CQE Academy

# CQE EXAM

## Mixed Statistics Practice Exam

To help you prepare for the CQE Exam

ANDY ROBERTSON

# Mix Up Your Practice with CQEAcademy.com

Hey There!

This 40-question practice exam focused on statistics is meant to simulate the actual CQE exam in both the mix of exam questions, and the difficulty.

**Within Statistics there are 8 topics, and below are the number of questions associated with each of those 8 topics based on what I think is their importance on the CQE Exam!**

- Collecting and Summarizing Data – 6 Questions
- Probability – 5 Questions
- Probability Distributions – 6 Questions
- Statistical Decision Making – 5 Questions
- Relationships Between Variables – 2 Questions
- Statistical Process Control – 7 Questions
- Process and Performance Capability – 5 Questions
- Design of Experiments – 4 Questions

And of course, all of these questions are completely mixed!!! So that you benefit from the learning technique of mixed practice.

You can also improve the learning process by spreading this quiz out over multiple days to get some spaced repetition.

The other way you can improve on this quiz is to time yourself. If this were the real CQE Exam, you'd have to complete these 40 questions in 1 hour and 15 minutes. Can you complete this quiz in that time?

If you got this practice exam from one of my emails, simply wait a day, and I'll share the solutions in the very next email!

IF you're interested in joining the CQE Academy community, you can sign up for the CQE Master Class, or if you're just focused on Statistics or Practice Exams, I have unique courses for just those area individually.

If you have any questions, shoot me an email at: Andy@CQEAcademy.com

Cheers!

Andy Robertson

-Your Guide to Certification

1. **In a designed experiment, when we have two factors whose effects on the response variable are combined in an indistinguishable way, we describe them as:**
   - Confounding
   - Balanced
   - Randomized
   - Interacting

2. **You're performing an ANOVA Analysis, and the total sum of squares is 36 and the treatment sum of squares is 16, what would the error sum of squares be?**
   - 20
   - 52
   - 30
   - 16

3. **Your product is dimensioned and toleranced at 1.25 ± 0.10in. You've performed a capability study and assessed your sample standard deviation to be 0.025 in. Calculate the Cp for your process.**
   - 1.0
   - 1.33
   - 1.66
   - 2.0

4. **You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of Factor B?**
   - -9.5
   - -21.5
   - -1.5
   - -8

| | | Factors | | Response |
|---|---|---|---|---|
| | | A | B | % Yield |
| Treatments | 1 | + | + | 64 |
| | 2 | - | + | 75 |
| | 3 | + | - | 87 |
| | 4 | - | - | 95 |

5. **You ship approximately 1,000 packages per day, and the mean number of shipping errors is equal to 15 per day. What is the probability that you will experience exactly 15 failures in one day?**
   - 5%
   - 10%
   - 15%
   - 25%

6. **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

7. **Calculate the point estimate for the sample mean using the following 5 sample data points: 116, 123, 133, 127, 119**
   - Sample Mean = 123.4
   - Sample Mean = 123.6
   - Sample Mean = 123.5
   - Sample Mean = 123.8

8. **For a random variable that is normally distributed with a mean value of 1.50 and a standard deviation of 0.25, what is the probability of occurrence of the values between 1.25 - 2.00.**
   - 47%
   - 75%
   - 66%
   - 82%

9. **You're creating a linear regression model for your data and you've calculated the following values. What is the predicted value of Y when X = 23:** $S_{yy} = 4130$, $S_{xy} = 1527$, $S_{xx} = 626.86$, $\beta_0 = 17.81$
   - 54
   - 56
   - 66
   - 74

10. **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 lower control limits for the X-bar chart:**
    - 220.52
    - 229.48
    - 233.14
    - 218.71

11. **Calculate $P_{pk}$ for the following Parameters: (USL = 675, LSL = 625, σ = 5, μ = 655)**
    - 0.67
    - 1.0
    - 1.33
    - 1.50

12. **You manufacture a widget and use a c chart to monitor the number of defects associated with your process. Your sample size is constant and on average you find 7 defects per sample. Identify the upper control limits for the c chart:**
    - 0
    - 10
    - 12
    - 15

