PassQueen
a.k.a dumpsqueen.com

# Lean Six Sigma Black Belt

## Six Sigma LSSBB

### Version Demo

**Total Demo Questions: 24**

**Total Premium Questions: 243**

**Buy Premium PDF**

https://passqueen.com

support@passqueen.com

# Topic Break Down

| Topic | No. of Questions |
|---|---|
| Topic 1, Define Phase | 16 |
| Topic 2, Measure Phase | 78 |
| Topic 3, Analyze Phase | 71 |
| Topic 4, Improve Phase | 53 |
| Topic 5, Control Phase | 24 |
| Topic 6, Mix Questions | 1 |
| Total | 243 |

QUESTION NO: 1

Cost of Poor Quality (COPQ) can be classified as Visible Costs and Hidden Costs. Which of these items is a Visible Cost?

**A.** Lost Customer Loyalty

**B.** Time Value of Money

**C.** Returns

**D.** Late Delivery

**ANSWER: C**

**Explanation:**

**Returns** is a visible Cost of Poor Quality because returned products generate direct, identifiable, and readily measurable costs after a product has reached the customer. These costs may include return freight, receiving and inspection activity, replacement processing, repair or rework, refund handling, disposal, and warranty-related administrative work. Since they are recorded through normal operational and financial systems, they appear clearly in reports and are therefore considered visible rather than concealed impacts of poor quality.

In the cost-of-quality framework, returns are generally classified as an external failure cost: the defect or nonconformance was detected after delivery to the customer. Tracking return rates, return reasons, associated labor, logistics expense, credits, and replacement costs allows a Lean Six Sigma team to quantify the financial impact of failures and prioritize process improvements that prevent recurrence. Reducing returns is consequently a direct way to reduce COPQ while improving customer experience and process capability. The American Society for Quality describes failure costs as costs arising when products or services fail to meet requirements, including failures discovered after delivery. See ASQ: Cost of Quality and Lean Enterprise Institute: Cost of Poor Quality.

## QUESTION NO: 2

When conducting an Attribute Agreement Analysis for a visual inspection system, which activities are appropriate? (Note: There are 3 correct answers).

**A.** Have each appraiser evaluate some parts more than once without knowing the prior result

**B.** Include parts that represent the range of acceptable and unacceptable conditions

**C.** Compare appraiser decisions with a known reference or standard when available

**D.** Use only parts that every appraiser can classify easily

**E.** Allow appraisers to discuss each classification before recording it

**ANSWER: A B C**

**Explanation:**

**Have each appraiser evaluate some parts more than once without knowing the prior result** is correct because repeated evaluations allow the team to estimate within-appraiser repeatability. An inspector who classifies the same part differently on repeated trials has poor repeatability.

**Include parts that represent the range of acceptable and unacceptable conditions** is correct because the study must challenge the inspection system with meaningful variation, including borderline conditions where practical. A study containing only obvious conforming or nonconforming parts can overstate actual inspection performance.

**Compare appraiser decisions with a known reference or standard when available** is correct because agreement with a standard supports assessment of accuracy. Agreement among appraisers alone is insufficient if all appraisers consistently make the same incorrect classification. The study should also evaluate reproducibility, which is agreement among appraisers. See ASQ guidance on Measurement System Analysis.

## QUESTION NO: 3

Contingency Tables are used to test for association, or dependency, between two or more classifications.

**A.** True

**B.** False

## ANSWER: A

**Explanation:**

**True** is correct. A contingency table, also called a cross-tabulation, arranges frequency counts for observations classified by categories of two or more categorical variables. It provides the structure used to examine whether the distribution of one classification differs across the categories of another classification. For example, a Black Belt might use a table to evaluate whether defect occurrence is associated with production shift, supplier, machine, or operator group.

The most common inferential procedure used with a contingency table is the chi-square test of independence. This test compares the observed cell counts with counts expected if the classifications were independent. A sufficiently large discrepancy provides evidence of an association or dependency between the variables. In Lean Six Sigma work, this is valuable during Analyze because it helps teams identify categorical factors that may be related to a categorical outcome, such as defective versus nondefective units. The approach requires appropriately defined mutually exclusive categories, independent observations, and adequate expected cell frequencies for the usual chi-square approximation. See the NIST overview of contingency tables and the NIST chi-square test guidance.

## QUESTION NO: 4

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-developed prioritization tool used to connect process inputs (the Xs) with important customer or business outputs (the Ys). It is appropriately created for every project when the team needs to identify and prioritize the process variables most likely to affect critical requirements. The relationships and importance ratings are based on the team's collective opinions, ideally informed by process knowledge, customer needs, and available data. Because project knowledge develops over time, it is also a living document throughout the project lifecycle: the team should revisit it whenever a parameter, process understanding, customer requirement, or significant input changes. Updating whenever a parameter is changed keeps the prioritization current and helps the team focus data collection, measurement-system analysis, and root-cause investigation on the most consequential inputs. This use aligns with the Lean Six Sigma emphasis on identifying vital inputs that drive critical outputs. See ASQ's overview of the cause-and-effect matrix and related cause-analysis tools and the ASQ Six Sigma resource for the role of input-output analysis in improvement projects.

