Sample Exam

Edition 202404

Content

Introduction

This is the EXIN LSSA Lean Six Sigma Black Belt (LSSBB.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
An organization is struggling with low performance in terms of quality, profitability, and productivity.

Why should this company consider a Lean transformation?

A) Lean focuses in particular on the needs of the organization.
B) Lean focuses primarily on increasing efficiency.
C) Lean is cheap, with little to no costs.
D) Lean offers opportunities for improving business processes.

2 / 60
A program of process improvement projects is to be initiated across a chain of tire and exhaust fitting outlets. A program manager will be required to lead this change, employing multiple analytical tools to assess current and potential performance targets.

Who should be assigned this program manager role?

A) Champion
B) CEO/Director
C) Black Belt
D) Yellow Belt

3 / 60
Please read the following delivery features:

1. Product packaged to arrive safely
2. Next day delivery achieved on a five-day service
3. Free surprise gift with every order
4. Very high-quality wrapping materials

According to KANO, which delivery features might cause a customer to be highly satisfied if fulfilled?

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

4 / 60
The manager of a cafe has created a list of customer requirements by listening to complaints, taking surveys, holding focus groups and conducting interviews. In order to understand what it is that fulfils customer needs, the manager has defined the following Critical to Quality (CTQs):

Quality Driver	Critical to Quality (CTQ)
Price	- Range € 2.00 till € 3.50
Choice	- Number of brands offered - Tasty coffee - Fresh: no older than 5 minutes
Staff	- Pleasant service - Prompt service: less than 5 minutes
Ambiance	- Pleasant and clean

Is the data an appropriate translation of the Voice of the Customer (VOC) into CTQ metrics?

A) Yes, because the quality drivers cover a wide range of factors.
B) Yes, because this diagram should identify the factors of influence.
C) No, because 'Ambiance' and 'Choice' are subjective and not operationalized.
D) No, because the price should be a single fee rather than a range.

5 / 60
ABC & Company is introducing a Business Balanced Scorecard (BSC) to align all existing business activities with the company's vision statement.

Which factor should be considered from the business process perspective?

A) Duplicate activities across functions
B) Expertise required to do the job
C) Profitability and return on investment
D) Quality performance per customer

6 / 60
The costs and benefits of an improvement project are summarized in the table below.

	Year 0	Year 1	Year 2
Cost of Team	€ 10,000	€ 0	€ 0
Capital Cost	€ 20,000	€ 0	€ 0
Reduction in Defects	€ 0	€ 15,000	€ 15,000
Resources Redeployed	€ 0	€ 9,000	€ 9,000

An interest rate of 5% can be assumed for the cost of money.

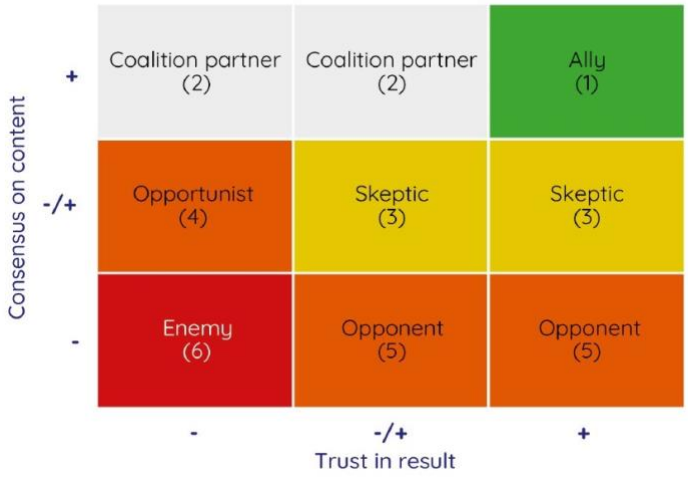
Please read the following:

1. The ROI at year 1 is -20%.
2. The ROI at year 2 is 60%.
3. The NPV is €14,600.
4. The NPV is €13,900.

Which statements are true?

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

7 / 60
The sales director of a vehicle breakdown recovery company has voiced concerns about the introduction of a new sales process. While fully supporting the need for a change to the existing process, the sales director has little confidence that it will be readily adopted by the sales teams and does not believe it will be successful.



What is the relationship of the sales director to this project?

A) Ally
B) Coalition partner
C) Opponent
D) Skeptic

8 / 60
Which statement does **not** describe a 'lessons learned' from an improvement project?

A) A company facing increasing pressure to cut costs and speed up lead times must implement internal controls and invest in new technology.
B) Drawing up a contract with the Ministry of Trade and Industry is a longer process than expected, and compensation should be sought for this.
C) The purchasing department's experience indicates that delays usually occur when contracts with third-party suppliers do not include a time frame within which delivery for the service is expected.
D) Two companies that provided technical support and that proved to be unreliable in other projects will not be identified as potential service providers.

9 / 60
A team of medical students has been working together for a few weeks. A query has been raised about the height/weight ratio used when calculating Body Mass Index. Having learned that one member of the team has a background in health and fitness training, the rest of the team turned to that member for guidance.

In what stage of development is this team?

A) Forming
B) Storming
C) Norming
D) Adjourning

10 / 60
A department within an organization is about to implement the 5S philosophy for the first time. No other department within the organization has any experience with this.

Which role should be appointed to manage this implementation?

A) Black Belt
B) Champion
C) Subject matter expert
D) Team member within the department

11 / 60
- A project is currently in week 9 of implementation.
- On the project's Gantt chart the delivery of certain materials by a supplier is planned in week 10.
- If this delivery is not received by week 15 the project will be delivered late.
- The supplier has promised that these materials should arrive by week 13.

How long can the delivery be delayed from the original delivery week without delaying the entire project (total float)?

A) 2 weeks
B) 3 weeks
C) 5 weeks
D) 6 weeks

12 / 60
Customers at a supermarket's self-service checkouts keep getting the error message 'please put the item in the bag', because they cannot open the plastic bags quickly enough.

Please read the following:

1. The customer's experience when opening a plastic bag takes longer than the checkout allows
2. Which parts of the scanning, bagging, and weighing process are involved
3. The average time to open a bag; the average time taken for the error message to appear
4. Who has the most influence out of the customer, bag supplier and software supplier

In the DMAIC roadmap, which of these are determined before the Define phase Gate Review?

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

13 / 60
A packaging manufacturer produces high volume packaging solutions for a range of high-profile customers. A production line operator has identified a defect in a carton they are producing. The perforation strip used to open each carton is not being properly perforated, so when a customer attempts to open a carton, the strip will not tear.

A Non-Conformity Report (NCR) has been completed.

Applying the Eight Disciplines (8D) problem solving method, what action should **not** be taken next?

A) Blocking parts in transit which could have the quality problem
B) Finding out which similar parts could also have this quality problem
C) Shut down the production line immediately and solve the problem
D) Starting additional quality checks to prevent the escape of problem parts

14 / 60
An international airline, applying the Eight Disciplines (8D) problem solving method, has empowered a team to solve the following problem:

A large number of passengers has complained about the waiting time during boarding. Based on the internal performance tracking data, the average Waste (Muda) is 6 minutes per boarding session.

There is no short-term fix available for this problem.

What is the next step this team should take?

A) Appoint a cross-functional team to analyze the problem
B) Create a cause & effect diagram to identify the most likely cause(s) of the problem
C) Identify alternative boarding systems that might resolve the problem
D) Improve quality systems to prevent this problem happening in the future

15 / 60
The director of a laboratory has conducted a risk assessment for hazards. In response to the findings, the director has selected appropriate Personal Protective Equipment (PPE). The PPE has been provided to the employees. The use of PPE is to be described in a procedure. This procedure must be produced by the laboratory employees and enforced by the laboratory supervisor.

Which entry is **least** appropriate to be part of the standard operating procedure (SOP)?

A) Employees using PPE must be trained in proper selection, care, and use.
B) Eye protection equipment is available in the PPE cabinet and is personally assigned.
C) Laboratory supervisor to evaluate and update the use of PPE on a quarterly basis.
D) Safety glasses must meet the requirements of ANSI Z87.1 (latest edition).

16 / 60
Which is a purpose of monitoring, evaluation, and auditing?

A) Ensures compliance with mandatory laws or regulatory ISO's
B) Helps to identify the root causes of problems
C) Identifies and generates warnings about significant risks
D) Identifies who is responsible for product/service deviations

17 / 60
What is the core of performance management?

A) Discussing and setting personal goals with individual employees
B) Discussing performance on KPIs established in the organization
C) Discussing the support that is necessary and the risks employees see
D) Looking back on yesterday's workday and looking forward to today

18 / 60
Which statement does **not** belong to the kaizen foundation?

A) Profit is number one
B) Quality is number one
C) Standardized work
D) The customer is the next process step

19 / 60
Why is visualization of data useful?

A) Visualization enables the organization to be 80% correct today, rather than 100% correct in 6 months.
B) Visualization encourages out-of-the-box thinking to generate as many ideas as possible.
C) Visualization identifies and eliminates the root cause of faults or problems.
D) Visualization makes it possible to draw conclusions from a large amount of data.

20 / 60
The manager of an online travel agency is reviewing its current processes to identify any areas for improvement. All processes are to be described separately for discussion and consideration at the next team meeting.

Which activity should be described as a physical process?

A) Deal with customer complaint
B) Send tickets and payment receipt by mail to customer
C) Take payment for booking
D) Update website with customer features and functionality

21 / 60
What does a high OEE index indicate?