13. **You've sampled 50 units from the latest production lot to measure the outer diameter of the product. The sample mean is 0.51in and the population standard deviation is known to be 0.07in. Calculate the 95% confidence interval:**
    - 0.491 - 0.529
    - 0.487 - 0.532
    - 0.369 - 0.651
    - 0.507 - 0.513

14. **Calculate the population variance of the following data set: 4, 8, 5, 7**
    - 3.33
    - 2.5
    - 1.83
    - 1.58

15. **If the probability of event A is P(A) = 33% and the probability of event B is P(B) = 40% and the intersection of A &B is P(A ∩ B) = 20%. If I told you that Event B had occurred, what is the probability that Event A has also occurred?**
    - 25%
    - 33%
    - 45%
    - 50%

16. **You're performing a hypothesis test to compare the sample variance to see if it's equivalent to a hypothesized population variance. You take 10 samples, and your hypothesis test has 10% alpha risk (2-tailed test). What is the left-tail critical value for this test?**
    - 3.325
    - 4.168
    - 3.940
    - 4.865

17. **You're manufacturing a widget and using an I-MR where you measure 3 consecutive samples to control the critical feature of the product. Your process has the following attributes:** $\bar{X} = 1.25, \overline{MR} = 0.55$ **Identify the upper control limits for the I chart:**
    - 0.275
    - 1.80
    - 2.225
    - 2.713

18. **You're creating a linear regression model for your data and you've calculated the following values. What is correlation coefficient for this data set:** $S_{yy} = 4130$, $S_{xy} = 1527$, $S_{xx} = 626.86$
    - -0.4
    - 0.25
    - 0.72
    - 0.95

19. **You're sampling 10 products from a population lot that has a 5% defective rate. What is the probability of getting exactly 1 defective unit in the sample?**
    - 5.98%
    - 31.51%
    - 7.45%
    - 24.26%

20. **A manufacturer wants to improve the way they start up their process to ensure that the product is within specifications. Which tool would you recommend?**
    - Short Run SPC
    - An X-bar and R Chart
    - Pre-Control Chart
    - Process Capability Analysis

21. **How many treatments would be required for a DOE with 4 factors where a quarter factorial design is chosen:**
    - 2
    - 4
    - 8
    - 16

22. **If you simultaneously flipped a coin and rolled a single six-sided die what is the probability that the coin lands on heads and the die lands on an even number?**
    - 8%
    - 16%
    - 25%
    - 32%

23. **Calculate $C_{pm}$ for the following Parameters: (USL = 10.85, LSL = 10.65, σ = 0.01, μ = 10.72, T = 10.75)**
    - 0.82
    - 1.05
    - 1.24
    - 1.52

24. **If you flip 3 coins simultaneously, what is the probability that you only get 1-coin land on heads?**
    - 12.5%
    - 25.0%
    - 37.5%
    - 50.0%

25. **A shipping operation distributed product at a mean time of 30 hours from receipt of order with a standard deviation of 2 hours. What percentage of shipments go out between 29 - 33 hours from time of receipt?**
    - 43%
    - 58%
    - 62%
    - 68%

**26. You've taken a random sample of 15 units from the latest production lot, and measured the overall height of the part. You calculate the sample mean to be 20.0 in, and the sample standard deviation to be 2.0 in. Calculate the 95% confidence interval for the population standard deviation.**

- $1.000 < \sigma < 3.000$
- $1.268 < \sigma < 2.842$
- $0.729 < \sigma < 2.645$
- $1.464 < \sigma < 3.154$

**27. How is the following equation read P(A|B):**

- The Probability of A AND B
- The Probability of A OR B
- The Probability of A given that B has occurred
- The Probability of B given that A has occurred

**28. Calculate the Range of the following data set: 24, 22, 26, 21, 20**

- 4
- 5
- 6
- 7

**29. What control chart would be used to monitor the number of defectives for a process with a constant sample size?**

- P Chart
- NP Chart
- C Chart
- U Chart

**30. When dealing with probabilities, what does the following symbol mean: $\cap$**

- Intersection
- Independence
- Union
- Mutually Exclusive

31. **This type of DOE design is used to study a process to determine which factors are critical and which are not.**
    - Screening/Characterization Design
    - Comparative Design
    - Modeling/Optimization Design
    - Full Factorial Design

