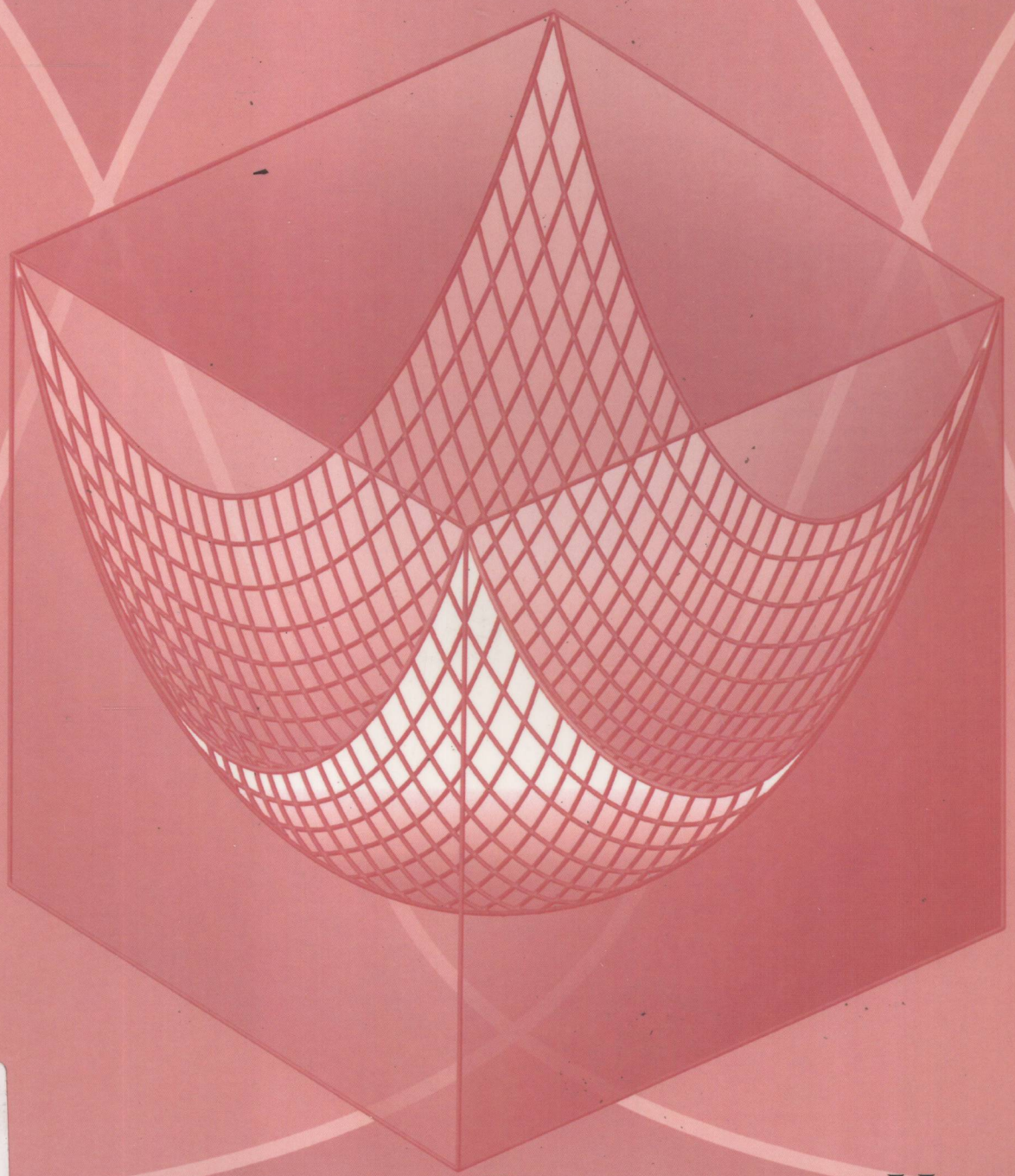
STUDENT SOLUTIONS MANUAL

FOURTH EDITION

ENGINEERING STATISTICS



ONTGOMERY RUNGER HUBELE

STUDENT SOLUTIONS MANUAL

ENGINEERING STATISTICS

Fourth Edition

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Chapter 2

DATA SUMMARY AND PRESENTATION

Section 2-1

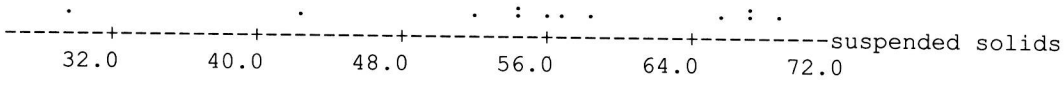
2-1. **Sample average:** $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{\sum_{i=1}^{12} x_i}{12} = \frac{673.1}{12} = 56.09$

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:



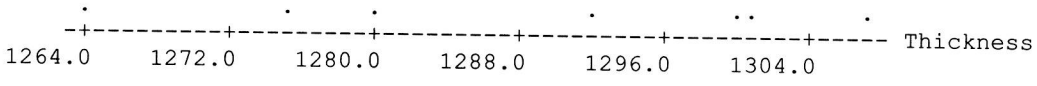
2-3. **Sample average:** $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{\sum_{i=1}^{7} x_i}{7} = \frac{9019}{7} = 1288.43$ angstroms

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:



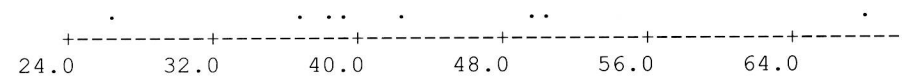
2-5. **Sample average:** $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{\sum_{i=1}^{8} x_i}{8} = \frac{351.8}{8} = 43.98$

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:



2-7. **Sample average:**

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

Sample variance:

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

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

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

$$= 16465.61 \text{ (watts/m}^2)^2$$

Sample standard deviation:

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

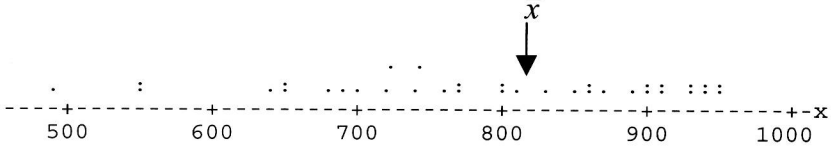
The sample standard deviation could also be found using

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

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)



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

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

2-11. 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.

