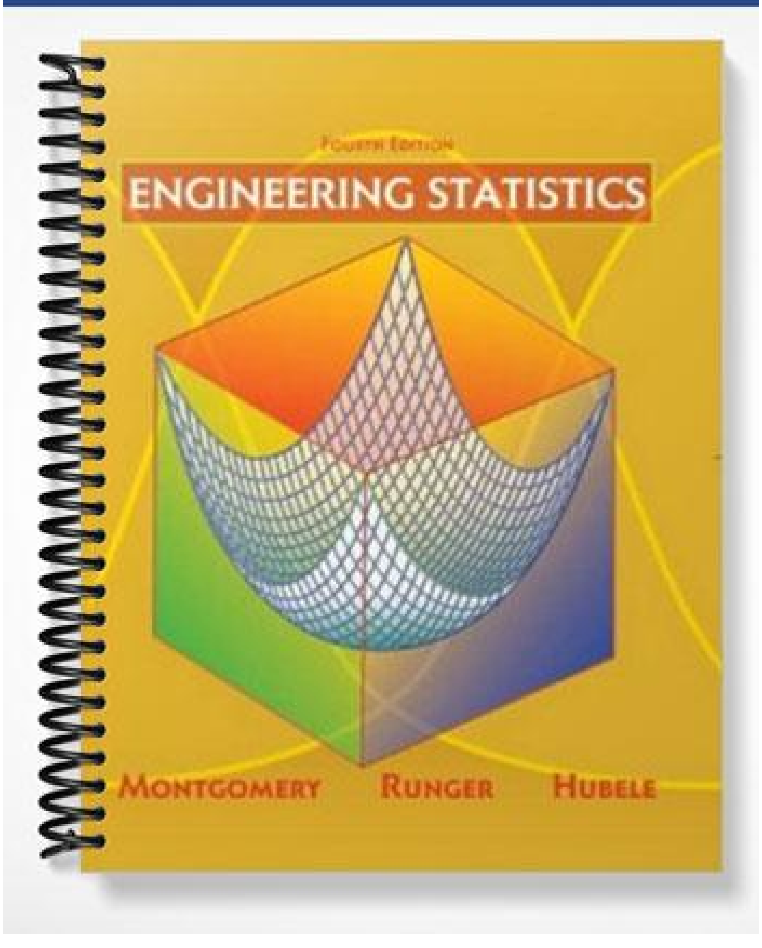
SOLUTIONS MANUAL



29October2008

Chapter 2

<u>Section 2-1</u>

2-1. **Sample average:** $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n} = \dfrac{\sum_{i=1}^{12} x_i}{12} = \dfrac{673.1}{12} = 56.09$

Sample standard deviation:

$\sum_{i=1}^{12} x_i = 673.10 \qquad \sum_{i=1}^{12} x_i^2 = 39168$

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}} = \sqrt{\frac{39168 - \frac{(673.10)^2}{12}}{12-1}} = \sqrt{\frac{1412.70}{11}} = \sqrt{128.43} = 11.33$$

Dot diagram:

```
    .               .           .  : .. .        . : .
-------+---------+---------+---------+---------+---------suspended solids
    32.0      40.0      48.0      56.0      64.0      72.0
```

2-2. **Sample average**: $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n} = \dfrac{\sum_{i=1}^{19} x_i}{19} = \dfrac{272.82}{19} = 14.36 \text{ min}$

Sample standard deviation:

$\sum_{i=1}^{19} x_i = 272.82 \qquad \sum_{i=1}^{19} x_i^2 = 10334$

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}} = \sqrt{\frac{10334 - \frac{(272.82)^2}{19}}{19-1}} = \sqrt{\frac{6416.59}{18}} = \sqrt{356.48 \ (\text{min})^2} = 18.88 \text{ min}$$

Dot diagram

```
 . .
.:::.:. .            ....                        .
+---------+---------+---------+---------+---------+------- Breakdown time
0        15        30        45        60        75
```

2-3. **Sample average**: $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n} = \dfrac{\sum_{i=1}^{7} x_i}{7} = \dfrac{9019}{7} = 1288.43 \text{ angstroms}$

Sample standard deviation:

$\sum_{i=1}^{7} x_i = 9019 \qquad \sum_{i=1}^{7} x_i^2 = 11621835$

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}} = \sqrt{\frac{11621835 - \frac{(9019)^2}{7}}{7-1}} = \sqrt{\frac{1497.71}{6}} = \sqrt{249.62 \ (\text{angstroms})^2} = 15.80 \text{ angstroms}$$

Dot diagram:

```
     .              .     .              .         ..       .
    -+---------+---------+---------+---------+---------+----- Thickness
1264.0    1272.0    1280.0    1288.0    1296.0    1304.0
```

2-4. **Sample average**: $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n} = \dfrac{\sum_{i=1}^{18} x_i}{18} = \dfrac{2272}{18} = 126.22$ kN

Sample standard deviation:

$$\sum_{i=1}^{18} x_i = 2272 \qquad \sum_{i=1}^{18} x_i^2 = 298392$$

$$s^2 = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}} = \sqrt{\frac{298392 - \frac{(2272)^2}{18}}{18-1}} = \sqrt{\frac{11615.11}{17}} = \sqrt{683.24 \ \ (kN)^2} = 26.14 \text{ kN}$$

Dot Diagram:

```
         .
     :   ::  .            ::      .          .  : .   .
 +---------+---------+---------+---------+---------+-------yield
90       105       120       135       150       165
```

2-5. **Sample average**: $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n} = \dfrac{\sum_{i=1}^{8} x_i}{8} = \dfrac{351.8}{8} = 43.98$

Sample standard deviation:

$$\sum_{i=1}^{8} x_i = 351.8 \qquad \sum_{i=1}^{8} x_i^2 = 16528.40$$

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}} = \sqrt{\frac{16528.04 - \frac{(351.8)^2}{8}}{8-1}} = \sqrt{\frac{1058}{7}} = \sqrt{151.143} = 12.29$$

Dot diagram:

```
      .             . ..   .        ..                    .
   +---------+---------+---------+---------+---------+-------
24.0      32.0      40.0      48.0      56.0      64.0
```

2-6. **Sample average**: $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n} = \dfrac{\sum_{i=1}^{9} x_i}{9} = \dfrac{19.56}{9} = 2.173$ mm

Sample standard deviation:

$$\sum_{i=1}^{9} x_i = 19.56 \qquad \sum_{i=1}^{9} x_i^2 = 45.953$$

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1}} = \sqrt{\frac{45.953 - \frac{(19.56)^2}{9}}{9-1}} = \sqrt{\frac{3.443}{8}} = \sqrt{0.4304} = 0.6560 \text{ mm}$$

Dot Diagram:

```
.     .            .     .  .         .  .          ..
-------+---------+---------+---------+---------+--------- Crack length
    1.40      1.75      2.10      2.45      2.80      3.15
```

2-7. **Sample average:**

$$\bar{x} = \frac{\sum_{i=1}^{35} x_i}{35} = \frac{28368}{35} = 810.514 \quad watts/m^2$$

Sample variance:

$$\sum_{i=1}^{35} x_i = 28368$$

$$\sum_{i=1}^{35} x_i^2 = 23552500$$

$$s^2 = \frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1} = \frac{23552500 - \frac{(28368)^2}{35}}{35-1} = \frac{559830.743}{34}$$

$$= 16465.61 \quad (watts/m^2)^2$$

Sample standard deviation:

$$s = \sqrt{16465.61} = 128.32 \quad watts/m^2$$

The sample standard deviation could also be found using

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

where

$$\sum_{i=1}^{35} (x_i - \bar{x})^2 = 559830.743$$

Dot Diagram (rounding of the data is used to create the dot diagram)

```
                                    x̄
                                    ↓
                         . .
    .     :        .:  ... . . .:  :. . .:. .:: :::
-----+---------+---------+---------+---------+---------+-x
    500       600       700       800       900      1000
```

The sample mean is the point at which the data would balance if it were on a scale.

2-8. **High Dose Group:**

Sample average:

$$\bar{x} = \frac{\sum_{i=1}^{22} x_i}{22} = \frac{1158.2}{22} = 52.65$$

Sample variance:

$$\sum_{i=1}^{22} x_i = 1158.2$$

$$\sum_{i=1}^{22} x_i^2 = 92270.6$$

$$s^2 = \frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1} = \frac{92270.6 - \frac{(1158.2)^2}{22}}{22-1} = \frac{31296.63}{21}$$

$$= 1490.32$$

Sample standard deviation:

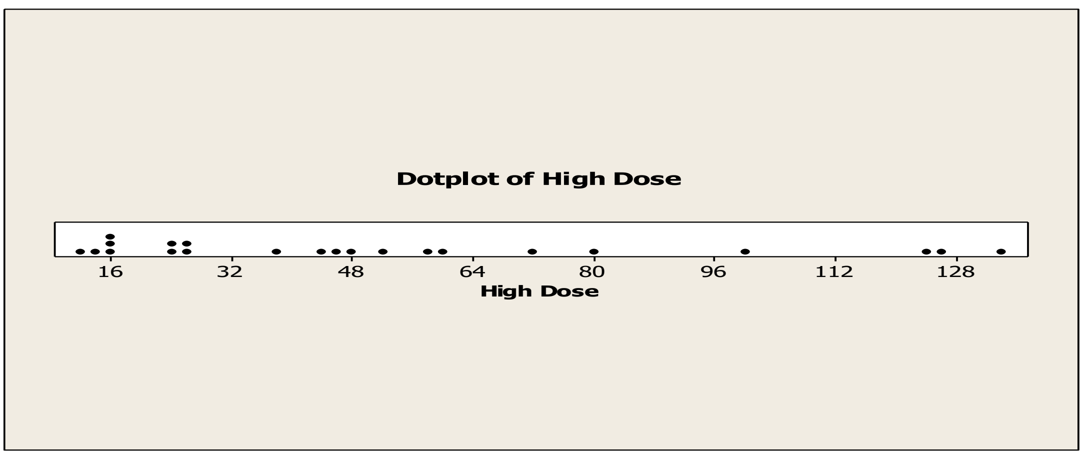
$$s = \sqrt{1490.32} = 38.60$$

The sample standard deviation could also be found using

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

where

$$\sum_{i=1}^{22} (x_i - \bar{x})^2 = 31296.6$$



Control Group:

Sample average:

$$\bar{x} = \frac{\sum_{i=1}^{22} x_i}{22} = \frac{8418.7}{22} = 382.67$$

Sample variance:

$$\sum_{i=1}^{22} x_i = 8418.7$$

$$\sum_{i=1}^{22} x_i^2 = 6901280$$

$$s^2 = \frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}}{n-1} = \frac{6901280 - \frac{(8418.7)^2}{22}}{22-1} = \frac{3679711.38}{21}$$

$$= 175224.35$$

Sample standard deviation:

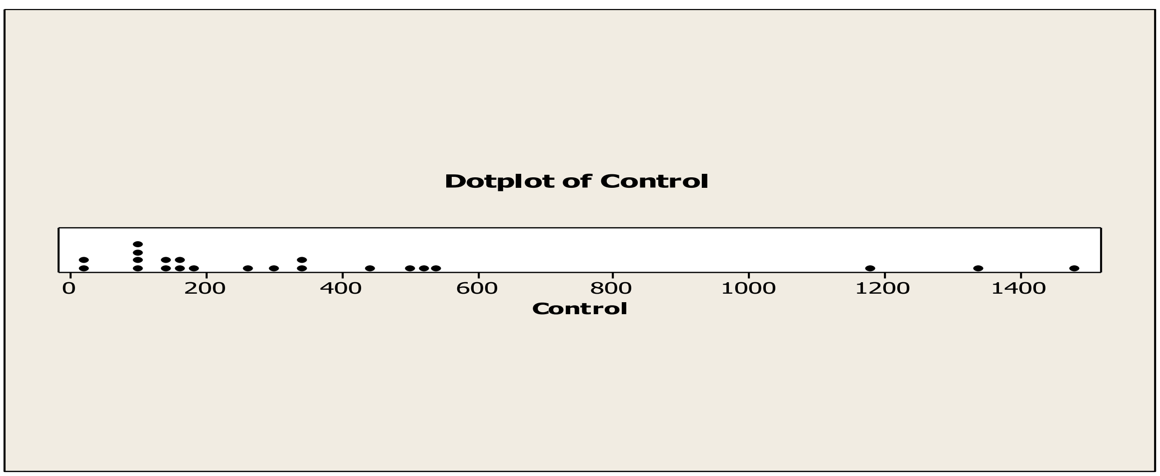
$$s = \sqrt{175224.35} = 418.60$$

The sample standard deviation could also be found using

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

where

$$\sum_{i=1}^{22} (x_i - \bar{x})^2 = 3679711.59$$



The control group has higher variance.

