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IASSC Lean Six Sigma – Black Belt

Six Sigma ICBB

Version Demo

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Topic Break Down

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QUESTION NO: 1

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 be evaluated at both the immediate unit level and the batch level. **Variation within consecutive pieces** captures the local, short-horizon fluctuation observed as units are produced in sequence under essentially the same operating conditions. This is the variation most directly associated with the inherent repeatability of the process during a run, including small changes in machine behavior, material flow, and measurement response. **Variation among consecutive batches** captures the short-term shift that can occur when one batch is completed and the next begins. Batch-to-batch effects may arise from normal changes in batch setup, raw-material lots, charging, mixing, or operating adjustments, even when the batches are produced close together in time. Considering both levels gives a practical short-term view of how consistently the batch process performs: consistency among units within a run and consistency from one sequential run to the next. This aligns with capability analysis practice, which depends on rational subgrouping and on estimating process variation from data collected under comparable, short-term conditions. See the NIST/SEMATECH process capability analysis guidance and the NIST discussion of rational subgroups and control-chart variation.

QUESTION NO: 2

If you can Poka-Yoke a defect out of the process entirely then you do not need use SPC on the characteristic of interest in the defect.

A. True

B. False

ANSWER: A

Explanation:

True is correct because effective Poka-Yoke (mistake-proofing) changes the process so that the defect cannot occur, or so that an error is automatically detected and prevented from passing to the next step. When the defect mechanism has genuinely been eliminated, there is no longer meaningful variation in that particular defect characteristic to monitor with statistical process control. SPC is principally used to distinguish common-cause from special-cause variation in an active, measurable process output or input and to maintain statistical control over characteristics that can still vary.

In Lean Six Sigma practice, prevention is preferred to detection. A robust error-proofing device therefore provides a stronger control than relying on sampling, inspection, or a control chart to identify nonconforming results after variation has occurred. The team should validate that the Poka-Yoke works under normal operating conditions and document it in the control plan. It may still monitor the Poka-Yoke device itself or other process characteristics as appropriate, but SPC is not required for the eliminated defect characteristic. See ASQ’s overview of mistake-proofing and NIST’s guidance on statistical process control.

QUESTION NO: 3

For the data shown here which statement(s) are true? (Choose two.)

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:

"With greater than 95% confidence, we conclude the samples are from Non-normal Distributions" is supported when the normality-test results shown for the samples have p-values below the conventional significance level of 0.05. At that level, the evidence is sufficient to reject the null hypothesis that the relevant sample data follow a normal distribution. In Lean Six Sigma analysis, this finding matters because it affects the choice of an appropriate inferential comparison method.

"If we wanted to compare the Central Tendencies of these three samples we could use Mood's Median test" is also correct. Mood's median test is a nonparametric procedure for comparing the medians of two or more independent groups. It does not require normally distributed population data and is therefore a suitable method when the normality assessment indicates non-normality. The test evaluates whether the groups plausibly share a common population median, using observations classified relative to the overall median. This makes it a valid choice for comparing the central locations of three independent samples when a parametric normality assumption is not supported. See the Minitab overview of Mood's median test and NIST's guidance on normality testing.

QUESTION NO: 4

To establish a sample size that will allow the proper overlap of distributions we do which of these?

A. Multiply Alpha by 1.75

B. Calculate one minus Beta

C. Calculate Beta plus 2

D. Multiply Beta by 3

ANSWER: B

Explanation:

Calculate one minus Beta is correct because $1 - \beta$ is the statistical power of a hypothesis test: the probability that the test will detect a real effect of the specified size when that effect truly exists. Sample-size planning uses the desired power together with the significance level (α), the expected variation, and the practically meaningful difference or effect size. Framing the requirement as power, rather than as β alone, gives a direct target for selecting enough observations to distinguish the sampling distributions under the null and alternative conditions with the intended degree of reliability. In practice, teams commonly select a power target such as 80% or 90%, meaning they want an 80% or 90% chance of identifying the specified process difference when it is present. This makes power analysis an essential part of planning valid Lean Six Sigma experiments, comparisons, and hypothesis tests before data collection. The NIST/SEMATECH e-Handbook describes power as 1 − β and explains its role in hypothesis testing and sample-size determination: NIST hypothesis-test power guidance. Additional sample-size and power concepts are provided by NIST sample-size guidance.

QUESTION NO: 5

From the information given below, identify the failure mode, which has the highest risk involved.

	Severity	Occurrence	Detection
Failure mode 1	8	2	2
Failure mode 2	8	4	4
Failure mode 3	10	3	3
Failure mode 4	9	2	4

A. Failure mode 1

B. Failure mode 2

C. Failure mode 3

D. Failure mode 4

ANSWER: B

Explanation:

Failure mode 2 has the highest risk because Failure Mode and Effects Analysis prioritizes risks using the Risk Priority Number (RPN), calculated by multiplying Severity, Occurrence, and Detection ratings: RPN = S × O × D. The information in the supplied FMEA table identifies Failure mode 2 as having the largest resulting RPN among the listed failure modes. This indicates the greatest combined concern when considering the seriousness of the potential effect, the likelihood that the cause will occur, and the ability of current controls to detect the failure before it reaches the customer or subsequent process.

In Lean Six Sigma practice, the RPN is used to rank failure modes and focus corrective or preventive action where it is expected to reduce overall process risk most effectively. The team would normally investigate Failure mode 2 first, identify actions that reduce occurrence or improve detection, assign ownership and due dates, and then recalculate the ratings after the actions are implemented. This disciplined prioritization is a core purpose of FMEA. ASQ describes FMEA as a proactive method for identifying and prioritizing potential process or product failures: ASQ—Failure Mode and Effects Analysis. Further FMEA guidance is available from NIST.

QUESTION NO: 6

Use this data to calculate the Z score. Average o

F.

65, Standard Deviation: 3, Upper Spec Limit: 72

A. 0.27

B. 1.5

C. 2.33

D. 4.12

ANSWER: C

Explanation:

2.33 is correct because the relevant value is the number of process standard deviations between the process average and the upper specification limit. Calculate that distance by subtracting the average, 65, from the upper specification limit, 72, giving 7 units. Then divide this specification distance by the process standard deviation of 3: 7 ÷ 3 = 2.333..., which rounds to 2.33. Thus, the upper specification limit lies approximately 2.33 standard deviations above the process average. In Lean Six Sigma capability analysis, this is commonly called the upper Z value, or Z_{USL}. It expresses the process's standardized distance to the upper requirement and is a useful basis for assessing upper-side capability. The calculation follows the standardization principle that a raw value is converted to a standardized distance by subtracting the mean and dividing by the standard deviation. See the NIST Engineering Statistics Handbook discussion of standard scores and the NIST process capability reference.

QUESTION NO: 7

The two types of data that are to be used in Statistical Analysis are Attribute and Variance.