2-13. 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
```

2-15. 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.

2-17.

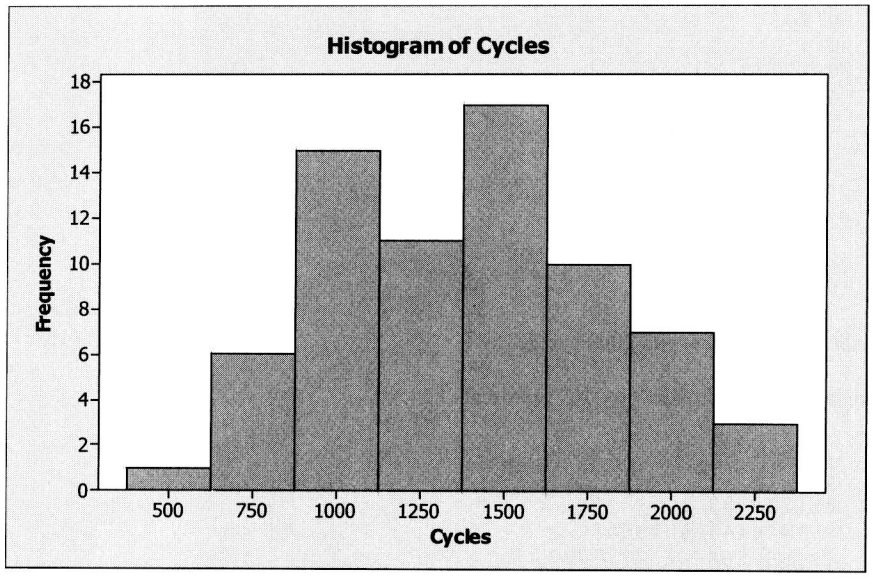
Variable	*N*	Median	*Q*1	*Q*3	5th	95th
Cycles	70	1436.5	1097.8	1735.0	772.85	2113.5

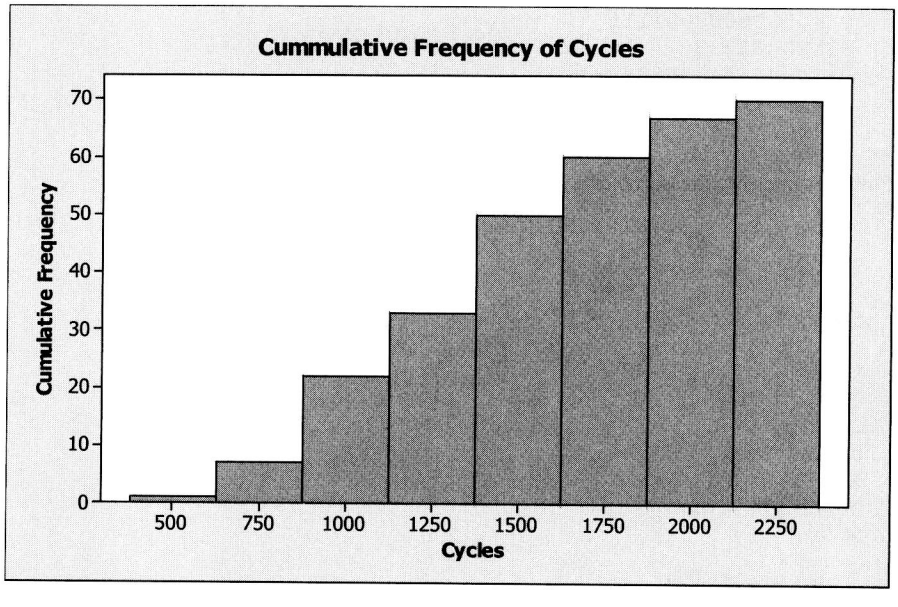
2-19.

Variable	*N*	Median	*Q*1	*Q*3	5th	95th
Yield	90	89.25	86.10	93.125	83.055	96.58

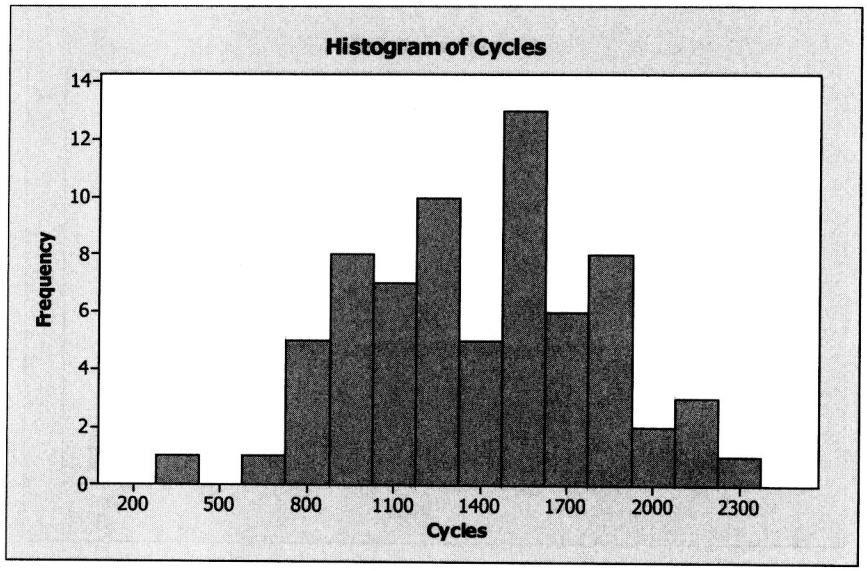
Section 2-3

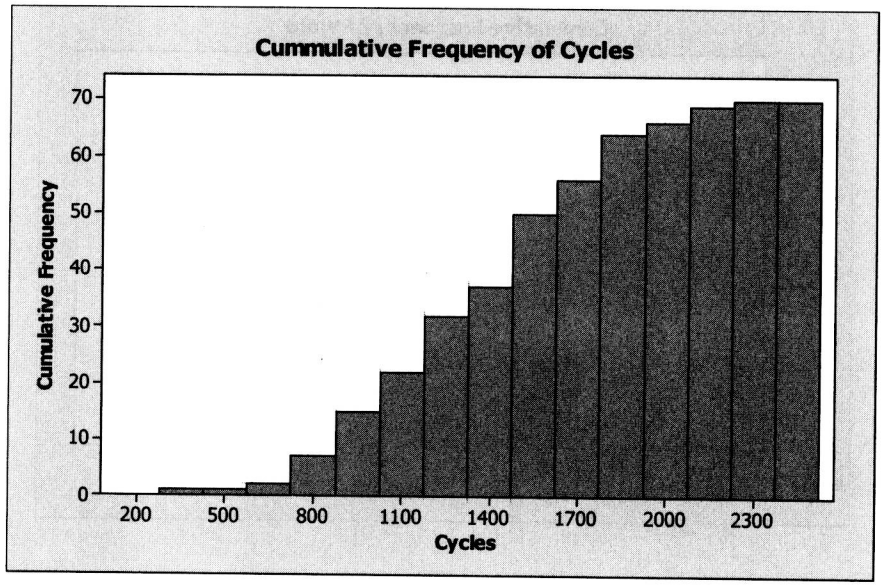
