Sample Exam

Edition 202404

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Introduction

This is the EXIN LSSA Lean Six Sigma Green Belt (LSSGB.EN) sample exam. The Rules and Regulations for EXIN's examinations apply to this exam.

This exam consists of 60 multiple-choice questions. Each multiple-choice question has a number of possible answers, of which only one is correct.

The maximum number of points that can be obtained for this exam is 60. Each correct answer is worth 1 point. You need 38 points or more to pass the exam.

The time allowed for this exam is 180 minutes.

For this exam you are allowed to use a simple calculator.

You are allowed to use the exam literature and Minitab for this exam.

Good luck!

Sample exam

1 / 60
What does a problem description identify?

A) The issue that the project team wants to improve
B) The members of the improvement team
C) The scope of the project
D) The strategic reasons for the project

2 / 60
A Belt has a progress meeting with his team members.

What should the Belt **not** do?

A) Explain why the given feedback is important
B) Provide guidelines concerning how to proceed with the project
C) Review the overall progress and the barriers
D) Tell team members clearly what to do and when

3 / 60
In order to solve a problem correctly, which must occur **first**?

A) The problem must be defined.
B) The process map must be created.
C) The measurement system must be analyzed.
D) The relevant data must be gathered.

4 / 60
Who is the right person to remove barriers arising in a Lean Six Sigma improvement project?

A) The Champion
B) The Master Black Belt
C) The process owner (customer of the improvement project)
D) The project leader

5 / 60
What do Lean and Six Sigma **not** share?

A) A focus on continuous improvement
B) A focus on customer satisfaction
C) A required commitment from top management
D) A required long learning curve

6 / 60
A company has just started a Lean Six Sigma initiative.

Which set of tools is the **best** to start with?

A) Lean tools, because they are more focused on root-cause analyses
B) Lean tools, because they make problems visible and eliminate waste (Muda)
C) Six Sigma tools, because they are a more scientific method to solve problems
D) Six Sigma tools, because they provide more measurement data

7 / 60
What is the **most** important aspect of functional requirements?

A) Describe a single, measurable performance
B) Describe how a product or service should operate
C) Provide upper and lower specification limits
D) Reflect the Voice of the Customer (VOC)

8 / 60
If CpU is determined to be 2.0 and CpL is determined to be 1.0, what factual statement can be made about the process?

A) A calculation error has been made.
B) Cpk must be reported as 1.0.
C) The process is not stable.
D) The process is shifted to the right.

9 / 60
What is the sum of squared deviations from the sample mean divided by n-1?

A) Chi-square distribution with n-1 degrees of freedom
B) Population variance
C) Sample standard deviation
D) Sample variance

10 / 60
Of a sample, all values are added together and this total is divided by the number of values.

What is this the definition of?

A) Mean
B) Median
C) Mode
D) Sample Size

11 / 60
A supervisor asks employees to record the occurrences of ten different non-conformities. He is just interested in frequencies and wants to use a simple method.

Which method should he use?

A) Attribute control chart
B) Check sheet
C) Pareto chart
D) Scatter plot

12 / 60
On a chicken farm, an automated egg inspector is used to sort out the eggs. The number of rejected eggs per 10 trays of 30 eggs is recorded.

What is this type of data called?

A) Attribute data
B) Categorical data
C) Continuous data
D) Discrete data

13 / 60
What is the term for the value with the highest frequency in a data set?

A) Average
B) Mean
C) Median
D) Mode

14 / 60
An inline automated test device tests every part on a production line. The output of the device is "accept" or "reject".

What is the name of this type of output data?

A) Attribute data
B) Discrete data
C) Random data
D) Variable data

15 / 60
A process engineer has developed a Process FMEA for a boiler assembly line. The following ratings were determined for a specific cause of an assembly failure:

Severity = 9
Occurrence = 2
Detection = 5

What is the risk priority number (RPN) for this cause/failure mode?

A) 10
B) 18
C) 45
D) 90

16 / 60
What is the purpose of a statistical test?

A) To calculate the significance of the hypothesis
B) To prove that a stated null hypothesis is true
C) To prove there is a difference between two or more samples
D) To quantify the likelihood of a test outcome when we assume a null hypothesis is true

17 / 60
Which graph is **best** suited to visualize the stability of a process?

A) Histogram
B) Line plot
C) Scatter plot
D) Time series plot

18 / 60
When performing an FMEA, what must a Belt do?

A) Calculate the expected number of failures in a given time interval
B) Estimate the probability of product success
C) Estimate the probability that the customer will detect the failure
D) Identify the failure modes of the product and the causes of the failure

19 / 60
In a variance analysis, the following is found:

- the adjusted sum of squares of the factor is 24 with 2 degrees of freedom
- the adjusted sum of squares of the error is 6 with 18 degrees of freedom.

What is the R-square of this model in percent?

A) 6%
B) 24%
C) 50%
D) 80%

20 / 60
A procedure is used to investigate two mutually exclusive statements about a population. Information from a sample is used to make conclusions about the population.

What is the name of this procedure?

A) Correlation analysis
B) Design of Experiment (DOE)
C) Hypothesis testing
D) Randomizing

21 / 60
What is the probability that the null hypothesis is actually true?

A) 0 or 1, the hypothesis is either true or false
B) Cannot say, it depends on the outcome of the test
C) The Beta risk (β)
D) The confidence level (1-α)

22 / 60
When a Belt calculates a statistic based on sample measurements as an estimate for a population parameter, the Belt can also calculate, with specified confidence, an upper and lower limit within which the true population parameter lies.

What is this called?

A) Confidence interval
B) Confidence level
C) Control limits
D) Sample range

23 / 60
Which is **not** an effective analytical technique used to determine the root cause of a problem submitted for corrective action?

A) Control charting
B) Data analysis
C) Pareto analysis
D) View of the Champion

24 / 60
Why is Design of Experiments (DOE) superior to the "One factor at a time" (OFAT) method?

A) DOE is a statistical method, OFAT is not.
B) DOE is randomized.
C) DOE shows interactions between factors and is also very efficient.
D) OFAT is not a structured method.

25 / 60
Which tool is **not** part of the 8-D problem-solving method?

A) 5-Whys method
B) Fishbone diagram
C) Is - Is-Not method
D) Waterfall method

26 / 60
An analysis of a Design of Experiments (DOE) shows an experimental error.

Which statement is true?

A) If the degrees of freedom increase, the experimental error will decrease.
B) The experimental error can be reduced only by improving the variability of the used materials.
C) The experimental error is caused by interactions between two or more factors.
D) The experimental error is the difference between the true value and the expected value according to the model.

27 / 60
At the early stages of the DMAIC project, the Voice of the Customer (VOC) shouted "safety" in every customer focus group, customer interview, and customer survey. The control plan addresses product performance in detail, but not product safety.

Should this control plan be implemented?

A) Yes, safety is not a CTQ.
B) Yes, the project leader is better informed than the customer; safety is no issue.
C) No, the main CTQ requirement was not addressed in the control plan.
D) No, the paperwork is not complete.

28 / 60
Please read the following list:

1. Poka-yoke
2. 5S
3. TPM
4. Kanban

Which techniques support operational control?

A) 1, 2, 3 and 4
B) 1, 2 and 4 only
C) 2, 3, and 4 only
D) 2 and 4 only

29 / 60
Please read the following statements:

1. Customer specifications can be used as control limits on control charts.
2. Control limits reflect the process capability.
3. You cannot use control limits that are narrower than specification limits in the Control chart.

Which statements about Statistical Process Control (SPC) are true?

A) Only 2 is true
B) Both 1 and 3 are true
C) Both 2 and 3 are true
D) All the statements are true

30 / 60
A Lean Six Sigma Green Belt is developing a control plan.

Which tool does **not** belong to such a plan?

A) Detection measures derived from the FMEA
B) Design of Experiment (DOE)
C) Monitoring of the critical to quality (CTQ)
D) Out-of-control Action Plan (OCAP)

31 / 60
After installing a new production process, an employee reveals that there are Out-of-Control Action Plans (OCAPs) missing in the control plan.