A. True

B. False

ANSWER: B

Explanation:

False is correct because the standard statistical-process-control and Six Sigma distinction is between *attribute data* and *variable data*, not "variance" data. Attribute data are observations recorded as categories, counts, or classifications, such as whether a unit passes inspection or the number of defects found. Variable data are numerical measurements on a scale, such as cycle time, diameter, weight, temperature, or an amount of variation in a measured characteristic. The measurement type determines the appropriate analytical and control-chart methods used during process analysis.

Variance has a different statistical meaning: it is a calculated measure describing the spread of numerical values around their mean. It may be computed from variable data, but it is not itself one of the two fundamental data types. Therefore, replacing "Variable" with "Variance" makes the statement inaccurate. This terminology is consistent with the American Society for Quality's discussion of data collection and analysis and NIST's reference material on measures of variation.

QUESTION NO: 8

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 explain curvature when with more statistical confidence than Linear Regressions

D. SLR can help quantify the significance of variation in X that influences the variation in Y 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 the expected value of a continuous response variable as a linear function of one predictor variable

ANSWER: C D F

Explanation:

"SLR can help quantify the significance of variation in X that influences the variation in Y via a mathematical equation" is applicable because simple linear regression estimates the relationship between one predictor, X, and a continuous response, Y, using a fitted linear equation. The analysis quantifies the estimated change in Y associated with X and uses inferential measures—such as the slope test, confidence interval, and p-value—to assess whether the observed linear association is statistically distinguishable from zero. "Non-linear Regressions can explain curvature when with more statistical confidence than Linear Regressions" is applicable when diagnostic plots and model-comparison statistics indicate that a curved functional form better represents the process relationship than a straight-line model. A suitable nonlinear or polynomial form can therefore provide a statistically supported representation of curvature. "SLR models the expected value of a continuous response variable as a linear function of one predictor variable" is also a defining characteristic: the fitted model estimates the conditional mean response, commonly written as $E(Y|X) = \beta_0 + \beta_1 X$. These concepts support process prediction and improvement by translating measured input-output relationships into an interpretable statistical model. See the NIST regression overview and the NIST simple linear regression guidance.

QUESTION NO: 9

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**. In the common English alliterative presentation of the Lean 5S workplace-organization method, the sequence is Sorting, Straightening, Shining, Standardizing, and Sustaining. Sorting means separating necessary workplace items from unnecessary ones so that only what is needed remains in the work area. This creates the foundation for an efficient, visual, and safe process environment. Straightening follows by arranging the needed items so they are easy to identify, access, use, and return to their designated locations. This is also frequently translated as "Set in Order," reflecting the original Japanese concept of *Seiton*. Together, Sorting and Straightening reduce searching, motion, clutter, and variation in how workspaces are maintained. They therefore support the subsequent activities of cleaning and inspecting the work area, establishing consistent standards, and sustaining the improved condition through routine discipline and management. The U.S. Environmental Protection Agency describes 5S as a workplace-organization method that includes Sort and Set in Order, while ASQ identifies Sort and Straighten as standard English terms used for the methodology. See the EPA overview of 5S and ASQ's 5S tutorial.

QUESTION NO: 10

Suppose a purchase order is inspected for the supplier address, quantity as per indent, price as per indent, and time to deliver. The inspection results for a set of 100 purchase orders are given in the table below. What is the DPMO?

Cause of rejection	Number of defects
Supplier name incorrect	1
Supplier door # incorrect	1
Quantity higher than that in the indent	3
Quantity less than that in the indent	1
Price is higher than that in the indent	2
Price is lower than that in the indent	2

A. 20,000

B. 22,000

C. 24,000

D. 25,000

ANSWER: D

Explanation:

25,000 is the DPMO. Defects per million opportunities is calculated as the number of defects divided by the total number of defect opportunities, multiplied by 1,000,000. Each purchase order is evaluated against four separately identifiable requirements: supplier address, quantity matching the indent, price matching the indent, and delivery time. Therefore, the 100 inspected purchase orders provide 400 opportunities for a defect (100 × 4). The inspection table shows 10 total defects across these requirements. Applying the standard calculation gives DPMO = (10 ÷ 400) × 1,000,000 = 25,000. This metric deliberately counts opportunities rather than merely counting purchase orders, because a single order can contain more than one defect and each critical requirement is an independent chance for nonconformance. DPMO is a normalized process-performance measure that supports comparison among processes with different numbers of units or defect opportunities. The calculation approach is consistent with the Six Sigma definition of defects per million opportunities described by ASQ's Six Sigma resources and the terminology in NIST's Engineering Statistics Handbook.

QUESTION NO: 11

Which of the following is not a component of Garvin's five definitions of quality?

A. Product based definition

B. Process based definition

C. Manufacturing based definition

D. Value based definition

ANSWER: B

Explanation:

"Process based definition" is correct because it is not one of David A. Garvin's five principal approaches to defining quality. Garvin's framework identifies five perspectives: transcendent quality, which recognizes quality as an innate form of excellence; product-based quality, which treats quality as measurable attributes or quantities; user-based quality, which depends on fitness for use and customer satisfaction; manufacturing-based quality, which emphasizes conformance to requirements or specifications; and value-based quality, which weighs performance or utility against price. This framework is especially useful in Lean Six Sigma because it shows that "quality" must be operationally defined in a way that fits the business context and customer needs before improvement performance can be measured reliably.

A process-based perspective is certainly important in quality management and continual improvement. For example, ISO management-system standards promote understanding and managing interrelated activities as processes. However, that process approach is distinct from Garvin's named five definitions of quality and therefore does not belong in his specific classification. See the ASQ Quality Glossary for quality-management terminology and the ISO 9001 quality-management overview for the process approach in modern quality systems.

QUESTION NO: 12

Range Charts are the technique used to determine if ______________ are occurring within the subgroups of the SPC Charts.

A. Common Causes

B. Special inspections

C. Unnatural forces

D. Special Causes

ANSWER: D

Explanation:

Special Causes is correct. In an $\bar{X}$–R control-chart system, the range (R) chart evaluates the amount of variation *within* each rational subgroup. For every subgroup, the range is calculated as the difference between its largest and smallest observation. Plotting these ranges over time shows whether short-term, within-subgroup process variation is stable and predictable.

Control limits on the range chart are calculated from the average range and constants that depend on subgroup size. A point outside those limits, or a nonrandom pattern identified using applicable control-chart rules, signals that the within-subgroup variation has changed in a way that warrants investigation. This is evidence of a special cause affecting process dispersion. The R chart should be assessed before interpreting the companion $\bar{X}$ chart, because a stable estimate of within-subgroup variation is required for valid control limits and reliable interpretation of subgroup averages.

This distinction is central to statistical process control: the R chart focuses on process spread within subgroups, while the $\bar{X}$ chart monitors changes in subgroup central tendency. See the [NIST/SEMATECH discussion of $\bar{X}$ and R charts] and ASQ's [control-chart resource].