A) A machine does not need much maintenance.
B) A machine is being exploited very effectively as compared to the so-called "ideal" machine.
C) A machine is running almost all the time with only a few stops.
D) A machine is running optimally in terms of the 8 Lean 'Waste (Muda)' categories.

22 / 60
What is the **best** way to measure the 'on-time' performance of the national railways?

A) Calculate the difference between the scheduled departure time and the actual departure time over a period of a month
B) Check the internet to record the departure time for each train over a period of a month
C) Record the number of trains that left at the scheduled departure time over a period of a day
D) Record the number of trains that left at the scheduled departure time over a period of a month

23 / 60
Calculate takt time using the following information:

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

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

24 / 60
Given the process below with 4 sequential process steps A through D:

Process step	Input	FTR	Waste	Rework	Output
A	80	72	5	3	75
B	75	66	5	4	70
C	70	56	10	4	60
D	60	45	10	5	50

What is the Total Process Yield and Rolled Throughput Yield?

A) Total Process Yield = 47.5% and Rolled Throughput Yield = 62.5%
B) Total Process Yield = 56.3% and Rolled Throughput Yield = 62.5%
C) Total Process Yield = 62.5% and Rolled Throughput Yield = 47.5%
D) Total Process Yield = 62.5% and Rolled Throughput Yield = 56.3%

25 / 60
Given the dataset: 2, 5, 6, 9, 8, 5, 7

What is the Range (R)?

A) 1
B) 5
C) 6
D) 7

26 / 60
Philips & Company manufactures screwdrivers. After a thorough market analysis, they have determined that customers prefer rubber handles over their current plastic handles. Customer research shows that they are willing to pay €1 more for this.

There is an additional cost of €0.60 per screwdriver for the production and logistics of the rubber handles.

Is there any added value in replacing the current screwdriver design with one with rubber handles?

A) Yes, because changing the design of a product adds value.
B) Yes, because customers are willing to pay more for this and it can be done profitably.
C) No, because rubber handles are not necessary for screwdrivers.
D) No, because there is an additional cost of €0.60 to produce screwdrivers with rubber handles.

27 / 60
An operational process consists of 5 sequential steps A through E. An improvement team creates the current state value stream map (VSM) and records the following process data:

Process Step	**A**	**B**	**C**	**D**	**E**
Processing Time (Seconds)	3.6	3	3.4	4.5	3.8
Stock (Pieces)	850	500	420	130	1100

The takt time is 5 seconds.

What is the value adding percentage?

A) 0.12%
B) 0.15%
C) 0.17%
D) 0.30%

28 / 60
What risk is imminent based on the information below?

Workdays:	20 per month
Shift length:	8 hours
Shifts:	3 per workday
Breaks:	60 minutes per shift
Down time:	20 minutes per shift
Cycle time:	30 seconds per product
Customer demand:	52,000 products per month

A) Overproduction (Muda)
B) Overprocessing (Muda)
C) Waiting (Muda)
D) Overburden (Muri)

29 / 60
Which is **not** a Waste (Muda)?

A) Inspection
B) Producing only what the market asks for
C) Rework
D) Transporting materials

30 / 60
A manufacturing plant has a number of inspections built into its production process. Many of these inspections are required to comply with health and safety regulations, some inspections are for quality control purposes, and two inspections are mandated by the customer.

Should any of these inspections be classed as Overprocessing or Waste (Muda)?

A) Yes, because the inspections mandated by a customer are unnecessary movement.
B) Yes, because the inspections measuring quality do not change the product.
C) No, because all inspections are classed as value adding.
D) No, because the mandated inspections are classed as a necessary activity.

31 / 60
- A continuous process has 5 consecutive steps.
- The time it takes for one person to process one piece is the process time.
- Assume a takt time of 4.5 minutes and process time without variation.
- In each 8-hour shift the employees take 30 minutes for lunch and two 15-minute breaks.

Step	WIP	Touch Time (Minutes)	Employees
A	10	8	2
B	40	15	3
C	2	3	1
D	10	20	5
E	2	12	4

What is the **best** action that can be taken to improve the Flow of this process?

A) Decrease the number of employees; the process is over-producing
B) Increase the number of employees; Work in Process (WIP) is increasing
C) Keep the total number of employees as it is now; train them on several tasks
D) Pay the employees to work on one 15-minute break on each shift

32 / 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

33 / 60
The changeover process of a mold in a press is described below:

1. Run empty / Stop production
2. Remove Mold A from the press
3. Clean and store Mold A
4. Pick up Mold B from storage
5. Adjust Mold B under the guidance of a mechanic specialist
6. Install Mold B in the press
7. Release production process by supervisor
8. Start production

Which activities should be eliminated, or made external, to reduce the changeover time?

A) 3, 4, 5
B) 3, 4, 7
C) 3, 7, 8
D) 4, 6, 7

34 / 60
A Failure Modes and Effects Analysis (FMEA) is conducted.

Which FMEA result would prioritize the development of mitigating actions to improve the inspection measures?

A) High severity, low occurrence, and medium detection risk ratings
B) Medium severity, high occurrence, and low detection risk ratings
C) Medium severity, medium occurrence, and medium detection risk ratings
D) Low severity, medium occurrence, and high detection risk ratings

35 / 60
A manufacturing company is replacing an existing horizontal saw with two new vertical cutting saws. These saws will guarantee accuracies to 0.0005", making it easier to accurately cut large panels into smaller size pieces whilst taking up less floor space.

At the early stages of the DMAIC project, in every customer focus group, customer interview and customer survey, the Voice of the Customer (VOC) specified the need for 'safety'.

The FMEA reviewed a number of potential safety issues and scored each of these with a relatively high Risk Priority Number (RPN).

The project leader has developed a Control plan to inspect and monitor product performance in detail, but this does not include any measures for safety.

Should this control plan be implemented?

A) Yes, because safety is not a Critical to Quality (CTQ) requirement.
B) Yes, because the project leader is better informed than the customer.
C) No, because a Control plan always includes measures that reduce high-risk safety issues.
D) No, because this plan should contain actions to minimize potential failures.

36 / 60
A courier company maintains statistics on all of its delivery routes. Past records show that route X takes between 10 and 15 minutes delivery time, depending on variations in traffic.

When checking the delivery records during the past week, the shift manager noticed that on Tuesday route X took 34 minutes to complete delivery. The shift manager has flagged this as a common cause variation and has proposed the use of bicycles which can move more easily through traffic jams than the vehicles they currently use.

Is this a valid observation?

A) Yes, because performance is outside of the normal upper and lower limits.
B) Yes, because the overall process should be improved so that variation is reduced.
C) No, because excessive traffic may have delayed the driver.
D) No, because this is a special cause variation that should be investigated further.

37 / 60
A scaffolding company is replacing its existing steel-bracketed scaffold system with a new 'Snapit' system. They want their new system to be light and easy to transport, and yet be as strong as the old system. They would like to reduce the time it takes to erect and dismantle the scaffold towers on site, and yet maintain the same level of stability as the old system.

How should the safety requirement be captured for the external Critical to Quality (CTQ)?

A) New system should survive a test bearing 150% of the specified load
B) 'Snapit' system must comply with legal requirements for load-bearing capacity and stability
C) Scaffold towers must be safe when used within specification
D) Scaffold towers should not collapse or fall over

38 / 60
Which description **best** describes the Toyota Kata philosophy?

A) According to a DMAIC roadmap, breakthroughs are being realized.
B) By repetitive practice and developing skills, continuous improvement becomes part of your daily work.
C) Customer demands are defined as Dissatisfiers, Satisfiers and Delighters.
D) With Toyota Kata the coach determines how a certain goal can be achieved in a structured way.

39 / 60
What is documented in the current state value stream map (VSM)?

A) Location of product defects
B) Material and information flows of a process
C) Opportunities for failure in the process
D) Optimal logistical flow through a process

40 / 60
- A random sample of size n is to be taken from a large population of wide tubes.
- The diameter of the parts has a standard deviation of 1 mm.
- A Black Belt wishes to estimate the true mean μ with a 95% confidence interval of 0.2 mm wide.

Which value is nearest to the required sample size?

A) 83
B) 165
C) 271
D) 385

41 / 60
Consider:
- a well-centered normally distributed process
- with a reported defect rate of 45,500 ppm (Parts per Million)
- and a tolerance of 20 units.

What is the standard deviation of this process?

A) 5
B) 6
C) 10
D) 12

42 / 60
A manufacturer of diagnostic devices wants to introduce a new device to the market. This device has a very high probability of failing.

- It is known that the probability of failure is constant within a batch.
- The batch size is 100.
- The batch is inspected by destructively testing a sample of 25 devices.
- The remaining devices are sent to the customer.
- A maximum of 50% failing devices is acceptable.

Which probability distribution should be used to calculate the acceptable number of failing devices in the sample?

A) Binomial distribution
B) Hypergeometric distribution
C) Normal distribution
D) Poisson distribution

43 / 60
The locknuts manufactured by one supplier must be compatible with bolts manufactured by another supplier. The locknuts must be produced within 0.02mm of the specified 6mm diameter.

What tool should be used to measure products against this given tolerance?

A) Calculator
B) Go/no-go gage
C) Ruler
D) Standard deviation

44 / 60
What can be quantified with a Gage R&R?