2-9. The only two data sets that may have resulted from a designed experiment is in Exercise 2-4 and 2-8.

Section 2-2

2-10. The stem and leaf display for weld strength N = 100
Leaf Unit = 1.0

```
  1   532 9
  1   533
  2   534 2
  4   535 47
  5   536 6
  9   537 5678
 20   538 12345778888
 26   539 016999
 37   540 11166677889
 46   541 123666688
(13)  542 0011222357899
 41   543 01111556
 33   544 00012455678
 22   545 233447899
 13   546 23569
  8   547 357
  5   548 11257
```

2-11. a) Stem-and-leaf display for cycles: unit = 100 1|2 represents 1200

```
  1     0T|3
  1     0F|
  5     0S|7777
 10     0o|88899
 22     1*|000000011111
 33     1T|22222223333
(15)    1F|444445555555555
 22     1S|66667777777
 11     1o|888899
  5     2*|011
  2     2T|22
```

b) No, only 5/70 survived beyond 2000 cycles.

2-12. Stem-and-leaf of Suspended solids N = 60
Leaf Unit = 1.0

```
  1     2 9
  2     3 1
  3     3 9
  8     4 22223
 12     4 5689
 20     5 01223444
(13)    5 5666777899999
 27     6 11244
 22     6 556677789
 13     7 022333
  7     7 6777
  3     8 01
  1     8 9
```

2-13. Stem-and-leaf display for yield: unit = 1   1|2 represents 12

```
     1     7o|8
     1     8*|
     7     8T|223333
    21     8F|44444444555555
    38     8S|66666666667777777
   (11)    8o|88888999999
    41     9*|00000000001111
    27     9T|22233333
    19     9F|444444445555
     7     9S|666677
     1     9o|8
```

2-14.

```
Stem-and-leaf of High Dose  N  = 22
Leaf Unit = 1.0

 5   1   24566
 9   2   3456
 10  3   8
(3)  4   367
 9   5   28
 7   6   0
 6   7   29
 4   8
 4   9   9
 3   10
 3   11
 3   12  46
 1   13  4
```

It's not symmetric – right skewed.

```
Stem-and-leaf of Control  N  = 22
Leaf Unit = 100
 11  0  00001111111
 11  0  2233
 7   0  4455
 3   0
 3   0
 3   1  1
 2   1  3
 1   1  4
```

It's not symmetric – right skewed.
Their shapes are similar.

2-15.

```
Stem-and-leaf of solar intensity measurements  N  = 35
Leaf Unit = 10

 1   4  9
 1   5
 3   5  56
 3   6
 7   6  5569
 10  7  003
 14  7  5677
(4)  8  0023
 17  8  56779
 12  9  00113344
 4   9  5556
```

It's not symmetric – left skewed.

2-16.

Variable	N	Median	Q1	Q3	5th	95th
Weld strength	100	5421.5	5399.0	5445.8	5366.45	5480.8

2-17.

Variable	N	Median	Q1	Q3	5th	95th
Cycles	70	1436.5	1097.8	1735.0	772.85	2113.5

2-18.

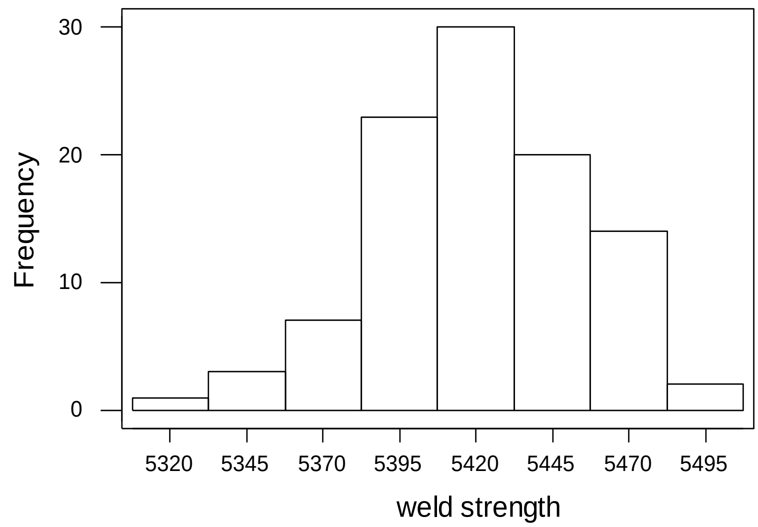
Variable	N	Median	Q1	Q3	5th	95th
Solids	60	59.45	52.03	68.35	39.455	79.965

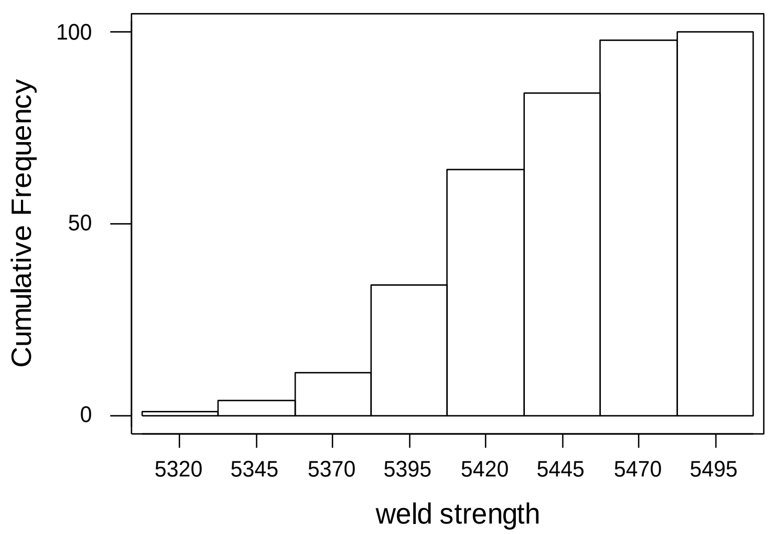
2-19.

Variable	N	Median	Q1	Q3	5th	95th
Yield	90	89.25	86.10	93.125	83.055	96.58

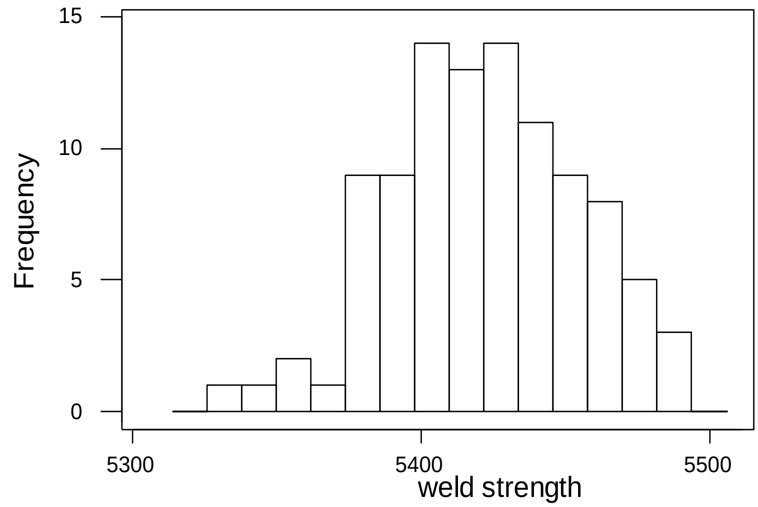
Section 2-3

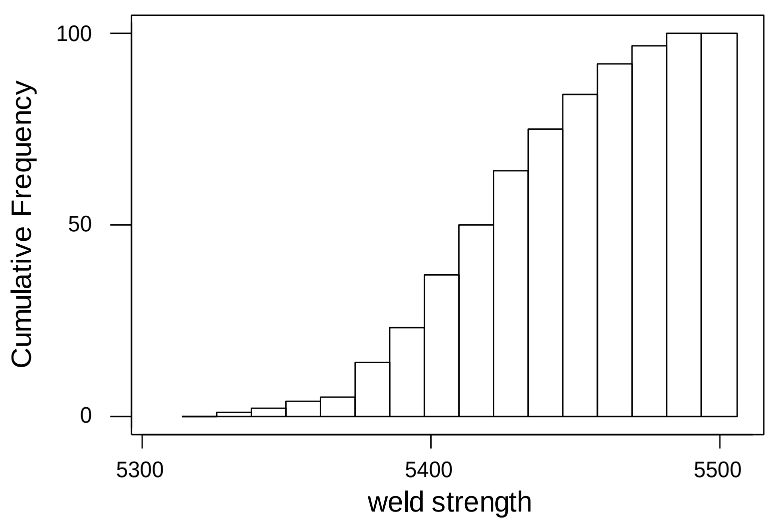
2-20. a) 8 bins





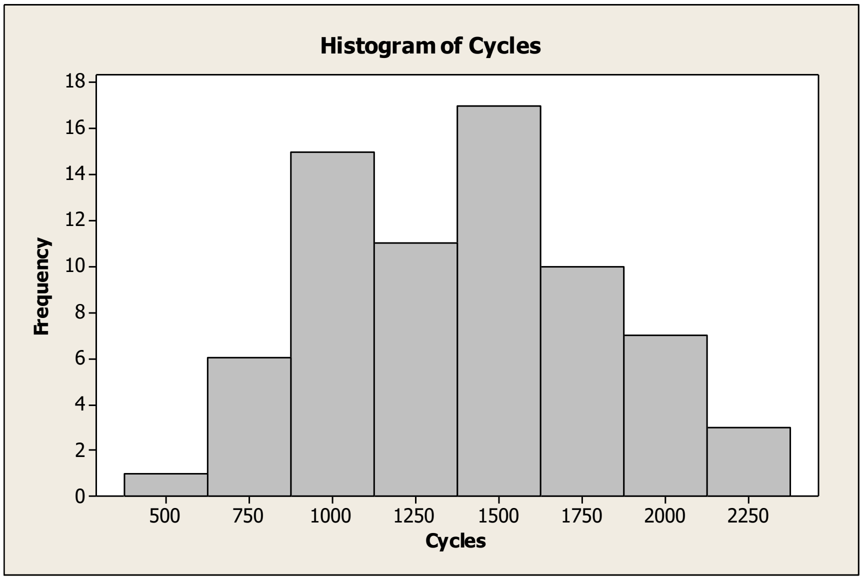
b) 16 bins

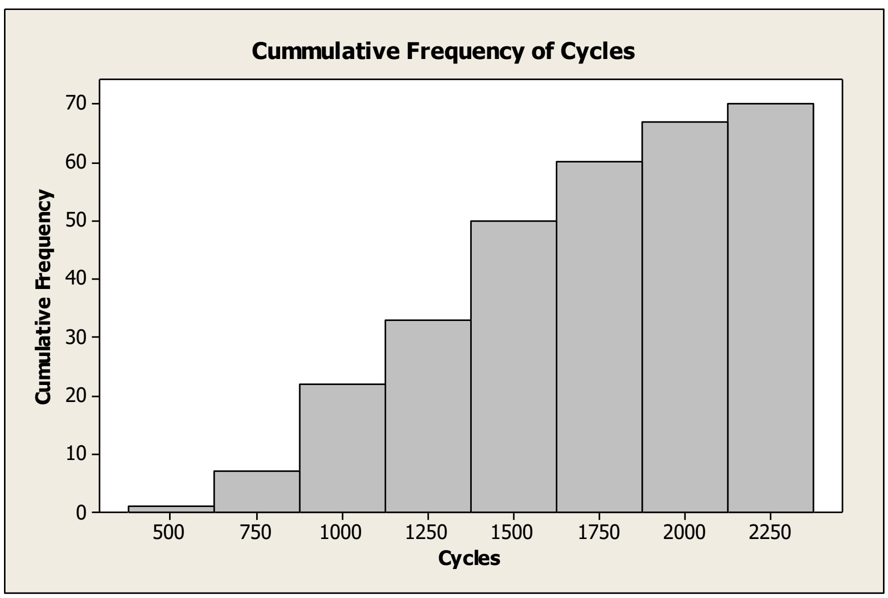




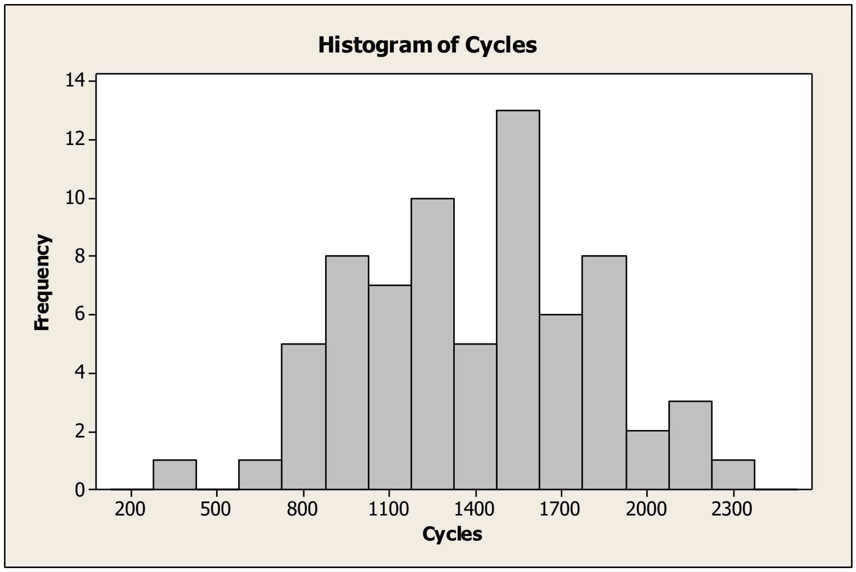
Yes, both histograms display similar information based on this dataset.