QUESTION NO: 13

Use this data to calculate the Z score. Average oF. 65, Standard Deviation: 3, Upper Spec

Limit: 72

A. 0.27

B. 1.5

C. 2.33

D. 4.12

ANSWER: C

Explanation:

The correct Z score is **2.33**. For an upper specification limit, the process Z value is calculated as the distance from the process mean to the upper specification limit, expressed in standard-deviation units: Z = (USL − mean) / standard deviation. Using the stated values gives Z = (72 − 65) / 3 = 7 / 3 = 2.333..., which rounds to 2.33.

This result means that the upper specification limit is 2.33 standard deviations above the process average. In Six Sigma process-capability work, this is commonly called the upper Z bench or the one-sided standardized distance to the upper specification boundary. It indicates the amount of natural process variation between the center of the process and the upper limit, assuming the mean and standard deviation appropriately represent the process distribution. The calculation uses the specification limit rather than a control limit because the objective is to assess conformance to customer or design requirements. See the American Society for Quality's discussion of [Six Sigma] and NIST's reference on the [standard normal distribution and Z values].

QUESTION NO: 14

SPC Charts are used extensively in different business and decision-making environments. In this example a vendor is being selected based on speed of delivery. Which of the conclusions would help you pick a vendor for your needs regarding lead-time of delivery from your vendors? (Note: There are 4 correct answers).

A. Vendor A with a much shorter lead time in delivery

B. Vendor B as it has a better consistency (lower variance) on lead time

C. Vendor B as Vendor A shows a situation out of control as shown in red

D. Vendor B as the Control Limits are much narrower than Vendor A

E. Vendor B with higher lead time, but a process with much narrower Control Limits

ANSWER: B C D E

Explanation:

For supplier selection based on delivery lead time, the useful conclusions emphasize predictable performance as well as the lead-time level. “Vendor B as it has a better consistency (lower variance) on lead time” is relevant because lower variation makes delivery commitments more dependable and planning easier. “Vendor B as Vendor A shows a situation out of control as shown in red” is also a sound conclusion: an out-of-control signal indicates special-cause variation, so the process is not statistically stable enough to support reliable predictions of future delivery performance. “Vendor B as the Control Limits are much narrower than Vendor A” and “Vendor B with higher lead time, but a process with much narrower Control Limits” identify the value of a more consistent, stable delivery process. Provided the charts use comparable measures, subgrouping, and scales, narrower control limits reflect less routine process variation. A vendor with a slightly longer average lead time may therefore be preferable when its process is stable and predictable, particularly where schedules, inventory, and customer commitments depend on dependable delivery. Control charts distinguish common-cause variation from special-cause signals and help organizations make decisions using process behavior rather than isolated delivery observations. See ASQ’s control-chart overview and the NIST Statistical Process Control handbook.

QUESTION NO: 15

Assessing process proportion as opposed to evaluating a process with respect to a set target can be done using one or more of these. (Choose two.)

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 a one-proportion hypothesis test assesses whether the underlying process proportion, denoted by p, is consistent with a specified reference or desired proportion. The analysis starts with observed counts, such as the number of defective units in a sample, and compares the resulting sample proportion with the stated value using an appropriate binomial or normal-approximation procedure. This gives a Black Belt an evidence-based way to determine whether the observed process result supports the claimed proportion.

“When we deal with Attribute type data” is correct because proportion analysis requires attribute data: each inspected opportunity or unit is classified into categories, commonly conforming/nonconforming, pass/fail, or defective/not defective. The proportion is calculated as the count in the category of interest divided by the total number inspected. In Lean Six Sigma, this is distinct from continuous measurement data, for which analyses of means, variation, and capability are typically used. The NIST guidance on proportion tests describes inference for a population proportion and the role of success/failure counts, while Minitab’s one-proportion test documentation illustrates the practical analysis of binary attribute outcomes. See NIST e-Handbook: Tests for Proportions and Minitab: Interpret the results for 1 Proportion.

QUESTION NO: 16

Which of the following tools incorporates statistical analysis in determining time estimates?

A. CPM

B. QFD

C. PERT

D. Gantt chart

ANSWER: C

Explanation:

PERT is correct because it uses a probabilistic approach to estimate project activity durations when there is uncertainty. For each activity, PERT combines three estimates: an optimistic time, a most likely time, and a pessimistic time. It calculates the expected duration using the weighted formula (optimistic + 4 × most likely + pessimistic) ÷ 6. This weighting reflects the assumption that the most likely estimate has greater influence than the extreme estimates. PERT can also calculate the variance and standard deviation for activity durations, allowing teams to assess uncertainty in the overall project schedule and estimate the likelihood of meeting a specified completion date. This statistical treatment makes PERT especially useful for new, complex, or less predictable work where a single deterministic duration estimate would conceal meaningful schedule risk. In Lean Six Sigma project management, its use supports data-based planning and risk-aware timing decisions. The Project Management Institute describes PERT as a technique that applies weighted duration estimates to determine expected activity durations; see PMI's discussion of three-point estimating. A practical overview of the expected-time and variance calculations is also available from ProjectManager's PERT guide.

QUESTION NO: 17

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 statement "The majority of the process is closer to the lower specification limit." is supported when the plotted process distribution and its location indicate that most observed thickness values lie toward the lower-side specification boundary. This identifies the lower limit as the more immediate side of concern for the current output distribution.

"The process has more problems with Variation than Centering." follows from the capability analysis when the process spread consumes too much of the specification width. In capability work, variation is evaluated by comparing the natural process spread with the tolerance range; a process can be located relatively near a target or limit yet still perform poorly because its spread is excessive. Reducing common- and special-cause variation is therefore essential to improving the process's capability. The American Society for Quality describes capability analysis as assessing whether a process can meet specification limits: ASQ Process Capability Analysis.

"The process follows a non-normal distribution with the given data." is also supported by the distributional assessment. Capability conclusions must use a distribution that reasonably represents the observed data; when normality diagnostics indicate non-normal behavior, the analysis should use an appropriate non-normal model or transformation rather than assume normality. Minitab's guidance discusses assessing normality and using nonnormal capability analysis when needed: Minitab Nonnormal Capability Analysis.

QUESTION NO: 18

Which of the following is not a basic principle of the 'theory of constraints'?

A. Convergence

B. Consistency

C. Persistency

D. Respect

ANSWER: C

Explanation:

Persistency is the correct selection because it is not identified as a basic Theory of Constraints principle in the terminology commonly used for this method. Theory of Constraints is founded on the idea that a system's performance is governed by its limiting factor, or constraint. Its improvement approach therefore seeks system-wide alignment around that limiting factor rather than isolated local optimization. The foundational principles associated with this perspective include convergence, meaning that system elements must work toward the shared organizational goal; consistency, meaning that decisions and measures should align with that goal; and respect, reflecting the role of people in making and sustaining improvement. "Persistency" may describe a useful personal quality when leading change, but it is not a named foundational principle of the Theory of Constraints. In practical application, TOC uses a structured focusing process: identify the constraint, exploit it, subordinate other activity to it, elevate it if needed, and then repeat once the constraint moves. This ongoing focus helps organizations improve throughput and overall system performance. See the TOC Institute overview of Theory of Constraints and Goldratt Group resources.