Why are these OCAPs so important?

A) An OCAP describes how the employee should react when the process goes out-of-control
B) An OCAP explains how to install the problem-solving team.
C) An OCAP lists which additional parameters the employee should measure.
D) An OCAP tells the employee what to do with the produced items.

32 / 60
Which control chart is normally used when monitoring the number of defects per shipment?

A) C chart
B) NP chart
C) P chart
D) U chart

33 / 60
Which chart is used to monitor the number of defects per part?

A) I-MR chart
B) NP chart
C) P chart
D) U chart

34 / 60
Please read the following characteristics:

1. Producing the right items
2. Delivering the right items
3. In the right amounts
4. At the right time

What are the characteristics of Just in time (JIT)?

A) 1 and 3 only
B) 2 and 3 only
C) 1, 2 and 4 only
D) 1, 2, 3 and 4

35 / 60
What is the **most** common technique used to reduce setup cycle time?

A) Kaizen
B) Six Sigma
C) Single Minute Exchange of Die (SMED)
D) Value Stream Mapping (VSM)

36 / 60
Calculate the takt time, based on the following data.

Customer demand: 80,000 pcs per month
Working days: 21 days per month
Available: 2 shifts of 8 hours per day
Breaks: 1 hour per shift per day

A) 0.22 seconds per piece
B) 6.62 seconds per piece
C) 13.23 seconds per piece
D) 15.12 seconds per piece

37 / 60
What must be done when cycle time of a certain process step is far below takt time?

A) Reduce customer demand
B) Reduce cycle time
C) Reduce the number of resources in this step
D) Start a Lean improvement program

38 / 60
Please read the following:

1. Preventing mistakes
2. Preventing overproduction
3. Parts are delivered at the right time
4. Parts are delivered in the correct quantity

Which characteristics belong to pull?

A) 1, 2, 3
B) 1, 2, 4
C) 1, 3, 4
D) 2, 3, 4

39 / 60
When is an activity **not** value adding?

A) When the activity contributes to the product or service
B) When the activity is done correctly the first time
C) When the activity is to perform a final inspection of the product or service
D) When the customer is willing to pay for the activity

40 / 60
A Lean professional is asked to implement a Lean tool to improve the visibility of problems in a process.

Which tool is the **best** choice to start with?

A) 5S
B) 5 Whys
C) Jidoka
D) Kanban

41 / 60
A supplier of wooden poles measures the length of poles produced by two employees Harry and Edward. The results are in the table below:

Employee	n	Mean	StdDev
Harry	15	71	3.2
Edward	25	69	2.8

They test the difference between the average lengths of the poles (two-sided with $\alpha = 0.05$) and assume equal variances.

What is the p-value and the conclusion?

A) P-value = 0.045 and there is a significant difference in length.
B) P-value = 0.045 and there is no significant difference in length.
C) P-value = 0.056 and the difference in length is significant.
D) P-value = 0.056 and they need more samples to demonstrate the difference.

42 / 60
Who makes the project charter in a Lean Six Sigma project?

A) The Black Belt as a coach
B) The Champion
C) The process owner
D) The project leader

43 / 60
Using Lean Six Sigma methodology, what will be the failure rate for a company at 5 sigma level?

A) 3.4 ppm
B) 233 ppm
C) 1350 ppm
D) 6210 ppm

44 / 60
Given the information below and using a 5% significance level.

	Rocket A	**Rocket B**
Sample size	61 readings	45 readings
Variance	1,347 km^2	2,137 km^2

Does the range of rocket type B have a larger variance than the range of rocket type A?

A) No significant difference, because p-value < 0.05
B) No significant difference, because p-value > 0.05
C) Significant difference, because p-value < 0.05
D) Significant difference, because p-value > 0.05

45 / 60
What is **not** a benefit of a designed experiment?

A) Analyzes different combinations of inputs
B) Identifies main and interaction effects
C) Preparation time is short
D) Relatively low cost to implement

46 / 60
See the dataset below:

7, 6, 9, 8, 5, 7

What is the standard deviation?

A) 1.2
B) 1.4
C) 1.9
D) 2.0

47 / 60
In the following ANOVA table, a p-value is missing.

Source	SS	DF	MS	F	p
Material	327	3	109	4.36	?
Machine	180	5	36	1.44	0.32
Interaction	375	15	25	1.00	0.53
Error	175	7	25		
Total	1057	30			

What is the missing p-value?

A) 0.03
B) 0.05
C) 0.07
D) 0.10

48 / 60
On ten consecutive days, three parts were sampled from a process to analyze the stability of the process.

The specification range is 98 ± 6.

Subgroup	Sample1	Sample2	Sample3
1	100	101	100
2	95	93	97
3	101	103	100
4	96	95	97
5	98	98	96
6	99	98	98
7	95	97	98
8	100	99	98
9	100	100	97
10	100	98	99

Which statement is true?

A) The process is out-of-control. The control limits of the mean are at 95.9 and 100.5.
B) The process is stable. The control limits of the mean are at 95.9 and 100.5.
C) The variation and mean are both out-of-control.
D) The variation and mean are stable in time.

49 / 60
A Belt wants to visualize and examine the center and spread of the data.

What can the Belt **best** use?

A) Box plot
B) Interval plot
C) Scatter plot
D) Time Series Plot

50 / 60
Why should a project charter be set up?

A) To describe the objective of the project
B) To estimate the benefits
C) To get a clear view on the problem
D) All of the above

51 / 60
There is a requirement for a Belt to perform a statistical test in order to demonstrate a difference in performance between two processes. The Belt states a null hypothesis and an alternative hypothesis. The Belt decides to use a confidence level $(1- \alpha) = 0.95$, calculates the sample sizes needed and conducts the test. The calculated significance of the test statistic is $p = 0.72$.

Which should be the result of the statistical test and the conclusion about the processes?

A) The null hypothesis is not rejected. There is not enough evidence that the processes are different.
B) The null hypothesis is rejected. The processes are different.
C) The alternative hypothesis is accepted. The processes are different.
D) The alternative hypothesis is rejected. The processes are different.

52 / 60
After returning from a two-week vacation a manager reviewed the Xbar and R charts that were maintained during the manager's absence. One of the Xbar charts shows the last 50 points to be very near the center line. In fact, they all seem to be within about one sigma of the center line.

What is the **best** explanation for this occurrence?

A) It shows that the operators did a very good job keeping the process close to target.
B) Somebody restored the original, wider control limit calculation.
C) The process standard deviation has decreased and the control limits were not recomputed.
D) There has been poor quality performance for quite some time.

53 / 60
Control chart rules are used to identify unusual events. Some rules indicate out-of-control situations.

Which rule gives a signal, but does **not** indicate an out-of-control situation?

A) 1 point more than 3 standard deviations from center line
B) 2 out of 3 points more than 2 standard deviations from center line (same side)
C) 6 points in a row, all increasing or all decreasing
D) 15 points in a row within 1 standard deviation of center line (either side)

54 / 60
Given the following output of a gage R&R study:

Source	% Study Variation
Total Gage R&R	9.52
Repeatability	7.70
Producibility	5.59
Operator	5.59
Part-to-part	99.5
Total Variation	100.00

A few statements are made about this:

1. The %contribution of Total Gage R&R is about 10%.
2. There is no part * operator interaction.
3. The measurement system is classified as ideal.
4. Part-to-part is the largest cause of study variation.

What can be deduced from the study?

A) 1, 2, 3
B) 1, 2, 4
C) 1, 3, 4
D) 2, 3, 4

55 / 60
An Xbar-R control chart is based on a sample size of 4. An operator mistakenly samples 2 parts instead of 4. The average and the range of the 2 observations are plotted on the control chart.

Which statement **best** describes the effect of this mistake?