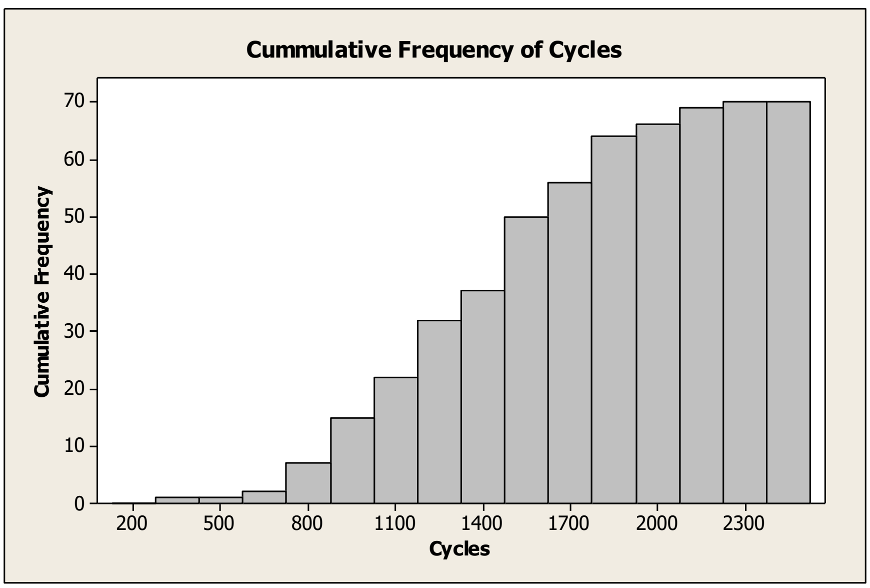
2-21. a) 8 bins


Histogram of Cycles
Frequency
0
2
4
6
8
10
12
14
16
18
500
750
1000
1250
1500
1750
2000
2250
Cycles


Cummulative Frequency of Cycles
Cumulative Frequency
0
10
20
30
40
50
60
70
500
750
1000
1250
1500
1750
2000
2250
Cycles

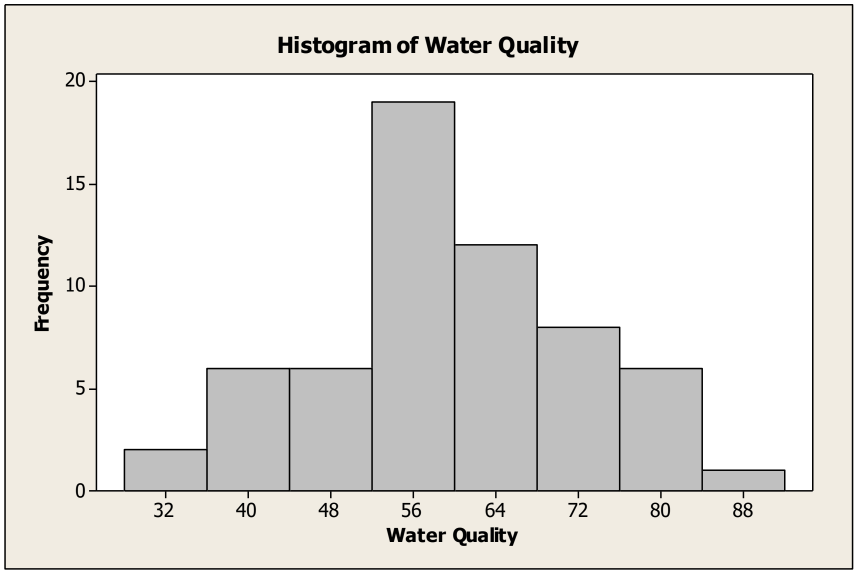
b) 16 bins



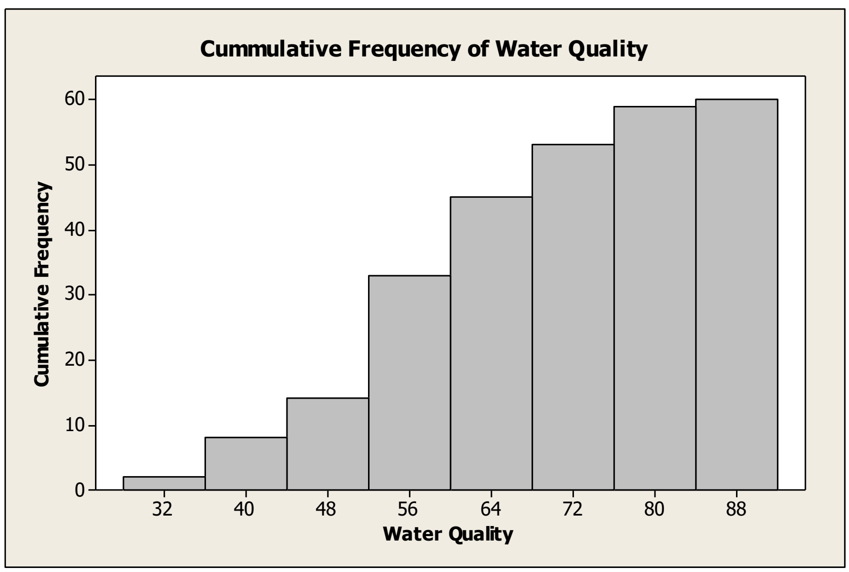


Yes, both histograms display similar information based on this dataset.

2-22. a) 8 bins

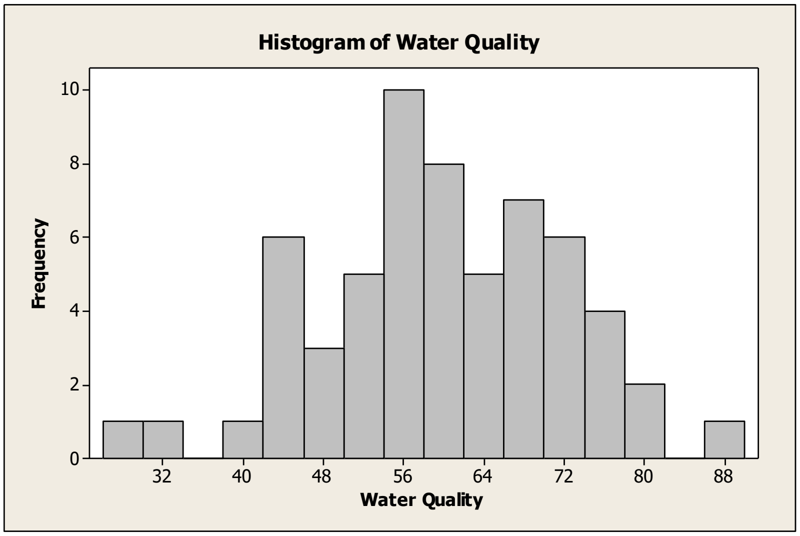


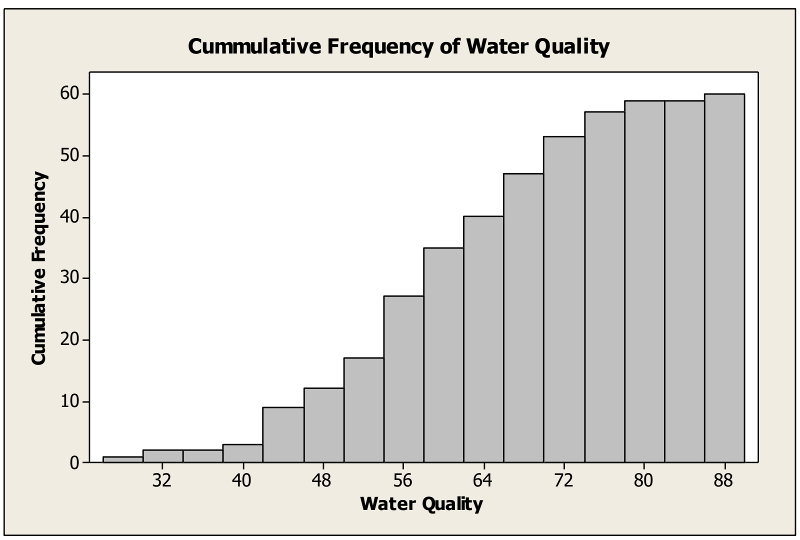
Histogram of Water Quality
20
15
10
5
0
Frequency
32
40
48
56
64
72
80
88
Water Quality



Cummulative Frequency of Water Quality
60
50
40
30
20
10
0
Cumulative Frequency
32
40
48
56
64
72
80
88
Water Quality