QUESTION NO: 19

When planning a crossed Gage R&R study for a variable measurement system, which items are appropriate? (Choose four.)

A. Select parts that represent the expected process variation

B. Use more than one appraiser

C. Have each appraiser measure each selected part repeatedly

D. Randomize the measurement sequence

E. Use only one appraiser to eliminate reproducibility variation

ANSWER: A B C D

Explanation:

A crossed Gage R&R study is designed to separate repeatability and reproducibility variation from part-to-part variation. The selected parts should represent the range of actual process variation, including parts near relevant specification boundaries where practical. Multiple appraisers are needed to evaluate reproducibility, and repeated measurements by each appraiser are needed to estimate repeatability.

Randomizing the measurement sequence helps prevent time-related, memory, learning, or order effects from being mistaken for measurement variation. Using only one appraiser would not permit an assessment of appraiser-to-appraiser reproducibility. See ASQ's Gage Repeatability and Reproducibility resource and NIST guidance on measurement process characterization.

QUESTION NO: 20

Who developed the concept of the Gantt chart?

A. Juran

B. Henry Gantt

C. Deming

D. Kaizen

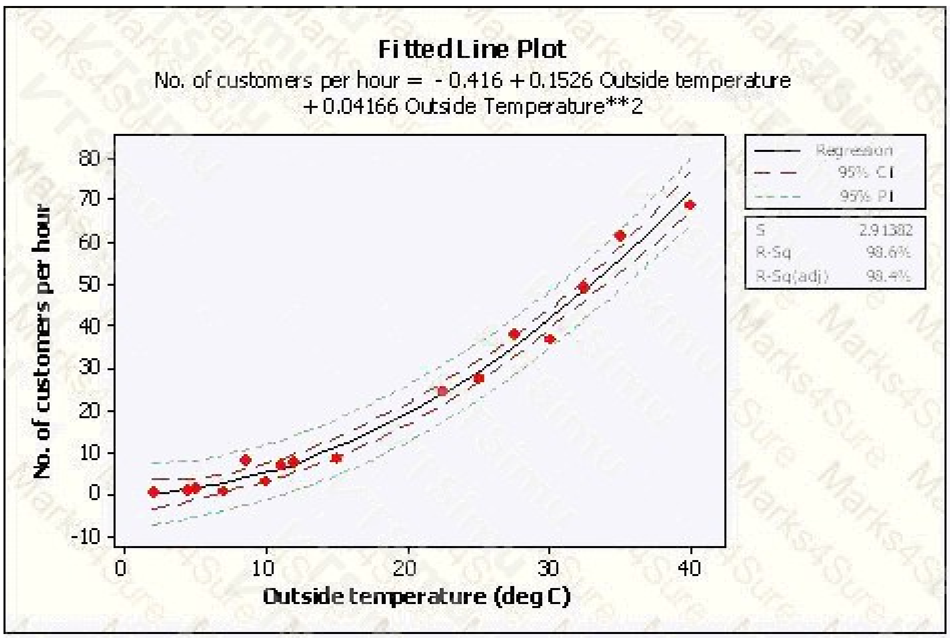
ANSWER: B

Explanation:

Henry Gantt developed the Gantt chart, a visual project-planning and scheduling tool that displays activities against time. The chart typically lists work tasks vertically and represents the project timeline horizontally, enabling teams to see planned start and finish dates, task duration, progress, and overlaps among activities. Gantt developed this form of bar chart in the early twentieth century while working on production-management problems. Its practical value lies in making a schedule easy to communicate and monitor: project leaders can coordinate work, assess whether activities are on track, and identify the effect that timing changes may have on planned completion. Although modern project-management software has expanded the technique with dependencies, milestones, and critical-path-related views, the central time-based bar-chart concept remains associated with Gantt. This historical attribution is documented by the Encyclopaedia Britannica biography of Henry L. Gantt and is also summarized by the American Society for Quality's Gantt chart resource. Therefore, Henry Gantt is the correct answer.

QUESTION NO: 21

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. In a regression plot, these bands represent uncertainty around the estimated mean response at each value of the predictor. Because the fitted relationship is curved, the appropriate model description is quadratic regression: the predicted mean number of customers changes according to a second-degree function of outside temperature. The confidence band therefore communicates the range of plausible locations for that fitted mean curve, at the stated confidence level, rather than the spread containing individual customer-count observations. NIST's regression guidance distinguishes confidence intervals for the mean response from prediction intervals for a new individual response; this distinction is central when interpreting fitted-line bands. See the NIST discussion of confidence intervals in regression.

The predicted number of customers per hour is close to 5 if the outside temperature is 10 deg C. This is obtained by locating 10 °C on the horizontal temperature axis and reading the fitted quadratic regression curve's corresponding vertical value, which is approximately five customers per hour. Regression predictions should be read from the fitted curve, not from a particular scattered observation, because the curve estimates the process's expected response. The use of a quadratic term to model curvature is also described in the NIST polynomial-regression reference.

QUESTION NO: 22

Which item(s) listed would impact the Process Capability for a process with a continuous output?

(Choose four.)

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:

Process capability for continuous data expresses how the natural process-output distribution compares with specification limits. Therefore, the **Shape of process data distribution (e.g. Normal Distribution)** matters because standard capability indices and their defect-rate interpretations depend on distributional assumptions; nonnormal data may require a transformation or a nonnormal capability analysis. **Process Standard Deviation** directly determines the spread of the process and is a core input to Cp, Cpk, Pp, and Ppk calculations. A smaller stable standard deviation produces a narrower natural tolerance and can improve capability relative to fixed specifications.

The **Presence of Special Causes or solely Common Causes** is essential because capability should be assessed only after the process is statistically stable and predictable. Special-cause variation makes an estimated average and standard deviation unreliable as descriptions of future performance. **Seasonal variation in process** can create time-based shifts or cycles in the process mean and/or variation. Unless that variation is modeled, stratified, or controlled, it affects the overall distribution used for the capability assessment and can reduce the process's sustained ability to meet specifications. See NIST's process capability analysis guidance and ASQ's process capability analysis overview.

QUESTION NO: 23

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: A

Explanation:

Significant change from one shift to another is correct because multiple modes in a histogram commonly indicate that observations have been drawn from two or more distinct process populations. A shift-to-shift change can create such populations when, for example, operators, setups, incoming material lots, environmental conditions, machines, or operating methods differ between shifts. Each shift may produce measurements centered around a different typical value; when the data are combined without stratification, the resulting histogram can show separate peaks rather than one single central peak.

For a Lean Six Sigma Belt, this pattern is a prompt to stratify the data by relevant process factors, particularly time-based categories such as shift, day, operator, machine, product family, or material lot. Plotting the data separately by shift and using tools such as box plots, run charts, and multi-vari studies can help establish whether shift is a meaningful source of variation. The NIST/SEMATECH handbook notes that a mixture of populations is a common reason a distribution departs from a single, simple pattern and that stratification is important for finding sources of variation. See the NIST discussion of histogram interpretation and the NIST guidance on identifying variation sources.