A) Increase the probability that the R chart shows an out-of-control condition
B) Increase the probability that the Xbar chart shows an out-of-control condition
C) Observations from a sample of 2 will always be nearer the center lines of the charts
D) Will not cause any misjudgments if the process is in control

56 / 60
A 2-level full factorial design with 4 quantitative factors A, B, C and D is created. 4 center points and no replicates are used. The results of the analysis are below.

Factorial Regression: Response versus A; B; C; D

Analysis of Variance (ANOVA)

Source	DF	Adj ss	Adj ms	f-value	p-value
Model	11	2802.20	254.75	58.65	0.000
Linear	4	2701.25	675.31	155.47	0.000
A	1	256.00	256.00	58.94	0.000
B	1	2304.00	2304.00	530.42	0.000
C	1	20.25	20.25	4.66	0.063
D	1	121.00	121.00	27.86	0.001
2-Way Interactions	6	93.75	15.62	3.60	0.049
A*B	1	4.00	4.00	0.92	0.365
A*C	1	2.25	2.25	0.52	0.492
A*D	1	0.00	0.00	0.00	1.000
B*C	1	6.25	6.25	1.44	0.265
B*D	1	81.00	81.00	18.65	0.003
C*D	1	0.25	0.25	0.06	0.816
Curvature	1	7.20	7.20	1.66	0.234
Error	8	34.75	4.34		
Lack-of-Fit	5	6.00	1.20	0.13	0.976
Pure Error	3	28.75	9.58		
Total	19	2836.95			

What can be concluded from the results table using a 5% significant level?

A) 3 main effects and the 2-way interaction B*D are significant.
B) All response observations are unusual; no conclusions can be made from this experiment.
C) Main effects A and C are significant.
D) There is no significant main effect, just 2 way interactions B*D and A*C.

57 / 60
The following 10 measurements were provided by an appraiser.

The True Value is 0.80mm.

1 = 0.75	6 = 0.80
2 = 0.75	7 = 0.75
3 = 0.80	8 = 0.75
4 = 0.80	9 = 0.75
5 = 0.65	10 = 0.70

What is the bias measurement in this system?

A) -0.05
B) 0.05
C) 12.50
D) 13.33

58 / 60
A Lean Six Sigma project must be addressed in phases. The DMAIC roadmap is used to do this.

What do the letters D, M, and A in this abbreviation stand for?

A) Define, Manufacture, and Analyze
B) Define, Measure, and Activate
C) Define, Measure, and Analyze
D) Determine, Measure, and Analyze

59 / 60
Please read the Critical to Quality (CTQ) steps:

1. Add additional CTQ levels as needed
2. Identify the customer's needs
3. Identify the customers
4. Validate the requirements with the customer
5. Identify the customer's basic requirements

What is the appropriate time sequence to arrange these CTQs from start to finish?

A) 2, 3, 4, 1, 5
B) 2, 3, 5, 4, 1
C) 3, 2, 4, 5, 1
D) 3, 2, 5, 1, 4

60 / 60
What does takt time mean?

A) The average time between consecutive customer orders
B) The average time between consecutive order deliveries
C) The average time between order and delivery
D) The shortest time between consecutive customer orders

Answer key

1 / 60
What does a problem description identify?

A) The issue that the project team wants to improve
B) The members of the improvement team
C) The scope of the project
D) The strategic reasons for the project

A) Correct. The core of the problem description is the problem itself. The other answer options are part of the project charter, not of the problem description.
B) Incorrect.
C) Incorrect.
D) Incorrect.

2 / 60
A Belt has a progress meeting with his team members.

What should the Belt **not** do?

A) Explain why the given feedback is important
B) Provide guidelines concerning how to proceed with the project
C) Review the overall progress and the barriers
D) Tell team members clearly what to do and when

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The Belt, as the project manager, should share the current status and barriers, the importance of any feedback, and guidelines on how to proceed. The team members should indicate how they proceed to make the project a success. The Belt should monitor or check for any questions and misunderstandings but may not be directive.

3 / 60
In order to solve a problem correctly, which must occur **first**?

A) The problem must be defined.
B) The process map must be created.
C) The measurement system must be analyzed.
D) The relevant data must be gathered.

A) Correct. Problems are solved following DMAIC, where Define (What is the problem? Seen in the VOC, CTQ, Project charter.) comes before Measure (How big is the problem? Seen in the verify measurement system, gather data on the problem, and process.). So, the problem definition comes first. The other answer options are elements of successive steps.
B) Incorrect.
C) Incorrect.
D) Incorrect.

4 / 60
Who is the right person to remove barriers arising in a Lean Six Sigma improvement project?

A) The Champion
B) The Master Black Belt
C) The process owner (customer of the improvement project)
D) The project leader

A) Correct. The Champion owns the problem and is responsible for the resources and the part of the organization touched by the project. As such, they have the decision power and means to remove obstacles. The project leader should identify the barriers and bring these to the Champion's attention. The project leader does not have the decision power to remove the obstacles; the same applies to the Master Black Belt and the process owner.
B) Incorrect.
C) Incorrect.
D) Incorrect.

5 / 60
What do Lean and Six Sigma **not** share?

A) A focus on continuous improvement
B) A focus on customer satisfaction
C) A required commitment from top management
D) A required long learning curve

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Both methodologies have the same focus: continuous improvement, starting at the customer to deliver value. The key to obtaining results in both methodologies is the support of senior management. Starting with Lean is relatively easy (e.g. with CIMM levels I and II). Mastering Six Sigma takes somewhat more time, due to the use of statistics (e.g. CIMM levels IV and up).

6 / 60
A company has just started a Lean Six Sigma initiative.

Which set of tools is the **best** to start with?

A) Lean tools, because they are more focused on root-cause analyses
B) Lean tools, because they make problems visible and eliminate waste (Muda)
C) Six Sigma tools, because they are a more scientific method to solve problems
D) Six Sigma tools, because they provide more measurement data

A) Incorrect.
B) Correct. A company should start on CIMM level I, all based on Lean techniques. Basic Lean techniques identify problems and waste and remove or reduce them. Root cause analysis is a bit more advanced Lean brainstorm technique on CIMM level II. Six Sigma techniques start at CIMM level IV.
C) Incorrect.
D) Incorrect.

7 / 60
What is the **most** important aspect of functional requirements?

A) Describe a single, measurable performance
B) Describe how a product or service should operate
C) Provide upper and lower specification limits
D) Reflect the Voice of the Customer (VOC)

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The key to functional requirements is the specification of the real customer needs. Therefore, requirements are not described to answer a 'how' (specifying methods), and do not give values (specification limits, target, units of measure). An example of a requirement is "As a user, I want the dishwasher to complete quickly, in order to have my dishes available as soon as possible.", instead of "Dishwasher cycle time must be between 30 and 90 minutes."

8 / 60
If CpU is determined to be 2.0 and CpL is determined to be 1.0, what factual statement can be made about the process?

A) A calculation error has been made.
B) Cpk must be reported as 1.0.
C) The process is not stable.
D) The process is shifted to the right.

A) Incorrect.
B) Correct. CpU and CpL are the process capabilities. They reflect the distance between the center of the data and the upper and lower specification limit. The Cpk is defined as the minimum of the CpU and the CpL, which is 1.0 in this case. If the CpU is 2.0 and the CpL is 1.0, the data are not centered but moved in the direction of the lower specification limit (LSL), not the upper specification limit (USL). The process has a smaller probability to exceed the USL than the LSL. Thus, the process is shifted to the left of the graph, not the right. There are no indications that a mistake has been made or that the process is not stable.
C) Incorrect.
D) Incorrect.

9 / 60
What is the sum of squared deviations from the sample mean divided by n-1?

A) Chi-square distribution with n-1 degrees of freedom
B) Population variance
C) Sample standard deviation
D) Sample variance

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The mathematical representation of sample variance (s^2) is what is described in the question:

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2$$

A comparable definition, using n instead of n-1, and the average of the population μ instead of x, is the variance of the population (σ^2). The square root of the variance is called the standard deviation (s). The formula for the chi-square distribution is completely different.