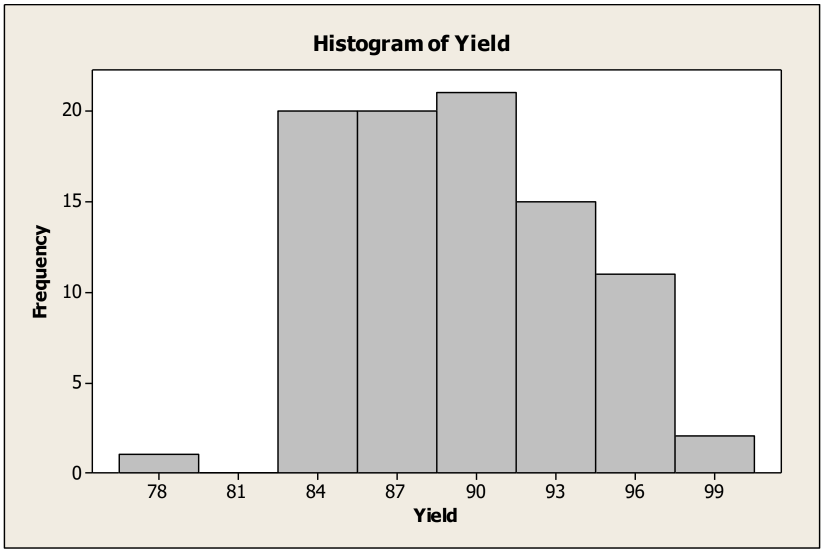
b) 16 bins

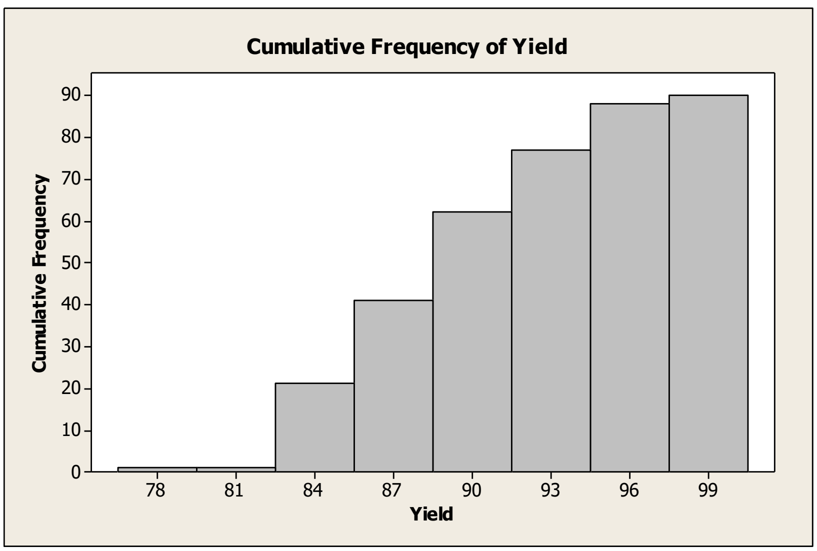




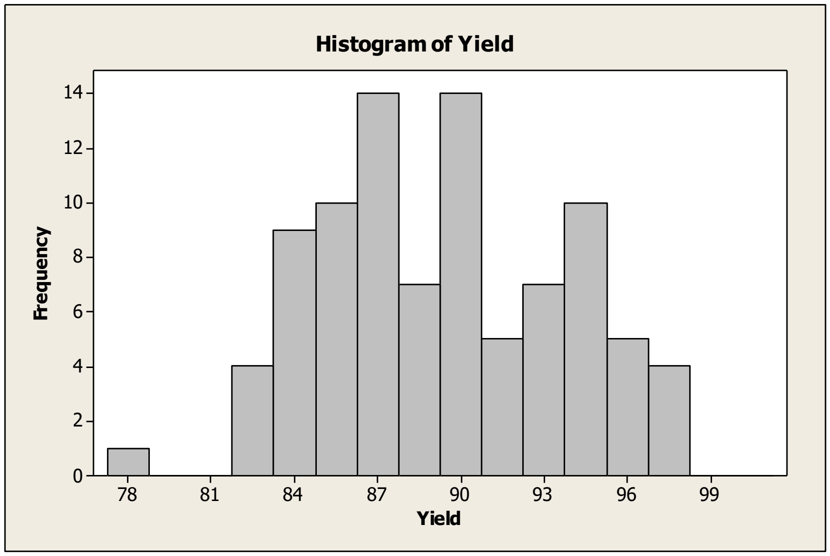
Yes, both histograms display similar information based on this dataset.

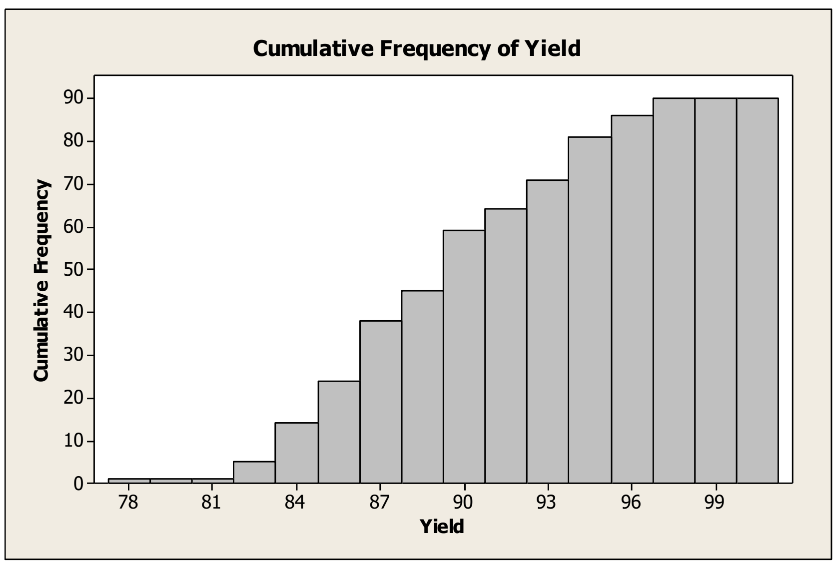
2-23. a) 8 bins


Histogram of Yield
Frequency
20
15
10
5
0
78
81
84
87
90
93
96
99
Yield


Cumulative Frequency of Yield
Cumulative Frequency
90
80
70
60
50
40
30
20
10
0
78
81
84
87
90
93
96
99
Yield

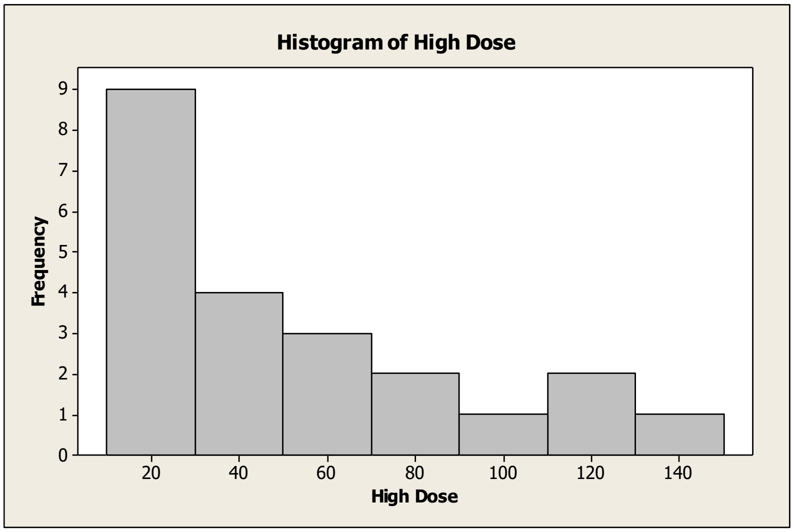
b) 16 bins

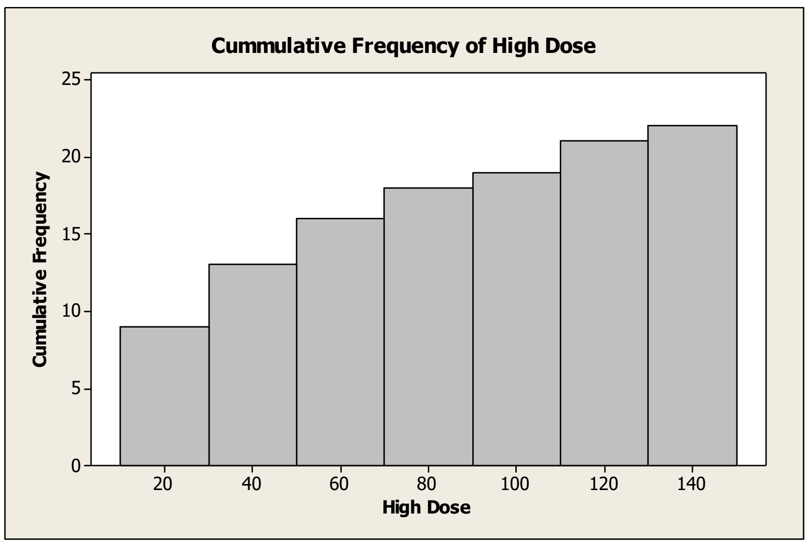




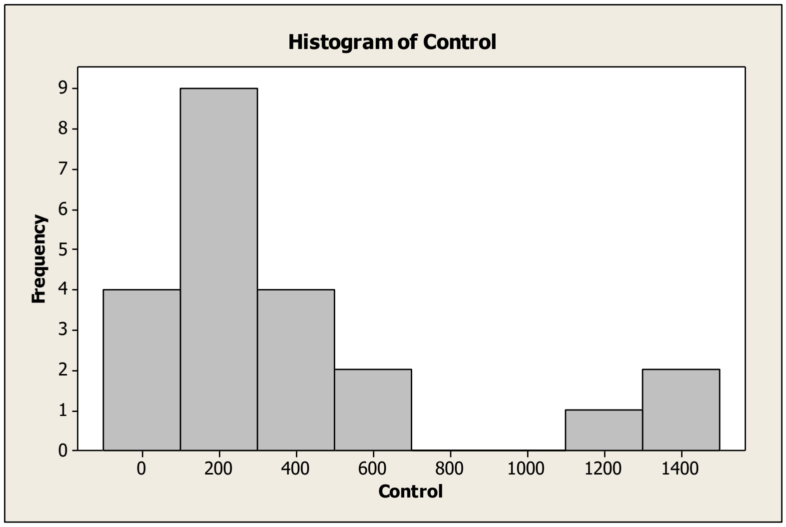
Yes, both histograms display similar information based on this dataset.

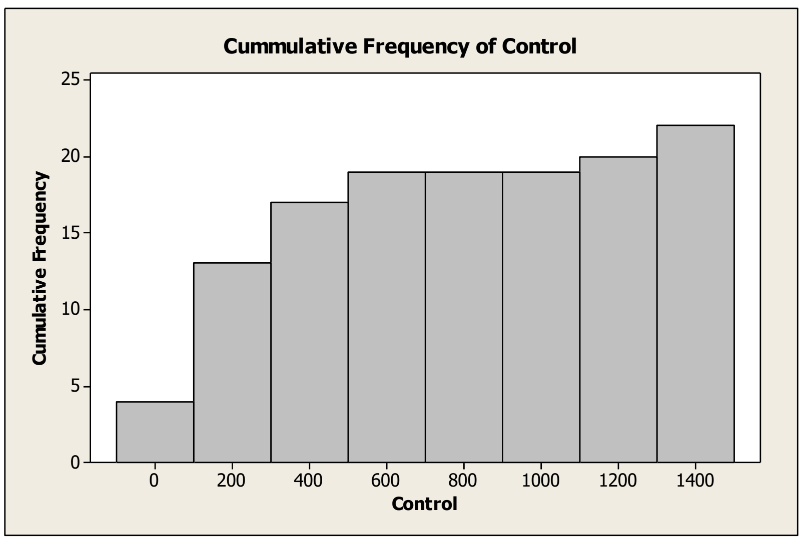
2-24. High Dose





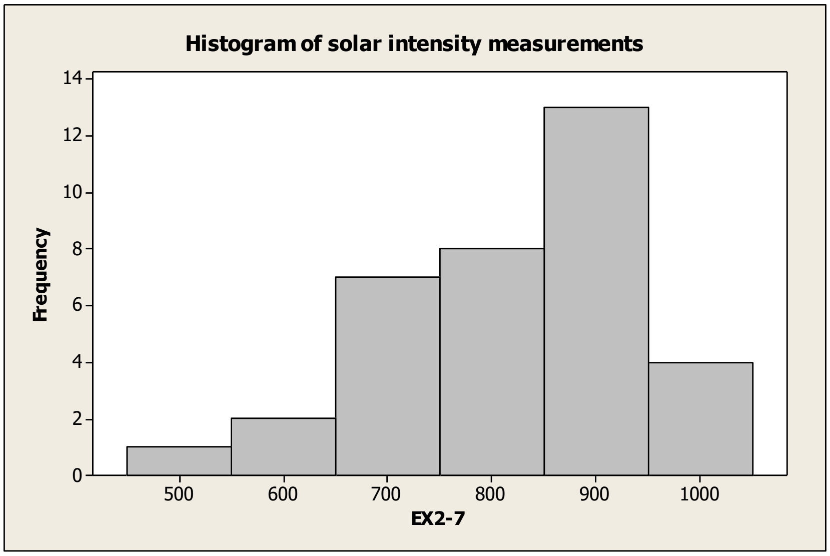
Control group

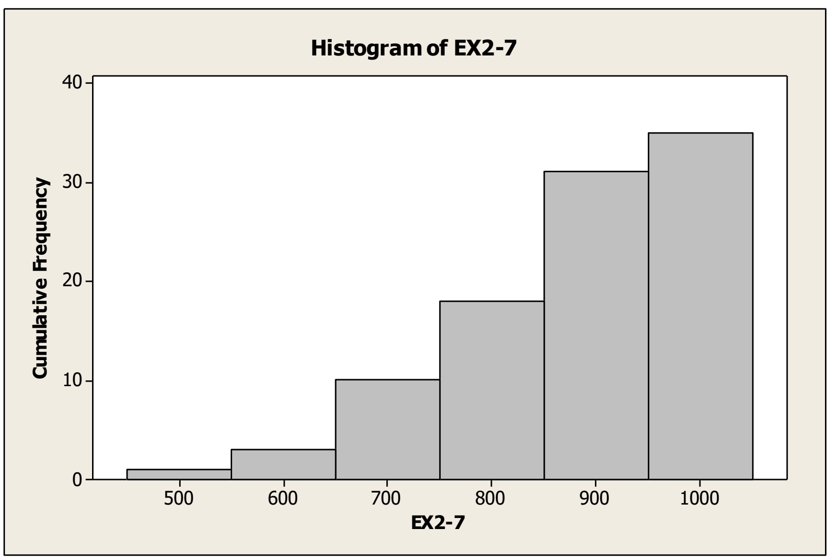




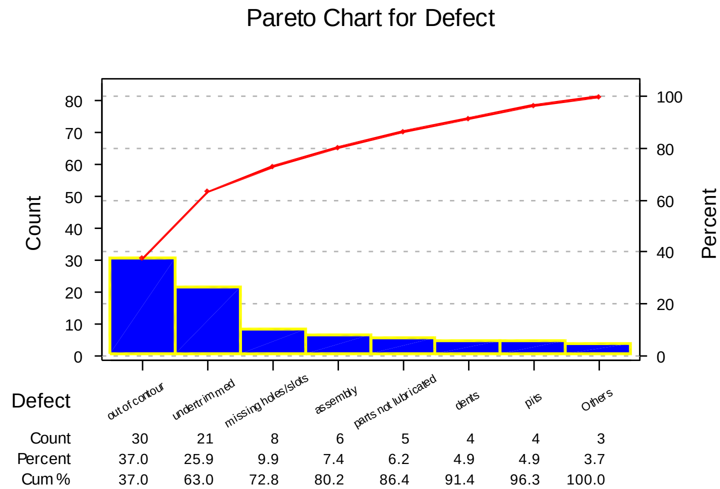
They both look similar.

