QUESTIONS:

1. **Identify all the statements below regarding the 7 QC Tools that are True:**
   - The scatter diagram is a visual prioritization tool.
   - The C&E Matrix allows you to graphically capture all the potential causes of a problem.
   - A Flow Chart is limited to only communicating process steps, and cannot be used for information flow.
   - The Histogram is a tool used to visualize the distribution of continuous data.
   - When a scatter plot reveals a positive relationship between two variables, that means that a positive increase in the independent variable (X) would result in a positive increase in the dependent variable.

2. **A Light Bulb Manufacturer has just launched a brand-new bulb and complaints have been received for a short lifespan of the new bulb. A team of engineers have been assembled for root cause analysis. Which tool could be used to identify potential root causes that might be contributing to this event?**
   - Check Sheet
   - Cause & Effect Diagram
   - Flow Chart
   - Scatter Plot

3. **A team of engineers at the Toasters Are Us Manufacturing Company has identified a new failure mode in their production process. What tool could be used to identify all potential root causes for this new failure mode?**
   - Cause & Effect Diagram
   - Matrix Diagram
   - Flow Chart
   - Pareto Chart

4. **A team of engineers at a machine shop has identified the most frequently occurring defect in shop and wants to brainstorm the potential causes. Which tool can use used to facilitate the brainstorming session for this failure mode?**
   - Pareto Chart
   - Check Sheet
   - Prioritization Matrix
   - Cause & Effect Diagram

5. **A team of engineers is working to improve a process to reduce the variation over time. What tool can be used to measure the variation over time to determine if specific changes have been effective in reducing variation?**
   - Histogram
   - Scatter Plot
   - Control Chart
   - Pareto Chart

6. **You've formed a kaizen team with an important customer to reduce the defects in your product. You've used a check sheet to collect frequency data on the defects. Using a pareto chart to analyze this data has revealed the top issues, and an improvement has been made to reduce this defect. Which tool can be used to determine if this change has resulted in a sustained reduction over time?**
   - Control Chart
   - Scatter Plot
   - Cause & Effect Diagram
   - Process Decision Program Chart

7. **A burger joint wants to monitor the number of defective burgers cooked over time to identify if any changes have occurred within the process. Which tool can be used to assess performance of the cooking process over time?**
   - Control Chart
   - Flow Chart
   - Histogram
   - Pareto Chart

8. **Fill in the blank: The _____ is a visual tool to explore all the potential factors that may be causing or contributing to a particular problem (effect).**
   - Flow Chart
   - Cause & Effect Diagram
   - Pareto Chart
   - Check Sheet

9. **Fill in the blank: A _____ is a statistically based tool that analyzes the variation of a process.**
   - Pareto Chart
   - Scatter Plot
   - Control Chart
   - Affinity Diagram

10. Which tools below can be combined with the Cause & Effect Diagram to make it more effective:

- 5 Why Analysis
- Scatter Plots
- Brainstorming
- Check Sheet

11. 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
- Not Enough Information

12. You're creating a linear regression model for your data and you've calculated the following values:

13. S_{yy} = 181, S_{xy} = -58, S_{xx} = 112

Based on these results, what percentage of variation in Y, can be explained by the variation in X:

Hint: See Exam Day Cheat Sheet - You'll be able to use this on the actual exam.

- 100%
- 81%
- 76%
- 41%
- 28%
- 16%
- 6%
- 1%
- Not Enough Information Provided

13. 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 range chart:

- 0
- 220.52
- 229.48
- 1.63
- 5.73
- 18.23
- 22.37

14. Calculate C_r for the following Parameters: (USL = 1.005, LSL = 0.995, σ = 0.002)

- 0.60
- 0.95
- 1.00
- 1.20
- 1.33

15. How many treatments would be required for a DOE with 8 factors where a quarter factorial design is chosen?

- 256
- 128
- 64
- 32
- 16
- 8

SOLUTIONS:

1. **Identify all the statements below regarding the 7 QC Tools that are True:**
   - The ~~**scatter diagram**~~ **(Pareto Chart)** is a visual prioritization tool. (False)
   - The C&E Matrix allows you to graphically capture all the potential causes of a problem. (True)
   - A Flow Chart is **(NOT)** limited to only communicating process steps, and ~~**cannot**~~ **(can also)** be used for information flow. (False)
   - The Histogram is a tool used to visualize the distribution of continuous data. (True)
   - When a scatter plot reveals a positive relationship between two variables, that means that a positive increase in the independent variable (X) would result in a positive increase in the dependent variable. (True)

