THE ULTIMATE CQE PRACTICE EXAM from CQEAcademy.com

SOLUTIONS

1. **This design activity could be described as the process where the examination & evaluation of objective evidence is used to confirm that your final product meets the customer's needs & intended use.**
   - Design Verification
   - **Design Validation**
   - Design Qualification
   - Design V&V Protocol

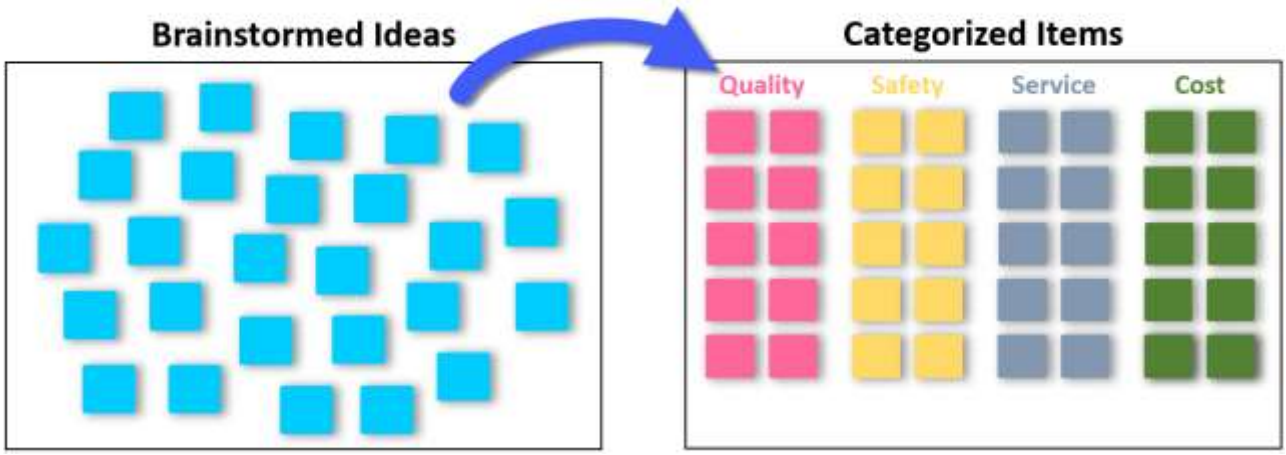
   Design Validation means confirmation by examination & evaluation of objective evidence to confirm that your final product meets the customer's needs & intended use.

   Design Verification means confirmation by examination and evaluation of objective evidence that your Design Output (Product Specification & Requirements) meets all your Design Inputs (Technical Reflection of Customer Needs).

2. **A group of engineers have conducted a survey of customers and received a large quantity of disparate and subjective feedback regarding their product.**

   What quality tool will best help them organize and analyze this feedback?
   - Matrix Diagram
   - Prioritization Matrix
   - Check Sheet
   - **Affinity Diagram**

   The **Affinity Diagram** is a tool that **facilitates brainstorming** and **organizes facts and data** into **themes or groups of common characteristics**.



3. **Calculate P_{pk} for the following Parameters: (USL = 20, LSL = 14, σ = 1, μ = 18)**
   - 0.50
   - **0.67**
   - 1.0
   - 1.33

$$P_{pk} = Min\left(\frac{USL - \tilde{x}}{3s_{p_p}}, \frac{\tilde{x} - LSL}{3s_{p_p}}\right) = Min\left(\frac{20 - 18}{3 * 1}, \frac{18 - 14}{3 * 1}\right)$$

$$P_{pk} = Min\left(\frac{2}{3}, \frac{4}{3}\right) = Min(0.67, 1.33) = 0.67$$

4. **At the end of your FMEA you discover that you must implement a corrective action for a particular failure mode because the Risk Priority number is too high.**

   In this instance you decide to implement a vision camera to sort out rejects which is an improvement over your current visual inspection. How would you change your FMEA as a result of this corrective action?
   - Increase the Detection Score
   - **Reduce the Detection Score**
   - Increase the Occurrence Score
   - Reduce the Occurrence Score

   Implementing an automated inspection process (vision camera) would improve detectability of a failure mode and thus result in a **reduction of the detection score**.

5. **Which QMS Document summarizes your organizations intentions & views with respect to the importance of quality as it relates to the organization's customers, employees and the business objectives.**
   - **The Quality Policy**
   - The Quality Objectives
   - The Quality Scorecard
   - The Quality Plan

   The **Quality Policy**, which is required in ISO 9001, should summarize your organizations intentions & views with respect to the importance of Quality. All subsequent documents in the Quality Management System (objectives, plans, scorecards, etc) should align with the goals & intentions outlined in the Quality Policy.

