 factorial design

D. The cutting speed and cutting angle are at the low level for the least tool age achieved

E. All factors had 2 levels in the experiment

ANSWER: B D E

Explanation:

The plot represents a two-level, three-factor factorial experiment: metal hardness, cutting speed, and cutting angle are each displayed at a low and a high setting. Thus, the experiment has the structure of a full 2^3 factorial design, with eight possible treatment combinations. The response pattern shown identifies the maximum tool age at the combination using high metal hardness and low cutting speed. This setting is therefore correctly described as producing the highest observed tool age in the plot. The plotted minimum occurs when both cutting speed and cutting angle are at their low levels, so that combination is also correctly identified as the least tool-age condition. In factorial DOE interpretation, identifying the factor settings associated with the largest and smallest fitted or observed responses is an important practical use of main-effect and interaction/cube plots. A two-level full factorial design evaluates every combination of the factors' low and high settings, enabling the effects and interactions to be assessed across the complete experimental region. See NIST's discussion of two-level full factorial designs and its 2^k factorial design notation.

QUESTION NO: 27

When one speaks of 20% of something contributing 80% of the affect they are referring to what is known as the _________________.

A. Shewhart Example

B. Pareto Principle

C. Balance Equation

D. Connection Principle

ANSWER: B

Explanation:

The correct answer is **Pareto Principle**. Also called the 80/20 rule, it expresses the common observation that a relatively small number of inputs, causes, or categories often accounts for a disproportionately large share of outcomes. In Lean Six Sigma work, this principle is especially useful for prioritization: a team can organize defect types, customer complaints, downtime causes, or process costs in descending order and focus improvement effort on the "vital few" contributors with the greatest overall effect.

The 80/20 relationship is a practical heuristic rather than a fixed law requiring every dataset to equal precisely 80 percent and 20 percent. The actual distribution may be 70/30, 90/10, or another uneven pattern. What matters is using data to identify the comparatively few causes that create most of the problem or opportunity. A Pareto chart is the standard visual tool for this analysis, combining sorted bars with a cumulative-percentage line to show which categories should receive priority. The American Society for Quality describes Pareto charts and their use in identifying the most significant contributors at ASQ's Pareto resource. The concept originates with economist Vilfredo Pareto and is widely applied in quality management; see Encyclopaedia Britannica's overview of the Pareto principle.

QUESTION NO: 28

For a batch manufacturing process, while assessing short term process variation, which variation category(ies) should one need to focus on? (Note: There are 2 correct answers).

A. Variation within consecutive pieces

B. Variation among consecutive batches

C. Variation among groups of pieces

D. Variation among the completed product

ANSWER: A B

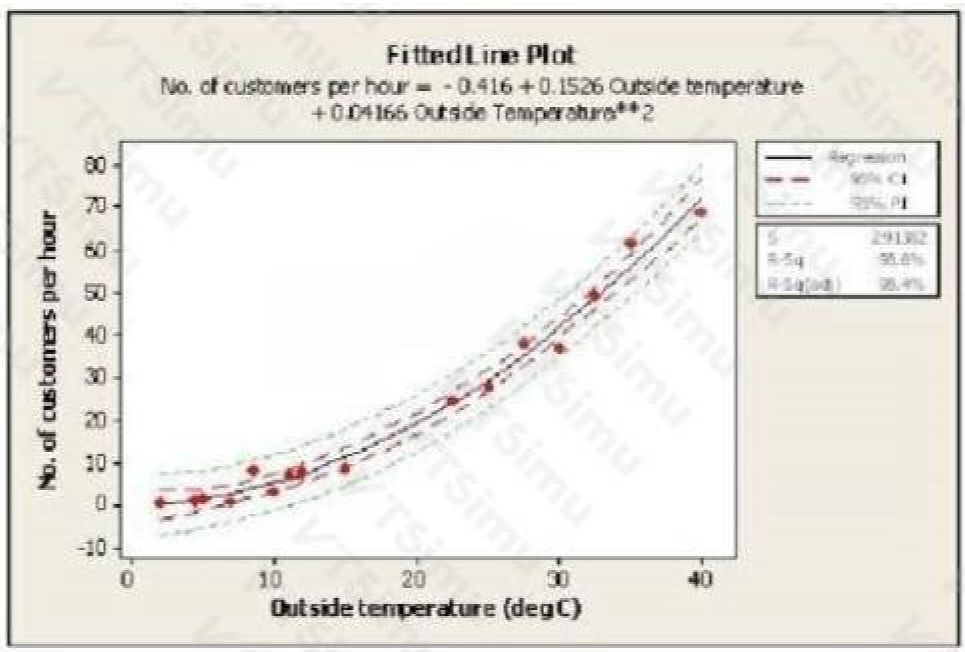
Explanation:

For a batch manufacturing process, short-term variation should capture the inherent, relatively immediate variation observed during production while distinguishing the batch structure that exists in the process. **Variation within consecutive pieces** is essential because it measures piece-to-piece fluctuation under closely comparable operating conditions. This is the core local estimate of process spread and is commonly represented by within-subgroup variation in capability analysis.

Variation among consecutive batches is also essential in batch manufacturing because each batch may introduce a short-cycle source of variation, such as a new material charge, setup, vessel fill, or processing run. Evaluating successive batches reveals the batch-to-batch component that must be understood along with within-batch piece variation. Together, these categories provide an appropriate short-term view of variation at the product-unit and batch levels, supporting capability assessment and improvement work. NIST explains that process capability analysis distinguishes variation estimated within rational subgroups from broader process variation; see the [NIST Process Capability Analysis handbook]. Additional practical guidance on within-subgroup variation is available in [Minitab's capability analysis documentation].

QUESTION NO: 29

Which statement(s) are correct about the Regression shown here? (Note: There are 2 correct answers).