2-21. a) 8 bins





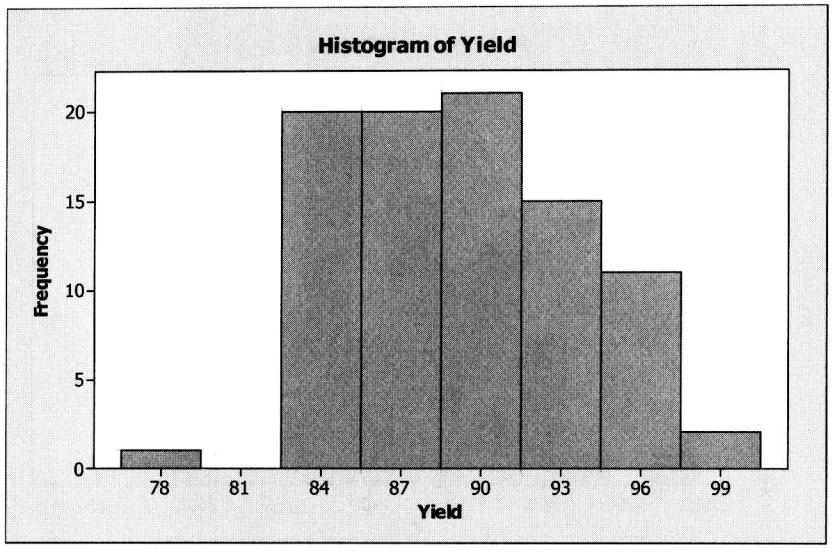
b) 16 bins

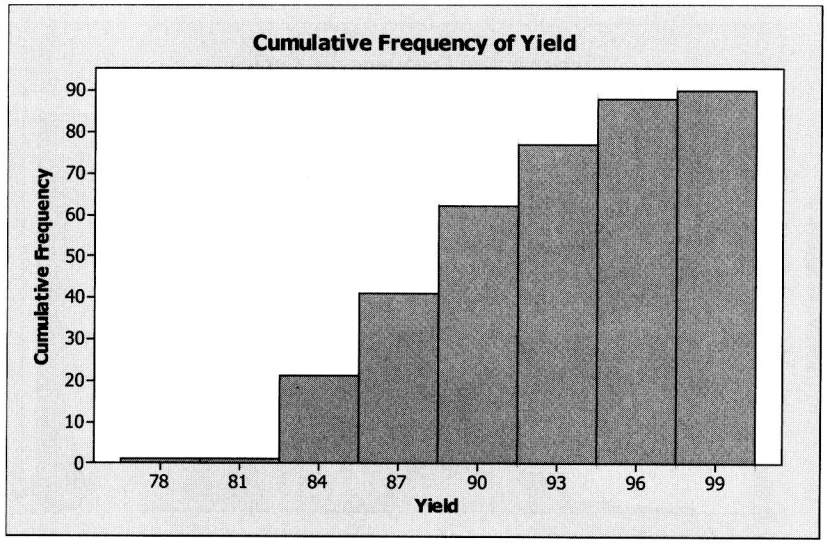




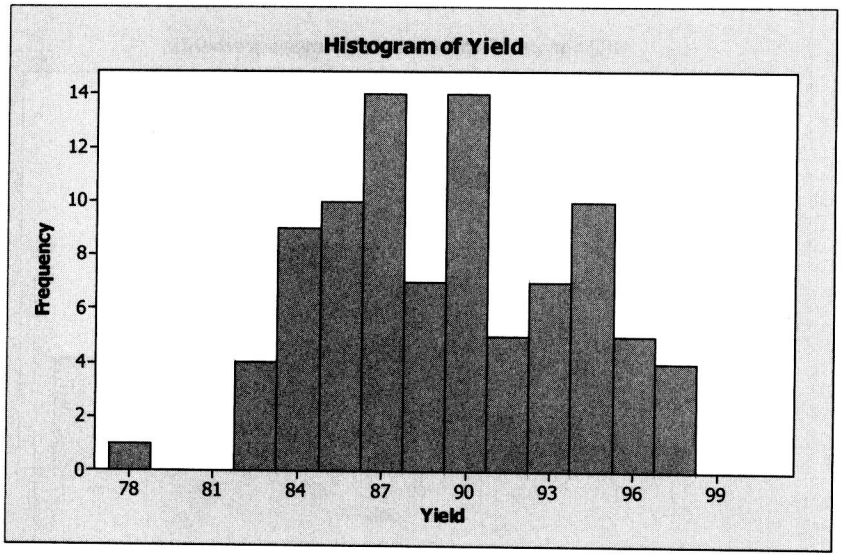
Yes, both histograms display similar information based on this dataset.

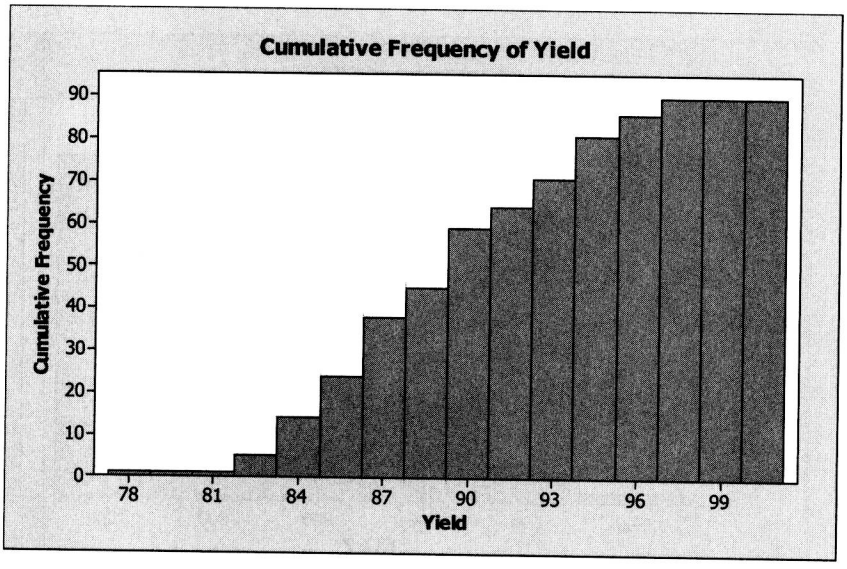
2-23. a) 8 bins


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


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

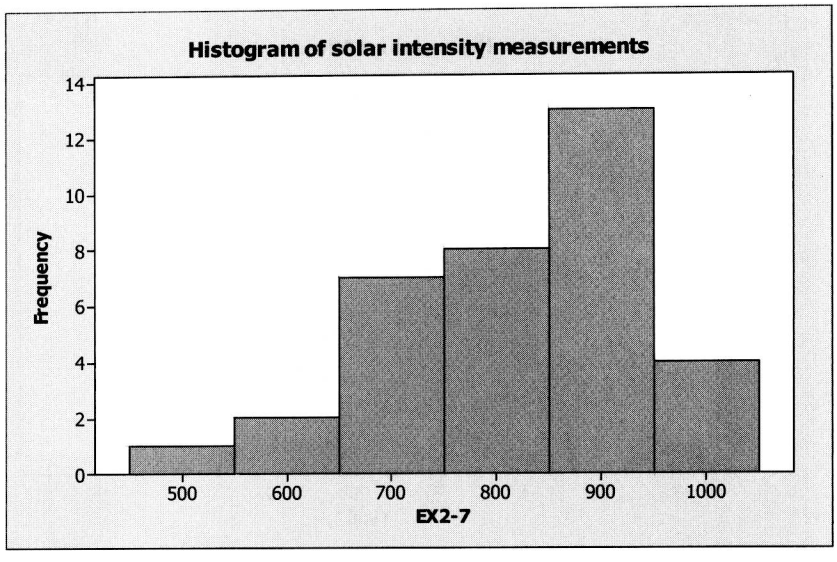
b) 16 bins

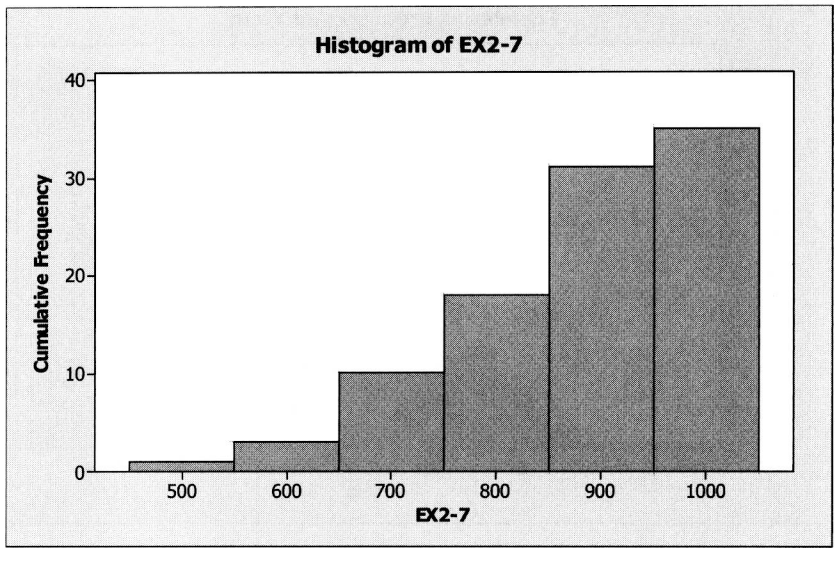