A) Both Reproducibility and Repeatability of a measurement system
B) Repeatability of a measurement system
C) Reporting and Repeating of a measurement system
D) Reproducibility of a measurement system

45 / 60
- The production time must be decreased by 1 minute.
- 25 samples are taken
- The standard deviation of the process is 2 minutes
- Assume normal distribution and use an alpha of 5%

What is the power of the test?

A) 14%
B) 19%
C) 80%
D) 86%

46 / 60
- In 2021, 2 types of Corona vaccines were tested on 2 groups of people.
- Each group contains 100 persons.
- A Black Belt recorded the number of affected and not affected people in both groups:

Vaccine	Negative	Positive
A	76	24
B	64	36

Which statement is true?

A) Both vaccines have no effect.
B) The Black Belt cannot say whether there is a significant difference between the vaccines or not.
C) There is no significant difference ($\alpha = 0.05$) between the vaccines.
D) Vaccine A is significantly better.

47 / 60
Given the following Analysis of Variance (ANOVA) table:

Source	DF	SS	MS	F	P
A	2	764.38	382.19	330.75	0
B	1	4.2	4.2	3.64	0.105
A*B	2	106.04	53.02	45.88	0
Error	6	6.93	1.16		
Total	11	881.55			

What statement can be made?

A) The main factor A has a significant effect on the response and the high R-sq indicates this model may be useful.
B) The main factor A has a significant effect on the response but R-sq is too low for this model to be useful.
C) The main factor B has a significant effect on the response and the high R-sq indicates this model may be useful.
D) The main factor B has a significant effect on the response but R-sq is too low for this model to be useful.

48 / 60
A dice is rolled 100 times. A goodness-of-fit analysis is performed with a confidence level of 95% and with the following data.

Category	Observed	Test Proportion	Expected	Contribution to chi-square
1	13	0.166667	16.667	0.80667
2	26	0.166667	16.667	5.22667
3	19	0.166667	16.667	0.32667
4	13	0.166667	16.667	0.80667
5	9	0.166667	16.667	3.52667
6	20	0.166667	16.667	0.66667

Please read the following:

1. The alternative hypothesis for the test is accepted.
2. The critical value for the chi-square statistic is 11.07 when the p-value equals 0.5.
3. The expected data follow a chi-square distribution.
4. The calculated chi-square statistic is insignificant at the 2.5% level.

Which statements are true?

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

49 / 60
An economist wants to predict how much a person is spending on a new car. 'Income', 'IQ', 'Age' and 'Vacation' (how much a person spends on a vacation) are included as predictor variables in a multiple linear regression analysis.

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-4574	1783	-2.56	0.022	
Income	0.5104	0.0806	6.33	0	11.04
IQ	8.9	20.3	0.44	0.667	1.65
Age	0.0	56.1	0.00	1	2.24
Vacation	0.27	1.79	0.15	0.001	9.08

What is true about this analysis?

A) One of two correlated variables must be removed from the analysis.
B) The final model can be derived by multiplying the Coef column of data by each term.
C) The final model should only contain the terms Constant, Income, and Vacation.
D) The predictor Age should be removed from the data and a new regression performed.

50 / 60
Given the following dataset:

A	B	C
6.935	14.2	2.265
1.523	13.1	0.597
2.599	12.7	1.237
4.009	15.2	1.649
4.687	14.7	2.312

Below are the results of the analysis to describe the variation of A, B and C with just two principal components.

Eigenvalue	2.4552	0.4614	0.0834
Proportion	0.818	0.154	0.028
Cumulative	0.818	0.972	1

Principal Component Analysis: A; B; C Eigenanalysis of the Correlation Matrix

Variable	PC1	PC2
A	0.593	-0.471
B	0.523	0.842
C	0.613	-0.263

Which variable accounts for the highest contribution to the total variability?

A) A contributes the least to the model for PC2.
B) B contributes the most to all the PCs.
C) PC1 accounts for the highest variance in the analysis.
D) PC2 accounts for the highest variance in the analysis.

51 / 60
On 10 consecutive days, 3 parts were sampled from a process to analyze the capability and the performance of the process.

The specification limits are LSL = 85 and USL = 105.

The customer asks for a Six Sigma process. The results are shown below.

Overall Capability	Potential (Within) Capability
PPL = 2.03	CPL = 3.37
PPU = 1.04	CPU = 1.73

Which statement can be made?

A) A Six Sigma project must be started to reduce the short-term spread.
B) All data is within specifications: the process performance meets the customer's requirements.
C) If the process is centered, the customer's requirement can be met.
D) The process has bad short-term capability because the Ppk value is too low.

52 / 60
To calculate process capability of non-normal data a Box-Cox transformation is used with a lambda = 0.5.

What would be the effect on the USL of 16 in the transformed graph?

A) Remains at 16
B) Changed to 4
C) Changed to 8
D) Changed to 256

53 / 60
Given the following dataset:

Temperature	Material	Yield
-1	-1	62
1	-1	74
-1	1	56
1	1	70

What is the temperature main effect in this 2^k factorial experiment?

A) -15
B) - 1
C) 13
D) 15

54 / 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

Source	DF	Adj ss	Adj ms	F-Value	P-Value
Mode	11	2802.2	254.75	58.65	0
Linear	4	2701.25	675.31	155.47	0
A	1	256	256	58.94	0
B	1	2304	2304	530.42	0
C	1	20.25	20.25	4.66	0.063
D	1	121	121	27.86	0.001
2-Way Interactions	6	93.75	15.62	3.6	0.049
A*B	1	4	4	0.92	0.365
A*C	1	2.25	2.25	0.52	0.492
A*D	1	0	0	0	1
B*C	1	6.25	6.25	1.44	0.265
B*D	1	81	81	18.65	0.003
C*D	1	0.25	0.25	0.06	0.816
Curvature	1	7.2	7.2	1.66	0.234
Error	8	34.75	4.34		
Lack-of-Fit	5	6	1.2	0.13	0.976
Pure Error	3	28.75	9.58		
Total	19	2836.95			

Evaluate the table. Use a 5% significant level.

What is the conclusion?

A) All response observations are insignificant.
B) Main effects A and C are significant.
C) There is no significant main effect, just 2-way interactions B*D and A*C.
D) 3 main effects and the 2-way interaction B*D are significant.

55 / 60
The Evolutionary Operations (EVOP) technique uses sequential experimentation. The first phase performed a 2-factor design all at 2 levels with center points. From the DOE the following response function was identified:

Y = 35 + 5a - 4b

- The target is to maximize the output.
- Start with a center point at (a = 28, b = 12).
- Use the path of the steepest ascent.
- The allowable 'a' step is 2 units.

What would be the center point for the next phase?

A) a = 30 and b = 9.5
B) a = 30 and b = 10.4
C) a = 26 and b = 13.6
D) a = 26 and b = 14.5

56 / 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 describes the effect of this mistake?

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

57 / 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 centerline. In fact, they all seem to be within about one sigma of the centerline.

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.

58 / 60
A bicycle manufacturer is planning to design and launch a new super-lightweight range of road bicycles. It is understood that the market for this range of products has grown exponentially with the boom in triathlons. Race participation has shown an increase of more than 300% in the past 3 years.

At which stage in the product lifecycle should the manufacturer forecast profits from this new range to reach its peak?

A) Decline
B) Development
C) Growth
D) Maturity

59 / 60
The design for a new camera is being developed.

When applying Designing for Excellence (DfX), which element is **not** a relevant factor?

A) How strong the camera casing should be to protect the camera lens
B) The number of pixels of the camera sensor
C) Whether the camera settings and buttons are easy to use and understand
D) Whether parts from other designs are being considered to use

60 / 60
Which tool can be used to translate a customer's requirements into appropriate company measures?

A) Cause and effect diagram
B) Quality function deployment (QFD)
C) SIPOC diagram
D) Value stream map (VSM)

Answer key

1 / 60
An organization is struggling with low performance in terms of quality, profitability, and productivity.

Why should this company consider a Lean transformation?

A) Lean focuses in particular on the needs of the organization.
B) Lean focuses primarily on increasing efficiency.
C) Lean is cheap, with little to no costs.
D) Lean offers opportunities for improving business processes.

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Lean offers opportunities for improving business processes to primarily add more value for the customers. So, the first focus is not on the needs of the organization or efficiency. Although a Lean transformation takes years and is not directly cheap, the company can solve the low quality and low productivity by improving business processes.

2 / 60
A program of process improvement projects is to be initiated across a chain of tire and exhaust fitting outlets. A program manager will be required to lead this change, employing multiple analytical tools to assess current and potential performance targets.

Who should be assigned this program manager role?

A) Champion
B) CEO/Director
C) Black Belt
D) Yellow Belt

A) Incorrect.
B) Incorrect.
C) Correct. Lean Six Sigma Black Belts are experts in executing Lean Six Sigma projects. As a program manager they are responsible for managing complex breakthrough projects and supporting improvement teams with tools and techniques. Black Belts have skills for applying both analytical tools and leading change. A Champion has a key management responsibility to be the principal of the project but has not the mentioned skills. This can be the CEO or Director. Team members are trained as Yellow Belts.
D) Incorrect.

3 / 60
Please read the following delivery features:

1. Product packaged to arrive safely
2. Next day delivery achieved on a five-day service
3. Free surprise gift with every order
4. Very high-quality wrapping materials

According to KANO, which delivery features might cause a customer to be highly satisfied if fulfilled?