## QUESTION NO: 5

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 is a rank-based, nonparametric procedure for comparing two independent populations or samples. It is appropriately described as focusing on equality of the median of the two populations when the populations have similarly shaped distributions and the practical question is one of location shift. Under that common condition, a systematic tendency for observations in one group to receive higher ranks than those in the other is interpreted as evidence that their central locations, including their medians, differ.

It is also more widely applicable than the traditional "t-test" because it does not require normally distributed population data and can be used with ordinal measurements as well as continuous data. Rather than relying on the original numerical values and a normal-model comparison of means, it operates on combined sample ranks. This makes it particularly useful in Lean Six Sigma analyses involving skewed process data, outliers, or rating-scale data, provided the samples are independent and the measurement observations can be ordered. The test's broader applicability is a key reason it is commonly selected when the assumptions for a two-sample t-test are not adequately supported. See the NIST Engineering Statistics Handbook discussion of the Mann-Whitney test and Penn State's overview of the Mann-Whitney test.

## QUESTION NO: 6

A Full Factorial experiment using a 2 level 4 factor approach has been proposed to test the viability of an extrusion machine experiment. How many treatment combinations will this approach involve?

**A.** 8

**B.** 16

**C.** 32

**D.** 64

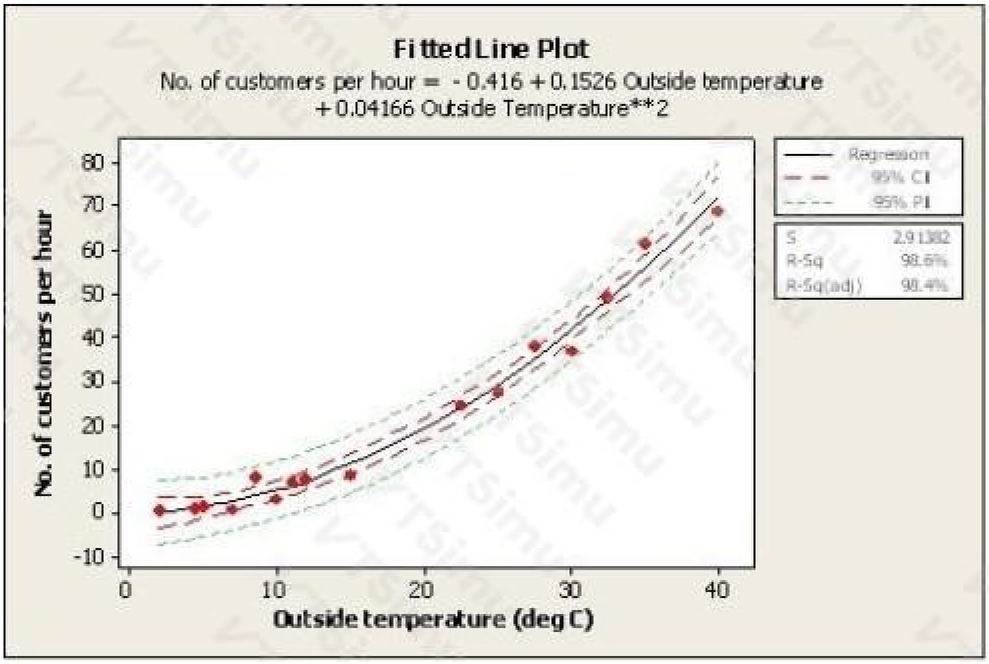
**ANSWER: B**

**Explanation:**

**16** is correct because a full factorial design includes every possible combination of the selected factor levels. The number of treatment combinations is calculated by multiplying the number of levels for each factor. Here, each of the four factors has two levels, so the calculation is $2 \times 2 \times 2 \times 2$, which equals 16. This is commonly written as a $2^4$ factorial design. Each treatment combination represents one unique setting of the extrusion-machine inputs and permits the team to estimate the factors' main effects as well as interaction effects, subject to the experimental model and replication strategy. Full factorial experiments are especially useful during the Analyze and Improve phases of Lean Six Sigma because they reveal whether the effect of one process input depends on the setting of another input. The National Institute of Standards and Technology describes factorial designs as experiments in which all combinations of factor levels are investigated; its discussion of two-level full factorial designs uses this same level-to-the-number-of-factors structure. See the NIST overview of factorial designs and the NIST discussion of two-level full factorial designs.

## QUESTION NO: 7

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, confidence bands describe uncertainty in the estimated mean response at each value of the predictor. They are therefore associated with the fitted curve, rather than defining an interval that is expected to contain every individual future or observed process measurement. Because the fitted relationship is quadratic, the estimated mean response and its confidence limits can curve as the outside temperature changes.

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 predictor scale and reading the value of the fitted quadratic regression curve at that temperature. The curve's fitted value is approximately 5 customers per hour; this is a model-based prediction of the average response, not a claim that every hour observed at 10°C will have exactly five customers. Regression confidence intervals and prediction intervals have distinct purposes, as summarized by the Minitab regression guidance and the NIST Engineering Statistics Handbook.