A. The dependent variable is the outside temperature

B. The relationship between outside temperature and number of customers per hour is a Linear Regression

C. The dashed lines indicate with 95% confidence where all of the process data should fall between

D. The dashed lines indicate with 95% confidence the estimate for the Quadratic Regression Line

E. The predicted number of customers per hour is close to 5 if the outside temperature is 10 deg C

ANSWER: D E

Explanation:

The dashed lines indicate with 95% confidence the estimate for the Quadratic Regression Line because they represent confidence bands around the fitted quadratic mean-response curve. A quadratic regression models the expected response as a curved function of the predictor, using a predictor term and its squared term. The fitted line is therefore an estimate of the average number of customers per hour at each outside temperature, rather than a claim that every individual future observation will lie within the dashed bounds. Confidence bands communicate the uncertainty in that estimated mean relationship; their width can vary across the range of observed temperatures because the precision of the fitted mean is not necessarily constant at all predictor values.

The predicted number of customers per hour is close to 5 if the outside temperature is 10 deg C because the plotted quadratic regression curve is approximately at a response value of five customers per hour when read at 10°C on the horizontal axis. This is a model-based prediction from the fitted curve, so it describes the estimated mean customer rate for that temperature. For background on regression models and interpreting fitted relationships, see the NIST regression overview and the Penn State explanation of confidence intervals for mean response.

QUESTION NO: 30

The _____________ Distribution would be the most desirable for modeling the number of stitch defects in a portion of fabric.

A. Exponential

B. Extended

C. Poisson

D. Weibull

ANSWER: C

Explanation:

The **Poisson** distribution is appropriate because the number of stitch defects in a defined portion of fabric is count data: the outcome is a nonnegative integer such as 0, 1, 2, and so on. In Lean Six Sigma quality analysis, this type of defect count is commonly modeled as a Poisson process when defects occur independently, the inspection area or fabric length is held constant, and the average defect rate is reasonably stable. The model is particularly useful for tracking defects per unit, comparing observed counts with the expected rate, and supporting c-chart or u-chart selection in statistical process control. For example, if multiple equal-sized fabric sections are inspected and the long-run mean number of stitch defects per section is known, the Poisson distribution provides probabilities for observing specified defect counts in future sections. NIST describes the Poisson distribution as a model for the number of events occurring in a fixed interval of time or space when events occur independently at a constant average rate. This directly matches counting stitch defects over a specified fabric portion. See the NIST Engineering Statistics Handbook's Poisson distribution reference and the NIST discussion of attribute control charts.

QUESTION NO: 31

From this list select the items that define what an X-Y Diagram is. (Note: There are 4 correct answers).

A. Created for every project

B. Based on team's collective opinions

C. Updated whenever a parameter is changed

D. Used to show each step in a process

E. A living document throughout project lifecycle

ANSWER: A B C E

Explanation:

An X-Y Diagram, often called an X-Y matrix or cause-and-effect matrix, is a team-based prioritization tool used in Lean Six Sigma to connect process inputs (the Xs) with customer or process outputs (the Ys). It is appropriately **Created for every project** when the team needs to identify and focus on the input variables most likely to affect critical outputs. The relationship ratings are generally **Based on team's collective opinions**, ideally informed by process knowledge, data, and cross-functional discussion. This makes the matrix a structured way to build consensus about which potential causes deserve further measurement, validation, or improvement effort.

The X-Y Diagram should be **Updated whenever a parameter is changed**, because changes to requirements, outputs, process inputs, or the team's understanding can alter priorities. Accordingly, it is **A living document throughout project lifecycle**, especially as Define and Measure work reveals better information about customer requirements and process relationships. Maintaining it over time helps the project team keep its analysis aligned with the current process and the critical-to-quality outcomes. The American Society for Quality describes cause-and-effect matrices as tools for evaluating relationships between process inputs and outputs; see ASQ Quality Tools. For additional Lean Six Sigma context on identifying input variables that affect outputs, see iSixSigma's X-Y Matrix overview.

QUESTION NO: 32

Some of the sources for different types of error that can be quantified using Statistical Analysis are __________________.

A. Error in sampling

B. Bias in sampling

C. Error in measurement

D. All of these answers are correct

ANSWER: D

Explanation:

All of these answers are correct is the appropriate choice because statistical analysis recognizes sampling error, sampling bias, and measurement error as important sources of uncertainty or variation affecting conclusions drawn from data. Sampling error is the random difference between a sample statistic and the true population value; it can be estimated with tools such as standard errors, confidence intervals, and sampling-distribution methods. Bias in sampling is a systematic departure caused by a nonrepresentative sampling process. Analysts can quantify and evaluate its likely impact through study-design assessment, comparison with known population benchmarks, weighting, and bias analysis. Measurement error arises when the observed value differs from the actual value because of instruments, procedures, operators, or recording processes. Measurement-system analysis, including repeatability and reproducibility studies, is used in Lean Six Sigma to quantify this variation. Treating these sources explicitly helps a Black Belt distinguish real process signals from artifacts introduced by data collection and sampling. The National Institute of Standards and Technology discusses sampling uncertainty and related statistical concepts in its Engineering Statistics Handbook, while its Measurement Process Characterization guidance describes evaluating measurement-process variation.

QUESTION NO: 33

Lean removes many forms of ______________ so that Six Sigma can focus on reducing _______________.

A. Movement, variation

B. Waste, cost

C. Inventory, defects

D. Waste, variability

ANSWER: D

Explanation:

Waste, variability is correct because Lean and Six Sigma are complementary improvement approaches with distinct primary aims. Lean concentrates on identifying and eliminating non-value-added activities, commonly called waste, to improve process flow, shorten lead times, and increase efficiency. In Lean terminology, waste includes issues such as unnecessary waiting, excess processing, unnecessary motion, excess inventory, defects, overproduction, and unused human capability. Once those sources of inefficiency are reduced, Six Sigma provides a disciplined, data-based method for reducing variability in the process and its outputs. Lower variability makes performance more predictable and helps ensure that products or services consistently meet customer requirements. The combined Lean Six Sigma approach therefore uses Lean to remove waste and improve flow, while using Six Sigma methods to reduce variation and improve quality. This relationship is reflected in the American Society for Quality's overview of Lean and its explanation of Six Sigma, which emphasizes variation reduction and process capability.

