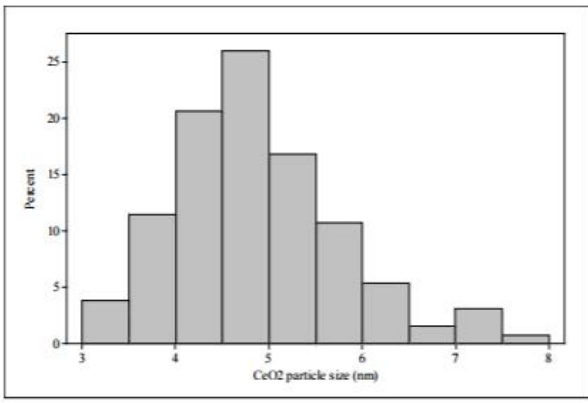
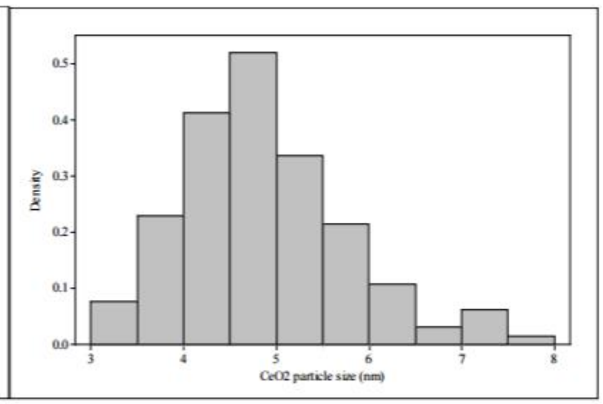
12. The sample size for this data set is $n = 5 + 15 + 27 + 34 + 22 + 14 + 7 + 2 + 4 + 1 = 131$.

a. The first four intervals correspond to observations less than 5, so the proportion of values less than 5 is $(5 + 15 + 27 + 34)/131 = 81/131 = .618$.

b. The last four intervals correspond to observations at least 6, so the proportion of values at least 6 is $(7 + 2 + 4 + 1)/131 = 14/131 = .107$.

c. **& d.** The relative (percent) frequency and density histograms appear below. The distribution of CeO_2 sizes is not symmetric, but rather positively skewed. Notice that the relative frequency and density histograms are essentially identical, other than the vertical axis labeling, because the bin widths are all the same.



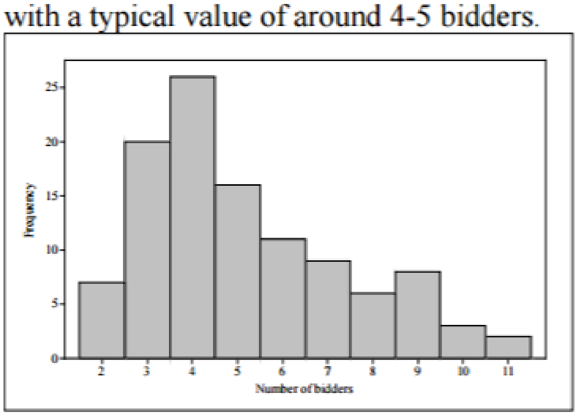


17. The sample size for this data set is $n = 7 + 20 + 26 + \ldots + 3 + 2 = 108$.

a. "At most five bidders" means 2, 3, 4, or 5 bidders. The proportion of contracts that involved at most 5 bidders is $(7 + 20 + 26 + 16)/108 = 69/108 = .639$.
Similarly, the proportion of contracts that involved at least 5 bidders (5 through 11) is equal to $(16 + 11 + 9 + 6 + 8 + 3 + 2)/108 = 55/108 = .509$.

b. The number of contracts with between 5 and 10 bidders, inclusive, is $16 + 11 + 9 + 6 + 8 + 3 = 53$, so the proportion is $53/108 = .491$. "Strictly" between 5 and 10 means 6, 7, 8, or 9 bidders, for a proportion equal to $(11 + 9 + 6 + 8)/108 = 34/108 = .315$.

c. The distribution of number of bidders is positively skewed, ranging from 2 to 11 bidders, with a typical value of around 4-5 bidders.