## QUESTION NO: 8

Which of these statements are applicable to a SIPOC Diagram during the Define Phase? (Note: There are 3 correct answers).

**A.** Identifies the high-level Suppliers, Inputs, Process, Outputs, and Customers

**B.** Helps establish the start and end boundaries of the process

**C.** Can clarify customer requirements associated with process outputs

**D.** Replaces the need for operational definitions of critical measures

**E.** Documents every detailed task and decision in the process

## ANSWER: A B C

**Explanation:**

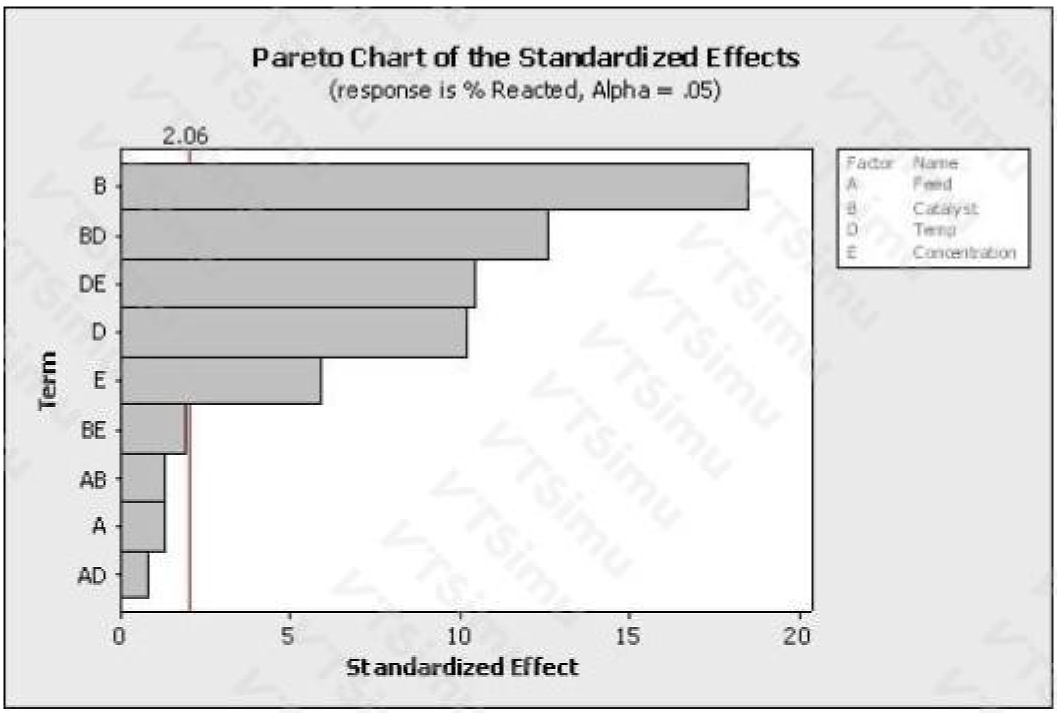
**Identifies the high-level Suppliers, Inputs, Process, Outputs, and Customers** is correct because SIPOC is an acronym for those five process elements. The tool gives the project team a shared high-level view of the process boundaries and major relationships before detailed process mapping begins.

**Helps establish the start and end boundaries of the process** is correct because the SIPOC process column defines the major process steps that occur within the project scope. This helps prevent a project team from studying too narrow or too broad a portion of the value stream.

**Can clarify customer requirements associated with process outputs** is correct because linking outputs to customers helps the team identify critical-to-quality requirements and understand what each customer receives from the process. SIPOC is not intended to document every activity, decision point, or rework loop; that level of detail belongs in a detailed process map or value stream map. See [ASQ guidance on SIPOC diagrams].

## QUESTION NO: 9

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:**

A Pareto chart of standardized effects ranks the estimated main effects and interactions by their absolute standardized magnitude. It shows which plotted terms exceed the displayed reference line and therefore meet the selected significance criterion, but it does not by itself establish the total number of factors originally included in the experimental design. A factor can be absent from the displayed list if its associated terms were not plotted, were excluded through model selection, or are not represented in the particular chart output. Thus, the total factor count is unknown from this graph alone.

The effects to retain are E, D, DE, BD, and B because these are the terms identified as exceeding the significance reference line on the Pareto chart. The value 2.06 is a critical standardized-effect cutoff, not an alpha risk. The chart's stated significance setting is an alpha risk of 0.05, meaning the screening decision uses a 5% Type I error rate. In DOE analysis, retaining statistically significant main effects and interactions provides the basis for fitting a hierarchical, interpretable mathematical model and then validating it with residual diagnostics and confirmation runs. Minitab describes Pareto charts of standardized effects as a way to identify statistically significant terms in factorial designs: Minitab documentation. Additional DOE guidance is available from the NIST/SEMATECH e-Handbook.