QUESTION NO: 34

Which of these are appropriate uses of a Value Stream Map during a Lean Six Sigma project? (Note: There are 3 correct answers).

A. Identifying material and information flow

B. Distinguishing value-added from non-value-added activity

C. Designing a future-state process

D. Calculating Gauge R&R variation

E. Ranking individual employee performance

ANSWER: A B C

Explanation:

Identifying material and information flow is correct because a value stream map visualizes how work, materials, and information move through the end-to-end process. **Distinguishing value-added from non-value-added activity** is correct because the map helps the team recognize delays, rework, queues, handoffs, and other waste. **Designing a future-state process** is correct because teams use the current-state map to develop an improved flow and control approach.

A value stream map is not a substitute for a detailed measurement-system analysis or an individual personnel performance appraisal. It is a systems-level Lean tool used to understand and improve the flow that delivers value to the customer. See Lean Enterprise Institute: Value Stream Mapping.

QUESTION NO: 35

One of the primary deliverables from performing a SIPOC is to begin to understand which outputs have the greatest effect on the customer most valued inputs.

A. True

B. False

ANSWER: B

Explanation:

“False” is correct because a SIPOC is a high-level process-definition tool that organizes the process around Suppliers, Inputs, Process, Outputs, and Customers. Its primary deliverables are a shared view of the process boundaries, the major process steps, the inputs required, the outputs produced, and the customers receiving those outputs. In Lean Six Sigma work, this overview helps a team identify who the customers are and begin clarifying the requirements or critical-to-quality characteristics associated with process outputs. The intended relationship runs from process outputs to customer needs: customers value particular output characteristics, and the team subsequently translates those needs into measurable requirements. It is therefore not accurate to describe SIPOC as determining which outputs affect a customer’s “most valued inputs.” Customer inputs and process inputs are distinct from the outputs delivered to customers. A well-constructed SIPOC provides an early, structured basis for defining the project scope and for later Voice of the Customer and CTQ analysis. See the ASQ SIPOC overview and the iSixSigma SIPOC definition.

QUESTION NO: 36

If an experiment has 5 factors and no replicates for a 2-level Experimental Design with 16 experimental runs which statement(s) are correct? (Note: There are 3 correct answers).

A. The Main Effects for the 5 factors are not aliased or confounded but the 2-way interactions are confounded with the 3-way interactions

B. The Main Effects are confounded with only 4-way interactions

C. The Experimental Design is half-fractional

D. The experiment has 8 experimental runs with the first factor at the high level

E. The experiment has only 4 experimental runs with the 5th factor at the high level

ANSWER: A B C D

Explanation:

A full two-level factorial experiment with five factors requires $2^5 = 32$ treatment combinations. Using 16 runs therefore creates a one-half fraction, written as a 2^{5-1} design. A conventional half-fraction for five factors can use the defining relation I = ABCDE, which has length five and therefore gives a resolution-V design. In this design, each main effect is clear of other main effects and of two-factor and three-factor interactions; its alias is a four-factor interaction. Thus, "The Main Effects are confounded with only 4-way interactions" correctly describes the main-effect alias structure. The two-factor interactions are aliased with complementary three-factor interactions, so "The Main Effects for the 5 factors are not aliased or confounded but the 2-way interactions are confounded with the 3-way interactions" is also correct. Finally, balance is a basic property of regular two-level factorial fractions: every factor column contains equal numbers of low and high settings. Consequently, "The experiment has 8 experimental runs with the first factor at the high level" is correct. These conclusions follow from the standard defining-relation and resolution rules for regular fractional factorial designs. See NIST's discussion of fractional factorial designs and NIST's factorial-design guidance.

QUESTION NO: 37

An x-bar and R chart is used to monitor a process. One week ago a new type of raw material was introduced and since that time 60 points have been plotted on the xbar chart and all are in the middle third of the chart. The corresponding 60 points on the R chart are all below the average range. This indicates that:

A. the operator has been plotting the points incorrectly

B. it is time to recalibrate the gage used

C. it is time to recalculate the control limits

D. the material manager should be asked to go back to the previous raw material so the charts will more accurately reflect the process

ANSWER: C

Explanation:

it is time to recalculate the control limits is correct because the sustained pattern following introduction of the new raw material indicates that the process's underlying variation has changed. In an X-bar and R chart, the X-bar chart monitors subgroup averages, while the R chart monitors within-subgroup spread. Sixty consecutive averages concentrated in the middle third, together with sixty ranges below the historical average range, is strong evidence that the process is operating with less variation than was represented by the existing limits. The limits were therefore calculated from data that no longer describes the current process condition.

Control limits are estimates of the expected natural variation of a stable process, not fixed specifications. Once the new material has been adopted and sufficient evidence confirms the resulting process is stable, limits should be recalculated using representative data collected under that current, consistent condition. This produces limits and center lines that reflect the process now being managed and restores the chart's usefulness for detecting meaningful special-cause variation. NIST's discussion of variables control charts explains that X-bar and range charts are based on estimates of process location and dispersion: NIST/SEMATECH e-Handbook. ASQ also describes control charts as tools for distinguishing routine process variation from changes requiring investigation: ASQ Control Charts.

QUESTION NO: 38

A Black Belt is conducting a Gauge R&R study for a continuous measurement system. The study shows that the largest source of measurement variation is the difference among appraisers. Which measurement-system characteristic is most directly inadequate?

A. Reproducibility

B. Repeatability

C. Linearity

D. Bias

ANSWER: A

Explanation:

Reproducibility is correct because reproducibility represents the variation in measurements caused by different appraisers measuring the same parts with the same measurement system. If the appraiser component is large, the measurement result depends materially on who performs the measurement.