6. **You're reviewing your company's Quarterly financial report (below)**
    - 15K - Scrap Failures
    - 2K - New Employee Screening & Training
    - 7K - New Process Qualifications
    - 20K - Custom Complaint Investigations & Product Exchanges
    - 11K - In-Process Inspector Wages
    - 9K - Raw Material Inspection Wages & Costs
    - 4K - Regulatory Appraisals
    - 10K - Engineering Redesign due to Failures
    - 17K - In Process & Supplier Audits
    - 5K - Defect Proofing via Continuous Improvement

Based on the following data, which totals up to 100K, what % of your costs are due to poor quality:

- 37%
- 42%
- **45%**
- 56%

If we break down the costs above, we can identify the costs associated with poor quality, which include: scrap failures customer complaints and engineering redesigns.

- 15K - Scrap Failures
- 2K - New Employee Screening & Training
- 7K - New Process Qualifications
- 20K - Custom Complaint Investigations & Product Exchanges
- 11K - In-Process Inspector Wages
- 9K - Raw Material Inspection Wages & Costs
- 4K - Regulatory Appraisals
- 10K - Engineering Redesign due to Failures
- 17K - In Process & Supplier Audits
- 5K - Defect Proofing via Continuous Improvement

These 3 costs (15K, 20K, 10K) total up to 45K of the total 100K in costs, representing **45%**.

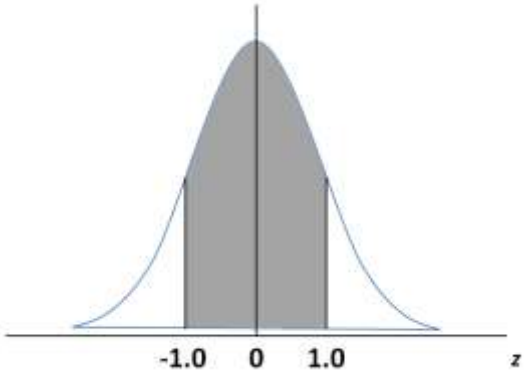
7. **This design deliverable captures the technical reflection of your customers' needs and they represent your customers' requirements for the final product relating to safety, performance, functionality, quality, reliability, and the intended use of your product.**
   - Design Outputs
   - Engineering Drawings
   - **Design Inputs**
   - Design Requirements

Design Inputs are the technical reflection of your customers' needs and they represent your customers' requirements for the final product relating to safety, performance, functionality, quality, reliability, and the intended use of your product.

8. **A shipping operation distributed product at a mean time of 48 hours from receipt of order with a standard deviation of 6 hours. What percentage of shipments go out between 42 - 54 hours from time of receipt?**
   - 34%
   - 68%
   - 66%
   - 32%

The first thing we must do is to calculate the Z transformation for the two-time values (42 hours & 54 hours).

$$Z(42\ hours) = \frac{42 - 48}{6} = \frac{-6}{6} = -1.0 \qquad AND \qquad Z(54\ Hours) = \frac{54 - 48}{6} = \frac{6}{6} = 1.0$$



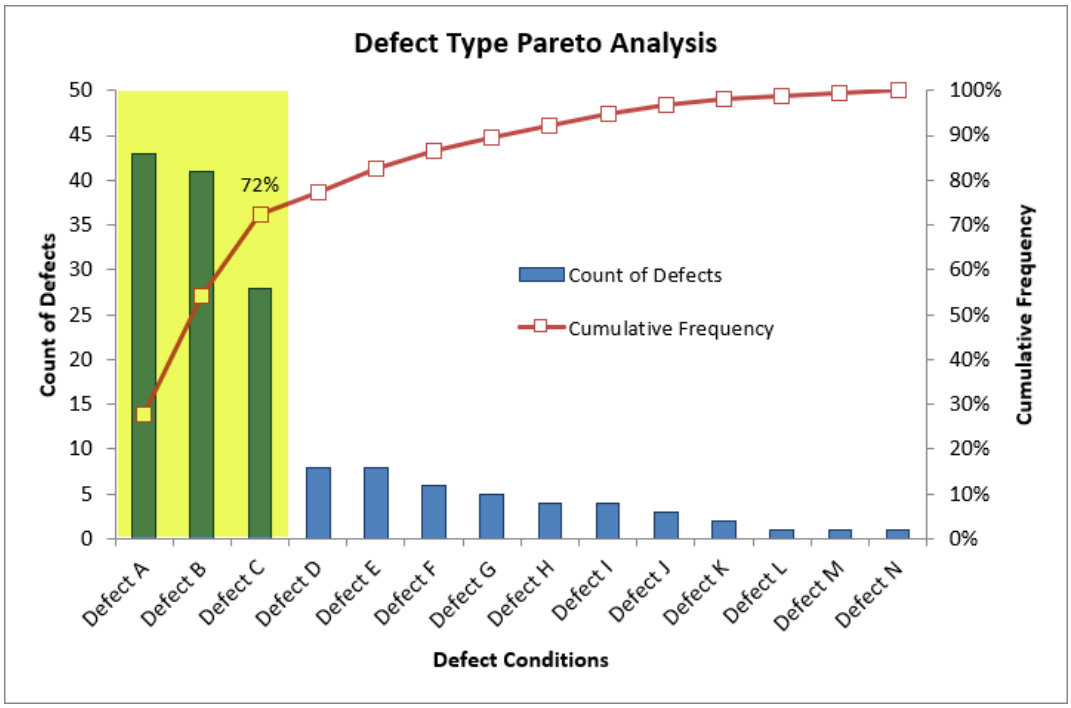
The probability that Z is between Z = -1.0 & 1.0 is equal to the shaded area above.