## QUESTION NO: 10

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

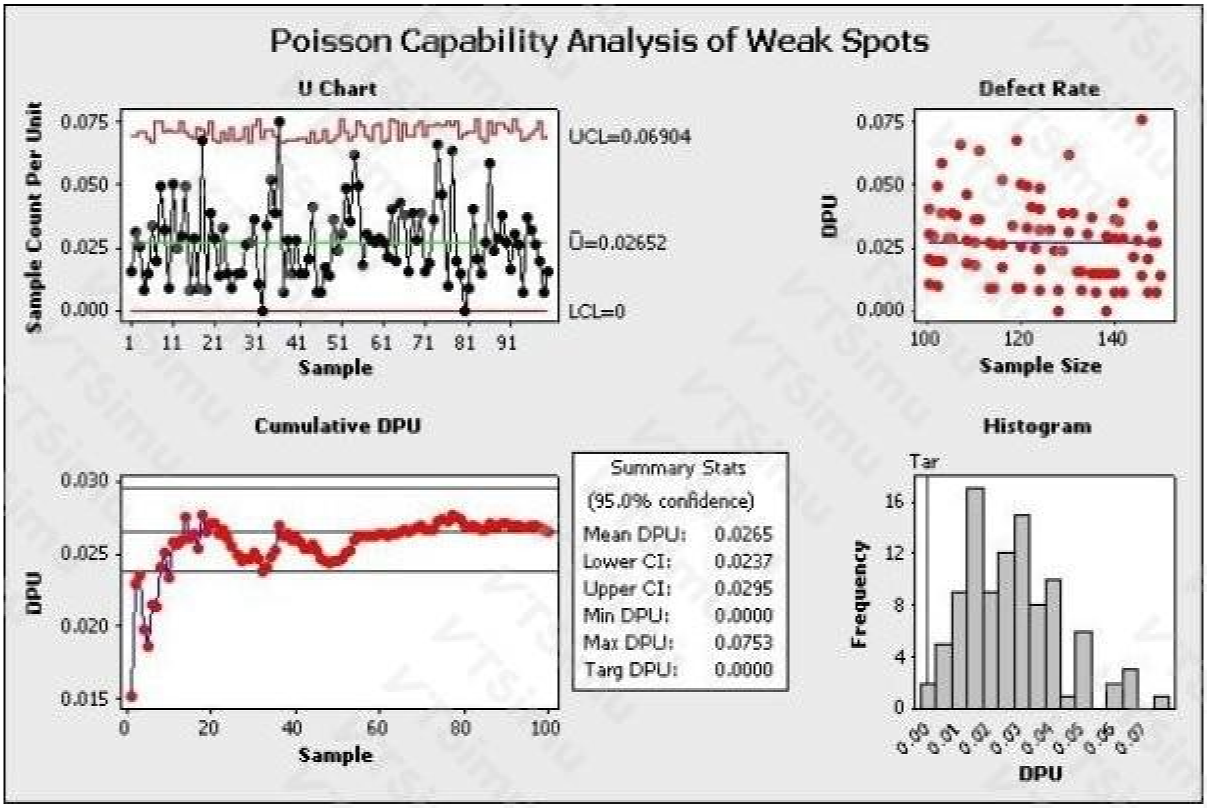
**Explanation:**

**Assignable** is correct because special-cause variation is also commonly called assignable-cause variation. It arises from an identifiable, non-random source that is not inherent in the stable process system. In Lean Six Sigma practice, identifying an assignable cause allows the team to investigate the specific condition, event, material, machine setting, method, or other source and take targeted corrective action.

**Pattern** is also correct in the context of how special causes are recognized on a control chart. A special cause often produces a non-random pattern rather than the random scatter expected from a process affected only by common causes. Recognizable signals can include sustained runs on one side of the centerline, shifts, trends, cycles, or individual points that exceed control limits. These patterns tell the Black Belt that the observed variation merits investigation for a specific source rather than treatment as ordinary system variation. The American Society for Quality describes special causes as factors outside the usual process that can be identified and corrected, while NIST describes the use of control-chart signals to detect unusual or non-random process behavior. See ASQ's overview of variation and the NIST control-chart guidance.