QUESTION NO: 24

The English words used for the 5S's are __________ , _____________ , Shining, Standardizing and Sustaining. (Choose two.)

A. Shaping

B. Sorting

C. Shifting

D. Straightening

ANSWER: B D

Explanation:

The correct English terms are **Sorting** and **Straightening**. They are the first two activities in the commonly taught English-language 5S sequence: Sort, Set in Order, Shine, Standardize, and Sustain. "Sorting" means separating what is necessary for the work area from what is unnecessary, so only required items remain available for the process. This creates the foundation for a visual, efficient, and safer workplace.

"Straightening" is also frequently expressed as "Set in Order." It means arranging the necessary tools, materials, equipment, and information so each has an identified location and can be found, used, and returned easily. In Lean Six Sigma practice, this reduces motion, search time, delays, and opportunities for error. The wording in the question uses the alliterative English convention—Sorting, Straightening, Shining, Standardizing, and Sustaining—rather than the alternative phrasing "Set in Order." Both conventions describe the same second 5S principle. The American Society for Quality describes 5S as a systematic workplace-organization method, while the Lean Enterprise Institute provides the related Lean definitions and terminology. See ASQ's 5S tutorial and the Lean Enterprise Institute 5S definition.

QUESTION NO: 25

Which actions support effective management of a project stakeholder during the Define phase? (Choose three.)

A. Identify stakeholders and their influence

B. Develop a communication plan appropriate to stakeholder needs

C. Engage process owners in defining requirements

D. Wait until implementation to communicate project impacts

E. Transfer sponsor decisions to informal team voting

ANSWER: A B C

Explanation:

Stakeholder management begins by identifying individuals or groups affected by the project or able to influence its outcome. The Belt should assess stakeholder interests and influence, establish an appropriate communication plan, and involve key process owners or subject-matter experts in defining requirements, risks, and project boundaries. These actions build alignment and improve the practicality of the project charter and implementation approach.

Delaying stakeholder communication until after implementation increases resistance and can allow important requirements to be missed. Replacing the sponsor's authority with informal team decisions is also inappropriate because the sponsor provides organizational direction, resources, and escalation support. See PMI guidance on stakeholder management and ASQ's Six Sigma resource.

QUESTION NO: 26

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:

Process capability for continuous data describes how well a process can produce output within its specification limits when the process is operating predictably. The **Shape of process data distribution (e.g. Normal Distribution)** affects both the validity of conventional capability-index calculations and the estimated proportion of output beyond specification limits. Standard Cp and Cpk calculations are commonly based on a normal-distribution model; when data are materially nonnormal, an appropriate transformation or nonnormal capability method is needed.

Process Standard Deviation directly determines the natural spread of process output. Because conventional capability indices compare the specification width with process variation, a larger standard deviation reduces potential capability, all else being equal.

Presence of Special Causes or solely Common Causes is fundamental because capability analysis is meaningful only for a statistically stable, predictable process. Special-cause variation means the process behavior is changing and a single capability estimate may not represent future performance.

Seasonal variation in process can change the process center, spread, or both over time. Unless that time-based pattern is understood and appropriately incorporated into the analysis, it undermines process stability and changes the effective capability observed across operating periods. See NIST's process capability analysis guidance and its control-chart and stability guidance.

QUESTION NO: 27

Which statements describe characteristics of a pull system using Kanban? (Choose three.)

A. Downstream consumption triggers replenishment

B. A Kanban signal authorizes production or movement

C. Work-in-process limits help expose flow problems

D. Forecast demand alone triggers all upstream production

E. Unlimited inventory is maintained to protect every process

ANSWER: A B C

Explanation:

In a pull system, downstream consumption triggers replenishment from the upstream process. A Kanban signal authorizes production or movement of a defined quantity, rather than allowing upstream operations to produce without regard to actual downstream need. Limits on containers or Kanban cards also establish work-in-process limits, which make excess inventory and flow problems visible.

Production based solely on a forecast without a downstream consumption signal is characteristic of a push approach. Pull systems are intended to improve flow and expose process constraints; they do not justify unlimited work-in-process inventory. See the Lean Enterprise Institute descriptions of pull systems and Kanban.

QUESTION NO: 28

A valuable tool to use during the Measure Phase to show material and information flow throughout an entire process is the ______________ .

A. Value Stream Map

B. FMEA

C. Pareto Chart

D. Standard Operating Procedure

ANSWER: A

Explanation:

Value Stream Map is correct because it provides an end-to-end visual representation of how materials and information move through a process to deliver a product or service. In Lean Six Sigma, it is particularly valuable in the Measure phase because the team needs to understand the current-state process before quantifying performance, identifying delays, and establishing an evidence-based baseline. A value stream map displays process steps, handoffs, inventories or queues, cycle times, waiting times, and both information and material flows. This broad view helps reveal where value is created and where non-value-added time, rework, bottlenecks, or excessive work-in-process may occur. The resulting current-state map supplies a shared factual picture of the process and supports subsequent analysis and improvement design. The Lean Enterprise Institute describes value-stream mapping as a method for visually mapping the flow of materials and information required to bring a product or service to the customer. ASQ likewise identifies value stream mapping as a Lean tool used to document all actions involved in delivering a product or service. See the Lean Enterprise Institute's definition of value-stream mapping and ASQ's value stream mapping resource.

QUESTION NO: 29

What does R stand for in the acronym- SMART?

A. Relevant

B. Reliability

C. Regression

D. Reproducibility

ANSWER: A

Explanation:

In the SMART framework, **Relevant** is the meaning of "R." SMART is a widely used method for defining objectives so that they provide clear direction and can be evaluated effectively. A relevant goal has a meaningful connection to the organization's priorities, the customer or process problem being addressed, and the intended business outcome. In Lean Six Sigma work, this alignment is especially important during project selection and charter development: the project goal should address a demonstrated need and support the organization's strategic objectives rather than represent an isolated improvement with little practical value.

Using SMART goals helps teams convert broad improvement intentions into an actionable project aim. The "Relevant" element prompts the project sponsor and team to confirm that the proposed work is worthwhile, appropriately scoped, and connected to factors such as customer requirements, quality, cost, delivery, safety, or operational performance. This focus supports selection of projects that can deliver meaningful, sustained benefits. The UK Government's guidance describes SMART objectives as objectives that should be relevant as well as specific, measurable, achievable, and time-bound: How to write SMART objectives. ASQ also discusses SMART goals as a structured approach for setting effective quality-related goals: ASQ SMART Goals.

QUESTION NO: 30

From this list select the items that define what an X-Y Diagram is. (Choose four.)