The probability of Z = 1.0 is equal to 0.34134, which is also equal to the probability of Z = -1.0.

So, the total probability from z= -1 to z = 1 is 68.168%.

9. **A team of engineers at an auto parts distribution center has been chartered to reduce customer complaints by 50%. They've collected complaint data for the past 12 months. What tool should be used to determine the most frequent complaint?**
   - Check Sheet
   - Cause & Effect Diagram
   - Prioritization Matrix
   - **Pareto Chart**

   A Pareto Chart is the perfect tool to analyze the various customer complaints to determine the most frequently occurring one. This tool can help you prioritize and determine which failure modes can be eliminated to achieve the goal of a 50% reduction.



10. **What Quality System concept provides an organization with the ability to demonstrate that a product was conforming to the design requirements during the manufacturing process.**
   - Material Identification
   - Material Status
   - **Material Traceability**
   - Material Classification

   Material Traceability is a record that provides the ability to trace the history, application and or location of an item. This includes the raw material inputs, or other inputs to the product, the tests performed, the lot/batch number associated with the product, and where the item was distributed, installed or used.

11. **A system is in its useful life period & has been shown to have a MTBF of 1,000 Hours. What is the Reliability of the system at 250 Hours?**
    - 75.6%
    - **77.8%**
    - 73.2%
    - 71.0%

    The first step in solving this problem is understanding that because the system is in its useful life period, we must use the Exponential Distribution to calculate reliability. We can plug in the time value (250 hours), and the MTBF (1,000 hours) to calculate the reliability.

$$R(t) = e^{-\lambda t} \; Where \; MTBF = \theta = \frac{1}{\lambda}$$

$$R(250) = e^{\frac{-t}{\theta}} = e^{\frac{-250}{1,000}} = e^{\frac{-1}{4}}$$

$$R(250) = .7788 \; or \; 77.88\% \; Reliability$$

    Using this equation, we can estimate the Reliability at 250 Hours to be 77.88%

12. **You've been tasked with improving a process, and you've identified that each individual who executes your process does it slightly different, and this person-to-person variation is resulting in poor yield downstream.**

    You're in the process of creating standard work to reduce the person-to-person variation. Which phase of the DMAIC process are you in?
    - Measure
    - Analyze
    - **Improve**
    - Control

    Creating **standard work** is an example of activity that would occur in the **IMPROVE phase** of the DMAIC Process.

13. **You're calculating the confidence interval for the population mean. What standard deviation is needed to create a 95% confidence interval equal to ± 4 when you've sampled 15 units.**
    - 2.82
    - **7.95**
    - 9.39
    - 30.77

    This question is all about the confidence interval equation, and we're solving for the standard deviation by looking at the right half of the equation being equal to 4.

$$\textbf{Confidence Interval for the Population Mean}: \bar{x} \pm Z_{\frac{\alpha}{2}} * \frac{\sigma}{\sqrt{n}}$$

$$Z_{\frac{\alpha}{2}} * \frac{\sigma}{\sqrt{n}} = 4$$

    At the 95% confidence level, our Z-score is 1.95, and we know the sample size (15), so we can re-arrange the equation to solve for the standard deviation.

$$\sigma = \frac{4 * \sqrt{15}}{1.95} = 7.95$$

14. **Which of the following statements is one of Deming's' 14 points:**
    - Increase Quality Through Inspection
    - Eliminate on The Job Training
    - **Create a Consistency of Purpose**
    - Promote Management by Objective & Daily Quotas

    Deming did NOT promote these 3 concepts; in fact, he was directly opposed to them:

    - **Increase Quality Through Inspection (Opposite of Point 3)**
    - **Eliminate on The Job Training (Opposite of Point 6)**
    - **Promote Management by Objective & Daily Quotas (Opposite of Point 11)**

15. **Identify the audit below that would be considered the largest in scope:**
    - 2nd Party Supplier Product Audit
    - 1st Party Process Audit
    - **3rd Party Quality Management System Audit**
    - 3rd Party Process Audit

    System Audits are always the largest is scope, followed by Process Audits, then finally Product Audits are the narrowest in scope. The parties involved in the audit (1st, 2nd, 3rd) don't contribute to the scope of the audit.

