CHAPTER 14 FORM C

Name_____ Course Number:_____ Section Number:_____

**Directions: Answer the questions and solve the problems in the spaces provided, or attach paper. Use graph paper for the control charts, if preferred.**

**Provide an appropriate response.**

1) A common goal of quality control is to reduce variation in a product or service. List and describe the two types of variability. Give an example of each.

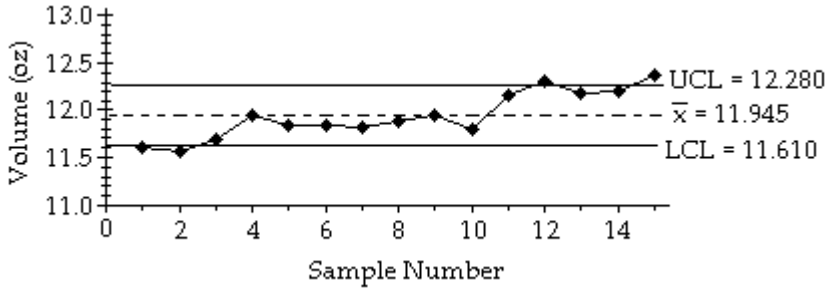
2) Describe a control chart. Complete the table to identify the important parts of different types of control charts.

| | Points plotted | Centerline and how to compute | Upper control limit | Lower control limit |
|---|---|---|---|---|
| Control chart for R | | | | |
| Control chart for $\overline{X}$ | | | | |
| Control chart for p | | | | |

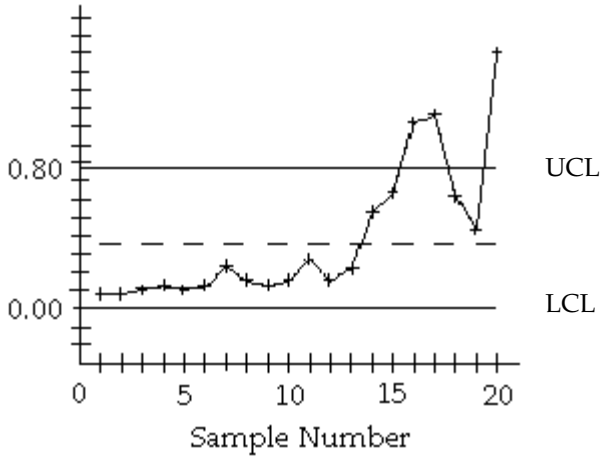
3) Draw a control chart that illustrates a process which is statistically stable and one which illustrates a process which is not statistically stable. Discuss the results.

**Examine the given run chart or control chart and determine whether the process is within statistical control. If it is not, identify which of the three out–of–statistical–control criteria apply.**

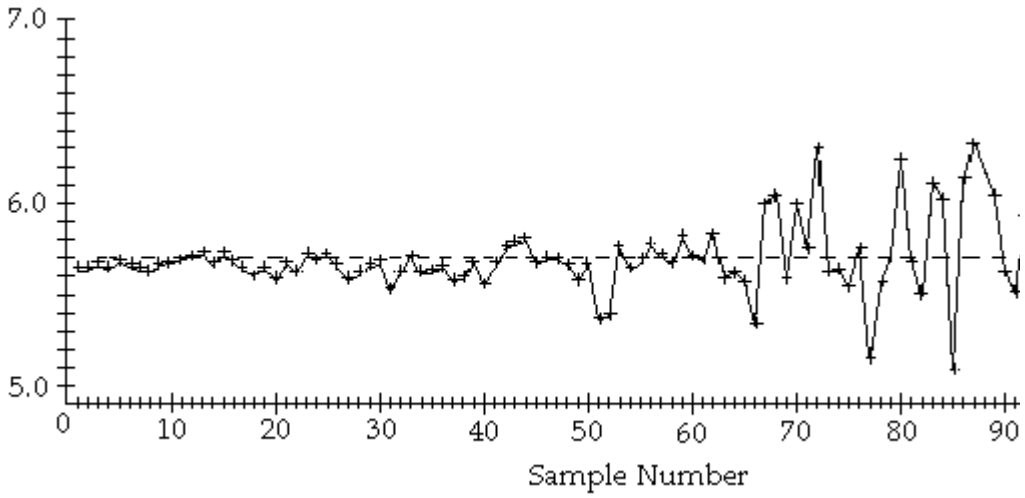
4) A control chart for $\bar{x}$ is shown below. Determine whether the process mean is within statistical control. If it is not, identify which of the three out–of–control criteria lead to rejection of a statistically stable mean.




