QUESTIONS:

1. **You have a control chart on your production floor, however this chart is not regularly reviewed, and out of control data points are not investigate. What control chart error is occurring?**
   - Over-Adjustment
   - Under-Adjustment
   - Misinterpretation
   - Standardization

2. **You have a control chart on your production floor, and anytime your most recent data point is not close to the average value, an adjustment to the process is being made. What control chart error is occurring?**
   - Standardization
   - Over-Adjustment
   - Misinterpretation
   - Acceptance

3. **What is the probability that a random sub-group of data falls within zone A on a control chart?**
   - 34.15%
   - 13.6%
   - 2.1%
   - 0.15%

4. **What is the probability that process is perfectly in control and stable, and produces a sub-group of data that falls outside of the control limits?**
   - 13.60%
   - 2.10%
   - 0.30%
   - 0.00%

5. **Consider the following Range chart. What conclusion can be drawn?**
   - The process is out of specifications
   - The process is in specification
   - The process is out of control
   - The process is in control

6. **Consider the following NP Chart. What conclusion can be drawn?**
   - The process is out of specifications
   - The process is in specification
   - The process is out of control
   - The process is in control

7. **You manufacture a widget and use a control chart to monitor the number of defects associated with your process. Your sample size in each subgroup is constantly 100. In the last 5 subgroups, you have found 13, 16, 12, 11 and 15 defects per sample subgroup consecutively. Identify the lower control limits for this control chart.**
   - 13.4
   - 0
   - 24.38
   - 2.42

8. **You manufacture a widget and use an x-bar and S chart to monitor your process, where you sample 10 units in each subgroup, and s-bar = 2.40. Estimate the population standard deviation for this process.**
   - 2.40
   - 2.43
   - 2.47
   - 2.50

9. **You're manufacturing a widget and using an I-MR to control the critical feature of the product. You use 6 consecutive samples to measure the moving range, which you've assessed the average moving range to be 12.45. What is the upper control limit of the moving range chart?**
   - 0
   - 24.95
   - 28.41
   - 40.67

10. **You're manufacturing a widget and using an X-bar and S chart to control the critical feature of the product. Your normal process has the following attributes: X-double bar is 18.25, S-bar is 2.25, n = 15. Identify the upper control limits for the S chart:**
    - 2.50
    - 3.34
    - 3.86
    - 3.54

SOLUTIONS:

1. **You have a control chart on your production floor, however this chart is not regularly reviewed, and out of control data points are not investigate. What control chart error is occurring?**
   - Over-Adjustment
   - **Under-Adjustment**
   - Misinterpretation
   - Standardization

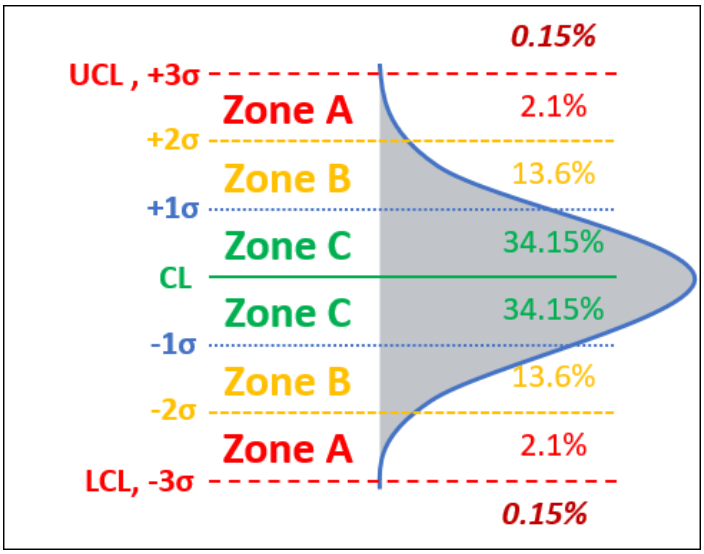
Explanation: Under-adjustment occurs when control charts are neglected or not regularly reviewed, leading to a failure in investigating and addressing out-of-control data points promptly.