32. **Calculate $C_r$ for the following Parameters: (USL = 675, LSL = 625, σ = 5)**
    - 0.60
    - 0.95
    - 1.00
    - 1.20

33. **You're performing a hypothesis test for the population mean, and your sample mean is 2.53, your null hypothesis for the population mean is 2.50, your sample size is 50 and your population standard deviation is 0.10. Calculate your test statistic for this hypothesis test:**
    - 0.300
    - 1.732
    - 2.121
    - 2.460

34. **During Acceptance sampling, your inspectors pull a sample of 32 parts, and perform their inspection. The acceptance criteria is that they accept the lot with 1 or fewer defects. Counting defects is considered which type of data:**
    - Discrete Data
    - Variable Data
    - Qualitative Data
    - Continuous Data

35. **What is the UCL for a p-chart when the average daily inspection quantity is 20, and the historical percentage of defectives is 0.01?**
    - 0.033
    - 0.055
    - 0.077
    - 0.099

36. **You've created a customer experience survey with the following possible selections: Terrible, Below Average, Average, Above Average, Amazing. What type of data will you be collecting?**
    - Nominal
    - Ordinal
    - Interval
    - Ratio

37. **What is the critical T-value when you measure 3 samples for a one-sided hypothesis test with a 1% alpha level?**
    - 6.965
    - 9.925
    - 4.541
    - 4.303

38. **Calculate $C_{pk}$ for the following Parameters: (USL = 17.65, LSL = 17.15, σ = 0.04, μ = 17.33)**
    - 1.0
    - 1.50
    - 1.67
    - 2.67

39. **You're performing a gauge R&R and you have operators using calipers to measure a known standard. These calipers are measuring the width of a gauge block. What type of data are they collecting in this Gauge R&R?**
    - Counted Data
    - Qualitative Data
    - Discrete Data
    - Continuous Data

40. **You're performing a hypothesis test for the population variance. You sample 10 parts and your sample standard deviation is 3.0, your null hypothesis for the population standard deviation is 4.0. Calculate your chi-squared test statistic:**
    - 5.06
    - 6.75
    - 7.5
    - 5.63

# THE 40 Question Statistics Practice Exam - CQEAcademy.com (Mixed Practice)

Below are the solutions to the 40 Question Statistics Practice Exam!

Not only can you see which questions you got wrong, along with the solutions, here is a complete breakdown of the topics associated with each question.

Circle all of the questions numbers you got wrong, to see if there is a particular topic that you're weak in and need to focus on!

| Topic Area | # Of Questions | Question Numbers |
|---|---|---|
| **Collecting & Summarizing Data** | 6 | 7, 14, 28, 34, 36, 39 |
| **Quantitative Concepts (Probability)** | 5 | 15, 22, 24, 27, 30 |
| **Probability Distributions** | 6 | 5, 8, 16, 19, 25, 37 |
| **Statistical Decision Making** | 5 | 2, 13, 26, 33, 40 |
| **Relationships Between Variables** | 2 | 9, 18 |
| **Statistical Process Control** | 7 | 6, 10, 12, 17, 20, 29, 35 |
| **Process & Performance Capability** | 5 | 3, 11, 23, 32, 38 |
| **Design of Experiments** | 4 | 1, 4, 21, 31 |

## SOLUTIONS

1. **In a designed experiment, when we have two factors whose effects on the response variable are combined in an indistinguishable way, we describe them as:**
   - **Confounding**
   - Balanced
   - Randomized
   - Interacting

2. **You're performing an ANOVA Analysis, and the total sum of squares is 36 and the treatment sum of squares is 16, what would the error sum of squares be?**
   - **20**
   - 52
   - 30
   - 16

$$SS_{error} = SS_{total} - SS_{treatment} = 36 - 16 = 20$$

3. **Your product is dimensioned and toleranced at 1.25 ± 0.10in. You've performed a capability study and assessed your sample standard deviation to be 0.025 in. Calculate the Cp for your process.**
   - 1.0
   - **1.33**
   - 1.66
   - 2.0

$$C_p = \frac{USL - LSL}{6\sigma} = \frac{1.35 - 1.15}{6 * 0.025} = \frac{0.20}{0.15} = 1.33$$