35. The sample size is $n = 15$.

a. The sample mean is $\bar{x} = 18.55/15 = 1.237$ μg/g and the sample median is $\tilde{x}$ = the 8th ordered value = .56 μg/g. These values are very different due to the heavy positive skewness in the data.

b. A 1/15 trimmed mean is obtained by removing the largest and smallest values and averaging the remaining 13 numbers: (.22 + ... + 3.07)/13 = 1.162. Similarly, a 2/15 trimmed mean is the average of the middle 11 values: (.25 + ... + 2.25)/11 = 1.074. Since the average of 1/15 and 2/15 is .1 (10%), a 10% trimmed mean is given by the midpoint of these two trimmed means: (1.162 + 1.074)/2 = 1.118 μg/g.

c. The median of the data set will remain .56 so long as that's the 8th ordered observation. Hence, the value .20 could be increased to as high as .56 without changing the fact that the 8th ordered observation is .56. Equivalently, .20 could be increased by as much as .36 without affecting the value of the sample median.

39.

a. $\Sigma x_i = 16.475$ so $\bar{x} = \dfrac{16.475}{16} = 1.0297$; $\tilde{x} = \dfrac{(1.007 + 1.011)}{2} = 1.009$

b. 1.394 can be decreased until it reaches 1.011 (i.e. by 1.394 – 1.011 = 0.383), the largest of the 2 middle values. If it is decreased by more than 0.383, the median will change.

44.

a. The maximum and minimum values are 182.6 and 180.3, respectively, so the range is 182.6 – 180.3 = 2.3°C.

b. Note: If we apply the hint and subtract 180 from each observation, the mean will be 1.41, and the middle two columns will not change. The sum and sum of squares will change, but those effects will cancel and the answer below will stay the same.

	x_i	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$	x_i^2
	180.5	–0.90833	0.82507	32580.3
	181.7	0.29167	0.08507	33014.9
	180.9	–0.50833	0.25840	32724.8
	181.6	0.19167	0.03674	32978.6
	182.6	1.19167	1.42007	33342.8
	181.6	0.19167	0.03674	32978.6
	181.3	–0.10833	0.01174	32869.7
	182.1	0.69167	0.47840	33160.4
	182.1	0.69167	0.47840	33160.4
	180.3	–1.10833	1.22840	32508.1
	181.7	0.29167	0.08507	33014.9
	180.5	–0.90833	0.82507	32580.3
sums:	2176.9	0	5.769167	394913.6
	$\bar{x}$ = 181.41			

$s^2 = \sum_{i=1}^{n}(x_i - \bar{x})^2 / (n-1) = 5.769167/(12 - 1) = 0.52447.$

c. $s = \sqrt{0.52447} = 0.724.$

d. $s^2 = \dfrac{\Sigma x^2 - (\Sigma x)^2 / n}{n-1} = \dfrac{394913.6 - (2176.9)^2 / 12}{11} = 0.52447.$

47.

a. From software, $\tilde{x} = 14.7\%$ and $\bar{x} = 14.88\%$. The sample average alcohol content of these 10 wines was 14.88%. Half the wines have alcohol content below 14.7% and half are above 14.7% alcohol.

b. Working long-hand, $\Sigma(x_i - \bar{x})^2 = (14.8 - 14.88)^2 + \ldots + (15.0 - 14.88)^2 = 7.536$. The sample variance equals $s^2 = \Sigma(x_i - \bar{x})^2 = 7.536/(10 - 1) = 0.837$.

c. Subtracting 13 from each value will not affect the variance. The 10 new observations are 1.8, 1.5, 3.1, 1.2, 2.9, 0.7, 3.2, 1.6, 0.8, and 2.0. The sum and sum of squares of these 10 new numbers are $\Sigma y_i = 18.8$ and $\Sigma y_i^2 = 42.88$. Using the sample variance shortcut, we obtain $s^2 = [42.88 - (18.8)^2/10]/(10 - 1) = 7.536/9 = 0.837$ again.