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

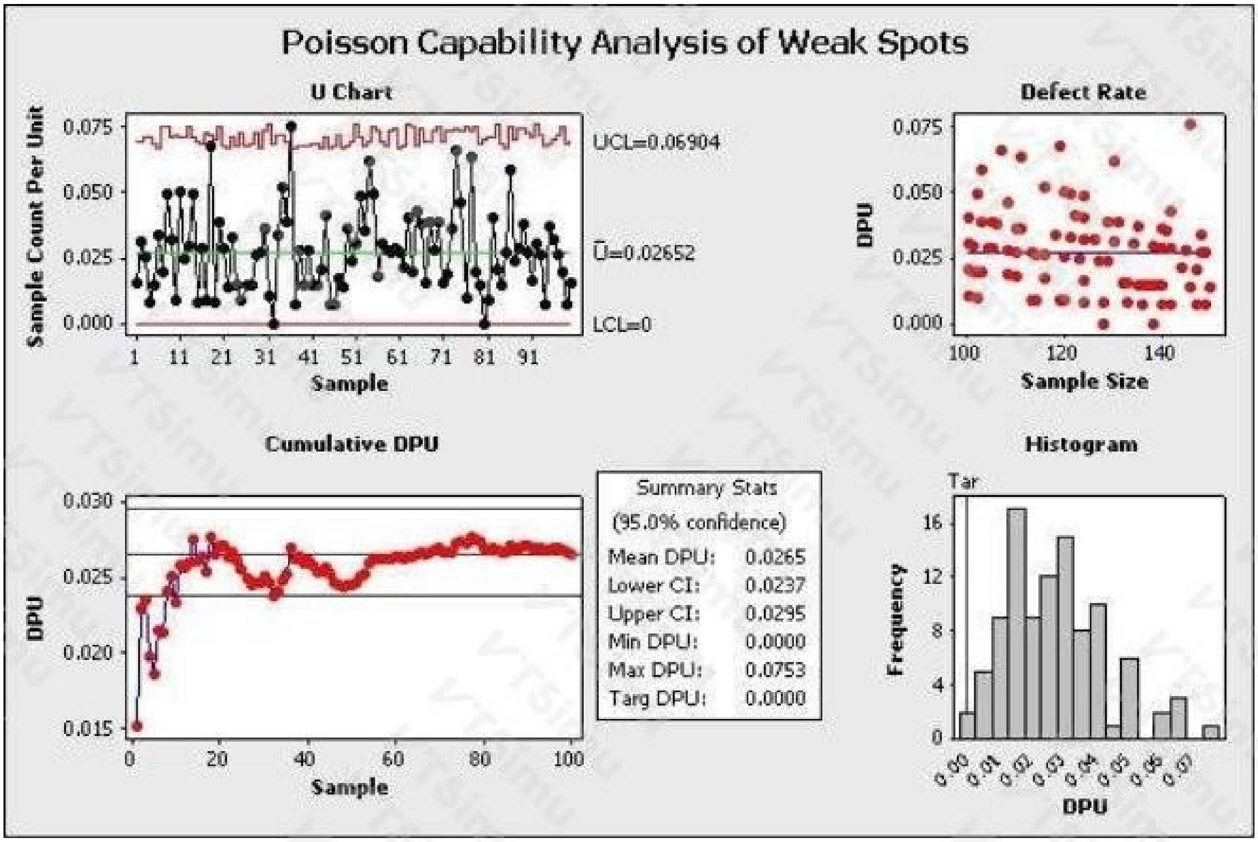
Explanation:

An X-Y Diagram, often called an X-Y matrix or cause-and-effect matrix, is a team-based prioritization tool used to connect process inputs (the Xs) with customer-critical or process output requirements (the Ys). It is normally created for every improvement project because the relevant outputs, process inputs, and priorities are specific to the problem being studied. It is based on the team's collective opinions and process knowledge, typically informed by the voice of the customer, process understanding, and available data. Team members score the relative relationship between each input and output requirement, allowing the project to identify the inputs most deserving of analysis, measurement, and improvement effort.

The X-Y Diagram should also be updated whenever a parameter is changed, such as when an important output requirement, input, process condition, or relationship rating is revised. In that sense, it is a living document throughout the project lifecycle rather than a one-time worksheet. Maintaining it as the project knowledge develops preserves alignment between customer needs, the selected critical inputs, and subsequent analysis. ASQ describes cause-analysis tools as structured methods for identifying and prioritizing potential causes, while Lean Six Sigma project methods emphasize translating customer requirements into measurable process factors. See ASQ Cause Analysis Tools and ASQ Six Sigma resources.

QUESTION NO: 31

Which statements are correct about the advanced Capability Analysis shown here? (Choose three.)



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:

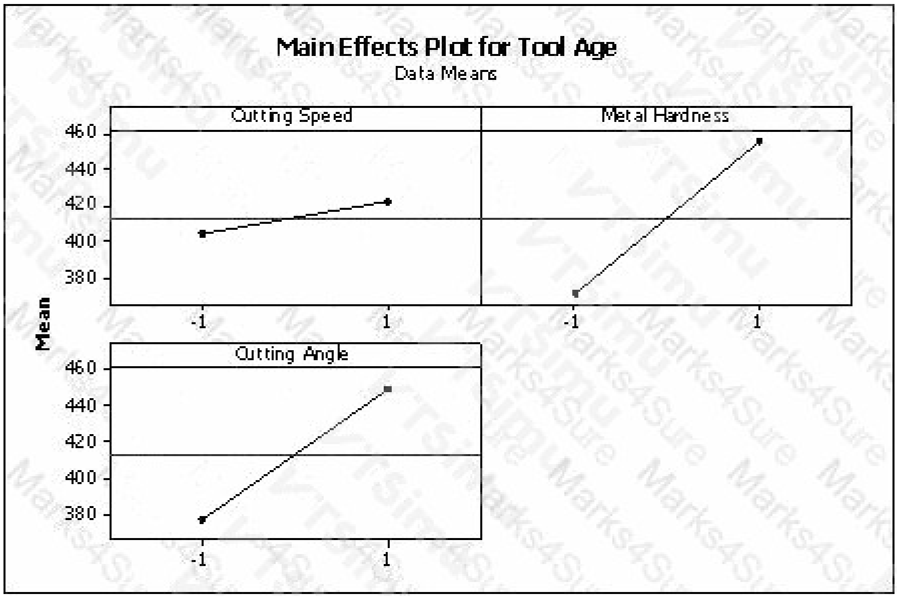
The average DPU with 95% confidence is between 0.024 and 0.0295 is correct because the advanced capability output reports an interval estimate for the process-wide defects-per-unit rate. A 95% confidence interval expresses the plausible range for the underlying average DPU based on the observed data and the fitted capability model. This is useful because it communicates the uncertainty around the point estimate rather than treating the observed rate as exact.

The DPU does not seem to vary depending on sample size is also correct when the displayed DPU values remain comparably distributed across observations having different opportunity counts or sample sizes. This supports interpreting the reported average DPU as a rate that is not visibly driven by differing subgroup sizes.