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

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct.1. Product packaged to arrive safely: This is a must-have, a basic need that is taken for granted. Fulfilment of this attribute alone will not result in satisfaction, but when not fulfilled it will result in dissatisfaction. So, this feature is incorrect.
2. Next day delivery achieved on a five-day service: This is called a one-dimensional quality attribute. The more provided of this feature (at a certain price), the more the customer is satisfied. It can also mean 'the faster the better'.
3. Free surprise gift with every order and 4. Very high-quality wrapping materials: These attributes provide satisfaction when achieved but do not cause dissatisfaction when not. These attributes are extra benefits and beyond the customers' expectations.

4 / 60
The manager of a cafe has created a list of customer requirements by listening to complaints, taking surveys, holding focus groups and conducting interviews. In order to understand what it is that fulfils customer needs, the manager has defined the following Critical to Quality (CTQs):

Quality Driver	Critical to Quality (CTQ)
Price	- Range € 2.00 till € 3.50
Choice	- Number of brands offered - Tasty coffee - Fresh: no older than 5 minutes
Staff	- Pleasant service - Prompt service: less than 5 minutes
Ambiance	- Pleasant and clean

Is the data an appropriate translation of the Voice of the Customer (VOC) into CTQ metrics?

A) Yes, because the quality drivers cover a wide range of factors.
B) Yes, because this diagram should identify the factors of influence.
C) No, because 'Ambiance' and 'Choice' are subjective and not operationalized.
D) No, because the price should be a single fee rather than a range.

A) Incorrect.
B) Incorrect.
C) Correct. A CTQ Flowdown represents the key measurable characteristics of a product whose performance standards or specification limits must be met to satisfy the customer requirement. The terms tasty coffee, pleasant service and ambiance are not measurable enough and need a measurable definition. The range for price is okay as it can be measured. Yes, the quality drivers cover a wide range of factors, which is good, but this is not enough. They should be measurable. The effort of decomposing the VOC to a lower level should focus on responses and not on defining the factors of influence.
D) Incorrect.

5 / 60
ABC & Company is introducing a Business Balanced Scorecard (BSC) to align all existing business activities with the company's vision statement.

Which factor should be considered from the business process perspective?

A) Duplicate activities across functions
B) Expertise required to do the job
C) Profitability and return on investment
D) Quality performance per customer

A) Correct. Duplicate activities across functions would be an area under the business process perspective, i.e. metrics referring to how well the business is running and whether its products and services conform to customer requirements. Expertise required to do the job would be considered under the learning and growth perspective. Quality performance per customer would be considered under the customer perspective. Profitability and return on investment (ROI) would be considered under the financial perspective.
B) Incorrect.
C) Incorrect.
D) Incorrect.

6 / 60
The costs and benefits of an improvement project are summarized in the table below.

	Year 0	Year 1	Year 2
Cost of Team	€ 10,000	€ 0	€ 0
Capital Cost	€ 20,000	€ 0	€ 0
Reduction in Defects	€ 0	€ 15,000	€ 15,000
Resources Redeployed	€ 0	€ 9,000	€ 9,000

An interest rate of 5% can be assumed for the cost of money.

Please read the following:

1. The ROI at year 1 is -20%.
2. The ROI at year 2 is 60%.
3. The NPV is €14,600.
4. The NPV is €13,900.

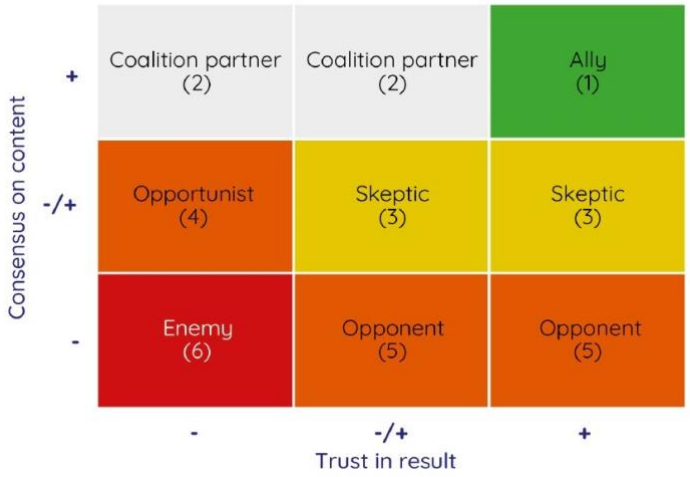
Which statements are true?

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

A) Correct. return on investment (ROI) at year 1 = (€15,000 + €9,000 - €10,000 - €20,000) / (€10,000 + €20,000) = -0.2 or -20%
ROI at year 2 = (€15,000 + €9,000 + €15,000 + €9,000 - €10,000 - €20,000) / (€10,000 + €20,000) = 0.6 or 60%
net present value (NPV) = (-€10, 000 - €20,000) + ((€15,000 + €9,000) / 1.05) + ((€15,000 + €9,000) / 1.05^2) = -30,000 + €22,857 + €21,769 = €14,626
B) Incorrect.
C) Incorrect.
D) Incorrect.

7 / 60

The sales director of a vehicle breakdown recovery company has voiced concerns about the introduction of a new sales process. While fully supporting the need for a change to the existing process, the sales director has little confidence that it will be readily adopted by the sales teams and does not believe it will be successful.



What is the relationship of the sales director to this project?

A) Ally
B) Coalition partner
C) Opponent
D) Skeptic

A) Incorrect.
B) Correct. The sales director is very supportive of the plan (+ on content) but has little confidence that the result will be achieved (- in result). This makes the sales director, following the table, a coalition partner.
C) Incorrect.
D) Incorrect.

8 / 60
Which statement does **not** describe a 'lessons learned' from an improvement project?

A) A company facing increasing pressure to cut costs and speed up lead times must implement internal controls and invest in new technology.
B) Drawing up a contract with the Ministry of Trade and Industry is a longer process than expected, and compensation should be sought for this.
C) The purchasing department's experience indicates that delays usually occur when contracts with third-party suppliers do not include a time frame within which delivery for the service is expected.
D) Two companies that provided technical support and that proved to be unreliable in other projects will not be identified as potential service providers.

A) Correct. The quote that "a company facing increasing pressure to cut costs and speed up lead times must implement internal controls and invest in new technology" is an (questionable) opinion and not a lesson learned from an improvement project. This knowledge cannot be used to promote the recurrence of desirable outcomes and prevent the recurrence of undesirable outcomes. All other answer options are suitable lessons learned.
B) Incorrect.
C) Incorrect.
D) Incorrect.

9 / 60
A team of medical students has been working together for a few weeks. A query has been raised about the height/weight ratio used when calculating Body Mass Index. Having learned that one member of the team has a background in health and fitness training, the rest of the team turned to that member for guidance.

In what stage of development is this team?

A) Forming
B) Storming
C) Norming
D) Adjourning

A) Incorrect.
B) Incorrect.
C) Correct. The five phases of team development are: forming, storming, norming, performing and adjourning.
- In the forming phase the first days or weeks, most team members are positive and polite. Some are anxious, as they have not fully understood what work the team will do.
- In the storming phase, people start to push against the boundaries established in the forming stage. Different work styles cause unforeseen problems and there may be conflict. People become frustrated. Team members may challenge authority, or jockey for position as their roles are clarified.
- In the norming phase, people start to resolve their differences, appreciate colleagues' strengths, and respect each other (the correct answer).
- In the adjourning phase, the team is dismantled and people are frequently just doing the last necessary things.

D) Incorrect.

10 / 60
A department within an organization is about to implement the 5S philosophy for the first time. No other department within the organization has any experience with this.

Which role should be appointed to manage this implementation?

A) Black Belt
B) Champion
C) Subject matter expert
D) Team member within the department

A) Correct. Although the 5S tool itself is very simple, the process of implementing the 5S philosophy across a department or an organization requires the competencies of a Black Belt who has Lean knowledge and expertise, and project management and management of change skills. A subject matter expert only has knowledge of the subject. A Champion has no 5S knowledge, similar to a team member.
B) Incorrect.
C) Incorrect.
D) Incorrect.

11 / 60
- A project is currently in week 9 of implementation.
- On the project's Gantt chart the delivery of certain materials by a supplier is planned in week 10.
- If this delivery is not received by week 15 the project will be delivered late.
- The supplier has promised that these materials should arrive by week 13.

How long can the delivery be delayed from the original delivery week without delaying the entire project (total float)?

A) 2 weeks
B) 3 weeks
C) 5 weeks
D) 6 weeks

A) Incorrect.
B) Incorrect.
C) Correct. Total float is defined as latest start time minus original delivery time: 15 – 10 = 5 weeks.
D) Incorrect.

12 / 60
Customers at a supermarket's self-service checkouts keep getting the error message 'please put the item in the bag', because they cannot open the plastic bags quickly enough.

Please read the following:

1. The customer’s experience when opening a plastic bag takes longer than the checkout allows
2. Which parts of the scanning, bagging, and weighing process are involved
3. The average time to open a bag; the average time taken for the error message to appear
4. Who has the most influence out of the customer, bag supplier and software supplier

In the DMAIC roadmap, which of these are determined before the Define phase Gate Review?

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

A) Incorrect.
B) Correct. 1. “The customer’s experience when opening a plastic bag takes longer than the checkout allows” is about the problem statement, part of the Define phase.
2. “Which parts of the scanning, bagging and weighing process are involved” is about the scope of the project, part of the Define phase.
3. “The average time to open a bag; the average time taken for the error message to appear” is about the measurement of the problem, part of the Measure phase.
4. “Who has influence on the process: the customer, the supplier of bags or the software supplier” is about the insights into the customers and the main suppliers, part of the Define phase.
C) Incorrect.
D) Incorrect.