2-25. 6 bins


Histogram of solar intensity measurements
Frequency
14
12
10
8
6
4
2
0
500
600
700
800
900
1000
EX2-7


Histogram of EX2-7
Cumulative Frequency
40
30
20
10
0
500
600
700
800
900
1000
EX2-7

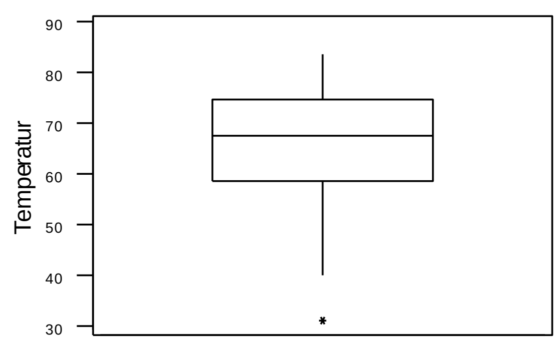
2-26.



Roughly 63% of defects are described by parts out of contour and parts under trimmed.

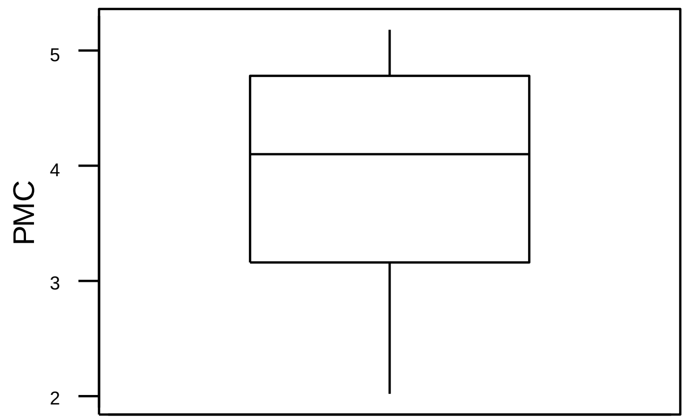
Section 2-4

2-27. a) Sample Mean: 65.86, Sample Standard Deviation: 12.16
b) Q_1: 58.5, Q_3: 75
c) Median: 67.5
d) Sample Mean: 66.86, Sample Standard Deviation: 10.74, Q_1: 60, Q_3: 75, Median: 68
The mean has increased while the sample standard deviation has decreased. The lower quartile has increased while the upper quartile has remained unchanged. The median has increased slightly due to the removal of the data point. The smallest value appears quite different than the other temperature values.
e) Using the entire data set, the box plot is

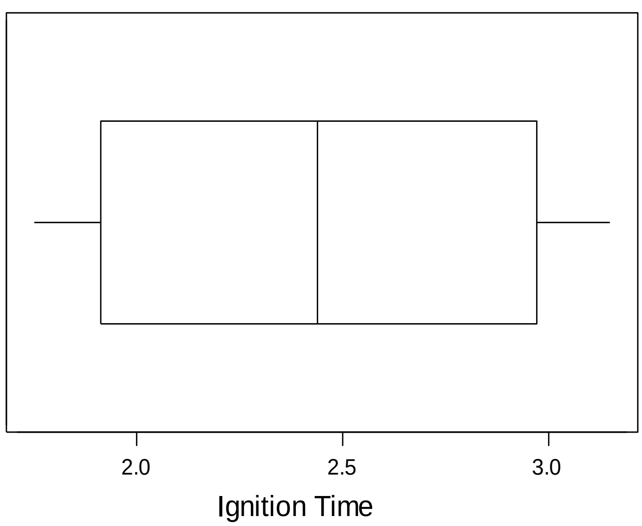


The value of 31 appears to be one possible outlier.

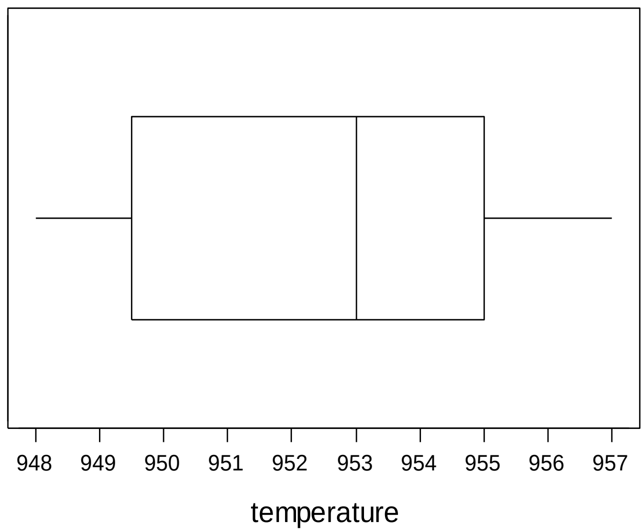
2-28. a) Sample Mean: 4
b) Sample Variance: 0.867, Sample Standard Deviation: 0.931
c)



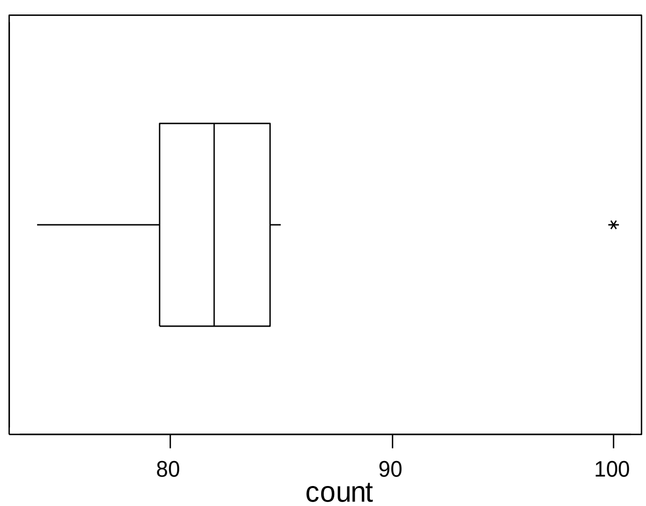
2-29. a) Sample mean = 2.415, Sample standard deviation = 0.534
b)



2-30. a) Sample mean = 952.44, Sample standard deviation = 3.09
b) Median = 953. The largest temperature could take on any value as long as it is the larger than the current largest value.
c)



2-31. a) Sample mean: 83.11, sample variance = 50.55, sample standard deviation = 7.11
b) Q_1 = 79.5, Q_3 = 84.50
c)

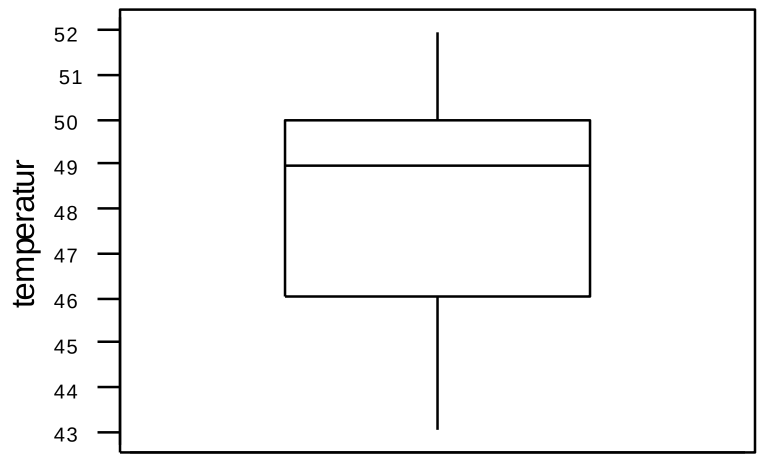


d) Sample mean = 81, sample standard deviation = 3.46, Q_1 = 79.25, Q_3 = 83.75. The sample mean and the sample standard deviation have decreased. The lower quartile has decreased slightly while the upper quartile has decreased.

2-32. a) Sample Mean: 48.125, Sample Median: 49

b) Sample Variance: 7.247, Sample Standard Deviation: 2.692

c) The data appear to be skewed.



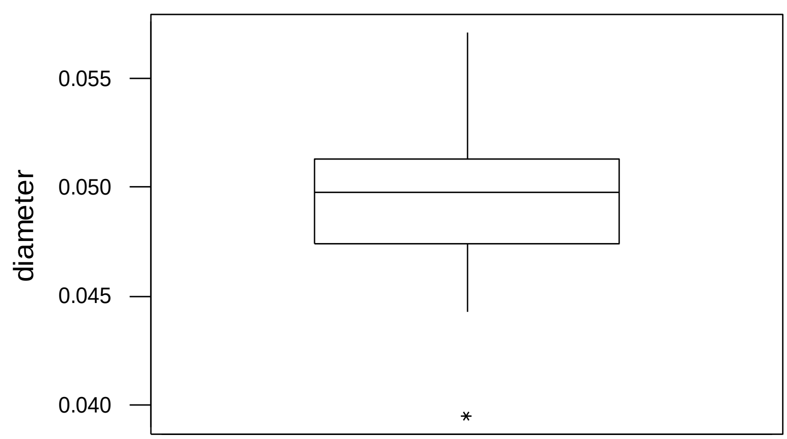
d) 5th Percentile: 43.25, 95th Percentile: 52

2-33. a) Sample Mean: 0.04939, Sample Variance: 0.00001568

b) Q_1: 0.04738, Q_3: 0.0513

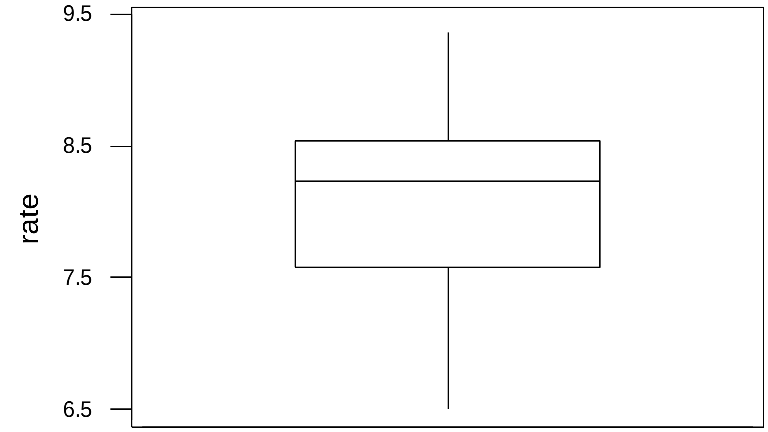
c) Sample Median: 0.04975

d)