2. **A Light Bulb Manufacturer has just launched a brand-new bulb and complaints have been received for a short lifespan of the new bulb. A team of engineers have been assembled for root cause analysis. Which tool could be used to identify potential root causes that might be contributing to this event?**
   - Check Sheet
   - **Cause & Effect Diagram**
   - Flow Chart
   - Scatter Plot

3. **A team of engineers at the Toasters Are Us Manufacturing Company has identified a new failure mode in their production process. What tool could be used to identify all potential root causes for this new failure mode?**
   - **Cause & Effect Diagram**
   - Matrix Diagram
   - Flow Chart
   - Pareto Chart

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   - Pareto Chart
   - Check Sheet
   - Prioritization Matrix
   - **Cause & Effect Diagram**

5. **A team of engineers is working to improve a process to reduce the variation over time. What tool can be used to measure the variation over time to determine if specific changes have been effective in reducing variation:**
   - Histogram
   - Scatter Plot
   - **Control Chart**
   - Pareto Chart

6. **You've formed a kaizen team with an important customer to reduce the defects in your product. You've used a check sheet to collect frequency data on the defects. Using a pareto chart to analyze this data has revealed the top issues, and an improvement has been made to reduce this defect. Which tool can be used to determine if this change has resulted in a sustained reduction over time?**
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   - Histogram
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8. **Fill in the blank: The _____ is a visual tool to explore all the potential factors that may be causing or contributing to a particular problem (effect).**
   - Flow Chart
   - **Cause & Effect Diagram**
   - Pareto Chart
   - Check Sheet

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   - Pareto Chart
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   - **Control Chart**
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10. Which tools below can be combined with the Cause & Effect Diagram to make it more effective:

- **5 Why Analysis**
- Scatter Plots
- **Brainstorming**
- Check Sheet

11. 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
- Not Enough Information

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

12. You're creating a linear regression model for your data and you've calculated the following values:

$S_{yy} = 181$, $S_{xy} = -58$, $S_{xx} = 112$

Based on these results, what percentage of variation in Y, can be explained by the variation in X:

- 100%
- 81%
- 76%
- 41%
- 28%
- 16%
- 6%
- 1%
- Not Enough Information Provided

This question is asking you to solve for the Coefficient of Determination, R^2. This coefficient reflects the proportion of variation in Y that can be explained by the variation in X.

Below is the equation to solve for the Pearson Correlation Coefficient, which then can be squared to find the coefficient of determination.

$$r_{xy} = \frac{S_{xy}}{\sqrt{S_{xx}} * \sqrt{S_{yy}}} = \frac{-58}{\sqrt{112} * \sqrt{181}} = -0.41$$

$$R^2 = -0.41^2 = 0.1659 = 16\%$$

13. 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 range chart:

- 0
- 220.52
- 229.48
- **1.63**
- 5.73
- 18.23
- **22.37**

First, we must look up the constants required to calculate the control limits for the range chart using the sample size (n=8), and we find $D_3 = 0.136$ and $D_4 = 1.864$.

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

Now we can calculate the control limits for the Range control chart:

$$\boldsymbol{UCL_R} = D_4 * \bar{R} = 1.864 * 12 = 22.37$$

$$\boldsymbol{LCL_R} = D_3 * \bar{R} = 0.136 * 12 = 1.63$$

14. Calculate C_r for the following Parameters: (USL = 1.005, LSL = 0.995, σ = 0.002)

- 0.60
- 0.95
- 1.00
- **1.20**
- 1.33

$$C_r = \frac{1}{C_p} = \frac{6\sigma}{USL - LSL} = \frac{6 * 0.002}{1.005 - 0.995} = \frac{0.012}{0.010} = \mathbf{1.20}$$

15. How many treatments would be required for a DOE with 8 factors where a quarter factorial design is chosen:

- 256
- 128
- **64**
- 32
- 16
- 8

$$\textbf{\textit{Quarter}}\ Factorial\ Design\text{: }Number\ of\ Treatments = \frac{Levels^{Factors}}{4} = \frac{L^F}{4} = \frac{2^F}{2^2} = 2^{8-2} = 2^6 = 64$$