4. **You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of Factor B?**
   - -9.5
   - **-21.5**
   - -1.5
   - -8

| | | Factors | | Response |
|---|---|---|---|---|
| | | A | B | % Yield |
| Treatments | 1 | + | + | 64 |
| | 2 | - | + | 75 |
| | 3 | + | - | 87 |
| | 4 | - | - | 95 |

$$\textit{Estimated Effect} = \textit{Average at High} - \textit{Average at Low} = \frac{64 + 75}{2} - \frac{87 + 95}{2} = -21.5$$

5. **You ship approximately 1,000 packages per day, and the mean number of shipping errors is equal to 15 per day. What is the probability that you will experience exactly 15 failures in one day?**
   - 5%
   - **10%**
   - 15%
   - 25%

$$f(x) = P(X = x) = \frac{e^{-\lambda} * \lambda^{x}}{x!} = \frac{e^{-15} * 15^{15}}{15!} = 0.1024 = 10.2\%$$

6. **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

$$Population\ Standard\ Deviation = \hat{\sigma} = \frac{\bar{s}}{C_4} = \frac{4.2}{0.9400} = 4.5$$

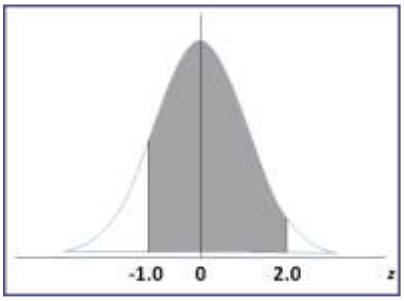
7. **Calculate the point estimate for the sample mean using the following 5 sample data points: 116, 123, 133, 127, 119**
   - Sample Mean = 123.4
   - **Sample Mean = 123.6**
   - Sample Mean = 123.5
   - Sample Mean = 123.8

8. **For a random variable that is normally distributed with a mean value of 1.50 and a standard deviation of 0.25, what is the probability of occurrence of the values between 1.25 - 2.00.**
   - 47%
   - 75%
   - 66%
   - **82%**

$$Z = \frac{1.25 - 1.50}{0.25} = -1.0 \qquad AND \qquad Z = \frac{2.00 - 1.50}{0.25} = 2.0$$

**Area under the Normal Curve from 0 to X**

| X | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 |
|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.00000 | 0.00399 | 0.00798 | 0.01197 | 0.01595 | 0.01994 | 0.02392 | 0.02790 |
| 0.9 | 0.31594 | 0.31859 | 0.32121 | 0.32381 | 0.32639 | 0.32894 | 0.33147 | 0.33398 |
| 1.0 | 0.34134 | 0.34375 | 0.34614 | 0.34849 | 0.35083 | 0.35314 | 0.35543 | 0.35769 |
| 1.1 | 0.36433 | 0.36650 | 0.36864 | 0.37076 | 0.37286 | 0.37493 | 0.37698 | 0.37900 |
| 1.9 | 0.47128 | 0.47193 | 0.47257 | 0.47320 | 0.47381 | 0.47441 | 0.47500 | 0.47558 |
| 2.0 | 0.47725 | 0.47778 | 0.47831 | 0.47882 | 0.47932 | 0.47982 | 0.48030 | 0.48077 |




Graphically this looks like this, with 34.134% of the distribution existing on the left half of the gray shaded area, and the other 47.725% existing on the right half of the gray shaded area out to Z = 2.0.