The maximum DPU in one observation was nearly 0.0753 is correct because the analysis display identifies the largest observed individual DPU at approximately that value. Individual DPU values describe observed defect rates for single observations, whereas the average DPU summarizes the overall process. See Minitab's Poisson capability analysis overview and NIST's process capability guidance.

QUESTION NO: 32

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 2^3 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 C E

Explanation:

The factorial plot represents a full two-level, three-factor experiment, conventionally written as a 2^3 factorial design. Thus, each of the three studied inputs—metal hardness, cutting speed, and cutting angle—has a low and high setting, producing eight treatment combinations before any replication or center points. This structure lets the team examine not only the individual effect of each input on tool age, but also whether the effect of one setting depends on another setting. The displayed treatment-combination results show that the greatest tool age occurs when metal hardness is at its high level and cutting speed is held at its low level. This is an operationally useful finding because it identifies a settings combination associated with maximizing the response. The statement that all factors had two levels is also supported directly by the two-level factorial coding and plot labels. Full factorial designs are widely used in Lean Six Sigma DOE because they estimate main effects and interactions efficiently when the number of factors is manageable. See the NIST Engineering Statistics Handbook discussion of two-level full factorial designs and the NIST guidance on 2^k factorial designs.

QUESTION NO: 33

Kaizens or Kaikakus and Six Sigma projects are intended to create incremental process improvements versus breakthrough, significant improvements.

A. True

B. False

ANSWER: B

Explanation:

False is correct because the statement incorrectly treats Kaizen, Kaikaku, and Six Sigma projects as though they share only an incremental-improvement intent. Kaizen is the Lean practice most closely associated with continuous, small-step improvements made frequently and sustained by the people doing the work. In contrast, Kaikaku denotes a more fundamental, transformational change to a process, system, or way of operating; it is used when incremental adjustments are insufficient to achieve the required performance level.

Six Sigma projects are selected and scoped to deliver a measurable business result by reducing variation, defects, cost, cycle time, or another critical performance gap. Depending on the project's charter, baseline capability, and target condition, the resulting improvement may be incremental or may be substantial and breakthrough-level. The DMAIC method provides the disciplined, data-driven structure for achieving and validating that improvement; it does not restrict projects to small changes. Thus, grouping Kaikaku and Six Sigma exclusively with incremental improvement is inaccurate. ASQ describes Kaizen as continuous improvement and Six Sigma as a methodology focused on reducing defects and variation: ASQ: Kaizen and ASQ: Six Sigma.

QUESTION NO: 34

Use this data to calculate the Z Score. Average of: 92, Standard Deviation: 2, Upper Spec Limit:

101

A. 0.75

B. 1.5

C. 2.25

D. 4.50

ANSWER: D

Explanation:

The correct answer is **4.50**. For a one-sided Z score based on the upper specification limit, calculate the distance from the process mean to that limit in units of the process standard deviation: Z = (USL − mean) / standard deviation. Substituting the supplied values gives Z = (101 − 92) / 2 = 9 / 2 = 4.50. Thus, the upper specification limit is 4.5 standard deviations above the process average. This statistic expresses the amount of process variation available between the process center and the upper requirement boundary. In Lean Six Sigma capability analysis, the upper Z value is useful for assessing the risk that normally distributed output will exceed the upper specification limit; a larger value indicates that the process mean is farther from that specification boundary relative to its observed variation. The calculation assumes that the stated standard deviation appropriately represents the process and that using a normal-distribution-based Z measure is suitable for the data. NIST describes standardization as expressing a value's distance from a mean in standard-deviation units in its Engineering Statistics Handbook. Further capability-analysis context is available from ASQ's process capability resource.

QUESTION NO: 35

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: B C D

Explanation:

A two-level full factorial experiment with five factors requires $2^5 = 32$ runs. Therefore, using 16 runs is a one-half fraction, commonly denoted 2^{5-1}. With the usual defining relation for this design, I = ABCDE, the design has Resolution V. Multiplying a main effect by the defining word shows that each main effect is aliased with a four-factor interaction; for example, A is aliased with BCDE. Thus, the statement that the main effects are confounded only with 4-way interactions correctly describes the aliasing structure. In a regular Resolution V half-fraction, two-factor interactions are instead aliased with three-factor interactions. Also, every factor column in a balanced two-level factorial fraction has equal numbers of low and high settings. Across 16 runs, each of the five factors is consequently set at its high level in 8 runs. These conclusions follow from the standard construction and alias structure of regular fractional factorial designs. See the NIST/SEMATECH discussion of fractional factorial designs and NIST/SEMATECH guidance on design resolution and aliasing.

QUESTION NO: 36

In the expansion of 'DMADOV', M stands for

A. Maximize

B. Minimize

C. Measure

D. Modify

ANSWER: C

Explanation:

Measure is correct. DMADOV is a Design for Six Sigma roadmap commonly expanded as Define, Measure, Analyze, Design, Optimize, and Verify. The Measure phase establishes a factual baseline for the design effort by translating customer needs and critical-to-quality requirements into measurable characteristics. Teams identify what data are needed, define operational measures, assess measurement-system capability where applicable, and quantify current performance or relevant process and product requirements. This evidence supports the later analytical and design decisions, ensuring that the proposed design is based on verified customer and business requirements rather than assumptions.

Although organizations may tailor Design for Six Sigma roadmaps to their products, services, and internal governance, measurement remains the essential activity represented by the second stage in this DMADOV sequence. It creates the reliable quantitative foundation needed to analyze requirements, develop a robust design, optimize performance, and verify that the final solution meets intended needs. The American Society for Quality describes Design for Six Sigma as a systematic approach for designing products and processes to meet customer expectations; its broader Design for Six Sigma resources are available at ASQ: Design for Six Sigma. Additional background on the DMADOV methodology is available from iSixSigma: DMADOV.

QUESTION NO: 37

Which of the following is false?

A. cp checks only whether the process has the potential to meet the requirements

B. cp checks whether the process has the potential to meet the requirements as well as whether the process is actually meeting requirements