## QUESTION NO: 11

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:**

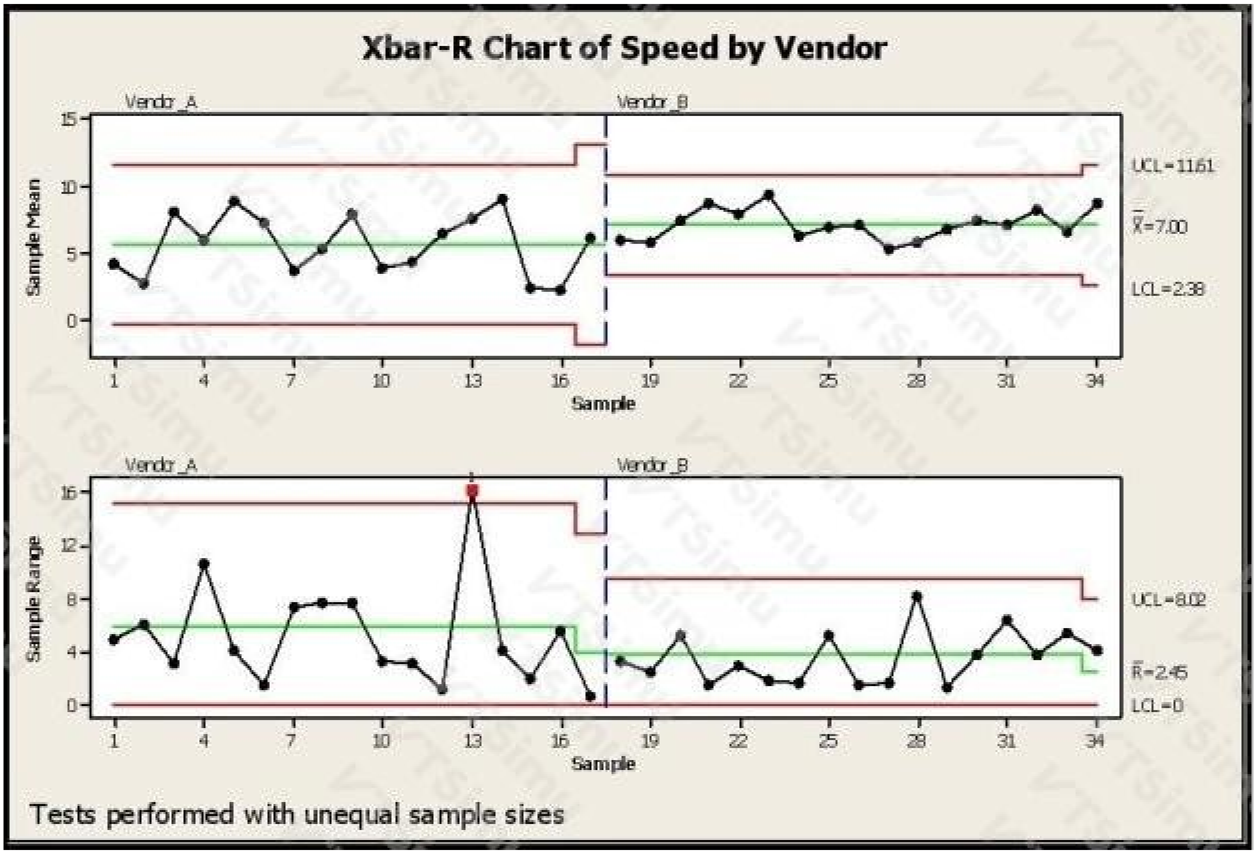
The advanced capability output reports the estimated defects per unit (DPU) and its confidence interval. The average DPU with 95% confidence is between 0.024 and 0.0295 is supported by the reported interval for the process-average DPU. This interval expresses the uncertainty around the underlying average defect rate estimated from the sampled opportunities or units; it is not merely the range of individual plotted observations.

The DPU does not seem to vary depending on sample size is supported by the relationship shown between DPU and sample size. A capability assessment should check this relationship because a systematic pattern would suggest that the rate estimate changes as subgroup size changes. The displayed pattern provides no meaningful evidence of such dependence, so a common DPU estimate is reasonable for the data shown.

The maximum DPU in one observation was nearly 0.0753 is also a direct reading of the individual-observation DPU results. This is the highest observed subgroup rate, rather than the overall average. DPU is a standard attribute-data metric defined as the total defects divided by the total units inspected; it supports comparing defect intensity when each unit can contain more than one defect. See Minitab's attribute capability analysis interpretation guidance and ASQ's Defects per Unit reference.

**QUESTION NO: 12**

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 a lead-time decision, the delivery process must be evaluated for both its average performance and its predictability. “Vendor B as it has a better consistency (lower variance) on lead time” is a sound conclusion because lower variation makes delivery commitments more dependable. “Vendor B as Vendor A shows a situation out of control as shown in red” is also appropriate: a point or pattern identified as out of control indicates special-cause variation, so Vendor A’s observed lead time cannot be treated as a stable, predictable process baseline until that cause is understood and addressed.

“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” correctly emphasize that a stable process with tighter natural variation can be operationally preferable. Narrower control limits on comparably constructed charts reflect less routine process variation, which enables more reliable scheduling, inventory planning, and customer promises. A somewhat higher average lead time may be manageable through planning or improvement, whereas an unstable and highly variable lead time creates materially greater delivery risk. Control charts are intended to distinguish common-cause variation from special-cause signals and support prediction only when a process is stable. See the ASQ control-chart resource and the NIST discussion of control charts.

**QUESTION NO: 13**

In a Fishbone Diagram the 6M's stand for Methods, Measurements, Machine, Man, Mother Nature and ____________ .

**A.** Management

**B.** Merger

**C.** Materials

**D.** Medical

**ANSWER: C**

**Explanation:**

**Materials** completes the commonly used 6M set of cause categories in a Fishbone (Ishikawa, or cause-and-effect) diagram: Man, Machine, Method, Material, Measurement, and Mother Nature (environment). These categories give a team a structured way to brainstorm and organize potential sources of variation or defects during root-cause analysis. Materials covers the inputs consumed, processed, or incorporated into the work, such as raw-material properties, supplier consistency, lot-to-lot variation, storage conditions, handling, contamination, and component specifications. For example, if a process produces inconsistent results, the team may investigate whether incoming material moisture, dimensions, composition, expiration status, or packaging condition is contributing to the observed problem. Using Materials as a dedicated branch helps ensure that input-related causes are examined systematically rather than being overlooked while the team focuses only on equipment or operator actions. The precise naming may vary slightly by organization, such as using "Material" rather than "Materials," but it refers to the same standard cause category. The American Society for Quality describes the fishbone diagram as a tool for identifying many possible causes of an effect and notes the use of standard cause categories in manufacturing contexts. See ASQ's Fishbone Diagram resource and Lean Enterprise Institute's Fishbone Diagram definition.