When we add these two shaded areas together, we find that the area under the curve equals **81.859%.**

9. **You're creating a linear regression model for your data and you've calculated the following values. What is the predicted value of Y when X = 23:** $S_{yy} = 4130$, $S_{xy} = 1527$, $S_{xx} = 626.86$, $\beta_0 = 17.81$

- 54
- 56
- 66
- **74**

To solve for Y, we need to calculate the slope coefficient: $\boldsymbol{\beta_1 = \frac{S_{xy}}{S_{xx}} = \frac{1527}{626.86} = 2.44}$

Now we can solve for Y(23). $\boldsymbol{Y(23) = 17.81 + 2.44 * 23 = 73.84}$

10. **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 lower control limits for the X-bar chart:**

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

$$\boldsymbol{Lower\ Control\ Limit}: \boldsymbol{LCL_{\bar{X}}} = \bar{\bar{X}} - A_2\bar{R} = 225 - 0.373 * 12 = \mathbf{220.52}$$

11. **Calculate $P_{pk}$ for the following Parameters: (USL = 675, LSL = 625, σ = 5, μ = 655)**

- 0.67
- 1.0
- **1.33**
- 1.50

$$P_{pk} = Min\left(\frac{USL - \tilde{x}}{3s_{p_p}}, \frac{\tilde{x} - LSL}{3s_{p_p}}\right) = Min\left(\frac{675 - 655}{3 * 5}, \frac{655 - 625}{3 * 5}\right) = Min\left(\frac{20}{15}, \frac{30}{15}\right) = Min(1.33, 2.0) = 1.33$$

12. **You manufacture a widget and use a c chart to monitor the number of defects associated with your process. Your sample size is constant and on average you find 7 defects per sample. Identify the upper control limits for the c chart:**

- 0
- 10
- 12
- **15**

$$UCL_c = \bar{c} + 3\sqrt{\bar{c}} = 7 + 3\sqrt{7} = 14.94$$

13. **You've sampled 50 units from the latest production lot to measure the outer diameter of the product. The sample mean is 0.51in and the population standard deviation is known to be 0.07in. Calculate the 95% confidence interval:**
    - **0.491 - 0.529**
    - 0.487 - 0.532
    - 0.369 - 0.651
    - 0.507 - 0.513

$$Interval\ Estimate = 0.51 \pm 1.96 * \frac{0.07}{\sqrt{50}} = 0.51 \pm 0.019 = 0.491 - 0.529$$

14. **Calculate the population variance of the following data set: 4, 8, 5, 7**
    - 3.33
    - **2.5**
    - 1.83
    - 1.58

$$\sigma^2 = \frac{\sum(x - \bar{\mu})^2}{N} = \frac{10}{4} = 2.5$$

15. **If the probability of event A is P(A) = 33% and the probability of event B is P(B) = 40% and the intersection of A &B is P(A ∩ B) = 20%. If I told you that Event B had occurred, what is the probability that Event A has also occurred?**
    - 25%
    - 33%
    - 45%
    - **50%**

**P(A|B) = P(A & B) / P(B) = 20% / 40% = 1/2 = 50%.**

16. **You're performing a hypothesis test to compare the sample variance to see if it's equivalent to a hypothesized population variance. You take 10 samples, and your hypothesis test has 10% alpha risk (2-tailed test). What is the left-tail critical value for this test?**
    - **3.325**
    - 4.168
    - 3.940
    - 4.865

When performing a hypothesis test to compare a sample variance against the population variance, we used the chi-squared distribution at 9 d.f.

**Left-Tail Critical Value of the Chi-Squared ($X^2$) Distribution**

| df (v) | 0.001 | 0.005 | 0.010 | 0.025 | 0.050 | 0.100 |
|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.000 | 0.001 | 0.004 | 0.016 |
| 2 | 0.002 | 0.010 | 0.020 | 0.051 | 0.103 | 0.211 |
| 3 | 0.024 | 0.072 | 0.115 | 0.216 | 0.352 | 0.584 |
| 4 | 0.091 | 0.207 | 0.297 | 0.484 | 0.711 | 1.064 |
| 5 | 0.210 | 0.412 | 0.554 | 0.831 | 1.145 | 1.610 |
| 6 | 0.381 | 0.676 | 0.872 | 1.237 | 1.635 | 2.204 |
| 7 | 0.598 | 0.989 | 1.239 | 1.690 | 2.167 | 2.833 |
| 8 | 0.857 | 1.344 | 1.646 | 2.180 | 2.733 | 3.490 |
| 9 | 1.152 | 1.735 | 2.088 | 2.700 | 3.325 | 4.168 |
| 10 | 1.479 | 2.156 | 2.558 | 3.247 | 3.940 | 4.865 |

With a 2-sided test, we have 5% alpha risk in the left tail, and at 9 degrees of freedom the left tail critical value is **3.325**.