2. **You have a control chart on your production floor, and anytime your most recent data point is not close to the average value, an adjustment to the process is being made. What control chart error is occurring?**
   - Standardization
   - **Over-Adjustment**
   - Misinterpretation
   - Acceptance

Explanation: Over-adjustment arises when changes to the process are made too frequently or prematurely, often triggered by normal variation, leading to unnecessary interventions and instability.

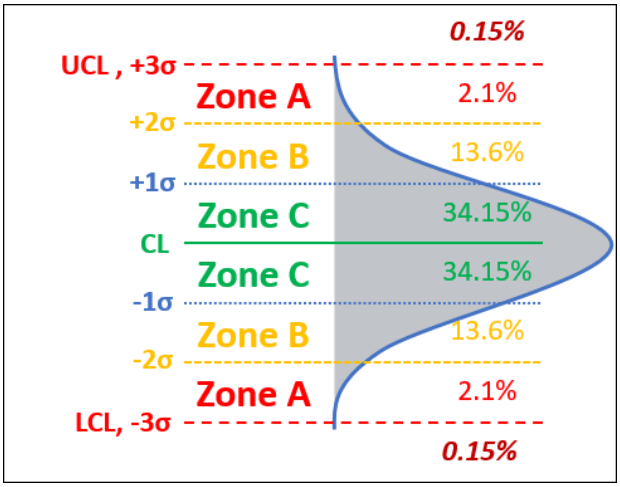
3. **What is the probability that a random sub-group of data falls within zone A on a control chart?**
   - 34.15%
   - 13.6%
   - **2.1%**
   - 0.15%

Explanation: Zone A on a control chart is the region from 2 standard deviations to 3 standard deviations, which captures a 2.1% proportion of the distribution of sample means.



4. What is the probability that process is perfectly in control and stable, and produces a sub-group of data that falls outside of the control limits?

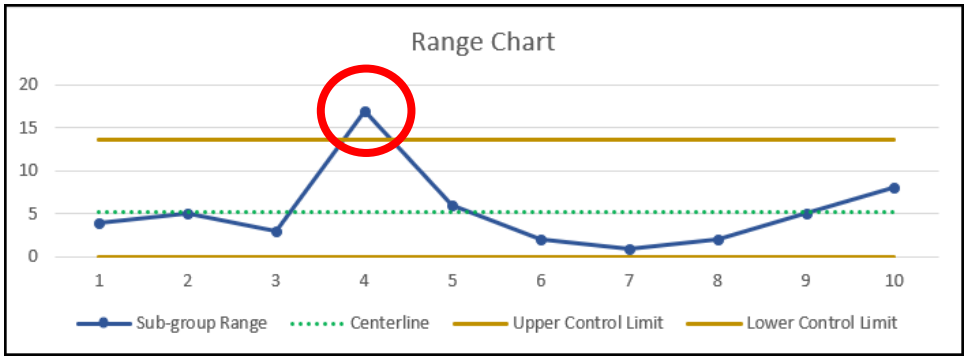
- 13.60%
- 2.10%
- **0.30%**
- 0.00%



Explanation: The control limits on a control chart capture **± 3 standard deviations** of the distribution of sample means, indicating that 99.7% of the data should fall within those control limits.