## QUESTION NO: 14

A valid Multiple Linear Regression (MLR) is characterized by all of these except?

**A.** It is an assumption that the X's (inputs) are not correlated to each other

**B.** The X's (inputs) are assumed to be independent of each other

**C.** The Residuals from MLR analysis have to be Normally Distributed

**D.** MLR is conducted based on a deliberate form of experimentation

**E.** It is not possible to evaluate interactions in a MLR analysis

**ANSWER: E**

**Explanation:**

"It is not possible to evaluate interactions in a MLR analysis" is the exception because multiple linear regression can explicitly evaluate interaction effects. An interaction is modeled by including a product term formed from two predictor variables, such as the product of temperature and pressure. Its coefficient estimates whether the expected effect of one predictor on the response changes as the level of the other predictor changes. This is a standard extension of the linear regression model: although the model remains linear in its estimated coefficients, it may include transformed predictors, polynomial terms, and products of predictors. In Lean Six Sigma work, interaction modeling is particularly valuable when process inputs do not act independently—for example, when the best machine setting depends on the material type or operating environment. Interaction terms should be selected based on process knowledge and/or a suitable experimental or analytical plan, and main effects are ordinarily retained when their interaction is included to support interpretable results. NIST's regression guidance discusses the use of interaction and polynomial terms in multiple regression models, while its handbook explains the broader regression-modeling framework. See NIST: Multiple Linear Regression and NIST: Regression Model Building.

## QUESTION NO: 15

When planning a two-level factorial experiment, which practices help protect the validity of the conclusions? (Note: There are 3 correct answers).

**A.** Randomizing the run order

**B.** Replicating treatment combinations when feasible

**C.** Blocking known nuisance variables

**D.** Changing factor settings during the experiment without documentation

**E.** Selecting factor levels after observing the response data

**ANSWER: A B C**

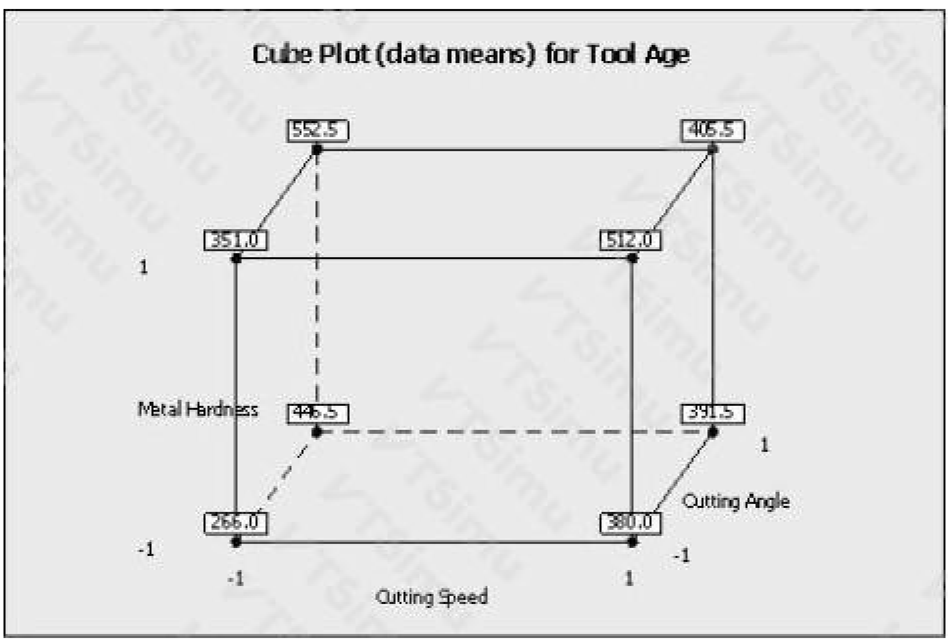
**Explanation:**

**Randomizing the run order**, **replicating treatment combinations when feasible**, and **blocking known nuisance variables** are sound DOE practices. Randomization reduces the risk that time-related or unrecognized external changes will be mistaken for factor effects. Replication provides an estimate of experimental error and strengthens inference. Blocking accounts for known nuisance variation, such as day, material lot, or equipment, without making that nuisance source the main experimental focus.

Changing factor settings during the study without recording them compromises the design, and selecting factor levels after reviewing response data introduces bias. NIST discusses the roles of randomization, replication, and blocking in experimental design at NIST: DOE principles.