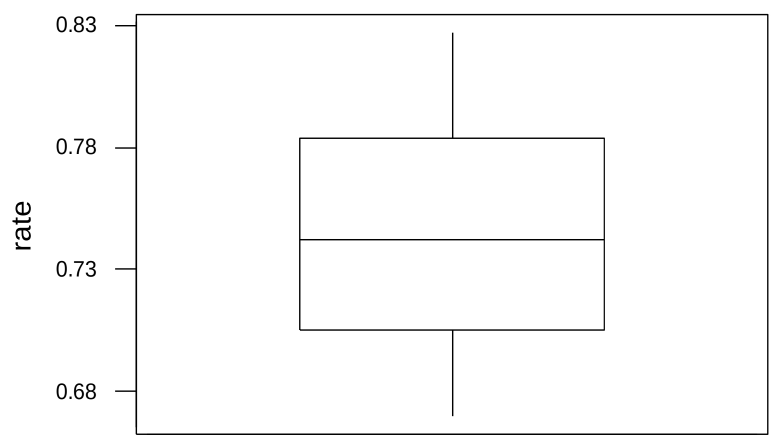
e) 5^{th} Percentile: 0.03974, 95^{th} Percentile: 0.057

2-34. a) Sample Mean: 8.059, Sample Variance: 0.661
b) Q_1: 7.575, Q_3: 8.535
c) Sample Median: 8.235
d)



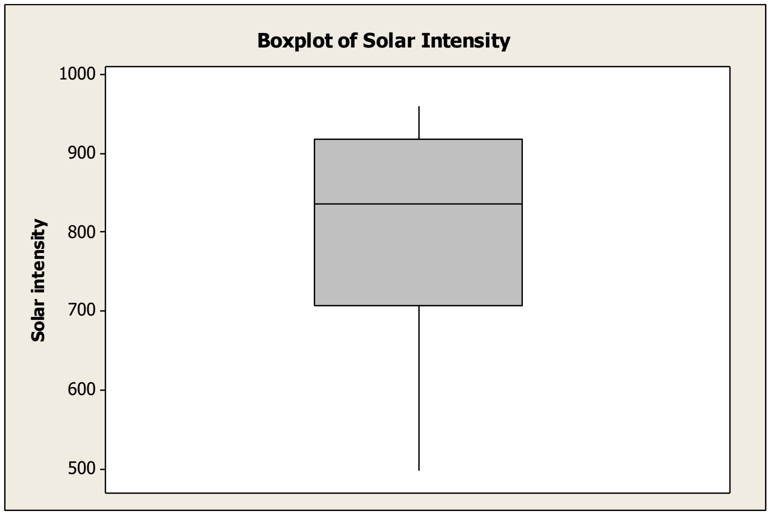
e) 5th Percentile: 6.175, 95th Percentile: 9.3315

2-35. a) Sample Mean: 0.7481, Sample Variance: 0.00226
b) Q_1: 0.7050, Q_3: 0.7838
c) Sample Median: 0.742
d)



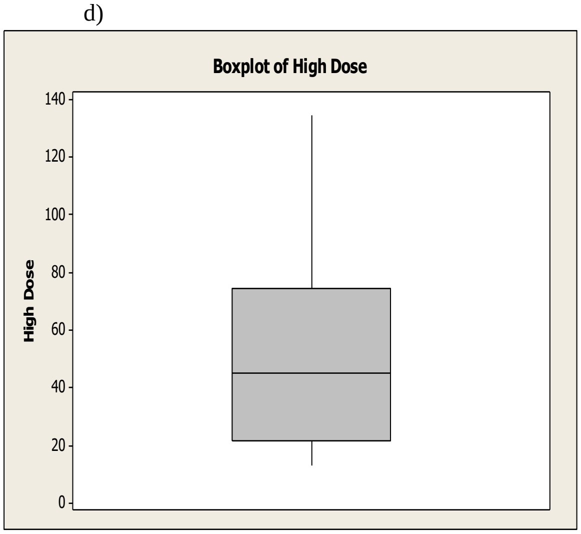
e) 5th Percentile: 0.5025, 95th Percentile: 0.821

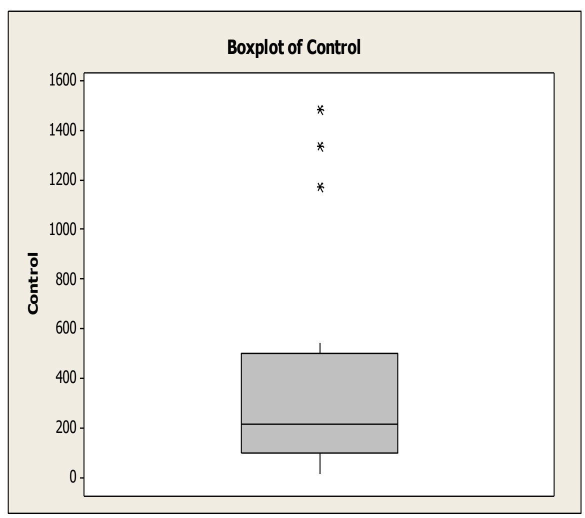
2-36. a) Sample Mean: 810.5, Sample Variance: 16465.61
b) Q_1: 708, Q_3: 918
c) Sample Median: 835
d)



e) 5^{th} Percentile: 546, 95^{th} Percentile: 957.6

2-37. a) High Dose: Sample Mean: 52.65, Sample Variance: 1490.32
Control: Sample Mean: 382.7, Sample Variance: 175224.35
b) High Dose: Q_1: 21.70, Q_3:74.38
Control: Q_1: 101.9, Q_3: 501.1
c) High Dose: Sample Median: 45
Control: Sample Median: 215.4
d)

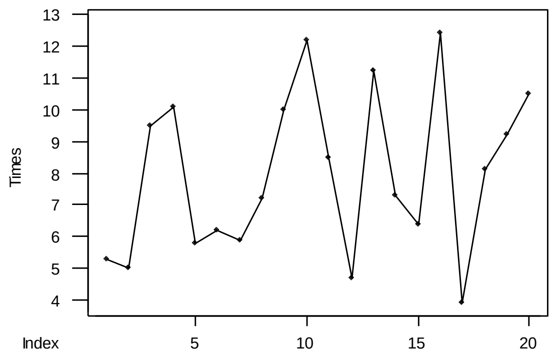




e) High Dose: 5^{th} Percentile: 13.125, 95^{th} Percentile: 133.67
Control: 5^{th} Percentile: 17.045, 95^{th} Percentile: 1460.23
All summary statistics are larger for the control group.

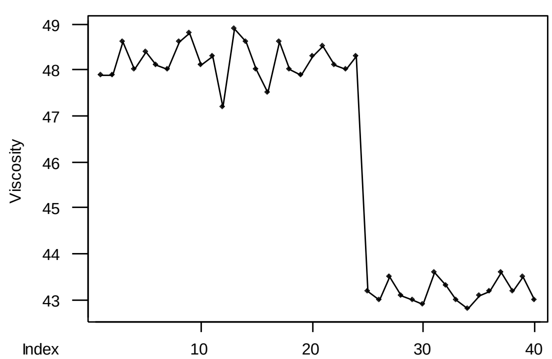
Section 2-5

2-38.



Computer response time appears random. No trends or patterns are obvious.

2-39. a)

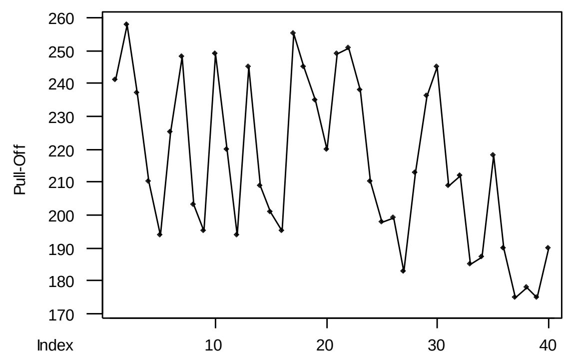


Stem-and-leaf display for Problem 2-32.Viscosity: unit = 0.1 1|2 represents 1.2

```
  2   42o|89
 12   43*|0000112223
 16   43o|5566
 16   44*|
 16   44o|
 16   45*|
 16   45o|
 16   46*|
 16   46o|
 17   47*|2
(4)   47o|5999
 19   48*|000001113334
  7   48o|5666689
```

b) The plots indicates that the process is not stable and not capable of meeting the specifications.

2-40. a)

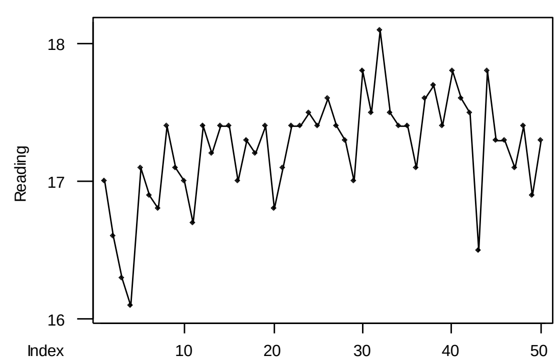


b) Stem-and-leaf display for Problem 2-33. Force: unit = 1 1|2 represents 12

```
  3   17|558
  6   18|357
 14   19|00445589
 18   20|1399
(5)   21|00238
 17   22|005
 14   23|5678
 10   24|1555899
  3   25|158
```

In the time series plot there appears to be a downward trend beginning after time 30.

2-41.

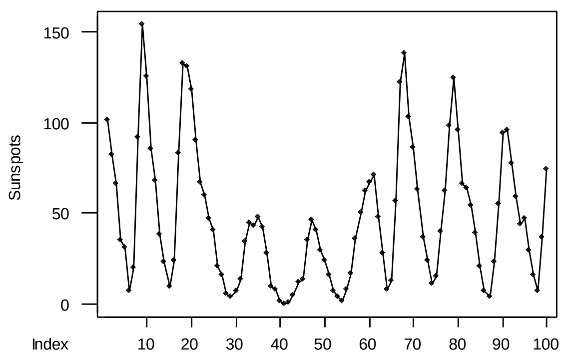


Stem-and-leaf display for Concentration: unit = 0.01   1|2 represents 0.12
LO|1610,1630

```
 3  165|0
 4  166|0
 5  167|0
 7  168|00
 9  169|00
13  170|0000
18  171|00000
20  172|00
25  173|00000
25  174|0000000000000
12  175|0000
 8  176|000
 5  177|0
 4  178|000

    HI|1810
```

The data appear skewed.

2-42. a)

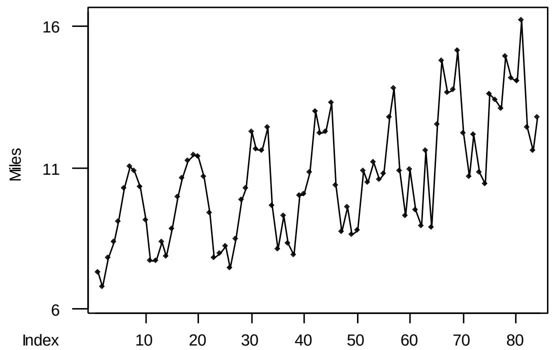


b) Stem-and-leaf display for Problem 2-35. Sunspots: unit = 1   1|2 represents 12

```
17     0|01224445677777888
29     1|001234456667
39     2|0113344488
50     3|00145567789
50     4|011234567788
38     5|04579
33     6|0223466778
23     7|147
20     8|2356
16     9|024668
10    10|13
 8    11|8
 7    12|245
 4    13|128

      HI|154
```

The data appears to decrease between 1790 and 1835, and after 1839 the stem and leaf plot indicates skewed data.