Repeatability concerns variation when the same appraiser measures the same part repeatedly. Bias concerns the systematic difference between observed measurements and a known reference value, while linearity concerns whether bias changes across the measurement range. A high appraiser-to-appraiser component therefore identifies a reproducibility problem. See NIST measurement-process characterization guidance.

QUESTION NO: 39

Which of the following tools would be most appropriate for collecting data to study the symptoms of a problem?

A. Check sheet

B. Flow diagram

C. Force-field analysis

D. Activity network diagram

ANSWER: A

Explanation:

Check sheet is the most appropriate tool because it is a structured, simple form used to gather data consistently at the point where events, defects, or other problem symptoms occur. Before collection begins, the team defines the symptom categories to be observed, the observation period, and the tally method. Each occurrence can then be recorded immediately, creating reliable factual evidence about frequency, location, timing, type, or other relevant characteristics of the problem.

In Lean Six Sigma problem solving, this direct observation and recording is valuable during early investigation because it converts anecdotal reports into data that can be summarized and analyzed. For example, a team can tally defect types by shift, machine, product, or service step, then use those counts to identify concentration patterns and prioritize further root-cause analysis. The American Society for Quality describes a check sheet as a structured, prepared form for collecting and analyzing data, including documenting the frequency of events or problems. This aligns precisely with studying problem symptoms. See ASQ: Check Sheet and NIST/SEMATECH e-Handbook: Check Sheets.

QUESTION NO: 40

Choose those characteristics of a Simple Linear Regression (SLR) Analysis that are applicable. (Note: There are 3 correct answers).

A. The Correlation Coefficient is always greater than the Regression Coefficient in a SLR

B. General Regression Analysis deals only with Continuous Data

C. Non-linear regressions can model curvature that a linear regression cannot represent.

D. SLR can quantify and test the statistical association between variation in a predictor and variation in a response via a mathematical equation.

E. A Correlation does not explain causation but a Regression Analysis with a statistically valid mathematical equation does explain causation

F. SLR models one response variable using one predictor variable with a straight-line equation.

ANSWER: C D F

Explanation:

Simple linear regression models the relationship between one predictor and one response using a straight-line mathematical form. Its fitted equation estimates how the expected response changes as the predictor changes, while associated statistical tests and confidence intervals assess whether the observed linear association is distinguishable from random sampling variation. Thus, it can quantify and test an association, provided the model assumptions and diagnostic checks are appropriate.

When the relationship has meaningful curvature, a nonlinear regression model can represent that curved functional form rather than forcing the relationship into a straight line. Whether it offers stronger statistical support depends on the data, the specified model, and validation or goodness-of-fit evidence; nevertheless, nonlinear regression is an appropriate method for modeling curvature. The defining structure of simple linear regression is one predictor and one response with a linear conditional-mean relationship, commonly expressed as an intercept plus a slope multiplied by the predictor. Regression findings describe modeled association and prediction; causal interpretation requires appropriate study design and additional causal assumptions. See the NIST overview of linear least-squares regression and the Penn State simple linear regression lesson.

QUESTION NO: 41

If it is desirable to maximize the response R, the following levels should be used:

A. A+ and B+

B. A+ and B–

C. A– and B+

D. A– and B–

E. none of the above

F. Cannot be determined from the information provided.

ANSWER: F

Explanation:

Cannot be determined from the information provided is the correct response because the question supplies no response model, experimental results, main-effect directions, interaction effect, contour plot, or optimizer output linking the factor settings for A and B to response R. In design of experiments and Lean Six Sigma analysis, selecting settings that maximize a response requires evaluating the fitted prediction equation or the observed response surface. For example, a model may contain linear terms for A and B as well as an A-by-B interaction; the maximizing combination depends on the signs and magnitudes of all applicable coefficients and, where relevant, the permitted operating region. Merely stating that R should be maximized does not establish whether increasing or decreasing either factor raises the predicted response. A defensible recommendation must therefore be based on the missing model or data rather than assumed from the plus/minus labels. This follows standard response-surface practice, in which factor settings are chosen using a fitted model and optimization of the predicted response within the design space. See NIST's response-surface methodology guidance and Minitab's Response Optimizer documentation.

QUESTION NO: 42

A population is bimodal with a variance of 5.77. One hundred samples of size 30 are randomly collected and the 100 sample means are calculated. The standard deviation of these sample means is approximately:

A. 5.77

B. 2.40

C. 1.05

D. 0.44

E. 0.19

ANSWER: D

Explanation:

The correct answer is **0.44**. The standard deviation of the sampling distribution of sample means, commonly called the standard error of the mean, is calculated as the population standard deviation divided by the square root of the sample size: c3$_{x05}$ = c3/6e05n. Because the stated population variance is 5.77, the population standard deviation is 6e055.77, approximately 2.40. With samples containing 30 observations, the standard deviation of the sample means is therefore 6e055.77/6e0530, or equivalently 6e05(5.77/30). This equals approximately 0.439, which rounds to 0.44. The fact that the source population is bimodal does not change this standard-error calculation, provided random samples are taken and the population variance is finite. Taking 100 separate samples produces 100 observed sample means; it does not divide the standard error by 100. Rather, those means can be used to observe or estimate the sampling distribution whose theoretical spread is approximately 0.44. This sampling-distribution principle is foundational to Lean Six Sigma inference and process estimation. See the NIST discussion of the standard error of the mean and the NIST treatment of sampling distributions and the central limit theorem.