10 / 60
Of a sample, all values are added together and this total is divided by the number of values.

What is this the definition of?

A) Mean
B) Median
C) Mode
D) Sample Size

A) Correct. This is the way a sample mean (average) is calculated. The median is the center value of the ordered data. The mode is the most frequent value. The sample size is the total number of data points.
B) Incorrect.
C) Incorrect.
D) Incorrect.

11 / 60
A supervisor asks employees to record the occurrences of ten different non-conformities. He is just interested in frequencies and wants to use a simple method.

Which method should he use?

A) Attribute control chart
B) Check sheet
C) Pareto chart
D) Scatter plot

A) Incorrect.
B) Correct. Key in the question is that the supervisor asks for a method to **record** the data. A Check sheet is a method meant to easily record the data in real-time right where it is generated, usually with pen and paper. It requires only tallying the number of occurrences (in prespecified categories). The other answer options are graphs, usually created with (statistical) software, to visualize the gathered data.
C) Incorrect.
D) Incorrect.

12 / 60
On a chicken farm, an automated egg inspector is used to sort out the eggs. The number of rejected eggs per 10 trays of 30 eggs is recorded.

What is this type of data called?

A) Attribute data
B) Categorical data
C) Continuous data
D) Discrete data

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The type of data is a countable number (number of rejected eggs per 10 trays of 30 eggs), so this is an example of quantitative, more specifically discrete data. These quantitative data are not continuous; the values between the counts do not have a meaning. Attribute and categorical data are qualitative data.

13 / 60
What is the term for the value with the highest frequency in a data set?

A) Average
B) Mean
C) Median
D) Mode

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The average and the mean are the same thing, and are computed by summing all values divided by the number of values. The median is the center value of the ordered data. The mode is the most frequent value. The Range (R) is the difference between the maximum and the minimum value of the data.

14 / 60
An inline automated test device tests every part on a production line. The output of the device is "accept" or "reject".

What is the name of this type of output data?

A) Attribute data
B) Discrete data
C) Random data
D) Variable data

A) Correct. Dichotomous data ("accept" or "reject") are examples of nominal data. Nominal data are a type of qualitative data, also called attribute data. Discrete data are a type of quantitative data, also called variable data. The data are measured as facts and are not random data.
B) Incorrect.
C) Incorrect.
D) Incorrect.

15 / 60
A process engineer has developed a Process FMEA for a boiler assembly line. The following ratings were determined for a specific cause of an assembly failure:

Severity = 9
Occurrence = 2
Detection = 5

What is the risk priority number (RPN) for this cause/failure mode?

A) 10
B) 18
C) 45
D) 90

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. RPN = Severity * Occurrence * Detection = 9 * 2 * 5 = 90

16 / 60
What is the purpose of a statistical test?

A) To calculate the significance of the hypothesis
B) To prove that a stated null hypothesis is true
C) To prove there is a difference between two or more samples
D) To quantify the likelihood of a test outcome when we assume a null hypothesis is true

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. A statistical test quantifies, through a p-value, the likelihood of the occurrence of the measured data, under the assumption that the null hypothesis is true. Thus, this cannot prove that a difference between samples exist. Statistical tests can never prove a hypothesis true since the hypothesis is the assumption for the test. For this reason, the significance of a hypothesis does not exist in statistics.

17 / 60
Which graph is **best** suited to visualize the stability of a process?

A) Histogram
B) Line plot
C) Scatter plot
D) Time series plot

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct.
- A histogram visually organizes data in intervals, to identify the frequency of the data in each interval.
- A line plot visualizes the frequency of occurrence of the data, summarized in a limited number of categories.
- A scatter plot is used to identify possible relationships between variables.
- A time series plot plots data in time, to investigate stability of a process over time.

18 / 60
When performing an FMEA, what must a Belt do?

A) Calculate the expected number of failures in a given time interval
B) Estimate the probability of product success
C) Estimate the probability that the customer will detect the failure
D) Identify the failure modes of the product and the causes of the failure

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Failure mode and effects analysis (FMEA) is a structured risk analysis methodology to identify potential sources of failure, the root cause of the failures, and countermeasures to mitigate these failures. This is done for all critical risks (with high enough RPN). All other answer options are not part of the FMEA.

19 / 60
In a variance analysis, the following is found:

- the adjusted sum of squares of the factor is 24 with 2 degrees of freedom
- the adjusted sum of squares of the error is 6 with 18 degrees of freedom.

What is the R-square of this model in percent?

A) 6%
B) 24%
C) 50%
D) 80%

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The R-square is calculated by dividing the adjusted sum of squares of the factor (SSR) by the sum of the SSR and the adjusted sum of squares of the error (SSE), multiplied by 100%. R-square = SSR / (SSR + SSE) * 100% = (24 / (24 + 6)) * 100% = 80%. The degrees of freedom (df) are superfluous information.

20 / 60
A procedure is used to investigate two mutually exclusive statements about a population. Information from a sample is used to make conclusions about the population.

What is the name of this procedure?

A) Correlation analysis
B) Design of Experiment (DOE)
C) Hypothesis testing
D) Randomizing

A) Incorrect.
B) Incorrect.
C) Correct. To draw a conclusion about a population, a null hypothesis (H0) and the alternative hypothesis (HA) are formulated. Subsequently, H0 is tested and either rejected or not. This is called hypothesis testing. Randomization is for generating random data or experiments. Correlation analysis and DOE are techniques that hypothesis testing may or may not be a part of.
D) Incorrect.

21 / 60
What is the probability that the null hypothesis is actually true?

A) 0 or 1, the hypothesis is either true or false
B) Cannot say, it depends on the outcome of the test
C) The Beta risk (β)
D) The confidence level (1-α)

A) Correct. The null hypothesis (H0) is either completely true or completely false with probability of 1 or 0. Since it is impossible to measure this, statistics are used to make an informed decision based on data to reject or maintain the null hypothesis. This is never a proof of the truth. The confidence level and beta-risks reflect the probabilities of deciding in favor of the wrong hypothesis.
B) Incorrect.
C) Incorrect.
D) Incorrect.

22 / 60
When a Belt calculates a statistic based on sample measurements as an estimate for a population parameter, the Belt can also calculate, with specified confidence, an upper and lower limit within which the true population parameter lies.

What is this called?

A) Confidence interval
B) Confidence level
C) Control limits
D) Sample range

A) Correct. The confidence interval is the range of values containing the true population value, with a chosen confidence level (usually 95%). The sample range is the difference between the lowest and highest value of the sample. Upper and lower control limits, calculated in statistical process control (SPC), are the boundaries containing the data of a stable process (usually 99.7%).
B) Incorrect.
C) Incorrect.
D) Incorrect.

23 / 60
Which is **not** an effective analytical technique used to determine the root cause of a problem submitted for corrective action?

A) Control charting
B) Data analysis
C) Pareto analysis
D) View of the Champion

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The view of the Champion is a subjective view and might not be based on observations of the process. LSS prefers objective data. The other answer options are all based on objective data.

24 / 60
Why is Design of Experiments (DOE) superior to the "One factor at a time" (OFAT) method?

A) DOE is a statistical method, OFAT is not.
B) DOE is randomized.
C) DOE shows interactions between factors and is also very efficient.
D) OFAT is not a structured method.

A) Incorrect.
B) Incorrect.
C) Correct. DOE can clarify larger numbers of factors and their interactions very efficiently. Both DOE and OFAT are statistical and structured methods, and both can run randomized experiments, which is preferred.
D) Incorrect.

25 / 60
Which tool is **not** part of the 8-D problem-solving method?

A) 5-Whys method
B) Fishbone diagram
C) Is - Is-Not method
D) Waterfall method

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. 8D uses problem statement techniques (Is – Is-Not method), and root cause analysis techniques (Fishbone diagram, 5-Whys method). The Waterfall method is a technique used in product development.