2-43. a)

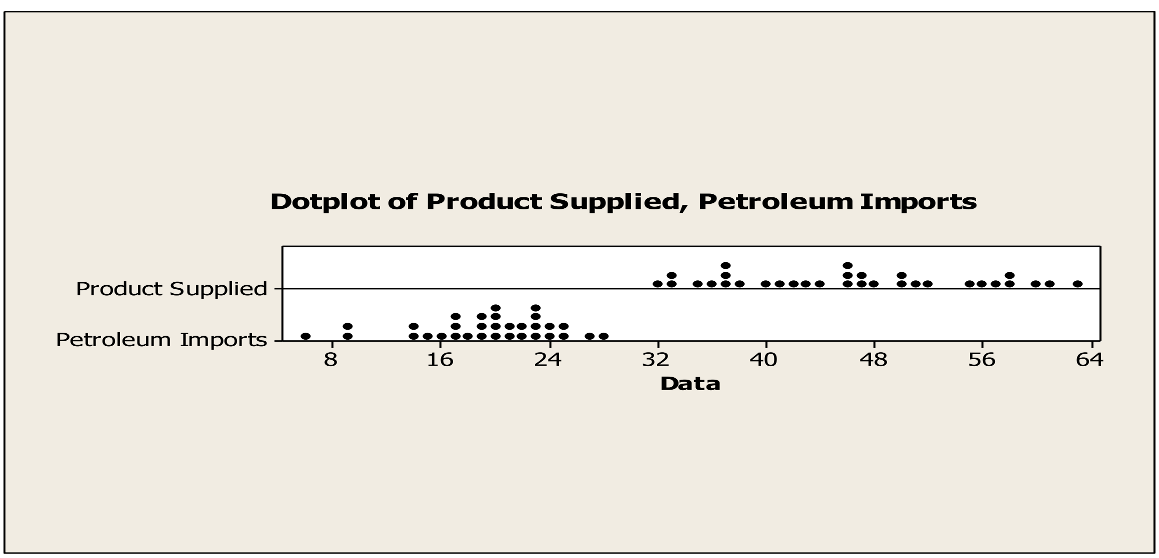


b) Stem-and-leaf display for Problem 2-36. Miles: unit = 0.1 1|2 represents 1.2

```
  1    6|7
 10    7|246678889
 22    8|013334677889
 33    9|01223466899
(18)  10|022334456667888889
 33   11|012345566
 24   12|11222345779
 13   13|1245678
  6   14|0179
  2   15|1
  1   16|2
```

There is an increasing trend in the data.

2-44. Digidot plot

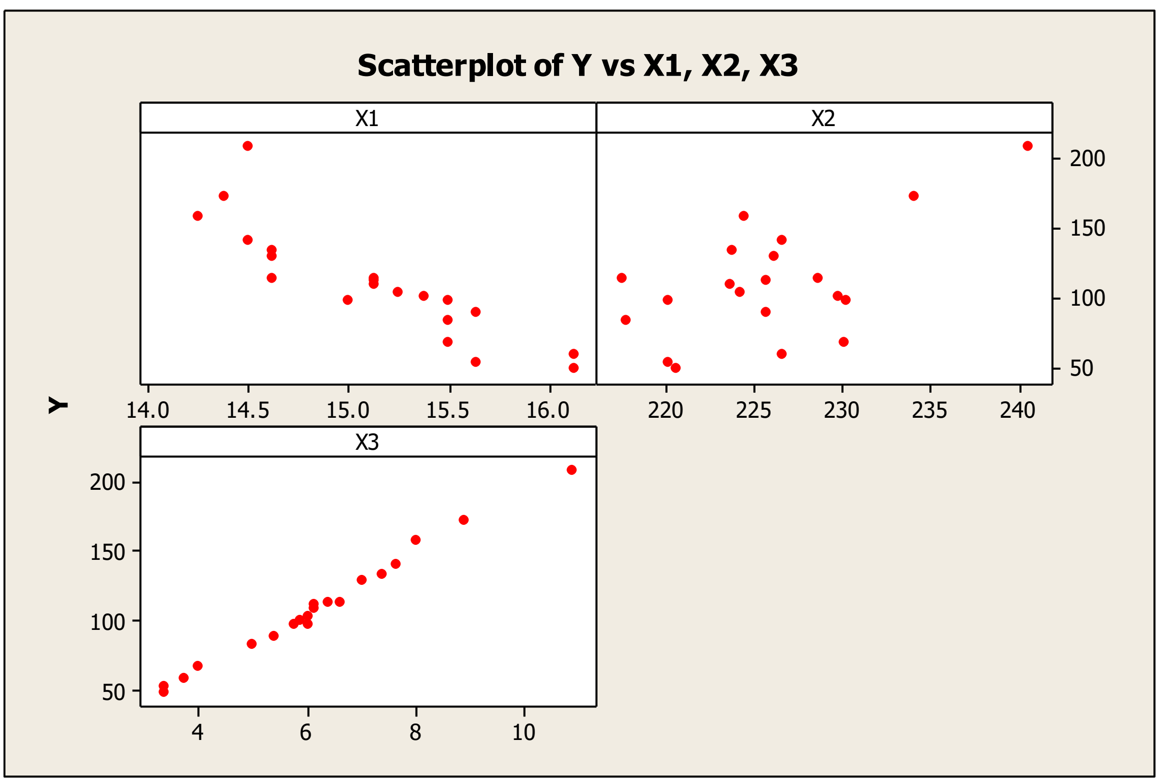


```
Stem-and-leaf of Product Supplied  N  = 32
Leaf Unit = 1.0

 4   3  2334
 9   3  66778
 14  4  00124
(7)  4  5566779
 11  5  0014
 7   5  5688
 3   6  013
```

```
Stem-and-leaf of Petroleum Imports  N  = 32
Leaf Unit = 1.0

 1   0  6
 3   0  89
 3   1
 5   1  33
 6   1  4
 11  1  66777
 16  1  89999
 16  2  000011
 10  2  2233
 6   2  4445
 2   2  67
```

Section 2-6

2-45. a) X1 has negative correlation with Y, X2 and X3 have positive correlation with Y.



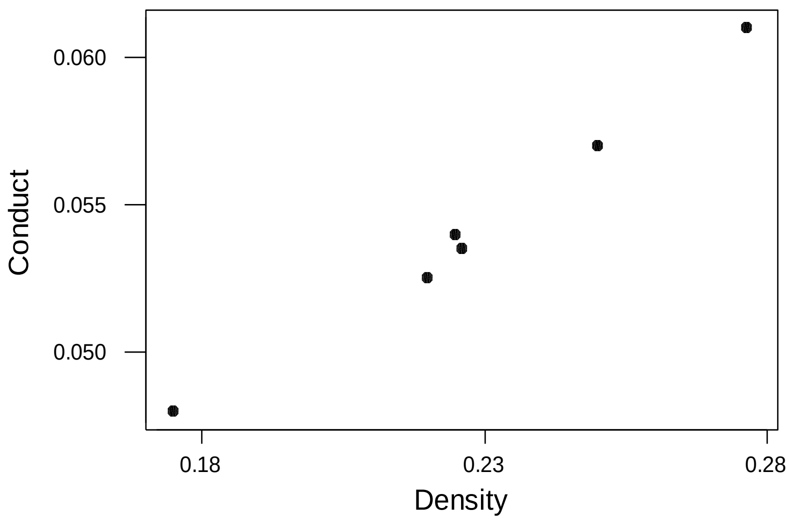
b) $r_{x_1} = \dfrac{S_{x_1y}}{\sqrt{S_{x_1x_1}S_{yy}}} = \dfrac{-375.185}{\sqrt{5.875 \times 30725.23}} = -0.883$

$r_{x_2} = \dfrac{S_{x_2y}}{\sqrt{S_{x_2x_2}S_{yy}}} = \dfrac{2486.19}{\sqrt{591.778 \times 30725.23}} = 0.585$

$r_{x_3} = \dfrac{S_{x_3y}}{\sqrt{S_{x_3x_3}S_{yy}}} = \dfrac{1415.5}{\sqrt{65.778 \times 30725.23}} = 0.995$

X1 has a strong negative correlation with Y, X3 has a strong positive correlation with Y and X2 has a moderate positive correlation with Y. The correlation coefficients agree with the scatter plot in part (a).

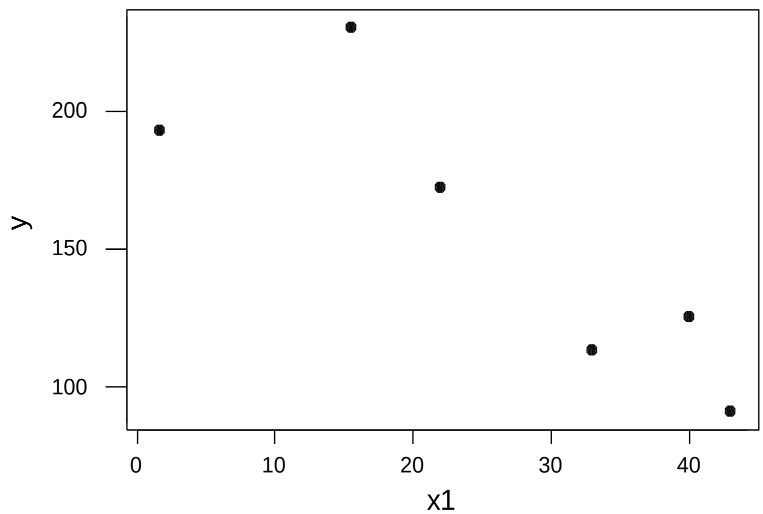
2-46. a) Positive sign



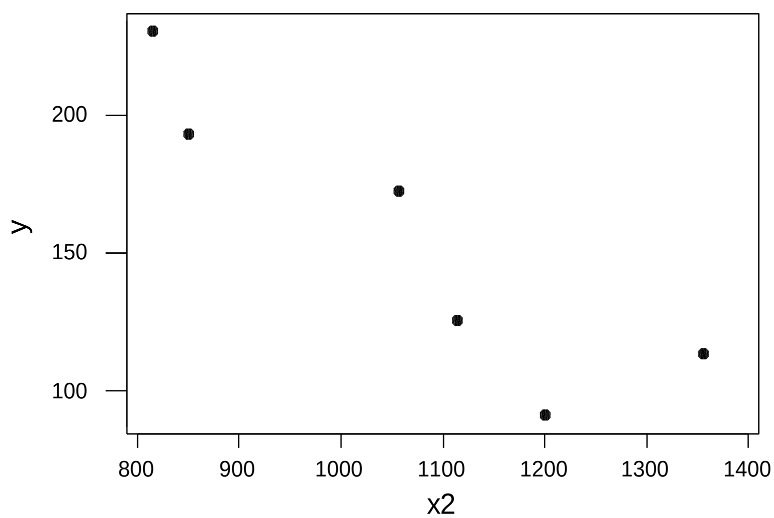
b) 0.993. X has a strong positive correlation with Y

2-47. a) Both sample correlations will be negative.

y versus x_1



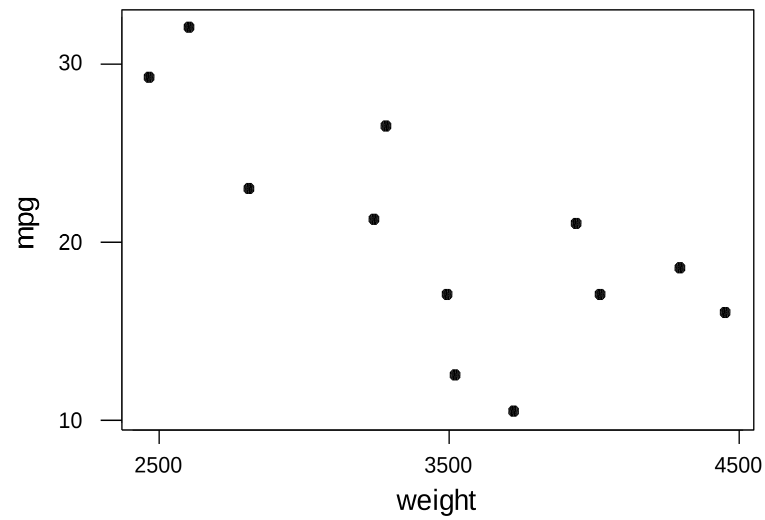
y versus x_2



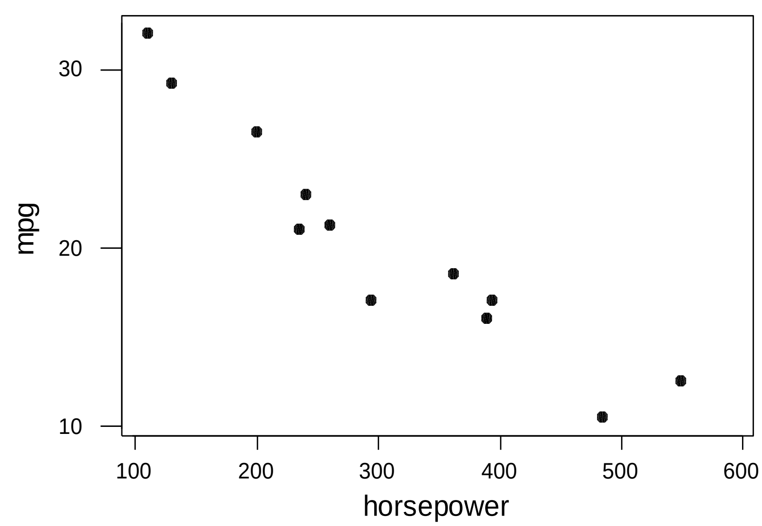
b) y versus x_1: -0.852; y versus x_2: -0.898. X1 and X2 have a moderately strong negative correlation with Y

2-48. a) Both sample correlations will be negative.