13 / 60
A packaging manufacturer produces high volume packaging solutions for a range of high-profile customers. A production line operator has identified a defect in a carton they are producing. The perforation strip used to open each carton is not being properly perforated, so when a customer attempts to open a carton, the strip will not tear.

A Non-Conformity Report (NCR) has been completed.

Applying the Eight Disciplines (8D) problem solving method, what action should **not** be taken next?

A) Blocking parts in transit which could have the quality problem
B) Finding out which similar parts could also have this quality problem
C) Shut down the production line immediately and solve the problem
D) Starting additional quality checks to prevent the escape of problem parts

A) Incorrect.
B) Incorrect.
C) Correct. Once the problem has been described (NCR), Step 3 – Develop Interim Containment Actions (ICA) is the next step. An ICA must be defined to guarantee that good parts will still be delivered, but at the same time no bad parts will be delivered. So, finding out which parts could also have this quality problem and doing quality checks to prevent delivering problem parts, are sensible actions. Shutting down the line until the root cause is solved would mean that the customer, or the next line in the process, would not receive any good parts.
D) Incorrect.

14 / 60
An international airline, applying the Eight Disciplines (8D) problem solving method, has empowered a team to solve the following problem:

A large number of passengers has complained about the waiting time during boarding. Based on the internal performance tracking data, the average Waste (Muda) is 6 minutes per boarding session.

There is no short-term fix available for this problem.

What is the next step this team should take?

A) Appoint a cross-functional team to analyze the problem
B) Create a cause & effect diagram to identify the most likely cause(s) of the problem
C) Identify alternative boarding systems that might resolve the problem
D) Improve quality systems to prevent this problem happening in the future

A) Incorrect.
B) Correct. Apparently, there is no short-term fix which implies that the steps of team establishment, problem description and the temporarily containment actions have been taken. The next step is to find the root cause of the problem. This can be done by using the cause & effect diagram. The other answer options reflect steps already taken (appointment of the team) or steps following the root cause analysis step (identifying alternative boarding systems as permanent corrective actions and improving quality systems to prevent reoccurrence).
C) Incorrect.
D) Incorrect.

15 / 60
The director of a laboratory has conducted a risk assessment for hazards. In response to the findings, the director has selected appropriate Personal Protective Equipment (PPE). The PPE has been provided to the employees. The use of PPE is to be described in a procedure. This procedure must be produced by the laboratory employees and enforced by the laboratory supervisor.

Which entry is **least** appropriate to be part of the standard operating procedure (SOP)?

A) Employees using PPE must be trained in proper selection, care, and use.
B) Eye protection equipment is available in the PPE cabinet and is personally assigned.
C) Laboratory supervisor to evaluate and update the use of PPE on a quarterly basis.
D) Safety glasses must meet the requirements of ANSI Z87.1 (latest edition).

A) Incorrect.
B) Incorrect.
C) Correct. Ensuring the SOP is followed consistently over time is crucial. Establishing an evaluation and review system will ascertain that over time all the steps of a SOP are still relevant and appropriate for the production system. Although it is relevant, evaluation and updating is not part of the SOP itself. All other answer options are part of the SOP: training, the requirements of the PPE, where the PPE can be found, and how it is assigned.
D) Incorrect.

16 / 60
Which is a purpose of monitoring, evaluation, and auditing?

A) Ensures compliance with mandatory laws or regulatory ISO's
B) Helps to identify the root causes of problems
C) Identifies and generates warnings about significant risks
D) Identifies who is responsible for product/service deviations

A) Incorrect.
B) Incorrect.
C) Correct. Auditors should assist the organization by identifying and evaluating significant exposures to risks. Next steps are to identify what the root cause of problems are and who can help solve them. This should not become about blaming responsible persons. Compliance is not a goal as such.
D) Incorrect.

17 / 60
What is the core of performance management?

A) Discussing and setting personal goals with individual employees
B) Discussing performance on KPIs established in the organization
C) Discussing the support that is necessary and the risks employees see
D) Looking back on yesterday's workday and looking forward to today

A) Incorrect.
B) Correct. The key to performance management is the dialogue about delivered and to be delivered performance. The form can be by looking back on and forward to a day. Essential is that performances are the central subject. This can also include employee satisfaction results. Because of discussing performances to be delivered in the future, one can discuss risks and support needed. Personal goal setting supports performance management.
C) Incorrect.
D) Incorrect.

18 / 60
Which statement does **not** belong to the kaizen foundation?

A) Profit is number one
B) Quality is number one
C) Standardized work
D) The customer is the next process step

A) Correct. Kaizen, or improving step by step, is frequently connected to standardized work, adding value for customers, and quality. The 'customer' can also be a colleague executing the next step in the process. Profit will follow, as highly improved processes deliver quality products at low cost. So, profit is not the number one goal.
B) Incorrect.
C) Incorrect.
D) Incorrect.

19 / 60
Why is visualization of data useful?

A) Visualization enables the organization to be 80% correct today, rather than 100% correct in 6 months.
B) Visualization encourages out-of-the-box thinking to generate as many ideas as possible.
C) Visualization identifies and eliminates the root cause of faults or problems.
D) Visualization makes it possible to draw conclusions from a large amount of data.

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Visualization of data has two key purposes. The first purpose is to help in graphical data analysis to develop hypotheses regarding trends, groups, and correlations within the data. These hypotheses can then lead to further data collection and testing with the purpose of drawing a statistically valid conclusion. The second purpose of visualization of data is used to communicate findings and conclusions to others. The other answer options are other concepts. The Kaizen principle: better to be 80% right today than 100% right in six months. Identifying the root cause and eliminating a problem is done by the root cause analysis (RCA) method of problem solving. Generate as many ideas as possible: this can be a purpose of brainstorming.

20 / 60
The manager of an online travel agency is reviewing its current processes to identify any areas for improvement. All processes are to be described separately for discussion and consideration at the next team meeting.

Which activity should be described as a physical process?

A) Deal with customer complaint
B) Send tickets and payment receipt by mail to customer
C) Take payment for booking
D) Update website with customer features and functionality

A) Incorrect.
B) Correct. "Send tickets and payment receipt by mail to customer" is a physical process, which includes distribution, transportation, and logistics. "Update website with customer features and functionality", "deal with customer complaint" and "take payment for booking" are transactional processes.
C) Incorrect.
D) Incorrect.

21 / 60
What does a high OEE index indicate?

A) A machine does not need much maintenance.
B) A machine is being exploited very effectively as compared to the so-called "ideal" machine.
C) A machine is running almost all the time with only a few stops.
D) A machine is running optimally in terms of the 8 Lean 'Waste (Muda)' categories.

A) Incorrect.
B) Correct. A high OEE indicates that a machine has a high availability, performance, and quality. Such a machine is being exploited very effectively as compared to the so-called "ideal" machine. The needed level of maintenance cannot be derived from a high OEE, it might even be a high level. The other two answer options do not cover the essential topics of availability, performance, and quality completely.
C) Incorrect.
D) Incorrect.

22 / 60
What is the **best** way to measure the 'on-time' performance of the national railways?

A) Calculate the difference between the scheduled departure time and the actual departure time over a period of a month
B) Check the internet to record the departure time for each train over a period of a month
C) Record the number of trains that left at the scheduled departure time over a period of a day
D) Record the number of trains that left at the scheduled departure time over a period of a month

A) Correct. "Calculate the difference between the scheduled departure time and the actual departure time over a period of a month" is the best way to measure the ‘on-time’ performance of the national railways because it gives information about the number of delays but also about the quantity of the delays. "Record the number of trains that left on time (for a day or a month)" only gives information about the number of trains on time and delayed but not on the quantity of the delays. "Check the internet to record the departure time for each train over a period of a month" does not give any information whether the trains are on time or delayed because there is no information available on the scheduled time of departure.
B) Incorrect.
C) Incorrect.
D) Incorrect.

23 / 60
Calculate takt time using the following information:

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

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. takt time = available production time / customer demand = (21 * 2 * (8 – 1) * 3600) / 80000 = 13.23 seconds per piece
D) Incorrect.

24 / 60
Given the process below with 4 sequential process steps A through D:

Process step	Input	FTR	Waste	Rework	Output
A	80	72	5	3	75
B	75	66	5	4	70
C	70	56	10	4	60
D	60	45	10	5	50

What is the Total Process Yield and Rolled Throughput Yield?

A) Total Process Yield = 47.5% and Rolled Throughput Yield = 62.5%
B) Total Process Yield = 56.3% and Rolled Throughput Yield = 62.5%
C) Total Process Yield = 62.5% and Rolled Throughput Yield = 47.5%
D) Total Process Yield = 62.5% and Rolled Throughput Yield = 56.3%

A) Incorrect.
B) Incorrect.
C) Correct. Total Process Yield = output of the whole process / total number of products entering the process * 100% = (50 / 80) * 100% = 62.5%
Rolled Throughput Yield = (multiply for all process steps (FTR per process step/ number of products of process step)) * 100% = ((72 / 80) * (66 / 75) * (56 / 70) * (45 / 60) *100%) = 47.5%
D) Incorrect.

25 / 60
Given the dataset: 2, 5, 6, 9, 8, 5, 7

What is the Range (R)?