16. **Once you've estimated the risk associated with your actual or potential failure modes, you can then compare them to your risk policy to determine if those risks are acceptable or not; this process is known as:**
    - Risk Analysis
    - Risk Mitigation
    - Risk Assessment
    - **Risk Evaluation**

    Comparing the risk for each of your failure modes to your risk policy to determine if those risks are acceptable or not is the **Risk Evaluation phase** of the Risk Assessment.

17. **You manufacture a widget and use an x-bar and S chart to monitor your process, where you sample 5 units in each subgroup, and s-bar = 4.2. Estimate the population standard deviation for this process.**
    - 4.2
    - 2.1
    - 3.9
    - **4.5**

    We divide S-bar by the factor c_4, which is based on the n=5 sample size.

$$\textbf{Population Standard Deviation} = \hat{\sigma} = \frac{\bar{s}}{C_4}$$

$$\hat{\sigma} = \frac{4.2}{0.9400} = 4.5$$

X-Bar and S Chart				
Subgroup Sample Size	X-Bar Factor	Standard Deviation Factors		Variance Factor
n	A_3	B_3	B_4	c_4
2	2.659	-	3.267	0.7979
3	1.954	-	2.568	0.8862
4	1.628	-	2.266	0.9213
5	1.427	-	2.089	0.9400
6	1.287	0.030	1.970	0.9515
7	1.182	0.118	1.882	0.9594
8	1.099	0.185	1.815	0.9650
9	1.032	0.239	1.761	0.9693
10	0.975	0.284	1.716	0.9727
15	0.789	0.428	1.572	0.9823
20	0.680	0.510	1.490	0.9869
25	0.606	0.565	1.435	0.9896

18. **Calculate Cpk for the following Parameters: (USL = 1.35, LSL = 1.15, σ = 0.025, μ = 1.25)**
    - 1.0
    - **1.33**
    - 1.67
    - 2.0

$$C_{pk} = Min(C_{p,Lower}, C_{p,Upper}) = Min\left(\frac{USL-\mu}{3s}, \frac{\mu-LSL}{3s}\right)$$

$$C_{pk} = Min\left(\frac{1.35-1.25}{3*0.025}, \frac{1.25-1.15}{3*0.025}\right)$$

$$C_{pk} = Min\left(\frac{0.10}{0.075}, \frac{0.10}{0.075}\right)$$

$$\boldsymbol{C_{pk} = Min(1.33, 1.33) = 1.33}$$

19. For a Single Sampling Plan at an AQL of 1.0 at a Normal, general inspection Level II per ANSI/ASQ Z1.4 what is the Reject Number for a total lot size of 500 units:

- 1
- **2**
- 3
- 4

First, we start with the sample size code letter table where we find the intersection of general inspection level II, and a lot size of 500 units to be the sample size code letter of H.

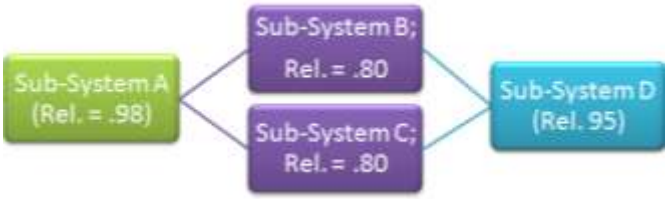
Lot or Batch Size	Special Inspection Levels				General Inspection Levels		
	S-1	S-2	S-3	S-4	I	II	III
2 to 8	A	A	A	A	A	A	B
9 to 15	A	A	A	A	A	B	C
16 to 25	A	A	B	B	B	C	D
26 to 50	A	B	B	C	C	D	E
51 to 90	B	B	C	C	C	E	F
91 to 150	B	B	C	D	D	F	G
151 to 280	B	C	D	E	E	G	H
281 to 500	B	C	D	E	F	H	J
501 to 1200	C	C	E	F	G	J	K
1201 to 3200	C	D	E	G	H	K	L
3201 to 10000	C	D	F	G	J	L	M
10001 to 35000	C	D	F	H	K	M	N
35001 to 150000	D	E	G	J	L	N	P
150001 to 500000	D	E	G	J	M	P	Q
> 500001	D	E	H	K	N	Q	R

Then, we can go to the single normal inspection table and look for the intersection of Code Letter H and AQL 1.0, which indicates that we accept on 1 or fewer defects, and reject on two or more defects.