5) A control chart for R is shown below. Determine whether the process variation is within statistical control. If it is not, identify which of the three out–of–control criteria lead to rejection of statistically stable variation.



6) A run chart for individual values is shown below. Does there appear to be a pattern suggesting that the process is not within statistical control? If so, describe the pattern.



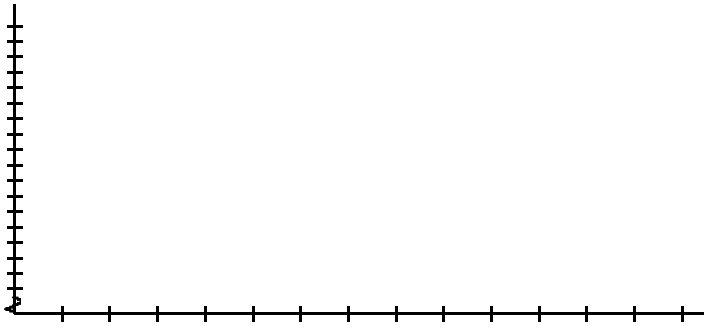
**Construct an $\bar{x}$ chart.**

**Control Chart Constants**

| | $\bar{x}$ | | s | | R | |
|---|---|---|---|---|---|---|
| **n** | **$A_2$** | **$A_3$** | **$B_3$** | **$B_4$** | **$D_3$** | **$D_4$** |
| **2** | **1.880** | **2.659** | **0.000** | **3.267** | **0.000** | **3.267** |
| **3** | **1.023** | **1.954** | **0.000** | **2.568** | **0.000** | **2.574** |
| **4** | **0.729** | **1.628** | **0.000** | **2.266** | **0.000** | **2.282** |
| **5** | **0.577** | **1.427** | **0.000** | **2.089** | **0.000** | **2.114** |
| **6** | **0.483** | **1.287** | **0.030** | **1.970** | **0.000** | **2.004** |
| **7** | **0.419** | **1.182** | **0.118** | **1.882** | **0.076** | **1.924** |
| **8** | **0.373** | **1.099** | **0.185** | **1.815** | **0.136** | **1.864** |
| **9** | **0.337** | **1.032** | **0.239** | **1.761** | **0.184** | **1.816** |
| **10** | **0.308** | **0.975** | **0.284** | **1.716** | **0.223** | **1.777** |

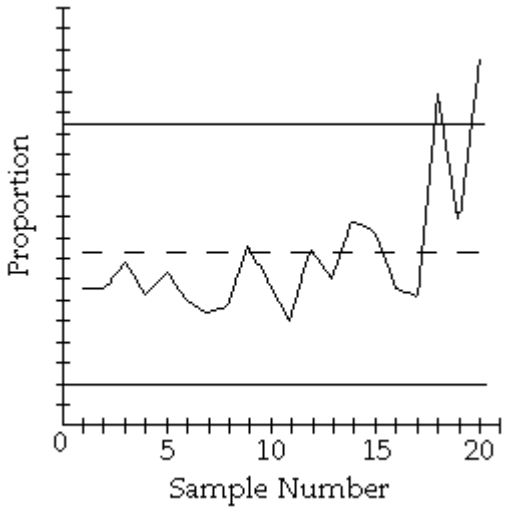
7) A machine that is supposed to produce ball bearings with a diameter of 7 millimeters yields the following data from a test of 5 ball bearings every 20 minutes.

| Sample | Ball Bearing Diameter (mm) | | | | | $\bar{x}$ | Range |
|---|---|---|---|---|---|---|---|
| 1 | 6.3 | 6.8 | 6.9 | 6.8 | 6.9 | 6.74 | 0.6 |
| 2 | 6.3 | 6.6 | 6.6 | 6.3 | 7.0 | 6.56 | 0.7 |
| 3 | 6.8 | 6.7 | 7.0 | 6.5 | 7.0 | 6.80 | 0.5 |
| 4 | 7.0 | 6.7 | 6.7 | 6.8 | 6.8 | 6.80 | 0.3 |
| 5 | 6.8 | 6.8 | 6.6 | 6.5 | 6.4 | 6.62 | 0.4 |
| 6 | 6.8 | 6.7 | 6.6 | 6.3 | 6.9 | 6.66 | 0.6 |
| 7 | 7.3 | 7.3 | 7.4 | 7.4 | 7.0 | 7.28 | 0.4 |
| 8 | 7.2 | 7.0 | 7.2 | 6.9 | 7.1 | 7.08 | 0.3 |
| 9 | 7.3 | 7.6 | 7.1 | 7.4 | 7.6 | 7.40 | 0.5 |
| 10 | 7.2 | 7.6 | 7.5 | 7.6 | 7.1 | 7.40 | 0.5 |
| 11 | 7.2 | 7.2 | 7.4 | 7.0 | 7.0 | 7.16 | 0.4 |
| 12 | 7.5 | 7.4 | 7.4 | 7.6 | 7.1 | 7.40 | 0.5 |