Yes, both histograms display similar information based on this dataset.

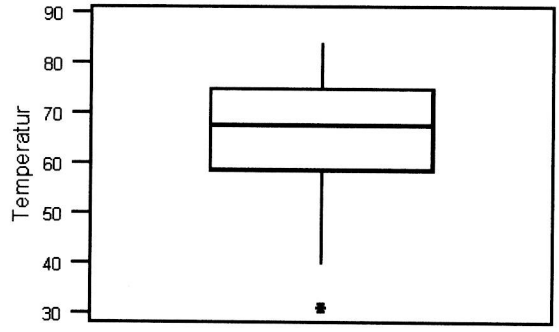
2-25. 6 bins


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


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

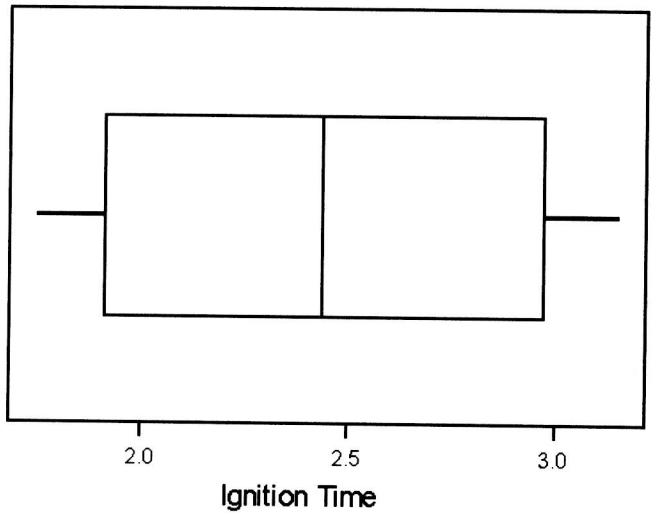
Section 2-4

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

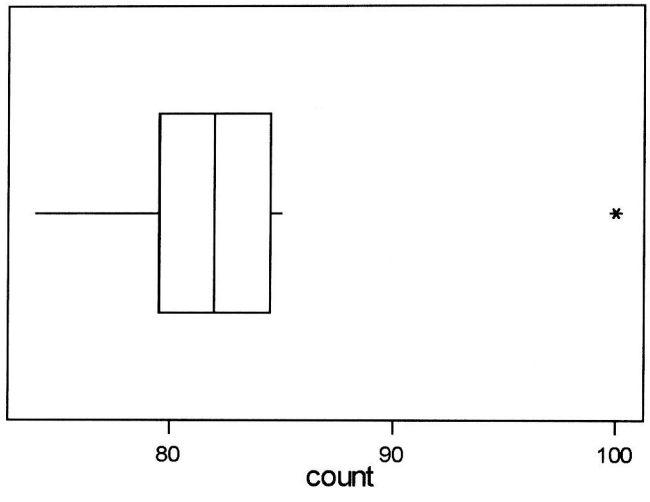


The value of 31 appears to be one possible outlier.