QUESTION NO: 43

If the probability that event A occurs is 0.51, the probability that event B occurs is 0.64 and that probability that both A and B occur is 0.23 then:

A. events A and B are complementary

B. events A and B are mutually exclusive

C. events A and B are supplementary

D. events A and B are not mutually exclusive

E. events A and B are statistically independent

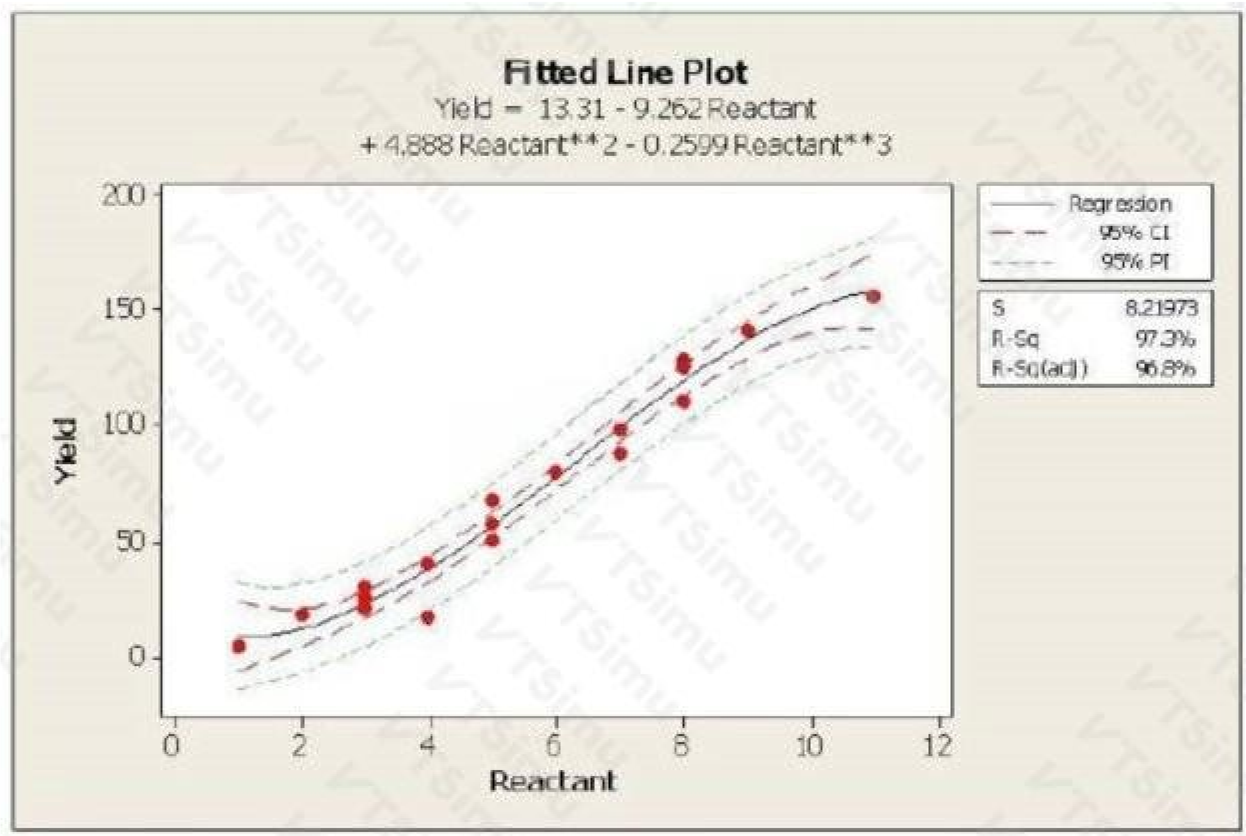
ANSWER: D

Explanation:

“events A and B are not mutually exclusive” is correct because mutually exclusive events cannot occur together. In probability notation, mutually exclusive events have an intersection probability of zero: $P(A \cap B) = 0$. Here, the question explicitly states that the probability both events occur is 0.23. Since 0.23 is greater than zero, there is a nonzero overlap between A and B, so they can occur at the same time and therefore are not mutually exclusive. This conclusion follows directly from the definition of mutual exclusivity and does not require calculating any additional probability. It is useful to distinguish overlap from independence: the supplied joint probability establishes that the events overlap, whereas independence would require the joint probability to equal the product of the individual probabilities. Probability rules for intersections and mutually exclusive events are summarized in OpenStax Introductory Statistics: Independent and Mutually Exclusive Events. For further treatment of event intersections and the addition rule, see Khan Academy’s probability library.

QUESTION NO: 44

Which statement is NOT correct about the Fitted Line Plot shown here?



A. The independent variable is the reactant

B. If the reactant was 10 units, with 95% confidence we would expect a minimum yield of 148 units

C. With at least 95% confidence, we can expect less than 10 units of Yield when the reactant is at a value of 1

D. A reactant value between 6 and 8 units yields around 40 to 60

E. When the reactant increases, the expected yield would increase

ANSWER: D

Explanation:

"A reactant value between 6 and 8 units yields around 40 to 60" is the statement that is not correct. A fitted line plot is interpreted by locating a value of the predictor, Reactant, on the horizontal axis and then reading the fitted, or expected, Yield from the regression line on the vertical axis. In the displayed plot, the fitted line is substantially above the 40-to-60 Yield range when Reactant is between 6 and 8. The line's upward slope indicates that fitted Yield rises as Reactant rises, and the plotted fitted values in this interval are materially higher than the stated range. Thus, 40 to 60 does not represent the yield indicated by the fitted relationship for Reactant values from 6 through 8. This interpretation concerns the model's estimated mean response; individual observations can vary around that line, which is why fitted-line output may also show confidence or prediction intervals. Minitab's guidance on reading regression fitted-line output is available at Minitab Support. Additional background on least-squares regression and fitted values is provided by NIST.