**Examine the given run chart or control chart and determine whether the process is within statistical control. If it is not, identify which of the three out–of–statistical–control criteria apply.**

8)




**Provide an appropriate response.**

**Control Chart Constants**

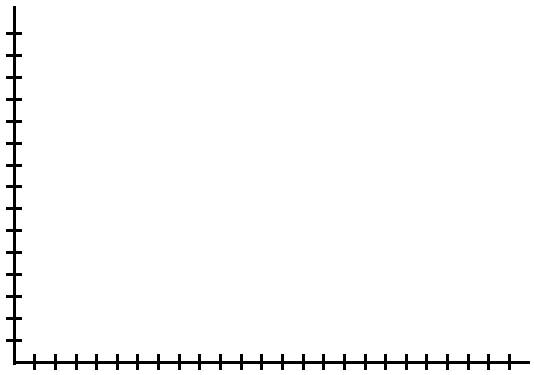
| | $\bar{x}$ | | s | | R | |
|---|---|---|---|---|---|---|
| **n** | $A_2$ | $A_3$ | $B_3$ | $B_4$ | $D_3$ | $D_4$ |
| **2** | 1.880 | 2.659 | 0.000 | 3.267 | 0.000 | 3.267 |
| **3** | 1.023 | 1.954 | 0.000 | 2.568 | 0.000 | 2.574 |
| **4** | 0.729 | 1.628 | 0.000 | 2.266 | 0.000 | 2.282 |
| **5** | 0.577 | 1.427 | 0.000 | 2.089 | 0.000 | 2.114 |
| **6** | 0.483 | 1.287 | 0.030 | 1.970 | 0.000 | 2.004 |
| **7** | 0.419 | 1.182 | 0.118 | 1.882 | 0.076 | 1.924 |
| **8** | 0.373 | 1.099 | 0.185 | 1.815 | 0.136 | 1.864 |
| **9** | 0.337 | 1.032 | 0.239 | 1.761 | 0.184 | 1.816 |
| **10** | 0.308 | 0.975 | 0.284 | 1.716 | 0.223 | 1.777 |

9) A control chart for attributes is to be constructed. Which process would have wider control limits, a process which has been having a 5% rate of nonconforming items, or a process which has been having a 10% of nonconforming items? Assume that both processes have the same sample sizes. For a given sample size, would it be easier to detect a shift from 5% to 10% or a shift from 10% to 15%? Explain your reasoning.

**Use the given process data to construct a control chart for p.**

10) If the weight of cereal in a particular packet is less than 14 ounces, the packet is considered nonconforming. Each week, the manufacturer randomly selects 1,000 cereal packets and determines the number that are nonconforming. The results for 12 consecutive weeks are shown below.

46 32 21 30 47 31 32 52 48 45 62 58



11) **Solve the problem.**

Solve the p chart. Calculate the centerline value, UCL, and LCL for a manufacturing process, whose sampling detects the following defects among 20 batches of 10,000 products per sample. Data are shown below.

3, 2, 5, 3, 4, 5, 8, 6, 7, 8, 8, 4, 7, 9, 4, 3, 8, 4, 3, 5

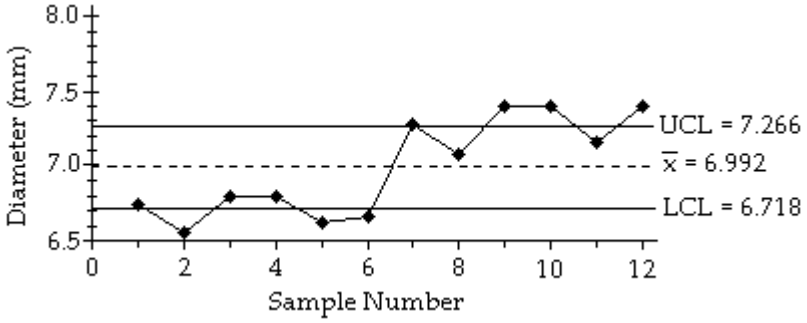
12) **Solve the problem.**

Solve the np chart, which is similar to the p chart, except that actual numbers of defects rather than proportions of defects are plotted on the vertical axis. For the data given in #11 above, calculate the centerline value, UCL, and LCL.