A) 1
B) 5
C) 6
D) 7

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. First sequence the numbers in numerical order. The Range is the absolute difference between maximum and minimum value of a data set (in this case 2 and 9), so the difference is 7.

26 / 60
Philips & Company manufactures screwdrivers. After a thorough market analysis, they have determined that customers prefer rubber handles over their current plastic handles. Customer research shows that they are willing to pay €1 more for this.

There is an additional cost of €0.60 per screwdriver for the production and logistics of the rubber handles.

Is there any added value in replacing the current screwdriver design with one with rubber handles?

A) Yes, because changing the design of a product adds value.
B) Yes, because customers are willing to pay more for this and it can be done profitably.
C) No, because rubber handles are not necessary for screwdrivers.
D) No, because there is an additional cost of €0.60 to produce screwdrivers with rubber handles.

A) Incorrect.
B) Correct. Yes, because customers are willing to pay more for this, so it adds value for the customer. And it can be done profitably, so it also adds value for the company. The answer option 'Yes, because changing the design of a product adds value.' is incorrect because this only takes the perspective of the customer.
C) Incorrect.
D) Incorrect.

27 / 60
An operational process consists of 5 sequential steps A through E. An improvement team creates the current state value stream map (VSM) and records the following process data:

Process Step	A	B	C	D	E
Processing Time (Seconds)	3.6	3	3.4	4.5	3.8
Stock (Pieces)	850	500	420	130	1100

The takt time is 5 seconds.

What is the value adding percentage?

A) 0.12%
B) 0.15%
C) 0.17%
D) 0.30%

A) Correct. The process can deliver the customer demand, since the takt time (5 seconds) is larger than the process time of the bottleneck (4.5 seconds). The process delivers a product every 5 seconds.
Throughput time = total Work in Process (WIP) * takt time = (850 + 500 + 420 + 130 + 1100) * 5 = 3000 * 5 = 15000 seconds
Value adding time = (3.6 + 3.0 + 3.4 + 4.5 + 3.8) = 18.3 seconds
Value adding percentage = value adding time / (throughput time + value adding time) = 18.3 / (15000 + 18.3) = 0.12%
B) Incorrect.
C) Incorrect.
D) Incorrect.

28 / 60
What risk is imminent based on the information below?

Workdays:	20 per month
Shift length:	8 hours
Shifts:	3 per workday
Breaks:	60 minutes per shift
Down time:	20 minutes per shift
Cycle time:	30 seconds per product
Customer demand:	52,000 products per month

A) Overproduction (Muda)
B) Overprocessing (Muda)
C) Waiting (Muda)
D) Overburden (Muri)

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Demand = 52,000 products per month
Production capacity = 20 days * 3 shifts * (480 minutes shift length - 60 minutes breaks - 20 minutes downtime) * 2 products per minute = 48,000 products per month
Demand capacity = production capacity / demand = 48,000 / 50,000 = 92%
This shows undercapacity (demand capacity < 100%), which leads to overburden.

29 / 60
Which is **not** a Waste (Muda)?

A) Inspection
B) Producing only what the market asks for
C) Rework
D) Transporting materials

A) Incorrect.
B) Correct. Overproduction is a waste. The opposite of overproduction is producing only what the market asks for, so this is not a waste. 'Transporting materials' is an example of the waste 'Transport', whereas 'rework' and 'inspection' are examples of the waste 'Overprocessing'.
C) Incorrect.
D) Incorrect.

30 / 60
A manufacturing plant has a number of inspections built into its production process. Many of these inspections are required to comply with health and safety regulations, some inspections are for quality control purposes, and two inspections are mandated by the customer.

Should any of these inspections be classed as Overprocessing or Waste (Muda)?

A) Yes, because the inspections mandated by a customer are unnecessary movement.
B) Yes, because the inspections measuring quality do not change the product.
C) No, because all inspections are classed as value adding.
D) No, because the mandated inspections are classed as a necessary activity.

A) Incorrect.
B) Correct. Overprocessing occurs any time that work is done to the product for which the customer is not willing to pay. Measuring quality and inspections are waste and classified as Overprocessing, because these are used for verification only and do not adjust or improve the quality of the product. The two inspections mandated by the customer are not a waste because they are essential for the customer.
C) Incorrect.
D) Incorrect.

31 / 60
- A continuous process has 5 consecutive steps.
- The time it takes for one person to process one piece is the process time.
- Assume a takt time of 4.5 minutes and process time without variation.
- In each 8-hour shift the employees take 30 minutes for lunch and two 15-minute breaks.

Step	WIP	Touch Time (Minutes)	Employees
A	10	8	2
B	40	15	3
C	2	3	1
D	10	20	5
E	2	12	4

What is the **best** action that can be taken to improve the Flow of this process?

A) Decrease the number of employees; the process is over-producing
B) Increase the number of employees; Work in Process (WIP) is increasing
C) Keep the total number of employees as it is now; train them on several tasks
D) Pay the employees to work on one 15-minute break on each shift

A) Incorrect.
B) Incorrect.
C) Correct. The best action is to keep the number of employees as is and train them on several tasks. Calculating the cycle times (cycle time = process time / number of employees) for each step gives:

step	cycle time
A	4
B	5
C	3
D	4
E	3

The cycle time from bottleneck step B does not achieve the takt time of 4.5 minutes. Training employees and transferring an employee from step E to step B decreases the cycle time of step B to 3.75 minutes (15 / 4 = 3.75). The cycle time at step E would change to 4 minutes (12 / 3 = 4), which would not slow the process down. Just increasing the number of employees (i.e. first at step B) helps, but at additional cost. The root cause is not the WIP but the high cycle time of step B. This process is not overproducing. Letting the employees work an additional 15 minutes is insufficient to solve the problem and adds cost.

D) Incorrect.

32 / 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.

33 / 60
The changeover process of a mold in a press is described below:

1. Run empty / Stop production
2. Remove Mold A from the press
3. Clean and store Mold A
4. Pick up Mold B from storage
5. Adjust Mold B under the guidance of a mechanic specialist
6. Install Mold B in the press
7. Release production process by supervisor
8. Start production

Which activities should be eliminated, or made external, to reduce the changeover time?

A) 3, 4, 5
B) 3, 4, 7
C) 3, 7, 8
D) 4, 6, 7

A) Correct. The SMED approach incorporates an eight-step approach. The key point is to move internal activities, frequently done during a changeover where the machine is stopped, into external activities that can be done while the machine is still running. In this question, these activities are: 3. Clean and store Mold A; 4. Pick up Mold B from storage; and 5. Adjust Mold B under the guidance of a mechanic specialist. The other activities can only be done when the mold is stopped.
B) Incorrect.
C) Incorrect.
D) Incorrect.

34 / 60
A Failure Modes and Effects Analysis (FMEA) is conducted.

Which FMEA result would prioritize the development of mitigating actions to improve the inspection measures?

A) High severity, low occurrence, and medium detection risk ratings
B) Medium severity, high occurrence, and low detection risk ratings
C) Medium severity, medium occurrence, and medium detection risk ratings
D) Low severity, medium occurrence, and high detection risk ratings

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Inspection measures improve the probability that a failure mode is detected on time. So, a FMEA outcome with a high detection rating would improve inspection measures. All other answer options have a lower detection risk rating.

35 / 60
A manufacturing company is replacing an existing horizontal saw with two new vertical cutting saws. These saws will guarantee accuracies to 0.0005", making it easier to accurately cut large panels into smaller size pieces whilst taking up less floor space.

At the early stages of the DMAIC project, in every customer focus group, customer interview and customer survey, the Voice of the Customer (VOC) specified the need for 'safety'.

The FMEA reviewed a number of potential safety issues and scored each of these with a relatively high Risk Priority Number (RPN).

The project leader has developed a Control plan to inspect and monitor product performance in detail, but this does not include any measures for safety.

Should this control plan be implemented?

A) Yes, because safety is not a Critical to Quality (CTQ) requirement.
B) Yes, because the project leader is better informed than the customer.
C) No, because a Control plan always includes measures that reduce high-risk safety issues.
D) No, because this plan should contain actions to minimize potential failures.

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The Control plan contains actions that should be performed to minimize or mitigate the potential failures as identified in the Failure Mode and Effect Analysis (FMEA). If safety is important to the customer, then this becomes a CTQ and the Control plan should include measures to mitigate high-risk safety issues. Even if safety is not the CTQ to improve for the project, high-risk safety issues should always be considered. A Control plan does not contain measures for all potential failures, only for the high-risk failures. Whether the customer or the project leader is better informed is irrelevant for this question.

36 / 60
A courier company maintains statistics on all of its delivery routes. Past records show that route X takes between 10 and 15 minutes delivery time, depending on variations in traffic.

When checking the delivery records during the past week, the shift manager noticed that on Tuesday route X took 34 minutes to complete delivery. The shift manager has flagged this as a common cause variation and has proposed the use of bicycles which can move more easily through traffic jams than the vehicles they currently use.

Is this a valid observation?

A) Yes, because performance is outside of the normal upper and lower limits.
B) Yes, because the overall process should be improved so that variation is reduced.
C) No, because excessive traffic may have delayed the driver.
D) No, because this is a special cause variation that should be investigated further.

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Typical performance level is between 10-15 minutes. This allows for traffic, etc. Anything outside of this time window would be a special cause variation. If the upper and lower limits of 10-15 minutes must be improved, then changing to bicycles could be a solution.