26 / 60
An analysis of a Design of Experiments (DOE) shows an experimental error.

Which statement is true?

A) If the degrees of freedom increase, the experimental error will decrease.
B) The experimental error can be reduced only by improving the variability of the used materials.
C) The experimental error is caused by interactions between two or more factors.
D) The experimental error is the difference between the true value and the expected value according to the model.

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. A DOE builds a model of the data points obtained in the experiments. Experimental error (residuals) is the difference between the expected value by the model and the measured value in the experiment. When the experimental error is 0, the model fits the data perfectly. The experimental error can sometimes be reduced by expanding the model, which leaves less degrees of freedom remaining. The experimental error has no relation with the interactions.

27 / 60
At the early stages of the DMAIC project, the Voice of the Customer (VOC) shouted "safety" in every customer focus group, customer interview, and customer survey. The control plan addresses product performance in detail, but not product safety.

Should this control plan be implemented?

A) Yes, safety is not a CTQ.
B) Yes, the project leader is better informed than the customer; safety is no issue.
C) No, the main CTQ requirement was not addressed in the control plan.
D) No, the paperwork is not complete.

A) Incorrect.
B) Incorrect.
C) Correct. The CTQ is derived from the VOC in the early stages of Define in a DMAIC project. It steers which problem is addressed, and with that the root cause in Analyze. As the measures identified in Improve are derived from effectively addressing the root cause, these are also the ones which need to be solidified in Control. Although safety might not be the CTQ of the project to improve, it cannot be ignored as the customers consistently emphasize. So, the control plan should contain measures around the CTQ 'safety' besides the measures concerning the improved CTQ.
D) Incorrect.

28 / 60
Please read the following list:

1. Poka-yoke
2. 5S
3. TPM
4. Kanban

Which techniques support operational control?

A) 1, 2, 3 and 4
B) 1, 2 and 4 only
C) 2, 3, and 4 only
D) 2 and 4 only

A) Correct. All are correct, since:
- Poka-yoke prevents specific errors from occurring.
- 5S helps to keep the working environment organized.
- TPM controls machine downtime and equipment reliability.
- Kanban stabilizes inventory.

B) Incorrect.
C) Incorrect.
D) Incorrect.

29 / 60
Please read the following statements:

1. Customer specifications can be used as control limits on control charts.
2. Control limits reflect the process capability.
3. You cannot use control limits that are narrower than specification limits in the Control chart.

Which statements about Statistical Process Control (SPC) are true?

A) Only 2 is true
B) Both 1 and 3 are true
C) Both 2 and 3 are true
D) All the statements are true

A) Correct. Control limits are calculated on the actual process variation and, therefore, reflect the process capability. If the process is capable enough to meet customer specifications (specification limits), the control limits should be within the specification limits, which means narrower limits can be used. Control limits are calculated based on the actual process variation, so they cannot be replaced by the specification limits of the customer.
B) Incorrect.
C) Incorrect.
D) Incorrect.

30 / 60
A Lean Six Sigma Green Belt is developing a control plan.

Which tool does **not** belong to such a plan?

A) Detection measures derived from the FMEA
B) Design of Experiment (DOE)
C) Monitoring of the critical to quality (CTQ)
D) Out-of-control Action Plan (OCAP)

A) Incorrect.
B) Correct. DOE is a technique used in the Improve phase of the project to find the optimal settings of the crucial parameters influencing the CTQ. DOE is not part of the control plan. All other answer options are suitable instruments to control the improved process.
C) Incorrect.
D) Incorrect.

31 / 60
After installing a new production process, an employee reveals that there are Out-of-Control Action Plans (OCAPs) missing in the control plan.

Why are these OCAPs so important?

A) An OCAP describes how the employee should react when the process goes out-of-control.
B) An OCAP explains how to install the problem-solving team.
C) An OCAP lists which additional parameters the employee should measure.
D) An OCAP tells the employee what to do with the produced items.

A) Correct. The OCAP describes how an operator should react when the process gets out of control. It is based on lessons learned from previous out-of-control situations. It is important for the operator to know how to act in the out-of-control situations. All other answer options describe different issues, not relevant for an out-of-control situation.
B) Incorrect.
C) Incorrect.
D) Incorrect.

32 / 60
Which control chart is normally used when monitoring the number of defects per shipment?

A) C chart
B) NP chart
C) P chart
D) U chart

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. P and NP charts are used for proportions. C and U charts are used for the number of defects per unit (attribute data). C charts can only be used when the sample size is fixed. U charts can always be used, even when the sample size is not fixed. Since it is unclear whether possible defects of an order are fixed or not, it is unclear if a C chart can be used. Therefore, a U chart should be used.

33 / 60
Which chart is used to monitor the number of defects per part?

A) I-MR chart
B) NP chart
C) P chart
D) U chart

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. I-MR charts are used for individual data points and moving range (continuous data). P and NP charts are used for proportions. C and U charts are used for the number of defects per unit (attribute data). C charts can only be used when the sample size is fixed. U charts can always be used, even when the sample size is not fixed. Since it is unclear whether possible defects of an order are fixed or not, it is unclear if a C chart can be used. Therefore, a U chart should be used.

34 / 60
Please read the following characteristics:

1. Producing the right items
2. Delivering the right items
3. In the right amounts
4. At the right time

What are the characteristics of Just in time (JIT)?

A) 1 and 3 only
B) 2 and 3 only
C) 1, 2 and 4 only
D) 1, 2, 3 and 4

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. JIT means delivering and producing the right products, at the right time (just before X needed), and in the correct quantity. All answer options are correct.

35 / 60
What is the **most** common technique used to reduce setup cycle time?

A) Kaizen
B) Six Sigma
C) Single Minute Exchange of Die (SMED)
D) Value Stream Mapping (VSM)

A) Incorrect.
B) Incorrect.
C) Correct. Reducing changeover or setup time is best done through SMED, which has a series of standardized steps to externalize activities and remove waste. Kaizen is a step-by-step way of continuous improvement. Six Sigma are (statistical) techniques to reduce variability. Value stream mapping is a technique of visualizing the process and the waste in the process.
D) Incorrect.

36 / 60
Calculate the takt time, based on the following data.

Customer demand: 80,000 pcs per month
Working days: 21 days per month
Available: 2 shifts of 8 hours per day
Breaks: 1 hour per shift per day

A) 0.22 seconds per piece
B) 6.62 seconds per piece
C) 13.23 seconds per piece
D) 15.12 seconds per piece

A) Incorrect.
B) Incorrect.
C) Correct. Total available time = 21 days/month * 2 shifts/day * (8 hours/shift - 1 hour/shift break) = 294 hours/month
Customer demand = 80,000 pieces/month
Takt time is the customer demand in available time: takt time = total available time / customer demand = 294 hours/month / 80,000 pieces/month = 0.003675 hours/piece = 0.2205 minutes/piece = 13.23 seconds/piece
D) Incorrect.

37 / 60
What must be done when cycle time of a certain process step is far below takt time?

A) Reduce customer demand
B) Reduce cycle time
C) Reduce the number of resources in this step
D) Start a Lean improvement program

A) Incorrect.
B) Incorrect.
C) Correct. When cycle time is below takt time, it means that the process step is faster than required to satisfy customer demand. This is good: all steps must be at or below takt time to keep up with customer demand. When a significant difference occurs (e.g. "far below"), care must be taken not to waste resources on that step as the wastes of Waiting, Overproduction, or Inventory may be unintentionally introduced. This does not need a full Lean improvement program. A further decrease of the cycle time is not necessary if takt time is already higher than cycle time. Decreasing the customer demand is also not necessary, as it would further increase the takt time.
D) Incorrect.

38 / 60
Please read the following:

1. Preventing mistakes
2. Preventing overproduction
3. Parts are delivered at the right time
4. Parts are delivered in the correct quantity

Which characteristics belong to pull?

A) 1, 2, 3
B) 1, 2, 4
C) 1, 3, 4
D) 2, 3, 4

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Pull aims at only producing what is required, at the right time, and right place for both the customer and the production stations in the process. The focus is not on preventing mistakes.