MPG versus weight

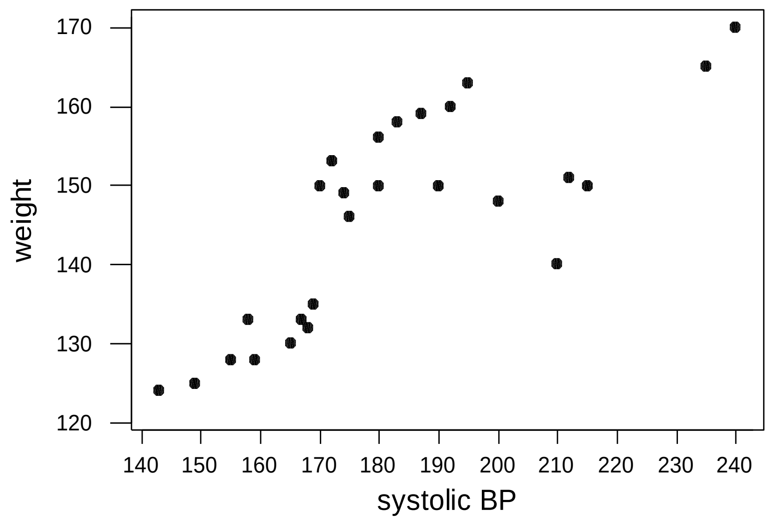


MPG versus horsepower



b) MPG versus weight: -0.709; MPG versus horsepower: -0.947. Weight has a strong negative correlation with MPG while weight has a moderate negative correlation with MPG

2-49. a) The correlation coefficient will be positive



b) 0.773. Weight has a moderate positive correlation with systolic BP.

Supplemental Exercises

2-50. a) Sample Mean = 7.1838; The sample mean value is close enough to the target value to accept the solution as conforming. There is slight difference due to inherent variability.

b) $s^2 = 0.000427$, $s = 0.02066$; A major source of variability would include measurement to measurement error. A low variance is desirable since it may indicate consistency from measurement to measurement.

2-51. a) $\sum_{i=1}^{6} x_i^2 = 10{,}433 \qquad \left(\sum_{i=1}^{6} x_i\right)^2 = 62{,}001 \qquad n = 6$

$$s^2 = \frac{\sum_{i=1}^{6} x_i^2 - \frac{\left(\sum_{i=1}^{6} x_i\right)^2}{n}}{n-1} = \frac{10{,}433 - \frac{62{,}001}{6}}{6-1} = 19.9\Omega^2 \qquad s = \sqrt{19.9\Omega^2} = 4.46\Omega$$

b) $\bar{x} = \frac{246}{6} = 41.5 \qquad n = 6$

$$s^2 = \frac{\sum_{i=1}^{6}(x_i - \bar{x})^2}{n-1} = \frac{99.5}{5} = 19.9\Omega^2; \qquad s = \sqrt{19.9\Omega^2} = 4.46\Omega$$

c) $s^2 = 19.9\Omega^2 \qquad s = 4.46\Omega$; Shifting the data from the sample by a constant amount has no effect on the sample variance or standard deviation.

d) Yes, the rescaling is by a factor of 10. Therefore, s^2 and s would be rescaled by multiplying s^2 by 10^2 (resulting in $1990\Omega^2$) and s by 10 (44.6Ω).

2-52. a) Sample Range = 3.2, $s^2 = 0.866$, $s = 0.931$

b) Sample Range = 3.2, $s^2 = 0.866$, $s = 0.931$;
These are the same as in part a). Any constant would produce the same results.

2-53. a) $\bar{x}_{n+1} = \dfrac{\sum_{i=1}^{n+1} x_i}{n+1} = \dfrac{\sum_{i=1}^{n} x_i + x_{n+1}}{n+1}$; $\bar{x}_{n+1} = \dfrac{n\bar{x}_n + x_{n+1}}{n+1}$; $\bar{x}_{n+1} = \dfrac{n}{n+1}\bar{x}_n + \dfrac{x_{n+1}}{n+1}$

b) $$ns_{n+1}^2 = \sum_{i=1}^{n} x_1^2 + x_{n+1}^2 - \frac{\left(\sum_{i=1}^{n} x_i + x_{n+1}\right)^2}{n+1}$$

$$= \sum_{i=1}^{n} x_i^2 + x_{n+1}^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n+1} - \frac{2x_{n+1}\sum_{i=1}^{n} x_i}{n+1} - \frac{x_{n+1}^2}{n+1}$$

$$= \sum_{i=1}^{n} x_i^2 + \frac{n}{n+1} x_{n+1}^2 - \frac{n}{n+1} 2x_{n+1}\bar{x}_n - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n+1}$$

$$= \left[\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum x_i\right)^2}{n+1}\right] + \frac{n}{n+1}\left[x_{n+1}^2 - 2x_{n+1}\bar{x}_n\right]$$

$$= \sum_{i=1}^{n} x_i^2 + \left[-\frac{\left(\sum x_i\right)^2}{n} + \frac{\left(\sum x_i\right)^2}{n}\right] - \frac{\left(\sum x_i\right)^2}{n+1} + \frac{n}{n+1}\left[x_{n+1}^2 - 2x_n\bar{x}_n\right]$$

$$= \sum_{i=1}^{n} x_i^2 - \frac{\left(\sum x_i\right)^2}{n} + \frac{(n+1)\left(\sum x_i\right)^2 - n\left(\sum x_i\right)^2}{n(n+1)} + \frac{n}{n+1}\left[x_{n+1}^2 - 2x_n\bar{x}_n\right]$$

$$= (n-1)s_n^2 + \frac{\left(\sum x_i\right)^2}{n(n+1)} + \frac{n}{n+1}\left[x_{n+1}^2 - 2x_n\bar{x}_n\right]$$

$$= (n-1)s_n^2 + \frac{n\bar{x}_n^{\ 2}}{n+1} + \frac{n}{n+1}\left[x_{n+1}^2 - 2x_n\bar{x}_n\right]$$

$$= (n-1)s_n^2 + \frac{n}{n+1}\left(x_{n+1} - 2x_n\bar{x}_n + \bar{x}_n^2\right)$$

$$= (n-1)s_n^2 + \frac{n}{n+1}\left(x_{n+1} - \bar{x}_n\right)^2$$

c) $\bar{x}_n = 41.5$ $\quad x_{n+1} = 46$ $\quad sn^2 = 19.9$ $\quad n = 6$

$$\bar{x}_{n+1} = \frac{6(41.5) + 46}{6+1}$$
$$= 42.14$$

$$s_{n+1} = \frac{\sqrt{(6-1)19.9 + \frac{6}{6+1}46 - 41.5}}{6}$$
$$= 4.41$$

2-54. The trimmed mean is pulled toward the median by eliminating outliers.

a) 10% Trimmed Mean = 89.29

b) 20% Trimmed Mean = 89.19, Difference is very small

c) No, the differences are very small, due to a very large data set with no significant outliers.

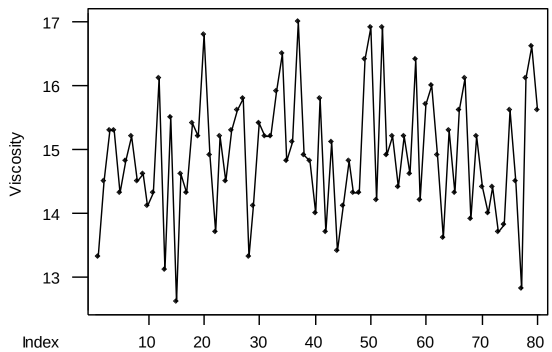
d) If nT/100 is not an integer, calculate the two surrounding integer values and interpolate between the two. For example, if nT/100 = 2/3, one could calculate the mean after trimming 2 and 3 observations from each end and then interpolate between these two means.

2-55. a) Sample 1: 4; Sample 2: 4 Yes, the two appear to exhibit the same variability.

b) Sample 1: 1.604, Sample 2: 1.852 No, sample 2 has a larger standard deviation.

c) The sample range is a crude estimate of the sample variability as compared to the sample standard deviation since the standard deviation uses the information from every data point in the sample whereas the range uses the information contained in only two data points - the minimum and maximum.

2-56. a)



The data appears to vary between 12.5 and 17, with no obvious pattern.

b) The plot indicates that the two processes generate similar results. This is evident since the data appear to be centered around the same mean.

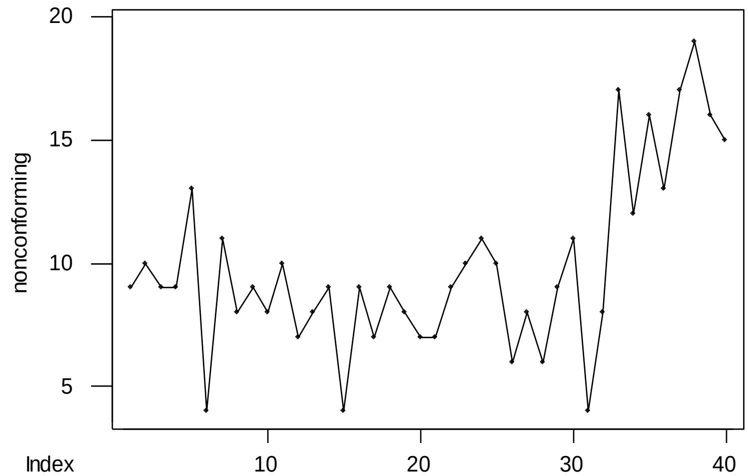
c) 1st 40 observations: Sample Mean = 14.87, Sample Variance = 0.899
2nd 40 observations: Sample Mean = 14.92, Sample Variance = 1.05
The quantities indicate the processes do yield the same mean level. The variability also appears to be about the same, with the sample variance for the 2nd 40 observations being slightly larger than that for the 1st 40.

2-57. a) Stem-and-leaf of nonconforming; N = 40, Leaf Unit = 0.10

3	4	000
3	5	
5	6	00
9	7	0000
15	8	000000
(9)	9	000000000
16	10	0000
12	11	000
9	12	0
8	13	00
6	14	
6	15	0
5	16	00
3	17	00
1	18	
1	19	0

b) Sample Mean: 9.8; Sample Standard deviation: 3.611

c) There appears to be an increase in the average number of nonconforming springs made during the 40 days.

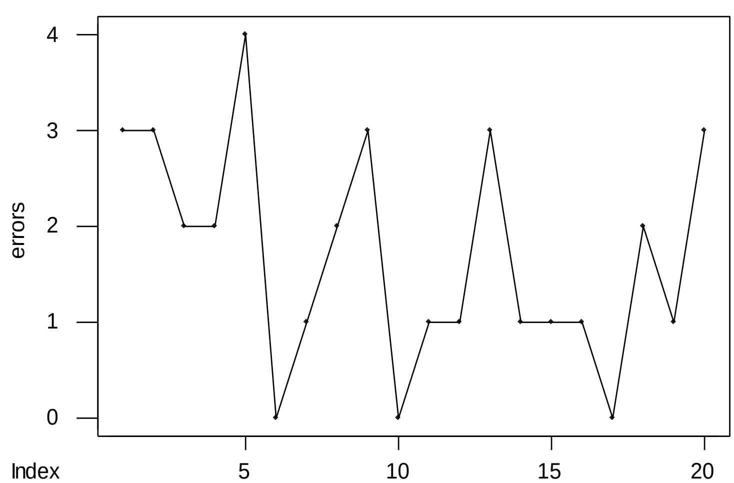


2-58. a) Stem-and-leaf of errors N = 20, Leaf Unit = 0.10

3 0 000
10 1 0000000
10 2 0000
6 3 00000

b) Sample average: 1.7, Sample Standard deviation: 1.174

c)



The time series plot indicates a slight decrease in the number of errors.