Sample Size Code Letter	Sample Size	AQL (Acceptance Quality Limit) for Normal Inspection												
		0.25	0.4	0.65	1	1.5	2.5	4	6.5	10	15	25	40	65
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A	2	↓	↓	↓	↓	↓	↓	↓	0 1	↓	↓	1 2	2 3	3 4
B	3	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6
C	5	↓	↓	↓	↓	↓	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8
D	8	↓	↓	↓	↓	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11
E	13	↓	↓	↓	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15
F	20	↓	↓	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22
G	32	↓	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑
H	50	0 1	↑	↑	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑
J	80	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑
K	125	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑
L	200	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑
M	315	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑
N	500	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑
P	800	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑	↑
Q	1250	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑	↑	↑
R	2000	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑

20. **Calculate the reliability of the system below:**

- **.89 or 89%**
- .95 or 95%
- .91 or 91%
- .87 or 87%



This system is a combination of **systems in both series and parallel.**

The final calculation will use the series system reliability calculation, however first we must determine the combined **reliability of Sub-System B and C using the Parallel System Reliability Equation:**

$$Parallel\ System\ Reliability\ of\ B\ and\ C = R_{B\ and\ C} = 1 - (U_B \times U_C)$$

$$Where\ U_B = 1 - R_B$$

$$U_B = 1 - 0.80 = 0.20$$

$$U_c = 1 - 0.80 = 0.20$$

$$R_{B\ and\ C} = 1 - (0.20 \times 0.20) = 0.96$$

Now we can calculate the total reliability of the system:

$$Series\ System\ Reliability = R_{system} = R_A \times R_{B\ and\ C} \times R_D$$

$$\boldsymbol{R_{system} = 0.98 \times 0.96 \times 0.95 = 0.894 = 89\%}$$

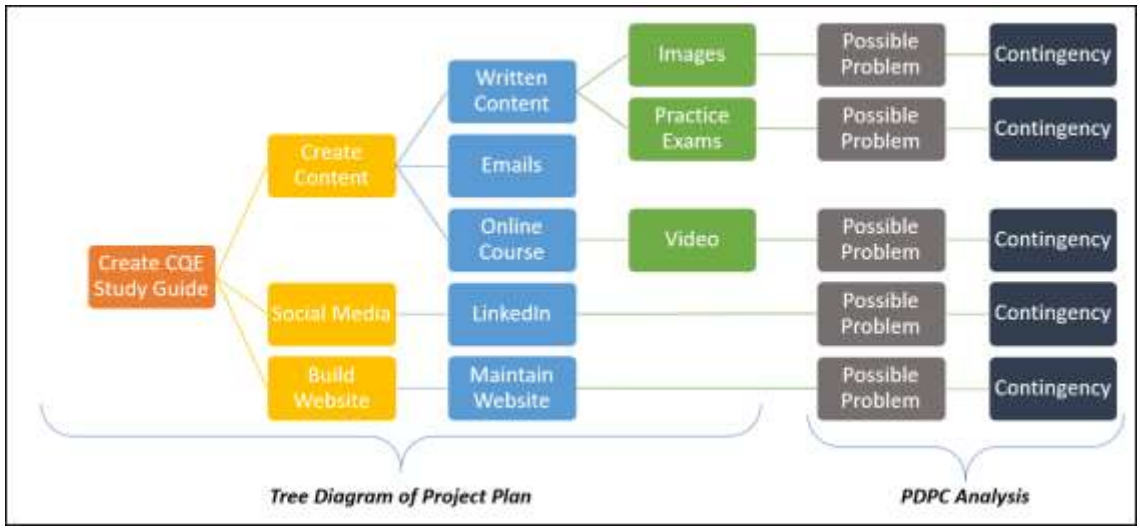
21. **Which term is defined as the degree of mutual agreement among individual measurements made under prescribed like conditions?**

- Accuracy
- **Precision**
- Measurement Error
- Metrology

Precision defined as the degree of mutual agreement among individual measurements made under prescribed like conditions.

22. **A machine shop is planning to move a line of machining equipment across town and any delays in the project will result in lost business. Which tool can be used to ensure that potential pitfalls in the project plan are identified and mitigated?**
    - **Process Decision Program Chart**
    - Tree Diagram
    - Flow Chart
    - Pareto Chart

    The **Process Decision Program Chart** is meant to facilitate a review of a project plan to identify potential issues and develop contingencies and counter-measures to ensure project success.



23. **You've formed a team to tackle a big problem. You attend a meeting and you notice that team members seem overwhelmed, and there appears to be competition amongst the team members. Which stage of team development is the team currently in?**
    - Forming
    - **Storming**
    - Norming
    - Performing

    Issues like competition amongst team members, and a feeling of overwhelm are a characteristic of the **Storming stage of team development** where team members may begin to feel overwhelmed by the teams new goals and may cling to their own opinions and try to steer the project in a selfish direction. This phase often results in conflict and resistance to group tasks.