39 / 60
When is an activity **not** value adding?

A) When the activity contributes to the product or service
B) When the activity is done correctly the first time
C) When the activity is to perform a final inspection of the product or service
D) When the customer is willing to pay for the activity

A) Incorrect.
B) Incorrect.
C) Correct. An activity is value adding if it satisfies all the following criteria:
- The customer is prepared to pay for it.
- The activity is done correctly the first time.
- The activity modifies the product or service.
Since 'inspection' does not satisfy all criteria, it is not value adding.
D) Incorrect.

40 / 60
A Lean professional is asked to implement a Lean tool to improve the visibility of problems in a process.

Which tool is the **best** choice to start with?

A) 5S
B) 5 Whys
C) Jidoka
D) Kanban

A) Correct. The starting tool is 5S: ensuring the workplace is properly organized so that wastes become visible and can be remedied to not re-occur. Kanban is also a visual tool but aimed at keeping inventories at a set level, not specifically to identify wastes. Jidoka is an advanced tool to stop the line when defects occur, to prevent passing on bad quality and remedy the defect immediately. It can be used when quality levels are already adequate. 5-Whys is used to identify the root cause of an issue.
B) Incorrect.
C) Incorrect.
D) Incorrect.

41 / 60
A supplier of wooden poles measures the length of poles produced by two employees Harry and Edward. The results are in the table below:

Employee	n	Mean	StdDev
Harry	15	71	3.2
Edward	25	69	2.8

They test the difference between the average lengths of the poles (two-sided with α = 0.05) and assume equal variances.

What is the p-value and the conclusion?

A) P-value = 0.045 and there is a significant difference in length.
B) P-value = 0.045 and there is no significant difference in length.
C) P-value = 0.056 and the difference in length is significant.
D) P-value = 0.056 and they need more samples to demonstrate the difference.

A) Correct. Perform a 2-sample t-test (comparing 2 samples to each other), using the summarized data (as given):

Under Options... check 'Assume equal variances' as suggested by the question. Checking the outcome of the test (P=0.045), it may be stated that the mean difference in length is statistically significant.

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
2,07	38	0,045

B) Incorrect.
C) Incorrect.
D) Incorrect.

42 / 60
Who makes the project charter in a Lean Six Sigma project?

A) The Black Belt as a coach
B) The Champion
C) The process owner
D) The project leader

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The project leader (Belt) creates the project charter. The Champion must approve the project charter. The coach (here a Black belt) supports the project leader in creating the project charter. The process owner can give relevant input for the charter.

43 / 60
Using Lean Six Sigma methodology, what will be the failure rate for a company at 5 sigma level?

A) 3.4 ppm
B) 233 ppm
C) 1350 ppm
D) 6210 ppm

A) Incorrect.
B) Correct. Using a sigma level reference table, a 5-sigma level process has a defect per million opportunities (DPMO) of 233 ppm. (Literature: A, Table F.1)
C) Incorrect.
D) Incorrect.

44 / 60
Given the information below and using a 5% significance level.

	Rocket A	Rocket B
Sample size	61 readings	45 readings
Variance	1,347 km^2	2,137 km^2

Does the range of rocket type B have a larger variance than the range of rocket type A?

A) No significant difference, because p-value < 0.05
B) No significant difference, because p-value > 0.05
C) Significant difference, because p-value < 0.05
D) Significant difference, because p-value > 0.05

A) Incorrect.
B) Incorrect.
C) Correct. Test for two-sample variances. As alternative hypothesis, choose 'Ratio < hypothesized', to discern if Sample 1 variance is smaller than Sample 2 variance. The p-value is 0.048 so the null hypothesis is rejected and the hypothesis that Rocket B has a larger variance is accepted:

Test

Null hypothesis $H_0: \sigma_1^2 / \sigma_2^2 = 1$
Alternative hypothesis $H_1: \sigma_1^2 / \sigma_2^2 < 1$
Significance level $\alpha = 0.05$

Method	Test Statistic	DF1	DF2	P-Value
F	0,63	60	44	0,048

D) Incorrect.

45 / 60
What is **not** a benefit of a designed experiment?

A) Analyzes different combinations of inputs
B) Identifies main and interaction effects
C) Preparation time is short
D) Relatively low cost to implement

A) Incorrect.
B) Incorrect.
C) Correct. A Design of Experiments (DOE) reduces the number of test runs compared to the One factor at a time (OFAT) method, which makes it very efficient. Through a balanced design of variations of input parameters, one can plan what set of inputs and their interactions are identified or analyzed. The DOE requires careful planning and hence takes more preparation time than the OFAT method.
D) Incorrect.

46 / 60
See the dataset below:

7, 6, 9, 8, 5, 7

What is the standard deviation?

A) 1.2
B) 1.4
C) 1.9
D) 2.0

A) Incorrect.
B) Correct. Either calculate s by hand using the formula in the literature or input the numbers into statistical software to find a standard deviation of 1.414. Minitab output:

Statistics

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
C1	6	0	7,000	0,577	1,414	5,000	5,750	7,000	8,250	9,000

C) Incorrect.
D) Incorrect.

47 / 60
In the following ANOVA table, a p-value is missing.

Source	SS	DF	MS	F	p
Material	327	3	109	4.36	?
Machine	180	5	36	1.44	0.32
Interaction	375	15	25	1.00	0.53
Error	175	7	25		
Total	1057	30			

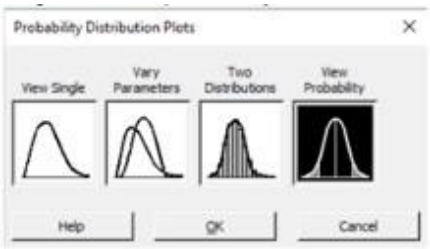
What is the missing p-value?

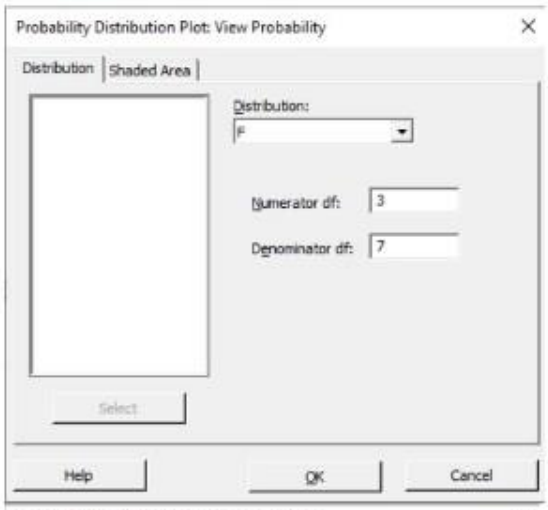
A) 0.03
B) 0.05
C) 0.07
D) 0.10

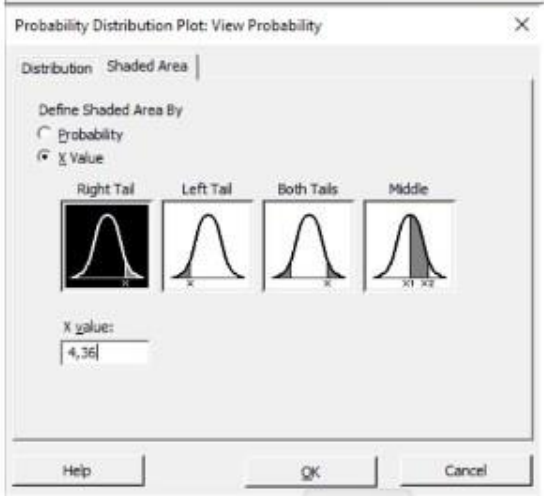
Feedback on the next page.