17. **You're manufacturing a widget and using an I-MR where you measure 3 consecutive samples to control the critical feature of the product. Your process has the following attributes:** $\bar{X} = 1.25, \overline{MR} = 0.55$
**Identify the upper control limits for the I chart:**
    - 0.275
    - 1.80
    - **2.225**
    - 2.713

$$UCL_I = \bar{X} + E_2\overline{MR} = 1.25 + 1.772 * 0.55 = \mathbf{2.225}$$

18. **You're creating a linear regression model for your data and you've calculated the following values. What is correlation coefficient for this data set:** $S_{yy} = 4130, S_{xy} = 1527, S_{xx} = 626.86$
    - -0.4
    - 0.25
    - 0.72
    - **0.95**

$$r_{xy} = \frac{S_{xy}}{\sqrt{S_{xx}} * \sqrt{S_{yy}}} = \frac{1527}{\sqrt{626.86} * \sqrt{4130}} = \mathbf{0.95}$$

19. **You're sampling 10 products from a population lot that has a 5% defective rate. What is the probability of getting exactly 1 defective unit in the sample?**
    - 5.98%
    - **31.51%**
    - 7.45%
    - 24.26%

$$P(X = x) = \binom{n}{x} p^x (1-p)^{n-x} = \binom{10}{1} 0.05^1 (1-0.05)^{10-1} = 10 * 0.05 * (0.95)^9 = 0.3151 = 31.51\%$$

20. **A manufacturer wants to improve the way they start up their process to ensure that the product is within specifications. Which tool would you recommend?**
    - Short Run SPC
    - An X-bar and R Chart
    - **Pre-Control Chart**
    - Process Capability Analysis

**21. How many treatments would be required for a DOE with 4 factors where a quarter factorial design is chosen:**

- 2
- **4**
- 8
- 16

$$\textbf{Quarter}\ Factorial\ Design\text{: }Number\ of\ Treatments = \frac{Levels^{Factors}}{4} = \frac{L^F}{4} = \frac{2^F}{2^2} = 2^{F-2} = 2^{4-2} = 2^2 = \mathbf{4}$$

**22. If you simultaneously flipped a coin and rolled a single six-sided die what is the probability that the coin lands on heads and the die lands on an even number?**

- 8%
- 16%
- **25%**
- 32%

Event A: Coin lands on Heads, P(A) = 50%; Event B: Die lands on an even number, P(B) = 3/6 = 50%

P(A ∩ B) = 50% * 50% = **25%**

**23. Calculate $C_{pm}$ for the following Parameters: (USL = 10.85, LSL = 10.65, σ = 0.01, μ = 10.72, T = 10.75)**

- 0.82
- **1.05**
- 1.24
- 1.52

$$C_{pm} = \frac{USL - LSL}{6\sqrt{s^2 + (\tilde{x} - T)^2}} = \frac{10.85 - 10.65}{6\sqrt{0.01^2 + (10.72 - 10.75)^2}} = \frac{0.20}{6\sqrt{0.01^2 + (.03)^2}} = \mathbf{1.05}$$

**24. If you flip 3 coins simultaneously, what is the probability that you only get 1-coin land on heads?**

- 12.5%
- 25.0%
- **37.5%**
- 50.0%

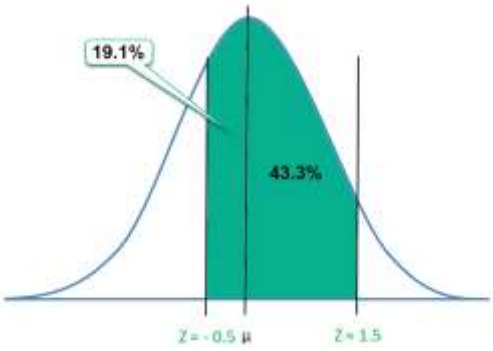
$$The\ Probability\ of\ Event\ A = \frac{The\ \#\ of\ Outcomes\ in\ A}{The\ Total\ \#\ of\ Possible\ Outcomes} = \frac{3}{8} = 37.5\%$$

The sample space for this experiment looks like this: (HHH, HHT, HTH, HTT, THH, THT, TTH, TTT). So there are 8 possible outcomes, and three outcomes match the desired condition (HHT, THH, HTH).