QUESTION NO: 45

In comparison to a full-factorial design of experiment (DOE), a traditional, one-at-a-time approach will

A. miss interactions

B. gain efficiencies

C. save time

D. cost less

ANSWER: A

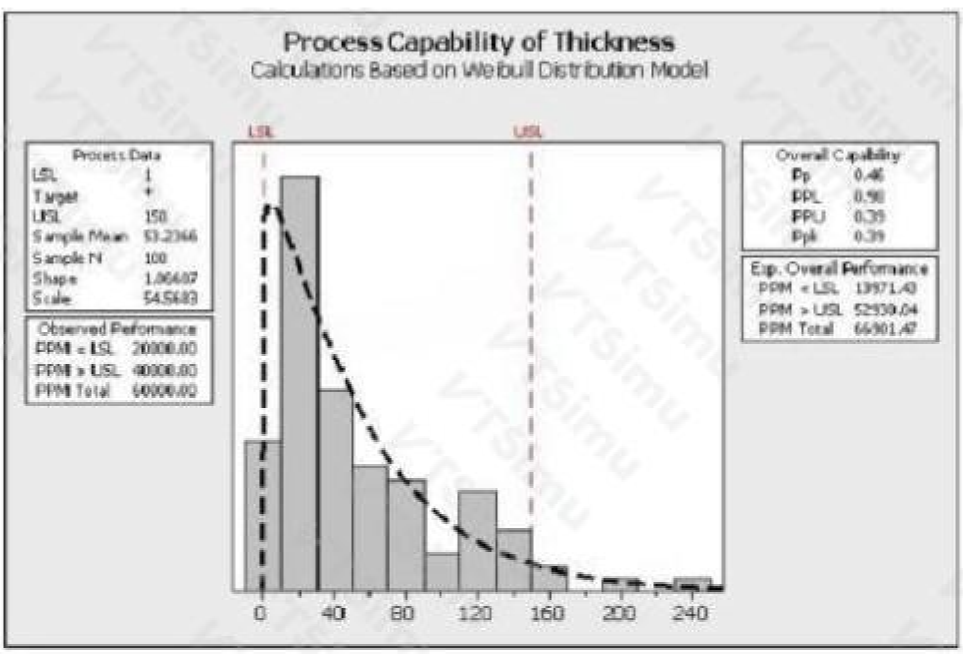
Explanation:

miss interactions is correct because the traditional one-factor-at-a-time method changes a single input while holding the remaining inputs at selected settings. That approach can estimate a limited local effect for the factor being changed, but it does not systematically observe combinations of factor levels. An interaction exists when the effect of one input on the response depends on the level of another input. Detecting and estimating that dependency requires experimental runs that vary the factors together in a structured design.

A full-factorial DOE includes every combination of the selected factor levels. This arrangement permits the analyst to estimate both main effects and interaction effects, using the experimental data to determine whether factors jointly influence the outcome. In Lean Six Sigma improvement work, this matters because process inputs often act together: a setting that appears beneficial at one condition may have a different effect under another condition. Factorial experimentation therefore provides a sound basis for modeling such combined behavior and selecting robust process settings. NIST's [Engineering Statistics Handbook on full factorial designs] describes how factorial designs assess interaction effects, while its [discussion of one-factor-at-a-time experiments] addresses the limitations of varying factors individually.

QUESTION NO: 46

Review the analysis shown there.



Which statements are true about the process? (Note: There are 3 correct answers).

A. The initial focus for this project would be to determine why the thicknesses are so frequently too low.

B. The majority of the process is closer to the lower specification limit.

C. This process is described with the Weibull Distribution.

D. The process has more problems with Variation than Centering.

E. The process follows a non-normal distribution with the given data.

ANSWER: B D E

Explanation:

The majority of the process is closer to the lower specification limit because the displayed process distribution and its central mass are positioned toward the low-thickness side of the specification range. This is an important practical observation: a process located nearer a specification boundary has less room for ordinary process movement before producing nonconforming output at that boundary.

The process has more problems with Variation than Centering because the analysis indicates that process spread is the dominant capability concern. In capability terms, variation is assessed by comparing the natural process spread with the specification width; reducing common-cause variation improves the process's ability to remain within limits. Centering remains relevant, but the graphical and capability evidence identifies excessive spread as the higher-priority issue.

The process follows a non-normal distribution with the given data because the analysis identifies a non-normal fitted distribution rather than a normal model. Capability conclusions should therefore be based on the displayed non-normal distribution and its fitted percentiles, rather than assuming symmetric normal behavior. This ensures estimated defect rates and specification-tail performance reflect the observed shape of the thickness data. See Minitab's guidance on nonnormal capability analysis and the NIST overview of process capability indices.

QUESTION NO: 47

Special Cause Variation falls into which two categories? (Note: There are 2 correct answers).

A. Natural

B. Short term

C. Assignable

D. Pattern

ANSWER: C D

Explanation:

Assignable and **Pattern** are the correct categories in this question's control-chart context. Special-cause variation represents non-random variation attributable to a specific, identifiable source outside the process's usual inherent behavior. Such a source is commonly called an assignable cause because investigation can potentially identify and remove, control, or standardize the condition that produced the unusual result. Examples include a changed machine setting, an incorrect material lot, a measurement problem, or a particular operator or environmental event.

Special causes may also be recognized through a non-random pattern in plotted process data, even when no single observation exceeds a control limit. Sustained runs on one side of the centerline, continuing trends, cycles, or other structured behavior indicate that the observations are not behaving like stable common-cause variation. Pattern-based control-chart rules are therefore used alongside point-beyond-limit rules to signal special causes and trigger investigation. This distinction supports Lean Six Sigma practice: identify an unusual signal, determine its assignable source, and take action to restore or improve process stability. See the NIST/SEMATECH e-Handbook control-chart guidance and ASQ's control-chart resource.

QUESTION NO: 48

Which of these statements correctly describe the use of center points in a two-level factorial experiment? (Note: There are 3 correct answers).

A. Center points set all continuous factors at midpoint levels

B. They can provide evidence of curvature

C. Replicated center points can help estimate pure error

D. They eliminate all aliasing in a fractional factorial design

E. They are additional high and low corner-point combinations

ANSWER: A B C

Explanation:

Center points are runs where all continuous factors are set at their midpoint levels is correct. **They can provide evidence of curvature** is correct because the average response at the center can be compared with the response predicted from the corner points of the factorial design. **They can help estimate pure error when replicated** is also correct because repeated center-point runs are performed at the same factor settings.