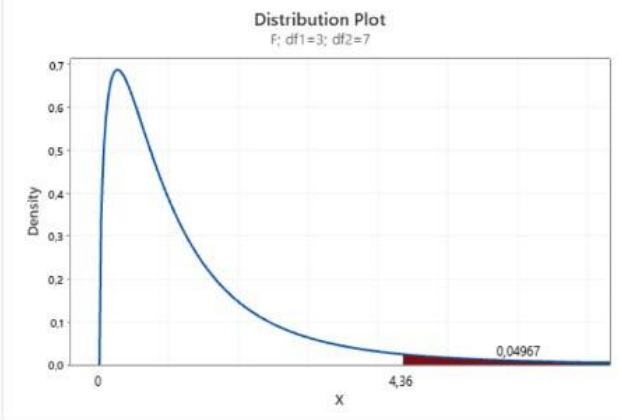
A) Incorrect.

B) Correct. This can be solved by using the F-distribution table or by using statistical software. The key to understanding is knowing the significance of the signal (Material variable) versus the error. The F-distribution should be used, with 3 degrees of freedom (df) for the factor Material, and 7 df for the error (see provided table). Using an F-distribution table for standard α = 0.05, look up the intersection of the number of df of the numerator v1 (3) and the number of df of denominator v2 (7). Find that 4.35 is listed as the critical value. This is slightly lower than the provided F-value of 4.36, which provides a p-value (left-sided) of just below 0.05. Alternatively, in Minitab, use 'Graph', then 'Probability Distribution Plot', to find the exact p-value and round this to 0.05:









C) Incorrect.

D) Incorrect.

48 / 60
On ten consecutive days, three parts were sampled from a process to analyze the stability of the process.

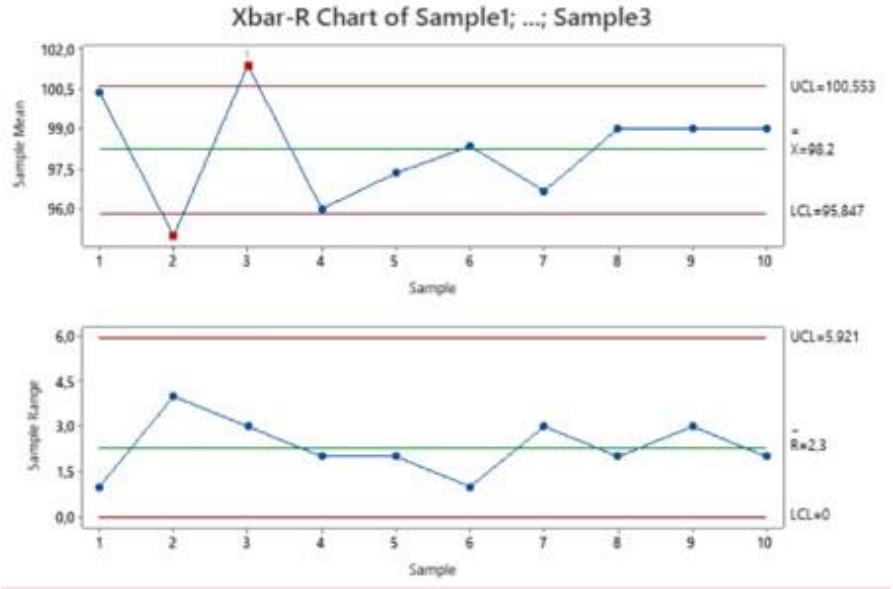
The specification range is 98 ± 6.

Subgroup	Sample1	Sample2	Sample3
1	100	101	100
2	95	93	97
3	101	103	100
4	96	95	97
5	98	98	96
6	99	98	98
7	95	97	98
8	100	99	98
9	100	100	97
10	100	98	99

Which statement is true?

A) The process is out-of-control. The control limits of the mean are at 95.9 and 100.5.
B) The process is stable. The control limits of the mean are at 95.9 and 100.5.
C) The variation and mean are both out-of-control.
D) The variation and mean are stable in time.

A) Correct. Enter the data in suitable statistical software such as Minitab. Plot the data in an Xbar-R chart. Control limits are 100.5 and 95.9 (mind the rounding towards the mean). Points 2 and 3 are outside the upper and lower control limits (UCL/LCL) and fail Test 1, so the process is out of control, even though it is well within specification limits. Depending on the priority, the cause for being out of control should be investigated and addressed.



B) Incorrect.
C) Incorrect.
D) Incorrect.

49 / 60
A Belt wants to visualize and examine the center and spread of the data.

What can the Belt **best** use?

A) Box plot
B) Interval plot
C) Scatter plot
D) Time Series Plot

A) Correct. A box plot yields a simplified graphical overview of the distribution of data points within a dataset: the center (median), the box (upper- and lower quartile representing the middle 50% of the data), and whiskers (lower and upper limit, and possible outliers). An interval plot looks similar to a box plot but is used to assess confidence intervals of the means of groups, showing a 95% confidence interval for the mean of each group. A scatter plot is used to visually investigate the potential relationship between two variables. A times series plot investigates performance over time.
B) Incorrect.
C) Incorrect.
D) Incorrect.

50 / 60
Why should a project charter be set up?

A) To describe the objective of the project
B) To estimate the benefits
C) To get a clear view on the problem
D) All of the above

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The project charter is a communication tool which shows immediately what the problem is, what the project aims to solve, and what the benefits to the organization will be. All given answer options are correct.

51 / 60
There is a requirement for a Belt to perform a statistical test in order to demonstrate a difference in performance between two processes. The Belt states a null hypothesis and an alternative hypothesis. The Belt decides to use a confidence level (1- α) = 0.95, calculates the sample sizes needed and conducts the test. The calculated significance of the test statistic is p = 0.72.

Which should be the result of the statistical test and the conclusion about the processes?

A) The null hypothesis is not rejected. There is not enough evidence that the processes are different.
B) The null hypothesis is rejected. The processes are different.
C) The alternative hypothesis is accepted. The processes are different.
D) The alternative hypothesis is rejected. The processes are different.

A) Correct. The desired significance level is α = 1 - 0.95 = 0.05. Since p > 0.05, the null hypothesis may not be rejected, and it may be assumed that the two processes perform the same. Although this means the alternative hypothesis is rejected and not accepted, there is not enough evidence that the processes are different.
B) Incorrect.
C) Incorrect.
D) Incorrect.

52 / 60
After returning from a two-week vacation a manager reviewed the Xbar and R charts that were maintained during the manager's absence. One of the Xbar charts shows the last 50 points to be very near the center line. In fact, they all seem to be within about one sigma of the center line.

What is the **best** explanation for this occurrence?

A) It shows that the operators did a very good job keeping the process close to target.
B) Somebody restored the original, wider control limit calculation.
C) The process standard deviation has decreased and the control limits were not recomputed.
D) There has been poor quality performance for quite some time.

A) Incorrect.
B) Incorrect.
C) Correct. This situation will be flagged by Out-of-Control Test 7 in Minitab. The occurrence indicates that the standard deviation of the measured process has reduced while no change in the mean has been noted. If there has been a poor-quality performance for quite some time, it is expected that either the data show a shift or an increased standard deviation. There is no information in the scenario to indicate what the target should be. There is an assumption here that the center line (the mean of the mean of the sampled values at the time that the control limits were calculated) is the target, but this is not necessarily true.
D) Incorrect.

53 / 60
Control chart rules are used to identify unusual events. Some rules indicate out-of-control situations.

Which rule gives a signal, but does **not** indicate an out-of-control situation?

A) 1 point more than 3 standard deviations from center line
B) 2 out of 3 points more than 2 standard deviations from center line (same side)
C) 6 points in a row, all increasing or all decreasing
D) 15 points in a row within 1 standard deviation of center line (either side)

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. To identify special-cause variation, seven tests with their respective rules are used. Test 7 signals that 15 consecutive datapoints are within 1 sigma of the center line. Though this is usually good for the process, it could mean that a significant improvement of the process has occurred. The cause should be identified, and if an improvement has taken place, ensure it is properly secured. Then the control limits are to be recalculated for the new situation. Test 1 signals that 1 point is more than 3 standard deviations from the center line, indicating an out-of-control situation for a disturbance of the process. Test 5 signals that 2 points out of 3 points are more than 2 standard deviations from the center line (same side), indicating an out-of-control situation or small shift in the process. Test 3 signals that 6 points in a row are all increasing or decreasing, indicating an out-of-control situation of a trend (drift) in the process.