24. **This symbol reflects which tolerance characteristic:**

- **Cylindricity**
- Position
- Concentricity
- Flatness

Cylindricity is the tolerance characteristic shown above.

Position, Concentricity, Flatness and **Runout** can be seen below:

Tolerance Type	Characteristic	Symbol
FORM	Flatness	
	Straightness	
	Cylindricity	
	Circularity	
LOCATION	Position	
	Symmetry	
	Concentricity	
ORIENTATION	Angularity	
	Parallelism	
	Perpendicularity	
PROFILE	Profile of a Surface	
	Profile of a Line	
RUNOUT	Runout	
	Total Runout	

25. **Which Audit Role is responsible for determining and implementing appropriate Corrective Actions for any audit findings:**

- The Auditor
- **The Auditee**
- The Client
- The Lead Auditor

The Auditee is responsible for determining appropriate corrective actions (CA's), implementing them and then verifying the effectiveness of those corrective actions.

In some cases, the auditor can be asked for their opinion regarding what the appropriate CA might be. Additionally, the client has the responsibility to follow up with the auditee to ensure all CA's have been shown to be effective, however this individual is not responsible for those CA's.

26. A vendor has just shipped you 3,000 units which you intend to inspect per ANSI/ASQ Z1.4 using a Single Sampling Plan at the normal, general level II inspection level at an AQL of 0.25. What is the sample size you must take?

- 50
- 80
- 125
- **200**

Starting at the sample size code letter, for general inspection level II, at a total lot size of 3,000 the **code letter is K**.

Lot or Batch Size	Special Inspection Levels				General Inspection Levels		
	S-1	S-2	S-3	S-4	I	II	III
2 to 8	A	A	A	A	A	A	B
9 to 15	A	A	A	A	A	B	C
16 to 25	A	A	B	B	B	C	D
26 to 50	A	B	B	C	C	D	E
51 to 90	B	B	C	C	C	E	F
91 to 150	B	B	C	D	D	F	G
151 to 280	B	C	D	E	E	G	H
281 to 500	B	C	D	E	F	H	J
501 to 1200	C	C	E	F	G	J	K
1201 to 3200	C	D	E	G	H	K	L
3201 to 10000	C	D	F	G	J	L	M
10001 to 35000	C	D	F	H	K	M	N
35001 to 150000	D	E	G	J	L	N	P
150001 to 500000	D	E	G	J	M	P	Q
> 500001	D	E	H	K	N	Q	R

When we go to the single normal inspection table, you can see **a down arrow** at the intersection of K and an AQL of 0.25. This means we must use the sampling plan below K, which is the **sample size code letter L**.

Sample Size Code Letter	Sample Size	AQL (Acceptance Quality Limit) for Normal Inspection												
		0.25	0.4	0.65	1	1.5	2.5	4	6.5	10	15	25	40	65
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A	2	↓	↓	↓	↓	↓	↓	↓	0 1	↓	↓	1 2	2 3	3 4
B	3	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6
C	5	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8
D	8	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11
E	13	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15
F	20	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22
G	32	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑
H	50	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑
J	80	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑
K	125	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑
L	200	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑
M	315	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑
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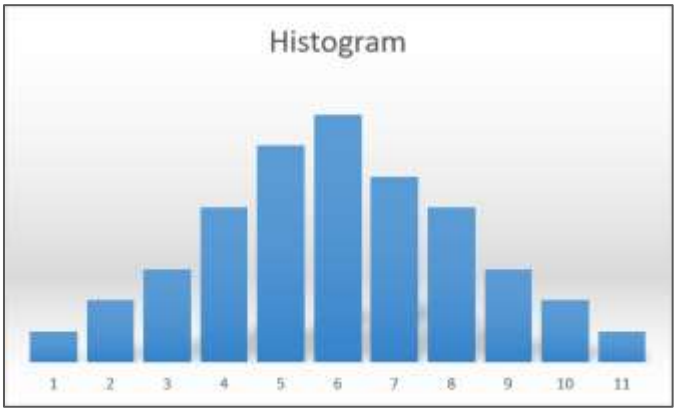
R	2000	10 11	14 15	21 22	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑

So, the sample size is 200 and the accept number (c) is 1.

27. **A team of engineers is working to qualify a new supplier for a critical component. The supplier has informed the team that the critical dimension on their component is normally distributed. Which tool can be used to confirm the vendors assertion?**

- Control Chart
- Check Sheet
- Scatter Plot
- **Histogram**

The **Histogram** is the appropriate tool to analyze a data set to assess the appropriate distribution associated with that data set.