1) Random variation is due to chance, the variation inherent in any process that is not capable of producing each good or service exactly the same way every time. Assignable variation results from causes that can be identified. Examples may vary.
2) A control chart of a process characteristic (such as a mean or range) consists of values plotted sequentially over time, and it includes a centerline, representing a central value of the characteristic measurement, as well as lower and upper control limits, representing boundaries used to separate and identify any points considered to be unusual.

| | Points plotted | Centerline and how to compute | Upper control limit | Lower control limit |
|---|---|---|---|---|
| Control chart for R | sample ranges | $\overline{R}$, the average of the sample ranges | $D_4\overline{R}$ $D_4$ is from a table | $D_3\overline{R}$ $D_3$ is from a table |
| Control chart for $\overline{X}$ | sample means | $\overline{\overline{X}}$, the average of the sample means | $\overline{\overline{X}} + A_2\overline{R}$ $A_2$ is from a table | $\overline{\overline{X}} - A_2\overline{R}$ $A_2$ is from a table |
| Control chart for p | sample proportions | $\overline{p}$, the pooled estimate of the proportion for all items sampled | $\overline{p} + 3\sqrt{\frac{\overline{p} \cdot \overline{q}}{n}}$ | $\overline{p} - 3\sqrt{\frac{\overline{p} \cdot \overline{q}}{n}}$ If the lower control limit is negative, use 0. |

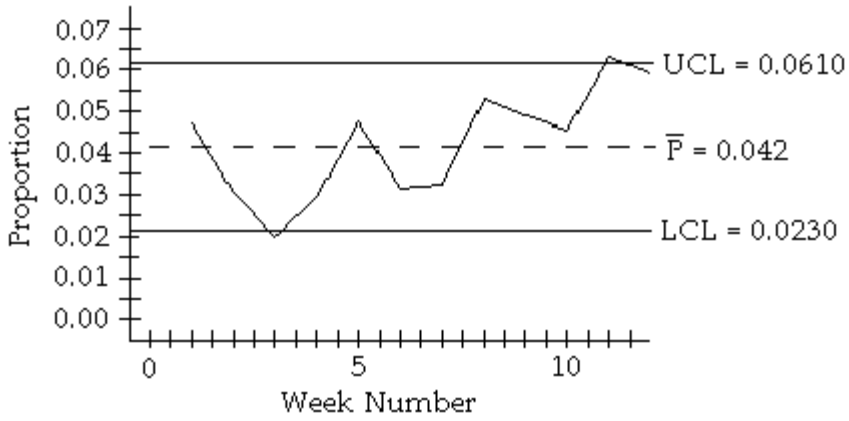
3) Examples will vary. The control chart which is statistically stable should show only random variation. The control chart which is not statistically stable will display at least one of the following: 1) There is a pattern, trend, or cycle that is obviously not random. 2) There is a point lying outside the region between the upper or lower control limits. 3) There are eight consecutive points all above or all below the centerline.
4) Process mean is not within statistical control. There are points above and below the control limits. There is an upward trend.
5) Process variation appears to be out of statistical control. There is an upward trend indicating that variation is increasing. There are points above the upper control limit. There are more than eight consecutive points below the centerline.
6) Process appears to be out of statistical control. The variation is increasing over time.
7)




8) Process appears to be out of statistical control. There are points that lie above the upper control limit. There are eight consecutive points below the centerline. There is increasing variation.

9) The process which has been having a 10% of nonconforming items would have wider control limits. It would be easier to detect a shift from 5% to 10% than a shift from 10% to 15%, because at a 5% rate of nonconforming items, the control limits are narrower, and it thus takes a smaller shift before the proportion falls outside the control limits.

10)




11) Centerline value = 0.00053; UCL = 0.00122; LCL = −0.000160

12) Centerline value = 5.3; UCL = 12.20; LCL = −1.60. [Students should discover that each np measure is n times its p counterpart.]