C. cp never checks whether the process is actually meeting requirements

D. Cp assumes that the process is stable.

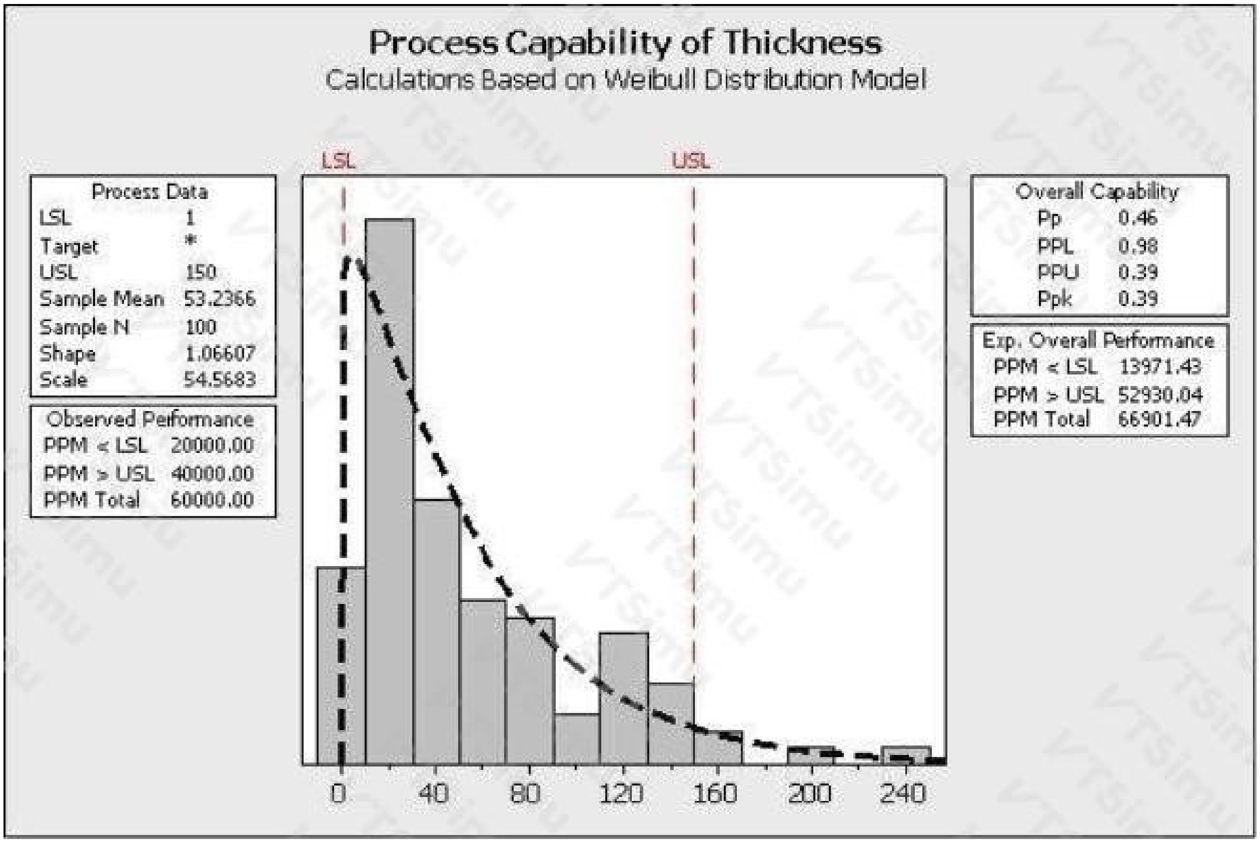
ANSWER: B

Explanation:

"cp checks whether the process has the potential to meet the requirements as well as whether the process is actually meeting requirements" is false. The Cp index is a measure of potential process capability: it compares the specification width, defined by the upper and lower specification limits, with the process's natural spread. Its conventional calculation, *Cp = (USL − LSL) / 6σ*, assumes that the process is statistically stable and that the standard deviation is a meaningful estimate of routine variation. Cp does not include the process mean, so it cannot show whether the process distribution is centered within the specification limits or quantify the capability actually achieved at its current centering. A process may have a high Cp because its variation is small relative to the tolerance while still producing nonconforming output if its mean is shifted. For an index that incorporates both process spread and centering relative to the nearest specification limit, practitioners use Cpk. Capability analysis should therefore first establish statistical control with appropriate control charts, then interpret Cp as potential capability and Cpk as capability adjusted for centering. See the NIST/SEMATECH e-Handbook discussion of process capability indices and the NIST guidance on assessing process stability before capability analysis.

QUESTION NO: 38

Review the analysis shown here.



Which statements are true about the process? (Choose three.)

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. The displayed process distribution is positioned toward the lower side of the specification range, so the process output is more concentrated in the direction of the lower limit than the upper limit. This is a centering observation based on the location of the fitted distribution relative to the specification limits.

The process has more problems with Variation than Centering. Although the distribution's location is relevant, its spread creates the more substantial capability concern: process output extends too broadly relative to the allowable specification interval. In capability work, reducing common-cause and special-cause variation is essential because a process with excessive spread will produce nonconforming results even when its average is adjusted toward target. This distinction between location and spread is central to interpreting capability results; see the NIST process-capability discussion.

The process follows a non-normal distribution with the given data. The analysis uses a non-normal fit rather than treating the thickness measurements as normally distributed. Therefore, interpretation of percent outside specification and capability must be based on the selected non-normal model and its fitted percentiles. Using an appropriate distribution is important because capability conclusions depend on accurately modeling the process tail behavior. Additional background on selecting and evaluating process distributions is available from NIST's distribution-fitting guidance.

QUESTION NO: 39

If a Six Sigma project was to reduce repair station inventory and the team found the inventory was creeping up over time which Lean tools should be considered in the Control Phase to reestablish and sustain the project success?

A. Review the Visual Factory to assure inventory in excess of desired visible

B. Improve the lighting to assure adequate visibility

C. Analyze data from supplier deliveries

D. Reword the standardized work instructions to use active verbs and not passive phrases

ANSWER: A

Explanation:

"Review the Visual Factory to assure inventory in excess of desired visible" is correct because visual management is a Lean control mechanism that makes the current condition immediately apparent at the point of work. For a repair station, this can include clearly marked inventory locations, maximum-quantity lines or labels, color-coded min/max indicators, standard container quantities, and visible replenishment signals. When inventory exceeds the established limit, the abnormal condition is exposed promptly rather than remaining hidden in bins, shelves, or work areas.

In the Control phase, the team must sustain the improved process by monitoring performance and responding consistently when process conditions drift. A Visual Factory supports this by making the desired inventory level and any deviation easy for operators, supervisors, and material handlers to see during routine work. The visual standard also enables a defined reaction plan: investigate the cause of excess stock, restore the established limit, and prevent recurrence. This approach reinforces standard work, supports daily management, and helps maintain the project's inventory-reduction gains without relying solely on periodic data review. The principles of visual controls and workplace organization are described by Lean Enterprise Institute's Visual Management overview and ASQ's Lean resources.

QUESTION NO: 40

Which actions are appropriate when conducting a Measurement System Analysis before using variable data for a process-capability study? (Choose three.)

A. Conduct a Gage R&R study

B. Assess measurement bias using a reference value

C. Select parts spanning the expected process range

D. Widen the specification limits to match gage variation

E. Increase sample size without evaluating the gage

ANSWER: A B C

Explanation:

The measurement system must be suitable for its intended use before capability conclusions are made. A Gage R&R study evaluates the contribution of repeatability and reproducibility to observed measurement variation. Comparing measurements against a traceable reference value evaluates bias, and selecting parts that span the expected process range allows the study to represent actual measurement conditions.

Changing specification limits to accommodate measurement variation does not improve the measurement system or the process. Increasing the number of measurements without a planned study may provide more data, but it does not establish that the gage is capable. See ASQ's Measurement System Analysis resource and NIST Measurement Process Characterization guidance.