Center points do not add new high or low factorial combinations and do not resolve aliasing inherent in a fractional factorial design. They are particularly useful when a first-order model is being evaluated for potential curvature before moving to response surface methods. See NIST guidance on two-level factorial designs and center points.

QUESTION NO: 49

Which items should be included in an effective Out-of-Control Action Plan for a critical process characteristic? (Note: There are 4 correct answers).

A. Defined control-chart signals that trigger action

B. Immediate containment instructions

C. Assigned responsibility for investigation and disposition

D. Documented corrective action and verification of effectiveness

E. Authorization to ignore signals if specifications are met

ANSWER: A B C D

Explanation:

Defined control-chart signals that trigger action is correct because the plan must state the conditions that require a response. **Immediate containment instructions** are correct because potentially affected product may need to be protected while the signal is investigated. **Assigned responsibility for investigation and disposition** is correct because response ownership must be clear. **Documented corrective action and verification of effectiveness** are correct because the organization needs evidence that the cause was addressed and process control was restored.

An OCAP should be linked to the control plan and should direct timely action when special-cause signals occur. It should not authorize operators to ignore signals merely because product currently appears to meet specifications. See ASQ's control-chart resource and NIST control-chart guidance.

QUESTION NO: 50

The Mann-Whitney test is a powerful test and is unique to situations from which of the choices listed? (Note: There are 2 correct answers).

A. Testing the identity of two populations

B. Focuses on equality of the Median of the two populations

C. Less powerful than the traditional “t-test”

D. More widely applicable than the traditional “t-test”

ANSWER: B D

Explanation:

The Mann–Whitney test focuses on equality of the Median of the two populations when the populations have similarly shaped distributions. More precisely, it is a rank-based, two-independent-sample procedure that evaluates whether observations from one population tend to be larger or smaller than those from the other. If the distributional shapes and spreads are comparable, that location shift is interpreted as a difference in population medians. This makes it especially useful in Lean Six Sigma work where a comparison between two independent process conditions is needed but normality is not well supported, measurements are ordinal, or outliers make a mean-based comparison less suitable.

It is also more widely applicable than the traditional “t-test” because it does not require the raw data in each group to follow a normal distribution and operates on ranks rather than the original numerical values. The test still requires independent observations and an appropriate independent-samples design, but its reduced distributional assumptions make it broadly useful for non-normal continuous data and ranked data. NIST describes the Mann–Whitney test as a nonparametric method for comparing two independent samples, while Penn State explains its rank-based comparison of population locations. See NIST/SEMATECH e-Handbook and Penn State STAT 200.

QUESTION NO: 51

Assessing process proportion as opposed to evaluating a process with respect to a set target can be done using one or more of these. (Note: There are 2 correct answers).

A. Process proportion equals some desired value

B. Process proportion equals some value range

C. Target is current

D. When we deal with Attribute type data

E. Proportion of the tail is equal

ANSWER: A D

Explanation:

“Process proportion equals some desired value” is correct because assessment of a process proportion is ordinarily framed as a one-proportion hypothesis test. The desired or benchmark proportion provides the reference value, and observed attribute results from the process are used to estimate the actual proportion and determine whether the data support that stated process proportion. For example, a team may evaluate whether the proportion of defective units is at an established acceptable level, or whether the proportion of orders completed correctly meets the desired rate. This is a standard Lean Six Sigma application of statistical inference for proportions.

“When we deal with Attribute type data” is also correct because a proportion is derived from categorical, countable outcomes rather than continuous measurements. Each sampled unit is classified into one of two relevant states, such as defective/nondefective, pass/fail, yes/no, or compliant/noncompliant. The number in the category of interest divided by the total number of opportunities or units produces the sample proportion used in the analysis. This distinction is essential when selecting an appropriate method: proportion-based analysis is intended for attribute data and supports process decisions involving rates, yields, defect fractions, or occurrence frequencies. See the NIST handbook’s discussion of the binomial distribution and ASQ’s overview of data collection and analysis.

QUESTION NO: 52

A(n) _______________ is best used to compare a Machine 1 average quality characteristic to the same quality characteristic of Machine 2.

A. F test

B. 1-Sample t-test

C. 2-Sample t-test

D. ANOVA test

ANSWER: C

Explanation:

A **2-Sample t-test** is the appropriate method when the goal is to compare the average value of one continuous quality characteristic measured from Machine 1 with the average of that same characteristic from Machine 2. The test evaluates whether the observed difference between the two sample means provides sufficient statistical evidence that the underlying machine population means differ, rather than being attributable to normal sampling variation. In Lean Six Sigma work, this is useful for assessing whether two machines perform comparably on measures such as fill weight, diameter, cycle time, or tensile strength.

The analysis should be planned with independent observations from each machine and a response that is approximately normally distributed within each group, particularly when sample sizes are small. Before interpreting results, practitioners should also consider process stability and the measurement system, because data from an unstable process or an inadequate gage system can make a comparison unreliable. Depending on whether the population variances can reasonably be treated as equal, the pooled or Welch form of the two-sample t procedure may be used; Welch's procedure is commonly suitable when equal variances are not assumed. See the NIST overview of two-sample t-tests and the Minitab 2-Sample t guidance.

QUESTION NO: 53

Which items are appropriate elements of standardized work used to sustain an improved process? (Note: There are 3 correct answers).