## QUESTION NO: 16

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:**

The correct statements follow directly from the direction and relative magnitude of the plotted main effects. “When the cutting speed increased from low to high level, the tool age increases” is supported because the cutting-speed trace rises from its low setting to its high setting. “The coefficient of the metal hardness is positively related to the output of tool age” is supported because the plotted response increases as metal hardness moves from its low to high level; in coded-factor terms, this indicates a positive estimated main-effect direction. “The coded coefficient is lower for cutting speed than the cutting angle related to the output of tool age” is supported by comparing the changes across the coded low and high settings: the cutting-angle effect has the larger vertical change, so its corresponding coded main-effect coefficient has a greater magnitude than that for cutting speed. Main-effects/factorial plots are useful graphical summaries for identifying the direction and relative size of factor effects. They do not themselves provide a confidence level; statistical significance at 95% confidence requires inferential output such as an ANOVA or regression results, including estimated effects and their uncertainty. See NIST’s discussion of main effects in factorial designs and interaction effects in factorial designs.

## QUESTION NO: 17

A ___________ is used primarily to track the stability of the average value of a metric of interest.

**A.** NP Chart

**B.** Xbar-R Chart

**C.** I-MR Chart

**D.** C Chart

**ANSWER: B**

**Explanation:**

An **Xbar-R Chart** is used when data are collected in rational subgroups, typically small samples taken from a process at regular intervals. Its Xbar component plots each subgroup mean and is therefore the primary tool for monitoring whether the process average, or central tendency, remains statistically stable over time. Control limits for the subgroup means are calculated from the process’s within-subgroup variation, estimated through the accompanying range chart. This approach lets a Black Belt distinguish routine common-cause variation in the average from signals that suggest a special cause has shifted the process center.

The range component is included because interpretation of the mean chart depends on stable short-term variation within subgroups. Together, the two charts provide a practical variable-data control-chart method for maintaining control of both the process mean and its within-subgroup spread. This is the standard application when measurements are continuous and subgroup sizes are generally small and consistent. The American Society for Quality describes Xbar-R charts as charts for variable data that monitor the average and range of a process: ASQ Control Charts. Further technical guidance on the Xbar chart’s use for subgroup averages is available from NIST/SEMATECH e-Handbook.

## QUESTION NO: 18

How many experimental runs exist in a Full Factorial and fully randomized design for 5 factors with 2 replicates for the Corner Points and no Center Points? The factors in the experiment are only at 2-levels.

**A.** 10

**B.** 128

**C.** 256

**D.** 64

**ANSWER: D**

**Explanation:**

**64** is correct because a full factorial experiment includes every possible combination of the factor levels. With five factors, each operated at two levels, the number of unique corner-point treatment combinations is calculated as $2^5$, which equals 32. The term "corner points" refers to these combinations of the low and high settings for all factors in the design space.

The design specifies two replicates for the corner points. Replication means independently running each of the 32 treatment combinations twice, so the total number of experimental runs is 32 × 2 = 64. Because no center points are included, there are no additional runs at the midpoint settings of the factors. Full randomization determines the order in which the 64 runs are performed; it does not change how many runs are required. This run-count approach is consistent with standard factorial-design practice: multiply the number of levels across factors, then multiply by the number of replicates, and finally add any separately specified center-point runs. See the NIST/SEMATECH discussion of full factorial designs and the NIST guidance on replicated factorial designs.

## QUESTION NO: 19

Two of the key deliverables for the Measure Phase are a robust description of the process and its flow and an assessment of the Measurement System.

**A.** True

**B.** False

## ANSWER: A

**Explanation:**

**True** is correct. In the Measure phase of DMAIC, the team develops a reliable, fact-based understanding of the current process before attempting improvements. A robust process description and flow—commonly documented through a process map, SIPOC, value-stream map, or detailed flowchart—makes the actual sequence of work, handoffs, inputs, outputs, and potential sources of variation visible. This current-state understanding establishes the operational context for gathering and interpreting performance data.

Assessment of the measurement system is equally essential because improvement decisions are only as dependable as the data used to make them. Measurement System Analysis evaluates whether the method for collecting data is suitable for its purpose, including consistency, repeatability, reproducibility, bias, stability, and discrimination as applicable. Confirming measurement-system capability allows the project team to establish a trustworthy baseline for the problem and quantify process performance with confidence. These activities support the Measure phase goal of validating the problem with accurate data and characterizing current-process performance. The American Society for Quality summarizes DMAIC and the Measure-phase focus at ASQ: DMAIC. Guidance on Measurement System Analysis is available from the National Institute of Standards and Technology.

## QUESTION NO: 20

Which control-chart method is generally more sensitive than a traditional Shewhart Individuals Chart for detecting small, sustained shifts in a process mean?

**A.** EWMA Chart

**B.** Histogram

**C.** Pareto Chart

**D.** Scatter Diagram

## ANSWER: A

**Explanation:**

**EWMA Chart** is correct. An Exponentially Weighted Moving Average chart combines the current observation with prior observations, assigning progressively smaller weights to older data. This accumulation of information makes it effective for detecting small and persistent shifts that may not cause any individual observation to exceed traditional three-sigma Shewhart limits.