54 / 60
Given the following output of a gage R&R study:

Source	% Study Variation
Total Gage R&R	9.52
Repeatability	7.70
Producibility	5.59
Operator	5.59
Part-to-part	99.5
Total Variation	100.00

A few statements are made about this:

1. The %contribution of Total Gage R&R is about 10%.
2. There is no part * operator interaction.
3. The measurement system is classified as ideal.
4. Part-to-part is the largest cause of study variation.

What can be deduced from the study?

A) 1, 2, 3
B) 1, 2, 4
C) 1, 3, 4
D) 2, 3, 4

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The %contribution = (%study variation)^2, so %contribution of Total Gage R&R = (0.0952)^2 = 0.009 = 0.9%. This is about 1%, not 10%. Reproducibility consists of operators, and part * operator interaction but only if it is significant. The absence of part * operator from the study indicates that the interaction is indeed insignificant. A measurement system with a Study Variation for the Total Gage R&R value of below 10%, as is the case here, is classified as an ideal measurement system. The Total study variation consists of Part-to-Part variation and Total Gage R&R variation. The part-to-part variation is very large compared to the Total Gage R&R variation and is indeed the largest cause of study variation.

55 / 60
An Xbar-R control chart is based on a sample size of 4. An operator mistakenly samples 2 parts instead of 4. The average and the range of the 2 observations are plotted on the control chart.

Which statement **best** describes the effect of this mistake?

A) Increase the probability that the R chart shows an out-of-control condition
B) Increase the probability that the Xbar chart shows an out-of-control condition
C) Observations from a sample of 2 will always be nearer the center lines of the charts
D) Will not cause any misjudgments if the process is in control

A) Incorrect.
B) Correct. A sample size of 2 would have a standard deviation of the population mean of $\sigma / \sqrt{2} = 0.707\sigma$, whereas a sample size of 4 would have a standard deviation of the population mean of $\sigma / \sqrt{4} = 0.5\sigma$. It is expected to see more variability in the sample of two parts and it is likely that the plotted mean will be further away from the center line of the Xbar chart. The prediction interval for a sample size of 2 = (n - 1) / (n + 1) = 33%, which means the probability that a third measure lands outside of the existing 2 observations is 66%. Thus, a smaller sample is always expected to have a smaller Range (R). It is likely that the Range for a sample size of 2 is smaller than average and likely to be further (lower) from the center line of the R-chart.
C) Incorrect.
D) Incorrect.

56 / 60
A 2-level full factorial design with 4 quantitative factors A, B, C and D is created. 4 center points and no replicates are used. The results of the analysis are below.

Factorial Regression: Response versus A; B; C; D

Analysis of Variance (ANOVA)

Source	DF	Adj ss	Adj ms	f-value	p-value
Model	11	2802.20	254.75	58.65	0.000
Linear	4	2701.25	675.31	155.47	0.000
A	1	256.00	256.00	58.94	0.000
B	1	2304.00	2304.00	530.42	0.000
C	1	20.25	20.25	4.66	0.063
D	1	121.00	121.00	27.86	0.001
2-Way Interactions	6	93.75	15.62	3.60	0.049
A*B	1	4.00	4.00	0.92	0.365
A*C	1	2.25	2.25	0.52	0.492
A*D	1	0.00	0.00	0.00	1.000
B*C	1	6.25	6.25	1.44	0.265
B*D	1	81.00	81.00	18.65	0.003
C*D	1	0.25	0.25	0.06	0.816
Curvature	1	7.20	7.20	1.66	0.234
Error	8	34.75	4.34		
Lack-of-Fit	5	6.00	1.20	0.13	0.976
Pure Error	3	28.75	9.58		
Total	19	2836.95			

What can be concluded from the results table using a 5% significant level?

A) 3 main effects and the 2-way interaction B*D are significant.
B) All response observations are unusual; no conclusions can be made from this experiment.
C) Main effects A and C are significant.
D) There is no significant main effect, just 2 way interactions B*D and A*C.

A) Correct. The p-value for the model is lower than 0.05 and is therefore significant at the 5% level. This means we can make conclusions with 95% confidence. The p-values for main effects A, B, D, and interaction B*D are all smaller than 0.05 and, therefore, significant at the 5% level. Main effect C is not significant. There is no information presented that indicates that the response observations are unusual.
B) Incorrect.
C) Incorrect.
D) Incorrect.

57 / 60
The following 10 measurements were provided by an appraiser.

The True Value is 0.80mm.

1 = 0.75	6 = 0.80
2 = 0.75	7 = 0.75
3 = 0.80	8 = 0.75
4 = 0.80	9 = 0.75
5 = 0.65	10 = 0.70

What is the bias measurement in this system?

A) -0.05
B) 0.05
C) 12.50
D) 13.33

A) Correct. Bias is the difference between the observed average and the True Value. Bias = observed average - True Value = 0.75 - 0.80 = -0.05.
B) Incorrect.
C) Incorrect.
D) Incorrect.

58 / 60
A Lean Six Sigma project must be addressed in phases. The DMAIC roadmap is used to do this.

What do the letters D, M, and A in this abbreviation stand for?

A) Define, Manufacture, and Analyze
B) Define, Measure, and Activate
C) Define, Measure, and Analyze
D) Determine, Measure, and Analyze

A) Incorrect.
B) Incorrect.
C) Correct. DMAIC: Define, Measure, Analyze, Improve, Control.
D) Incorrect.

59 / 60
Please read the Critical to Quality (CTQ) steps:

1. Add additional CTQ levels as needed
2. Identify the customer's needs
3. Identify the customers
4. Validate the requirements with the customer
5. Identify the customer's basic requirements

What is the appropriate time sequence to arrange these CTQs from start to finish?

A) 2, 3, 4, 1, 5
B) 2, 3, 5, 4, 1
C) 3, 2, 4, 5, 1
D) 3, 2, 5, 1, 4

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The Voice of the Customer (VOC) identifies the customers and documents their needs. The CTQ tree translates the needs into measurable requirements, adding additional levels as needed. As a conclusion, it yields the most important parameter (Y) the project will address and for which it will find the most important x as Y = f(x) in Analyze. Therefore, it is crucial to validate with the customer that the right Y has been selected.

60 / 60
What does takt time mean?

A) The average time between consecutive customer orders
B) The average time between consecutive order deliveries
C) The average time between order and delivery
D) The shortest time between consecutive customer orders

A) Correct. The formal definition of takt time is: takt time = total available time / customer demand. This corresponds to the average time between two customer orders, not to the shortest time between orders. The average time between orders (takt time) can be different from the average time between two deliveries (cycle time). The time between customer order and delivery is called lead time.
B) Incorrect.
C) Incorrect.
D) Incorrect.

Evaluation

The table below shows the correct answers to the questions in this sample exam.

Question	Answer	Question	Answer
1	A	**31**	A
2	D	**32**	D
3	A	**33**	D
4	A	**34**	D
5	D	**35**	C
6	B	**36**	C
7	D	**37**	C
8	B	**38**	D
9	D	**39**	C
10	A	**40**	A
11	B	**41**	A
12	D	**42**	D
13	D	**43**	B
14	A	**44**	C
15	D	**45**	C
16	D	**46**	B
17	D	**47**	B
18	D	**48**	A
19	D	**49**	A
20	C	**50**	D
21	A	**51**	A
22	A	**52**	C
23	D	**53**	D
24	C	**54**	D
25	D	**55**	B
26	D	**56**	A
27	C	**57**	A
28	A	**58**	C
29	A	**59**	D
30	B	**60**	A

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