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

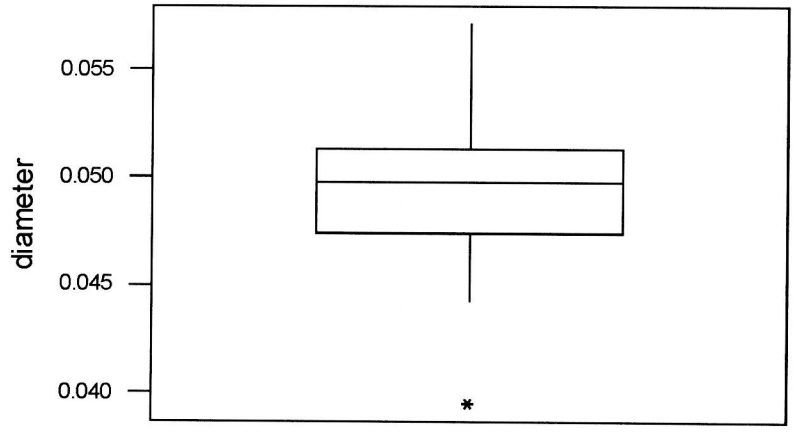


2-31. a) Sample mean: 83.11, sample variance = 50.55, sample standard deviation = 7.11
b) $Q_1 = 79.5$, $Q_3 = 84.50$
c)



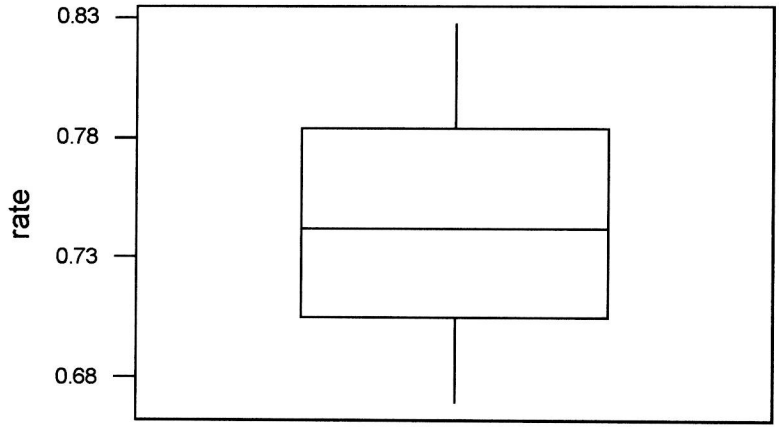
d) Sample mean = 81, sample standard deviation = 3.46, $Q_1 = 79.25$, $Q_3 = 83.75$. The sample mean and the sample standard deviation have decreased. The lower quartile has decreased slightly while the upper quartile has decreased.