**25. A shipping operation distributed product at a mean time of 30 hours from receipt of order with a standard deviation of 2 hours. What percentage of shipments go out between 29 - 33 hours from time of receipt?**

- 43%
- 58%
- **62%**
- 68%

$$Z(29\ hours) = \frac{29 - 30}{2} = \frac{-1}{2} = -0.5 \qquad AND \qquad Z(33\ Hours) = \frac{33 - 30}{2} = \frac{3}{2} = 1.5$$




Area under the Normal Curve from 0 to X

| X | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 |
|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.00000 | 0.00399 | 0.00798 | 0.01197 | 0.01595 | 0.01994 | 0.02392 | 0.02790 |
| 0.3 | 0.11791 | 0.12172 | 0.12552 | 0.12930 | 0.13307 | 0.13683 | 0.14058 | 0.14431 |
| 0.4 | 0.15542 | 0.15910 | 0.16276 | 0.16640 | 0.17003 | 0.17364 | 0.17724 | 0.18082 |
| 0.5 | 0.19146 | 0.19497 | 0.19847 | 0.20194 | 0.20540 | 0.20884 | 0.21226 | 0.21566 |
| 0.6 | 0.22575 | 0.22907 | 0.23237 | 0.23565 | 0.23891 | 0.24215 | 0.24537 | 0.24857 |
| 0.7 | 0.25804 | 0.26115 | 0.26424 | | | | | |
| 1.4 | 0.41924 | 0.42073 | 0.42220 | 0.42364 | 0.42507 | 0.42647 | 0.42785 | 0.42922 |
| 1.5 | 0.43319 | 0.43448 | 0.43574 | 0.43699 | 0.43822 | 0.43943 | 0.44062 | 0.44179 |

**26. You've taken a random sample of 15 units from the latest production lot, and measured the overall height of the part. You calculate the sample mean to be 20.0 in, and the sample standard deviation to be 2.0 in. Calculate the 95% confidence interval for the population standard deviation.**

- 1.000 < σ < 3.000
- 1.268 < σ < 2.842
- 0.729 < σ < 2.645
- **1.464 < σ < 3.154**

$$\textbf{\textit{Confidence Interval for Standard Deviation}}: \quad \sqrt{\frac{(n-1)s^2}{X^2_{1-\alpha/2}}} < \sigma < \sqrt{\frac{(n-1)s^2}{X^2_{\alpha/2}}}$$

$$\sqrt{\frac{(15-1)2^2}{26.119}} < \sigma < \sqrt{\frac{(15-1)2^2}{5.629}}$$

$$1.464 < \sigma < 3.154$$

**27. How is the following equation read P(A|B):**

- The Probability of A AND B
- The Probability of A OR B
- **The Probability of A given that B has occurred**
- The Probability of B given that A has occurred

28. **Calculate the Range of the following data set: 24, 22, 26, 21, 20**

- 4
- 5
- **6**
- 7

The range is calculated as the max (**26**) minus the min (**20**), and in this example is **6.**

29. **What control chart would be used to monitor the number of defectives for a process with a constant sample size?**

- P Chart
- **NP Chart**
- C Chart
- U Chart

30. **When dealing with probabilities, what does the following symbol mean: *∩***

- **Intersection**
- Independence
- Union
- Mutually Exclusive

31. **This type of DOE design is used to study a process to determine which factors are critical and which are not.**

- **Screening/Characterization Design**
- Comparative Design
- Modeling/Optimization Design
- Full Factorial Design

32. **Calculate $C_r$ for the following Parameters: (USL = 675, LSL = 625, σ = 5)**