37 / 60
A scaffolding company is replacing its existing steel-bracketed scaffold system with a new 'Snapit' system. They want their new system to be light and easy to transport, and yet be as strong as the old system. They would like to reduce the time it takes to erect and dismantle the scaffold towers on site, and yet maintain the same level of stability as the old system.

How should the safety requirement be captured for the external Critical to Quality (CTQ)?

A) New system should survive a test bearing 150% of the specified load
B) 'Snapit' system must comply with legal requirements for load-bearing capacity and stability
C) Scaffold towers must be safe when used within specification
D) Scaffold towers should not collapse or fall over

A) Incorrect.
B) Correct. The CTQs are 'load-bearing capacity' and 'stability', as described by the legal requirements that cover safety. No accidents are a benefit but not a CTQ. Collapsing is too vague for a CTQ and a (negative) result than a CTQ. The test bearing 150% of the specified load is only one of the necessary two CTQs and the number 150% is not part of the information in the question.
C) Incorrect.
D) Incorrect.

38 / 60
Which description **best** describes the Toyota Kata philosophy?

A) According to a DMAIC roadmap, breakthroughs are being realized.
B) By repetitive practice and developing skills, continuous improvement becomes part of your daily work.
C) Customer demands are defined as Dissatisfiers, Satisfiers and Delighters.
D) With Toyota Kata the coach determines how a certain goal can be achieved in a structured way.

A) Incorrect.
B) Correct. Toyota Kata consists of an improvement Kata and a coaching Kata. It is a structured way in which, through repetitive practice and developing skills, continuous improvement becomes part of daily work. The coach does not determine how a certain goal can be achieved. The employee defines the future states and the obstacles to overcome. The Kano model defines customer demands as Dissatisfiers, Satisfiers, and Delighters. The goal of the DMAIC roadmap is to realize breakthroughs but it is a different approach.
C) Incorrect.
D) Incorrect.

39 / 60
What is documented in the current state value stream map (VSM)?

A) Location of product defects
B) Material and information flows of a process
C) Opportunities for failure in the process
D) Optimal logistical flow through a process

A) Incorrect.
B) Correct. 'Mapping the process' is one of the steps within Value Stream Mapping (VSM). In addition, flows of material and information are visualized. The amount of Work in Process (WIP), cycle times, and waiting times are also mapped. Opportunities for failure in the process and location of product defects are not displayed in the VSM. The optimal logistical flow might be given in the future state.
C) Incorrect.
D) Incorrect.

40 / 60
- A random sample of size n is to be taken from a large population of wide tubes.
- The diameter of the parts has a standard deviation of 1 mm.
- A Black Belt wishes to estimate the true mean μ with a 95% confidence interval of 0.2 mm wide.

Which value is nearest to the required sample size?

A) 83
B) 165
C) 271
D) 385

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. The z-score (z) for a 95% confidence level is 1.96. The standard deviation (sd) of the parts is 1 mm. The error (E) is 0.1 mm, because the confidence interval is 0.2 mm wide and the test is two-sided (0.2 / 2 = 0.1).
Sample size = (z * sd / E)^2 = (1.96 * 1 mm / 0.1 mm)^2 = 384
This is rounded up to 385.

41 / 60
Consider:
- a well-centered normally distributed process
- with a reported defect rate of 45,500 ppm (Parts per Million)
- and a tolerance of 20 units.

What is the standard deviation of this process?

A) 5
B) 6
C) 10
D) 12

A) Correct. Using a sigma level reference table, a process of 45,500 ppm is considered a 2-sigma level process with a distance between the Upper Sigma Level (USL) and Lower Sigma Level (LSL) of 4 sigma. The tolerance given is 20 units. sd = tolerance / (USL – LSL) = 20 / 4 = 5. (Literature: A, Table F.1)
B) Incorrect.
C) Incorrect.
D) Incorrect.

42 / 60
A manufacturer of diagnostic devices wants to introduce a new device to the market. This device has a very high probability of failing.

- It is known that the probability of failure is constant within a batch.
- The batch size is 100.
- The batch is inspected by destructively testing a sample of 25 devices.
- The remaining devices are sent to the customer.
- A maximum of 50% failing devices is acceptable.

Which probability distribution should be used to calculate the acceptable number of failing devices in the sample?

A) Binomial distribution
B) Hypergeometric distribution
C) Normal distribution
D) Poisson distribution

A) Incorrect.
B) Correct. The Hypergeometric distribution is a discrete distribution, used for samples drawn from relatively small populations, without replacement, and with two possible outcomes: 'success' and 'failure'.
C) Incorrect.
D) Incorrect.

43 / 60
The locknuts manufactured by one supplier must be compatible with bolts manufactured by another supplier. The locknuts must be produced within 0.02mm of the specified 6mm diameter.

What tool should be used to measure products against this given tolerance?

A) Calculator
B) Go/no-go gage
C) Ruler
D) Standard deviation

A) Incorrect.
B) Correct. Whether a locknut is within or outside of specifications is a dichotomous choice, that can best be made using a go/no-go gage with the two possible outcomes: 'ok' (pass) or 'not ok' (fail).
C) Incorrect.
D) Incorrect.

44 / 60
What can be quantified with a Gage R&R?

A) Both Reproducibility and Repeatability of a measurement system
B) Repeatability of a measurement system
C) Reporting and Repeating of a measurement system
D) Reproducibility of a measurement system

A) Correct. A Gage R&R study studies the precision of a measurement system. The precision is defined both by repeatability and reproducibility.
B) Incorrect.
C) Incorrect.
D) Incorrect.

45 / 60
- The production time must be decreased by 1 minute.
- 25 samples are taken
- The standard deviation of the process is 2 minutes
- Assume normal distribution and use an alpha of 5%

What is the power of the test?

A) 14%
B) 19%
C) 80%
D) 86%

A) Incorrect.
B) Incorrect.
C) Correct. Using a power table, the power of this test is 0.8051. (Literature: A, Table C.1)
D) Incorrect.

46 / 60
- In 2021, 2 types of Corona vaccines were tested on 2 groups of people.
- Each group contains 100 persons.
- A Black Belt recorded the number of affected and not affected people in both groups:

Vaccine	Negative	Positive
A	76	24
B	64	36

Which statement is true?

A) Both vaccines have no effect.
B) The Black Belt cannot say whether there is a significant difference between the vaccines or not.
C) There is no significant difference ($\alpha = 0.05$) between the vaccines.
D) Vaccine A is significantly better.

A) Incorrect.
B) Incorrect.
C) Correct. A chi-square test for association gives $p = 0.064$ or, alternatively, a 2-proportions test gives $p = 0.62$. Either p-value is larger than the critical value of 5% significance ($\alpha = 0.05$). There is no evidence of significant differences between the two vaccines.
D) Incorrect.

47 / 60
Given the following Analysis of Variance (ANOVA) table:

Source	DF	SS	MS	F	P
A	2	764.38	382.19	330.75	0
B	1	4.2	4.2	3.64	0.105
A*B	2	106.04	53.02	45.88	0
Error	6	6.93	1.16		
Total	11	881.55			

What statement can be made?

A) The main factor A has a significant effect on the response and the high R-sq indicates this model may be useful.
B) The main factor A has a significant effect on the response but R-sq is too low for this model to be useful.
C) The main factor B has a significant effect on the response and the high R-sq indicates this model may be useful.
D) The main factor B has a significant effect on the response but R-sq is too low for this model to be useful.

A) Correct. R-sq = 1 - (SS_{Error} / SS_{Total}) = 1 - (622 / 3,123) = 1 - 19.92% = 80.08%. A model fits the data sufficiently well to be useful if R-sq > 0.7. The p-value for factor A is lower than a standard significance level of 0.05 and is significant. The p-value for factor B is higher than a standard significance level of 0.05 and is not significant.
B) Incorrect.
C) Incorrect.
D) Incorrect.

48 / 60
A dice is rolled 100 times. A goodness-of-fit analysis is performed with a confidence level of 95% and with the following data.

Category	Observed	Test Proportion	Expected	Contribution to chi-square
1	13	0.166667	16.667	0.80667
2	26	0.166667	16.667	5.22667
3	19	0.166667	16.667	0.32667
4	13	0.166667	16.667	0.80667
5	9	0.166667	16.667	3.52667
6	20	0.166667	16.667	0.66667

Please read the following:

1. The alternative hypothesis for the test is accepted.
2. The critical value for the chi-square statistic is 11.07 when the p-value equals 0.5.
3. The expected data follow a chi-square distribution.
4. The calculated chi-square statistic is insignificant at the 2.5% level.

Which statements are true?

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

A) Incorrect.
B) Correct. There are 6 - 1 = 5 degrees of freedom (df). Using a distribution table, the chi-square critical value (α = 0.025) = 12.83 and the chi-square critical value (α = 0.05) = 11.07. (This makes statement 2 true.) The calculated chi-square statistic = sum of all chi-square contributions = 11.36. Since 11.36 < 12.83, the calculated chi-square statistic is insignificant at the 2.5% level. (This makes statement 4 true.) Since 11.37 > 11.07, the observed data is significantly different to the expected distribution. The null hypothesis of a 'good fit' is rejected and the alternate hypothesis is accepted. (This makes statement 1 true.) The expected data counts are all identical and, therefore, are not from a chi-square distribution but from a uniform distribution. (This makes statement 3 untrue.)
C) Incorrect.
D) Incorrect.

49 / 60

An economist wants to predict how much a person is spending on a new car. 'Income', 'IQ', 'Age' and 'Vacation' (how much a person spends on a vacation) are included as predictor variables in a multiple linear regression analysis.