28. **Calculate the sample standard deviation of the following data set: 1, 3, 5, 7, 9**

- 2.83
- **3.16**
- 8
- 10

Find the sample variance of the following 7 sample measurements: **1, 3, 5, 7, 9**

$$Sample\ Mean = \bar{x} = \frac{\sum x}{n} = \frac{1+3+5+7+9}{5} = \frac{25}{5} = 5$$

x	$(x-\bar{x})$	$(x-\bar{x})^2$
1	1 – 5 = -4	16
3	3 – 5 = -2	4
5	5 – 5 = 0	0
7	7 – 5 = 2	4
9	9 – 5 = 4	16
		$\sum(x-\bar{x})^2 = 40$

$$Sample\ Standard\ Deviation = s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$$

$$Sample\ Standard\ Deviation = s = \sqrt{\frac{40}{4}} = 3.16$$

29. **Identify the correct order of the Risk Assessment Process steps in chronological order:**
    - Risk Analysis, Risk Evaluation, Risk Identification
    - Risk Analysis, Risk Identification, Risk Evaluation
    - Risk Identification, Risk Evaluation, Risk Analysis
    - **Risk Identification, Risk Analysis, Risk Evaluation**

    The correct order of the risk assessment process is Risk Identification, Risk Analysis and Risk Evaluation.

30. **How many treatments would be required for a DOE with 6 factors where a half factorial design is chosen:**
    - 64
    - **32**
    - 16
    - 8

$$Half\ Factorial\ Design: Number\ of\ Treatments = \frac{Levels^{Factors}}{2} = 2^{F-1} = 2^{6-1} = 32$$

31. **You're performing a supplier audit on a long-time vendor and you discover that the supplier has knowingly shipped defective product to another of their customers, but not your organization. You're asked to leave this out of your audit report, what should you do?**

    - Agree to leave the finding out of the audit report because the vendor has been a long-time partner with your organization.
    - **Include the observation in your audit report as a critical observation and request the customer to take corrective action.**
    - Leave the finding out of the audit report but make a note to verbally deliver this finding to your manager.
    - Include the observation in your audit report as a recommendation for improvement without requiring corrective action.

    This situation represents a serious lack of integrity on the part of the supplier and should influence your organizations desire to do business with them. Thus, you should include this finding in your audit report and ensure that it is classified as a critical observation and escalated within your own organization.

32. **You're performing a hypothesis test for the population mean and you know the population standard deviation. You plan to sample 45 units from your population and you'd like to use a 2-sided test at a 5% significance level. What is the rejection criteria for this hypothesis test?**

- 1.345
- 1.650
- 1.761
- **1.960**

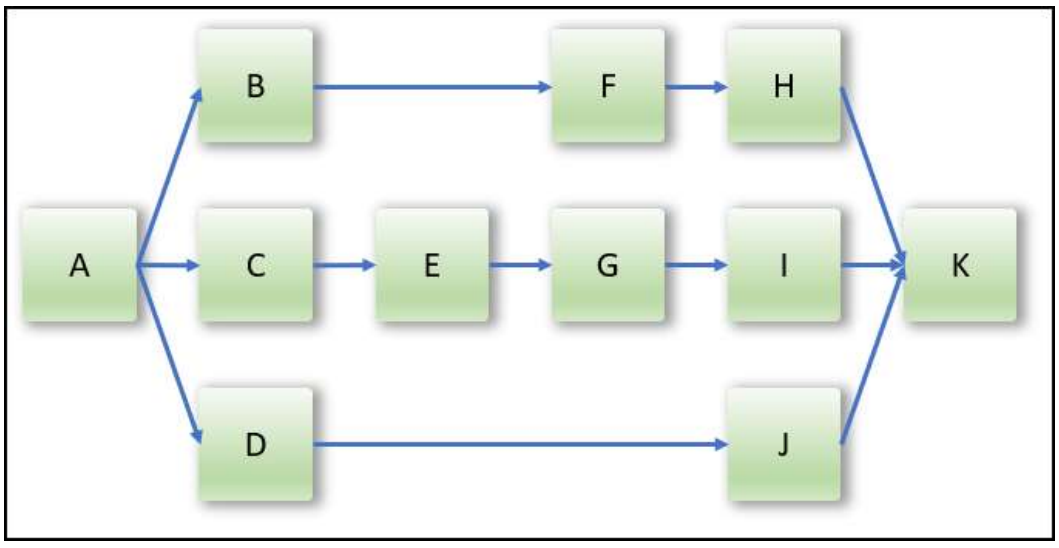
Because we know the population standard deviation and we're sampling more than 30 units we can use the normal distribution for your hypothesis test.

Based on the 2-sided test, and 5% significance level, we can look up the Z-value associated with 47.5% of the population, which is Z_{crit} = 1.960

33. **This project planning tool that defines the sequential tasks requires to complete a complex project, including the critical path.**

- Process Decision Program Chart
- Tree Diagram
- **Activity Network Diagram**
- Interrelationship Digraph

The **Activity Network Diagram** is a Project Planning and Management tool that defines the sequential tasks requires to complete a project.