2-33. a) Sample Mean: 0.04939, Sample Variance: 0.00001568
b) Q_1: 0.04738, Q_3: 0.0513
c) Sample Median: 0.04975
d)



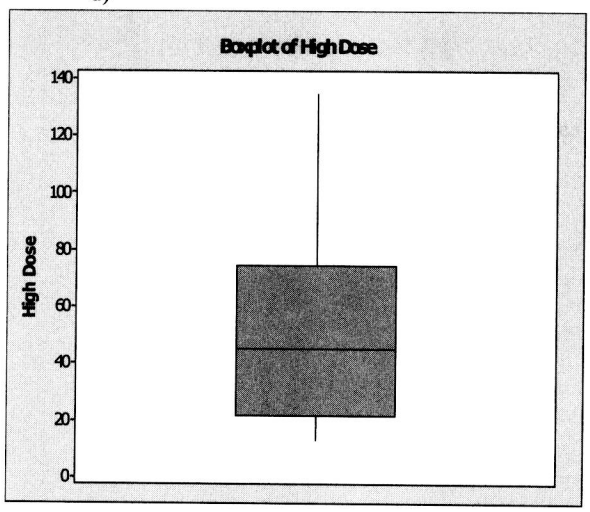
e) 5th Percentile: 0.03974, 95th Percentile: 0.057

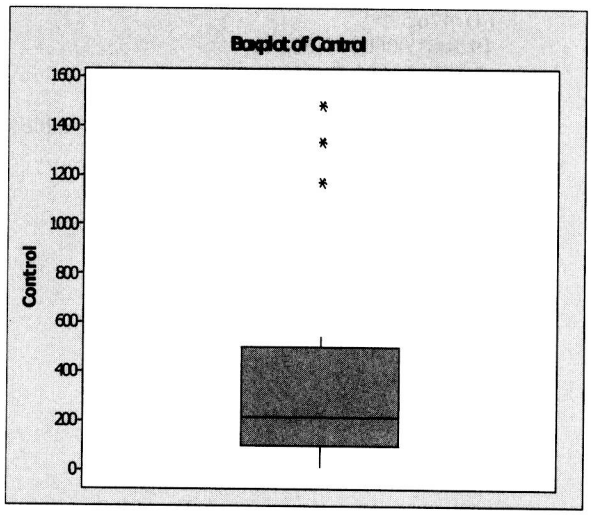
2-35. a) Sample Mean: 0.7481, Sample Variance: 0.00226
b) Q_1: 0.7050, Q_3: 0.7838
c) Sample Median: 0.742
d)



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

2-37. 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)