- **0.60**
- 0.95
- 1.00
- 1.20

$$C_r = \frac{1}{C_p} = \frac{6\sigma}{USL - LSL} = \frac{6 * 5}{675 - 625} = \frac{30}{50} = 0.60$$

33. **You're performing a hypothesis test for the population mean, and your sample mean is 2.53, your null hypothesis for the population mean is 2.50, your sample size is 50 and your population standard deviation is 0.10. Calculate your test statistic for this hypothesis test:**
    - 0.300
    - 1.732
    - **2.121**
    - 2.460

$$z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{2.53 - 2.50}{\frac{0.10}{\sqrt{50}}} = 2.121$$

34. **During Acceptance sampling, your inspectors pull a sample of 32 parts, and perform their inspection. The acceptance criteria is that they accept the lot with 1 or fewer defects. Counting defects is considered which type of data:**
    - **Discrete Data**
    - Variable Data
    - Qualitative Data
    - Continuous Data

35. **What is the UCL for a p-chart when the average daily inspection quantity is 20, and the historical percentage of defectives is 0.01?**
    - 0.033
    - 0.055
    - **0.077**
    - 0.099

$$UCL_{\bar{p}} = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{\bar{n}}} = 0.01 + 3\sqrt{\frac{0.01(1-0.01)}{20}} = 0.01 + 3\sqrt{0.000495} = 0.077 \; or \; 7.7\%$$

36. **You've created a customer experience survey with the following possible selections: Terrible, Below Average, Average, Above Average, Amazing. What type of data will you be collecting?**
    - Nominal
    - **Ordinal**
    - Interval
    - Ratio

37. **What is the critical T-value when you measure 3 samples for a one-sided hypothesis test with a 1% alpha level?**

- **6.965**
- 9.925
- 4.541
- 4.303

| Critical Values of the Student T's Distribution at Various Degrees of Freedom and Alpha Levels (α) | | | | | | |
|---|---|---|---|---|---|---|
| df (v) | α = 0.1 | α = 0.05 | α = 0.025 | α = 0.01 | α = 0.005 | α = 0.001 |
| 1 | 3.078 | 6.314 | 12.706 | 31.821 | 63.657 | 318.309 |
| 2 | 1.886 | 2.920 | 4.303 | 6.965 | 9.925 | 22.327 |
| 3 | 1.638 | 2.353 | 3.182 | 4.541 | 5.841 | 10.215 |
| 4 | 1.533 | 2.132 | 2.776 | 3.747 | 4.604 | 7.173 |
| 5 | 1.476 | 2.015 | 2.571 | 3.365 | 4.032 | 5.893 |

38. **Calculate $C_{pk}$ for the following Parameters: (USL = 17.65, LSL = 17.15, σ = 0.04, μ = 17.33)**

- 1.0
- **1.50**
- 1.67
- 2.67

$$C_{pk} = Min(C_{p,Lower}, C_{p,Upper}) = Min\left(\frac{USL-\mu}{3s}, \frac{\mu - LSL}{3s}\right) = Min\left(\frac{17.65-17.33}{3*0.04}, \frac{17.33-17.15}{3*0.04}\right)$$

$$C_{pk} = Min\left(\frac{0.32}{0.12}, \frac{0.18}{0.12}\right) = Min(2.67\,, 1.5) = \mathbf{1.50}$$

39. **You're performing a gauge R&R and you have operators using calipers to measure a known standard. These calipers are measuring the width of a gauge block. What type of data are they collecting in this Gauge R&R?**

- Counted Data
- Qualitative Data
- Discrete Data
- **Continuous Data**

40. **You're performing a hypothesis test for the population variance. You sample 10 parts and your sample standard deviation is 3.0, your null hypothesis for the population standard deviation is 4.0. Calculate your chi-squared test statistic:**

- **5.06**
- 6.75
- 7.5
- 5.63

$$\boldsymbol{Chi\ Squared\ Test\ Statistic}: X^2 = \frac{(N-1)s^2}{\sigma^2} = \frac{(10-1)3^2}{4^2} = \mathbf{5.06}$$