The size of devices currently undergoing development is measured in nanometers (nm), or $10^{-9}\times$ meters. Engineers fabricating a new transmission-type electron multiplier[2] created an array of silicon nanopillars on a flat silicon membrane. Subsequently, they measured the diameters (nm) of 50 pillars.

62	68	69	80	68	79	83	70	74	73
74	75	80	77	80	83	73	79	100	93
92	101	87	96	99	94	102	95	90	98
86	93	91	90	95	97	87	89	100	93
92	98	101	97	102	91	87	110	106	118

Group these measurements into a frequency distribution and construct a histogram using (60,70], (70, 80], (80,90], (90,100], (100, 110], (110,120], where the right-hand endpoint is included but the left-hand endpoint is not.

2.11 Convert the distribution obtained in the preceding exercise into a cumulative "less than or equal to" distribution and graph its ogive.

2.12 The following are the ignition times of certain upholstery materials exposed to a flame (given to the nearest hundredth of a second):

2.58	2.51	4.04	6.43	1.58	4.32	2.20	4.19
4.79	6.20	1.52	1.38	3.87	4.54	5.12	5.15
5.50	5.92	4.56	2.46	6.90	1.47	2.11	2.32
6.75	5.84	8.80	7.40	4.72	3.62	2.46	8.75
2.65	7.86	4.71	6.25	9.45	12.80	1.42	1.92
7.60	8.79	5.92	9.65	5.09	4.11	6.37	5.40
11.25	3.90	5.33	8.64	7.41	7.95	10.60	3.81
3.78	3.75	3.10	6.43	1.70	6.40	3.24	1.79
4.90	3.49	6.77	5.62	9.70	5.11	4.50	2.50
5.21	1.76	9.20	1.20	6.85	2.80	7.35	11.75

Group these figures into a table with a suitable number of equal classes and construct a histogram.

2.13 Convert the distribution obtained in Exercise 2.12 into a cumulative "less than" distribution and plot its ogive.

2.14 An engineer uses a thermocouple to monitor the temperature of a stable reaction. The ordered values of 50 observations (Courtesy of Scott Sanders), in tenths of °C, are

1.11	1.21	1.21	1.21	1.23	1.24	1.25	1.25	1.27	1.27	1.28
1.29	1.31	1.31	1.31	1.32	1.34	1.34	1.35	1.36	1.36	1.36
1.36	1.36	1.36	1.36	1.37	1.39	1.40	1.41	1.42	1.42	1.42
1.42	1.43	1.43	1.43	1.44	1.44	1.44	1.47	1.48	1.48	1.50
1.50	1.56	1.56	1.60	1.60	1.68					

Group these figures into a distribution having the classes 1.10–1.19, 1.20–1.29, 1.30–1.39, . . . , and 1.60–1.69, and plot a histogram using [1.10, 1.20), . . . , [1.60, 1.70), where the left-hand endpoint is included but the right-hand endpoint is not.

2.15 Convert the distribution obtained in Exercise 2.14 into a cumulative "less than" distribution and plot its ogive.

2.16 The following are the number of automobile accidents that occurred at 60 major intersections in a certain city during a Fourth of July weekend:

0	2	5	0	1	4	1	0	2	1
5	0	1	3	0	0	2	1	3	1
1	4	0	2	4	1	2	4	0	4
3	5	0	1	3	6	4	2	0	2
0	2	3	0	4	2	5	1	1	2
2	1	6	5	0	3	3	0	0	4

Group these data into a frequency distribution showing how often each of the values occurs and draw a bar chart.

2.17 Given a set of observations $x_1, x_2, \ldots,$ and x_n, we define their **empirical cumulative distribution** as the function whose values $F(x)$ equal the proportion of the observations less than or equal to x. Graph the empirical cumulative distribution for the 12 measurements of Exercise 2.3.

2.18 Referring to Exercise 2.17, graph the Empirical cumulative distribution for the data in Exercise 2.16.

2.19 The pictogram of Figure 2.11 is intended to illustrate the fact that per capita income in the United States doubled from $21,385 in 1993 to $42,643 in 2012. Does this pictogram convey a fair impression of the actual change? If not, state how it might be modified.

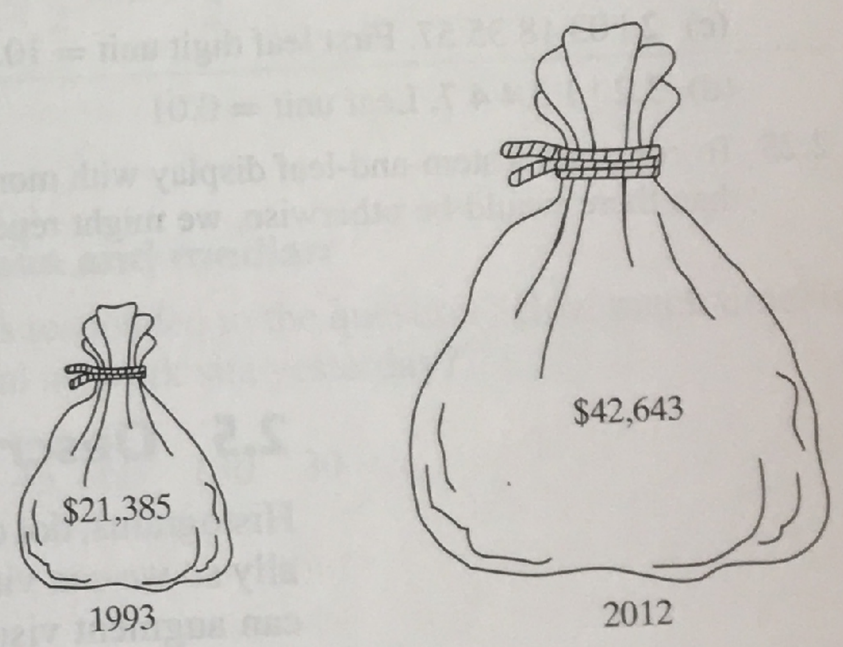

Figure 2.11 Pictogram for Exercise 2.19

2.20 Categorical distributions are often presented graphically by means of **pie charts**, in which a circle is divided into sectors proportional in size to the frequencies (or percentages) with which the data are distributed among the categories. Draw a pie chart to represent the following data, obtained in a study in

[2]H. Qin, H. Kim, and R. Blick, *Nanotechnology* **19** (2008), 095504. (5pp)