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-4574	1783	-2.56	0.022	
Income	0.5104	0.0806	6.33	0	11.04
IQ	8.9	20.3	0.44	0.667	1.65
Age	0.0	56.1	0.00	1	2.24
Vacation	0.27	1.79	0.15	0.001	9.08

What is true about this analysis?

A) One of two correlated variables must be removed from the analysis.
B) The final model can be derived by multiplying the Coef column of data by each term.
C) The final model should only contain the terms Constant, Income, and Vacation.
D) The predictor Age should be removed from the data and a new regression performed.

A) Correct. A variance inflation factor (VIF) measures how correlated predictor variables are. The VIFs of 11.04 and 9.08 show that Income and Vacation are highly correlated. This indicates these two predictors measure essentially the same thing, which should be solved by removing one of the two variables (or combining them into a single variable).
B) Incorrect.
C) Incorrect.
D) Incorrect.

50 / 60
Given the following dataset:

A	B	C
6.935	14.2	2.265
1.523	13.1	0.597
2.599	12.7	1.237
4.009	15.2	1.649
4.687	14.7	2.312

Below are the results of the analysis to describe the variation of A, B and C with just two principal components.

Eigenvalue	2.4552	0.4614	0.0834
Proportion	0.818	0.154	0.028
Cumulative	0.818	0.972	1

Principal Component Analysis: A; B; C Eigenanalysis of the Correlation Matrix

Variable	PC1	PC2
A	0.593	-0.471
B	0.523	0.842
C	0.613	-0.263

Which variable accounts for the highest contribution to the total variability?

A) A contributes the least to the model for PC2.
B) B contributes the most to all the PCs.
C) PC1 accounts for the highest variance in the analysis.
D) PC2 accounts for the highest variance in the analysis.

A) Incorrect.
B) Incorrect.
C) Correct. The technique sorts the principal components by their Eigenvalues. The Eigenvalues represent the contribution to the variation. These are only given for the principal components. Since the Eigenvalue of PC1 is larger than the Eigenvalue of PC2 (2.4552 > 0.4614), PC1 accounts for the highest variance in the analysis.
D) Incorrect.

51 / 60
On 10 consecutive days, 3 parts were sampled from a process to analyze the capability and the performance of the process.

The specification limits are LSL = 85 and USL = 105.

The customer asks for a Six Sigma process. The results are shown below.

Overall Capability	Potential (Within) Capability
PPL = 2.03	CPL = 3.37
PPU = 1.04	CPU = 1.73

Which statement can be made?

A) A Six Sigma project must be started to reduce the short-term spread.
B) All data is within specifications: the process performance meets the customer's requirements.
C) If the process is centered, the customer's requirement can be met.
D) The process has bad short-term capability because the Ppk value is too low.

A) Incorrect.
B) Incorrect.
C) Correct. Cpk = min (CpL, CpU) = 1.73. This does not meet the customer requirement of a Six Sigma process (a Cpk of at least 2). The customer has a tolerance width of 5.1 sigmas (tolerance = CpL + CpU = 3.37 + 1.73 = 5.1), which indicates Cp = 2.55. If the process can be controlled at the center of this tolerance, a Cpk of 2.55 will be achieved, which satisfies the customer requirement. Short-term capability is measured by the Cpk value, and not by the Ppk value.
D) Incorrect.

52 / 60
To calculate process capability of non-normal data a Box-Cox transformation is used with a lambda = 0.5.

What would be the effect on the USL of 16 in the transformed graph?

A) Remains at 16
B) Changed to 4
C) Changed to 8
D) Changed to 256

A) Incorrect.
B) Correct. A Box-Cox transformation is described by y = x^λ {-5 < λ < +5}. Transformed USL = 16^0.5 = 4.
C) Incorrect.
D) Incorrect.

53 / 60
Given the following dataset:

Temperature	Material	Yield
-1	-1	62
1	-1	74
-1	1	56
1	1	70

What is the temperature main effect in this 2^k factorial experiment?

A) -15
B) - 1
C) 13
D) 15

A) Incorrect.
B) Incorrect.
C) Correct. Temperature main effect = (average effect of $Temperature_{high}(1)$) - (average effect of $Temperature_{low}(-1)$) = ((74 + 70) / 2) - ((62 + 56) / 2) = 13
D) Incorrect.

54 / 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

Source	DF	Adj ss	Adj ms	F-Value	P-Value
Mode	11	2802.2	254.75	58.65	0
Linear	4	2701.25	675.31	155.47	0
A	1	256	256	58.94	0
B	1	2304	2304	530.42	0
C	1	20.25	20.25	4.66	0.063
D	1	121	121	27.86	0.001
2-Way Interactions	6	93.75	15.62	3.6	0.049
A*B	1	4	4	0.92	0.365
A*C	1	2.25	2.25	0.52	0.492
A*D	1	0	0	0	1
B*C	1	6.25	6.25	1.44	0.265
B*D	1	81	81	18.65	0.003
C*D	1	0.25	0.25	0.06	0.816
Curvature	1	7.2	7.2	1.66	0.234
Error	8	34.75	4.34		
Lack-of-Fit	5	6	1.2	0.13	0.976
Pure Error	3	28.75	9.58		
Total	19	2836.95			

Evaluate the table. Use a 5% significant level.

What is the conclusion?

A) All response observations are insignificant.
B) Main effects A and C are significant.
C) There is no significant main effect, just 2-way interactions B*D and A*C.
D) 3 main effects and the 2-way interaction B*D are significant.

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. All p-values < 0.05 are significant at the 5% level. This is true for main effects A, B, D, and interaction B*D.

55 / 60
The Evolutionary Operations (EVOP) technique uses sequential experimentation. The first phase performed a 2-factor design all at 2 levels with center points. From the DOE the following response function was identified:

Y = 35 + 5a - 4b

- The target is to maximize the output.
- Start with a center point at (a = 28, b = 12).
- Use the path of the steepest ascent.
- The allowable 'a' step is 2 units.

What would be the center point for the next phase?

A) a = 30 and b = 9.5
B) a = 30 and b = 10.4
C) a = 26 and b = 13.6
D) a = 26 and b = 14.5

A) Incorrect.
B) Correct. The response at the current center point is Y = 35 + 5 * 28 - 4 * 12 = 127. The line of equal response where Y = 127, is b = 5a / 4, passing through (a = 28, b = 12). The path of steepest ascent is a tangential line b = -4a / 5, also passing through (a = 28, b = 12). Thus, an 'a' step of 2 units will equate to a 'b' step of b = -4 * 2 / 5 = -1.6. The next center point should be placed at (a = 28 + 2 = 30, b = 12 - 1.6 = 10.4)
C) Incorrect.
D) Incorrect.

56 / 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 describes the effect of this mistake?

A) Increase the probability that the R-chart shows an out-of-control signal
B) Increase the probability that the Xbar-chart shows an out-of-control signal
C) Observations from a sample of 2 will always be nearer the centerlines 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.

57 / 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 centerline. In fact, they all seem to be within about one sigma of the centerline.

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. Control limits should only be changed if the cause of the change is known. The standard deviation of the process has decreased but no indication is given that the cause of this occurrence is known. The occurrence indicates that the standard deviation of the measured process has reduced while no change in the mean has been noted. A mistake that is often made by using SPC charts, is that the control limits on the SPC chart are used as specification limits. There is no information in the scenario to indicate what the target should be. There is an assumption here that the center line is the target, but it is in fact the mean of the mean of the sampled values at the time that the control limits were calculated.
D) Incorrect.

58 / 60
A bicycle manufacturer is planning to design and launch a new super-lightweight range of road bicycles. It is understood that the market for this range of products has grown exponentially with the boom in triathlons. Race participation has shown an increase of more than 300% in the past 3 years.

At which stage in the product lifecycle should the manufacturer forecast profits from this new range to reach its peak?

A) Decline
B) Development
C) Growth
D) Maturity

A) Incorrect.
B) Incorrect.
C) Incorrect.
D) Correct. Product Lifecycle Management (PLM) is the process of managing the entire lifecycle of products. A product is most costly when moving from development to growth. The peak of its profitability is when it reaches maturity.

59 / 60
The design for a new camera is being developed.

When applying Designing for Excellence (DfX), which element is **not** a relevant factor?

A) How strong the camera casing should be to protect the camera lens
B) The number of pixels of the camera sensor
C) Whether the camera settings and buttons are easy to use and understand
D) Whether parts from other designs are being considered to use

A) Incorrect.
B) Correct. Design for Excellence (DfX) is a design practice which not only focuses on design aspects, but also on all other aspects of the product lifecycle, including materials, producibility, maintainability, ergonomics, logistics, reliability, environment, and disposal. Ease of use is a product requirement based on the customer needs. This is part of critical parameter management (CPM) and of DfX.
C) Incorrect.
D) Incorrect.

60 / 60
Which tool can be used to translate a customer's requirements into appropriate company measures?

A) Cause and effect diagram
B) Quality function deployment (QFD)
C) SIPOC diagram
D) Value stream map (VSM)

A) Incorrect.
B) Correct. A SIPOC is a high-level process mapping tool. A VSM is constructed to identify waste and non-value adding activities. QFD is a method whereby customer requirements are transformed into observable variables. A cause & effect diagram is a summary of possible causes for a certain effect collected during a brainstorming session.
C) Incorrect.
D) Incorrect.

Evaluation

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

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

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