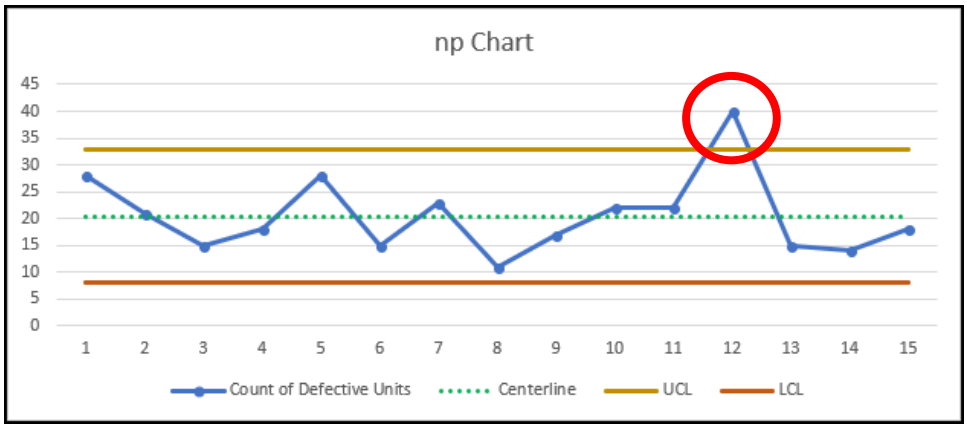
Hence a perfectly in-control, stable process still has a small (0.30%) probability of producing a data point outside of the control limits.

5. Consider the following Range chart. What conclusion can be drawn?



- The process is out of specifications
- The process is in specification
- **The process is out of control**
- The process is in control

6. Consider the following NP Chart. What conclusion can be drawn?



- The process is out of specifications
- The process is in specification
- **The process is out of control**
- The process is in control

7. You manufacture a widget and use a control chart to monitor the number of defects associated with your process. Your sample size in each subgroup is constantly 100. In the last 5 subgroups, you have found 13, 16, 12, 11 and 15 defects per sample subgroup consecutively. Identify the lower control limits for this control chart.

- 13.4
- 0
- 24.38
- **2.42**

Because we are dealing with defects and the sample size is constant, then we are using C chart.

First, we must calculate the centerline of the C chart:

$$\bar{c} = \boldsymbol{Centerline} = \frac{\sum c}{k} = \frac{Sum\ of\ All\ Defects}{\#\ of\ Subgroups} = \frac{13 + 16 + 12 + 11 + 15}{5} = 13.4$$

$$\boldsymbol{LCL_c} = \bar{c} - 3\sqrt{\bar{c}} = 13.4 - 3 * \sqrt{13.4} = \mathbf{2.42}$$

8. You manufacture a widget and use an x-bar and S chart to monitor your process, where you sample 10 units in each subgroup, and s-bar = 2.40. Estimate the population standard deviation for this process.

- 2.40
- 2.43
- **2.47**
- 2.50

We divide S-bar by the factor C_4, which is based on the n=10 sample size.

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

$$\hat{\sigma} = \frac{2.40}{0.9727} = \mathbf{2.47}$$

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

9. You're manufacturing a widget and using an I-MR to control the critical feature of the product. You use 6 consecutive samples to measure the moving range, which you've assessed the average moving range to be 12.45. What is the upper control limit of the moving range chart?

- 0
- **24.95**
- 28.41
- 40.67

$$UCL_{MR} = D_4 * \overline{MR}$$

$$UCL_{MR} = 2.004 * 12.45 = \mathbf{24.95}$$

I-MR Chart				
Subgroup Sample Size	Individual Factor	Moving Range Factors		Variance Factor
n	E_2	D_3	D_4	d_2
2	2.660	-	3.267	1.128
3	1.772	-	2.575	1.693
4	1.457	-	2.282	2.059
5	1.290	-	2.115	2.326
6	1.184	-	2.004	2.534
7	1.109	0.076	1.924	2.704
8	1.054	0.136	1.864	2.847
9	1.010	0.184	1.816	2.970
10	0.975	0.223	1.777	3.078

When using six consecutive samples to measure the moving range, the D_4 factor is 2.004.

10. You're manufacturing a widget and using an X-bar and S chart to control the critical feature of the product. Your normal process has the following attributes: X-double bar is 18.25, S-bar is 2.25, n = 15. Identify the upper control limits for the S chart:

- 2.50
- 3.34
- 3.86
- **3.54**

$$\boldsymbol{UCL_s} = B_4\bar{s}$$

$$At\ a\ sample\ size\ of\ 15, the\ B_4 = 1.572$$

$$\boldsymbol{UCL_s} = 1.572 * 2.25 = \mathbf{3.537}$$

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
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