A traditional Individuals Chart is effective for larger, more immediate shifts but is less sensitive to subtle drift. The EWMA smoothing constant controls the relative emphasis placed on recent observations, and the chart should be designed with an appropriate center line, control limits, and reaction plan. See NIST guidance on EWMA control charts.

## QUESTION NO: 21

Fractional Factorial designs are used to reduce the ____________ because the number of runs has been lowered.

**A.** Time and cost of experiments

**B.** Number of people involved

**C.** Number of data measurement points

**D.** Output summary

## ANSWER: A

**Explanation:**

Fractional factorial designs reduce the **time and cost of experiments** by deliberately conducting only a selected fraction of the treatment combinations required by a full factorial design. For example, a full two-level design with several factors requires a run for every possible combination of factor settings; as the number of factors grows, this total rises rapidly. A fractional design uses a planned subset of those combinations, allowing the team to screen factors and estimate the effects that are most important for the process while using fewer experimental runs. Because every run may consume material, machine capacity, operator labor, laboratory testing, setup effort, and calendar time, reducing the run count directly lowers the resources needed to complete the study. The fraction is selected systematically—not arbitrarily—so that the resulting design has an understood alias structure and resolution, enabling the Black Belt to make appropriate assumptions about which effects can be separated at the screening stage. This efficiency is why fractional factorial methods are especially valuable early in DOE work, when many potential input factors must be investigated economically. See the NIST/SEMATECH e-Handbook discussion of fractional factorial designs and ASQ's Design of Experiments resource.

## QUESTION NO: 22

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, % steam, ...**

```
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  0.000
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       F      P
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:**

The incorrect statements are "If the air-fuel ratio increases by 1, the TurbineOutput more than triples" and "The SteamExitTemp explains the most variation of the TurbineOutput." A regression coefficient expresses the expected additive change in the response for a one-unit increase in a predictor, holding the other predictors constant. Thus, even if the air-fuel-ratio coefficient is greater than 3, it means TurbineOutput is predicted to increase by more than three output units; it does not mean that the output is multiplied by three or "triples." Such a multiplicative interpretation would require a model fitted on a logarithmic scale and an appropriate back-transformation. The relative influence indicated in the displayed regression results is associated with the air-fuel ratio rather than SteamExitTemp, so SteamExitTemp cannot properly be identified as explaining the most TurbineOutput variation. In multiple regression, comparisons of predictor influence should be based on the output's reported effect measures, such as standardized coefficients or other stated importance statistics, while considering that predictors are assessed conditional on the others. The model fit statistics describe variation explained by the model as a whole, not a basis for interpreting an unstandardized coefficient as a percentage or multiplier. See the NIST regression-coefficient interpretation guidance and NIST discussion of multiple linear regression.

## QUESTION NO: 23

On a _________________ one can see a pattern from the graphed points such that conclusions can be drawn about the largest family of Variation.

**A.** Multi-Vari Chart

**B.** Weighted Scale

**C.** X-Y Matrix

**D.** Poisson Chart

**ANSWER: A**

**Explanation:**

A Multi-Vari Chart is designed to display variation in a process in a way that helps a Lean Six Sigma team identify the dominant, or largest, family of variation. Measurements are collected and plotted across meaningful sources such as positions within a unit, units within a batch, shifts, operators, time periods, or other stratification factors. The visual pattern makes it possible to compare the relative spread associated with each source and determine where improvement investigation should be focused.

In Black Belt practice, this chart is especially useful during the Measure and Analyze phases because it turns raw measurement data into an interpretable view of variation. For example, a repeating difference by machine position suggests positional variation, while differences between time-based groups can indicate temporal or cyclical variation. By showing these patterns together, the chart supports evidence-based prioritization of the process factor contributing most substantially to overall variation. This is consistent with the purpose of multivari studies: separating and visualizing variation across multiple families before pursuing root-cause confirmation. See the ASQ overview of multivari charts and the NIST process-improvement handbook for related process-variation and improvement guidance.

## QUESTION NO: 24

With Measurement System Analysis we are concerned with two issues that impact the potential variability of the data. They are ____________ and Accuracy.

**A.** Spread

**B.** Reliability

**C.** Precision

**D.** Deflection

**ANSWER: C**

**Explanation:**

Precision is correct because measurement system analysis evaluates whether a measurement system produces data that are both precise and accurate. Precision describes the consistency of repeated measurements: when the same characteristic is measured repeatedly under specified conditions, a precise system produces closely clustered results. In MSA, precision is commonly assessed through repeatability (variation when one appraiser uses the same device to measure the same part repeatedly) and reproducibility (variation attributable to different appraisers using the measurement system). These sources contribute to measurement-system variation and directly affect how reliably a team can detect actual process variation.

Accuracy addresses how close measurements are to a recognized reference or true value, whereas precision addresses the amount of random scatter in repeated observations. A useful measurement system needs sufficient precision so that observed differences in the data can be attributed to the process or product rather than excessive measurement variation. This distinction is foundational to gauge repeatability and reproducibility studies and to deciding whether data are fit for process analysis and improvement. The AIAG Measurement Systems Analysis materials identify MSA as a method for assessing measurement-system quality, and NIST's discussion of gauge R&R describes repeatability and reproducibility as core precision-related components.