34. **You've just completed a gauge R&R study. The repeatability was analyzed to be 0.5679 standard deviations, and the reproducibility was analyzed to be 0.4231 standard deviation. What is the measurement system variation?**

- 0.9910
- 0.5679
- 0.4231
- **0.7082**

$$Measurement\ System\ Variation\ (GRR) = \sigma_{GRR} = \sqrt{(EV)^2 + (AV)^2}$$

$$\boldsymbol{\sigma_{GRR} = \sqrt{(0.5679)^2 + (0.4231)^2} = 0.7082}$$

35. **If your risk assessment identifies a risk that exceeds your pre-determined risk criteria, then which activity within risk management is required?**

- Risk Mitigation
- Risk Acceptance
- **Risk Reduction**
- Risk Control

Risk Reduction is required whenever a risk or failure mode that exceeds your pre-determined risk criteria. In essence, you've confirmed that this failure mode has an unacceptable level of risk that must be reduced.

36. **You're manufacturing a widget and using an X-bar and R chart to control the critical feature of the product. Your normal process has the following attributes: X-double bar is 225, R-bar is 12, n = 8. Identify the upper and lower control limits for the X-bar chart:**

- 218.71
- 220.52
- **229.48**
- 233.14

$$\boldsymbol{Upper\ Control\ Limit: UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R}}$$

Now we must look up the A_2 constant using the sample size (n=8), and we find $A_2 = 0.373$

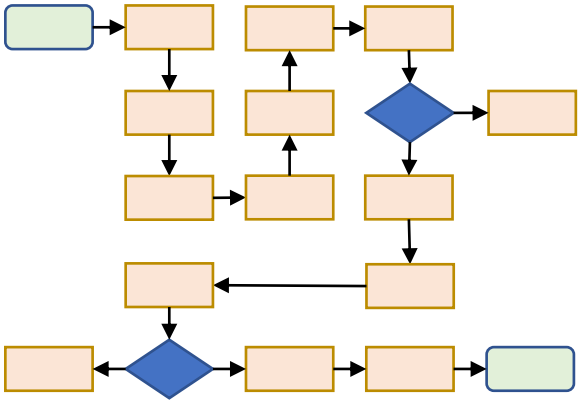
$$\boldsymbol{UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R}}$$

$$\boldsymbol{UCL_{\bar{X}} = 225 + 0.373 * 12 = 229.48}$$

X-Bar and R Chart				
Subgroup Sample Size	X-Bar Factor	Range Factors		Variance Factor
n	A_2	D_3	D_4	d_2
2	1.880	-	3.267	1.128
3	1.023	-	2.575	1.693
4	0.729	-	2.282	2.059
5	0.577	-	2.115	2.326
6	0.483	-	2.004	2.534
7	0.419	0.076	1.924	2.704
8	0.373	0.136	1.864	2.847
9	0.337	0.184	1.816	2.970
10	0.308	0.223	1.777	3.078
15	0.223	0.347	1.653	3.472
20	0.180	0.415	1.585	3.735
25	0.153	0.459	1.541	3.931

37. **A team of engineers at an Electronics Manufacturer wants to improve the way material moves through the production process. At the start of the improvement process the team needs to align on the current state of the process. Which tool will best help the team align on the existing process?**
    - Cause & Effect Diagram
    - Check Sheet
    - **Flow Chart**
    - Activity Network Diagram

    A **flow chart** or **flow diagram** is a great way to **visualize and align** on the current state of the process.



Current State of the Process

38. **This quality system process is meant to quantify the variation associated with a measurement system and determine if a measurement system is appropriate and suitable for your needs.**
    - Calibration
    - Metrology
    - Design of Experiments
    - **Measurement System Analysis**

    Measurement System Analysis (MSA) is meant to quantify the **variation** associated with a **measurement system** and will allow you to determine if a measurement system is **appropriate and suitable** for your needs.

39. **Which phase of the DFSS process could be characterized as the process where different, potential design concepts are considered through their ability to fulfill the products CTQs in a robust way.**

- Measure
- **Analyze**
- Design
- Verify

The **Analyze phase** of the DMADV process is where different, potential design concepts are assessed and analyzed for their ability to fulfill the products CTQs in a robust way.

40. **What is the purpose of the ISO 9000 family?**

- To prescribe the methods for quality management & control
- **To assist organizations, of all types and sizes, to implement and operate effective quality management systems**
- To define the requirements, test methods & acceptance criteria to guarantee product conformance for any product
- To ensure companies comply with all international, national and industry standards

As defined by ISO, and contained within the standard itself, the purpose of the ISO 9000 family is **to assist organizations, of all types and sizes, to implement and operate effective quality management systems.**