A. Defined work sequence

B. Expected work time or pace

C. Standard work-in-process level

D. A prohibition on future process changes

E. Individual operator preference as the governing method

ANSWER: A B C

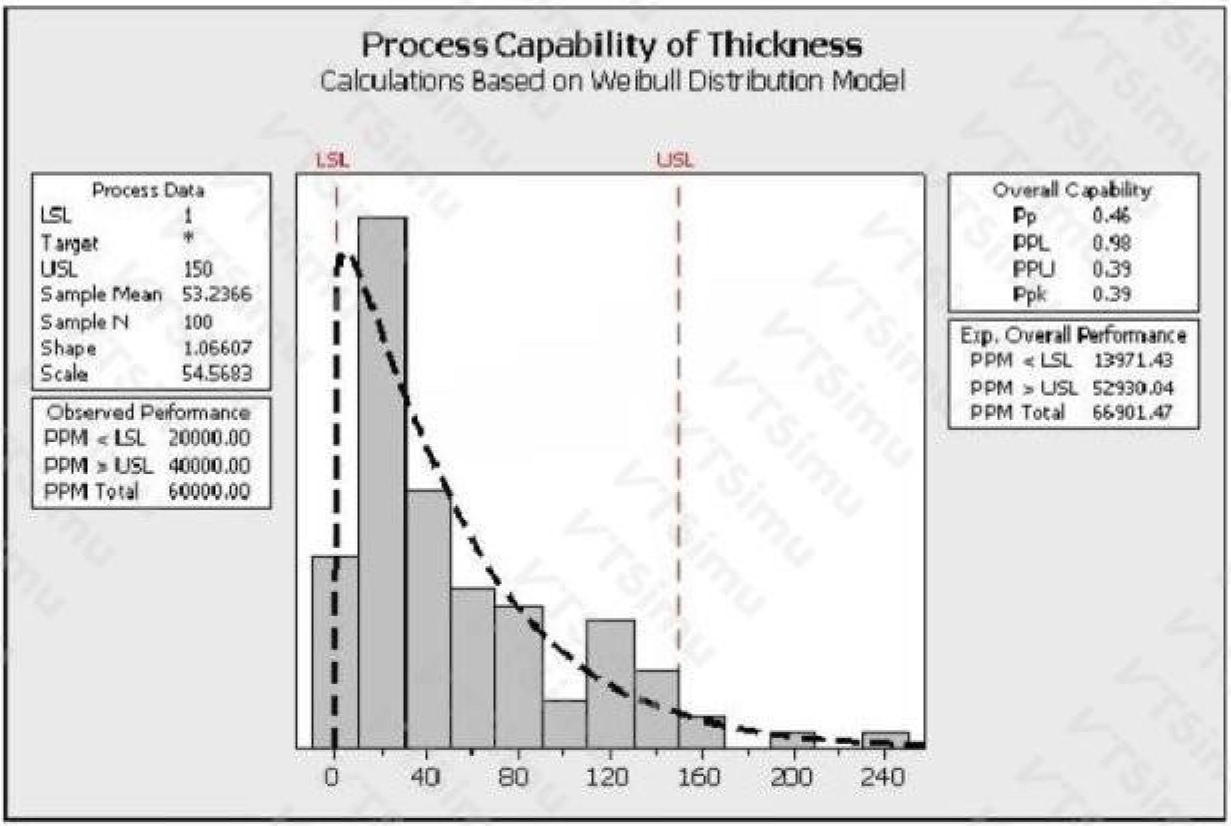
Explanation:

Standardized work documents the current best known method for performing work safely, consistently, and in accordance with customer and process requirements. It should specify the work sequence, the expected time or pace for the work, and the standard amount of work-in-process or inventory needed to support the sequence. These elements make deviations visible and provide a baseline for training, auditing, and future improvement.

Standardized work is not intended to prevent improvement. When an improvement is validated, the standard should be revised so the organization adopts the new best method. Lean Enterprise Institute describes standardized work as documenting the best currently known method for performing a task; see Standardized Work.

QUESTION NO: 54

Review the analysis shown here. Which statements are true about the process? (Note: There are 3 correct answers).



A. The initial focus for this project would be to determine why the thicknesses are so frequently too low

B. The majority of the process is closer to the lower specification limit

C. This process is described with the Weibull Distribution

D. The process has more problems with Variation than Centering

E. The process follows a non-normal distribution with the given data

ANSWER: B D E

Explanation:

The process is closer to the lower specification limit because the capability analysis shows that the process location is offset toward that limit. In a capability assessment, this relationship is reflected by the relative distances from the process center or relevant percentile estimates to each specification boundary. The lower-side capability is therefore the more consequential side for evaluating conformance.

The process has more problems with variation than centering because the spread of the observed process relative to the specification width is the primary capability concern. Reducing common-cause and special-cause variation is consequently the most direct improvement focus: a narrower, stable distribution places more output within the specification limits and improves capability performance.

The process follows a non-normal distribution with the given data because the analysis uses a non-normal capability model rather than treating the measurements as normally distributed. Capability analysis should use a distribution that adequately represents the actual data; otherwise, estimated tail probabilities and predicted nonconforming rates can be misleading. This is particularly important when the displayed distributional fit and probability plot indicate asymmetry or another departure from normality. Guidance on assessing normality and selecting an appropriate distributional model is available from NIST’s normality-assessment handbook and its process-capability discussion.

QUESTION NO: 55

Which of these conditions should be evaluated when interpreting a scatter plot and correlation coefficient between two continuous variables? (Note: There are 3 correct answers).

A. Whether the relationship appears linear

B. Whether outliers influence the result

C. Whether a causal mechanism has been established independently

D. A high correlation proves causation

E. A zero correlation proves no relationship of any form exists

ANSWER: A B C

Explanation:

A scatter plot should be evaluated for the form of the relationship, including whether the association appears approximately linear. Outliers should also be investigated because a single unusual observation can strongly influence the correlation coefficient and fitted regression line. In addition, correlation alone does not establish a causal relationship; common causes, reverse causation, and confounding may explain an observed association.

A correlation coefficient summarizes the direction and strength of linear association. It does not prove that changing one variable will cause a change in the other, and a near-zero correlation does not necessarily rule out a nonlinear relationship. NIST discusses scatter plots and correlation analysis in its exploratory data analysis guidance.