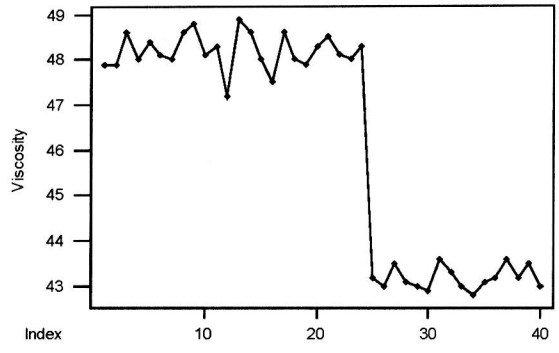




e) High Dose: 5th Percentile: 13.125, 95th Percentile: 133.67
Control: 5th Percentile: 17.045, 95th Percentile: 1460.23
All summary statistics are larger for the control group.

Section 2-5

2-39. a)

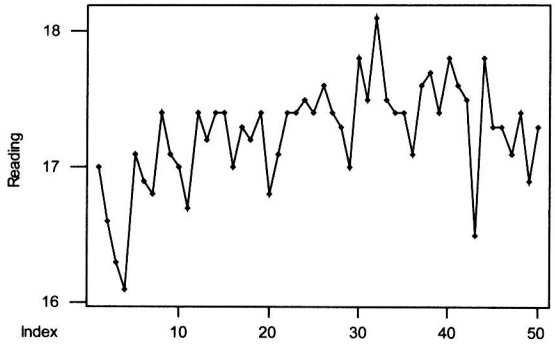


Stem-and-leaf display for Problem 2-32.Viscosity: unit = 0.1 1|2 represents 1.2

```
 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.

2-41.



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.