1. (a) Use $\chi^2_{cdf}(\text{lower, upper, degrees})$. Max occurs at $x = n - 2$, where $n =$ degrees.

(i) $P(12 \leq \chi^2_{(19)} \leq 25) \approx 0.725$

(ii) $P(\chi^2_{(17)} \leq 20) \approx 0.726$

(iii) $P(\chi^2_{(22)} \geq 20) \approx 0.583$

(b) (i) $90\%$ of the $\chi^2_{(19)}$ distribution is from 10.12 to 30.14

(ii) $95\%$ of the $\chi^2_{(17)}$ distribution is from 7.564 to 30.19

(iii) $98\%$ of the $\chi^2_{(22)}$ distribution is from 9.542 to 40.29

2. For a normal distribution with $\mu = 53$ and $\sigma = 0.9$:

(a) With $n = 40$:

$$P(0.81 \leq S \leq 0.99) = P\left(\frac{\frac{39 \times 0.81^2}{0.9^2}}{\sigma^2} \leq \frac{(n-1)S^2}{\sigma^2} \leq \frac{\frac{39 \times 0.99^2}{0.9^2}}{\sigma^2}\right) = P\left(31.59 \leq \chi^2_{(39)} \leq 47.19\right) \approx 0.6218.$$  

(b) For $n = 30$ and $S = 0.76$, we use the 95% chi-square scores from the $\chi^2_{(29)}$ curve which are $L = 16.05$ and $R = 45.72$. Then, $\sqrt{\frac{(n-1) \times S^2}{R}} \leq \sigma \leq \sqrt{\frac{(n-1) \times S^2}{L}}$, so we have a 95% confidence interval of $\sqrt{\frac{29 \times 0.76^2}{45.72}} \leq \sigma \leq \sqrt{\frac{29 \times 0.76^2}{16.05}}$, or $0.6053 \leq \sigma \leq 1.0216$.

(c) With $S = 0.86$ and $n = 30$: We test $H_0: \sigma = 0.90$ vs. $H_a: \sigma < 0.90$.

The test stat is $\frac{(n-1)S^2}{\sigma^2} = \frac{29 \times 0.86^2}{0.9^2} = 26.4795$. The $P$-value is $P(0 \leq \chi^2_{(29)} \leq 26.4795) \approx 0.40$ (the left-tail for $H_a: \sigma < 0.90$). If $\sigma = 0.90$ were true, then there is a 40% chance of obtaining an $S$ of 0.86 or lower with a sample of size 30. No evidence to reject $H_0$.

(d) With $S = 1.2$ and $n = 37$: We test $H_0: \sigma = 0.90$ vs. $H_a: \sigma > 0.90$.

The test stat is $\frac{(n-1)S^2}{\sigma^2} = \frac{36 \times 1.2^2}{0.9^2} = 64$. Now the $P$-value is $P(\chi^2_{(36)} \geq 64) \approx 0.00277$ (the right-tail for $H_a: \sigma > 0.90$). If $\sigma = 0.90$ were true, then there is only a .00277 probability of obtaining an $S$ of 1.2 or higher with a sample of size 37. There is evidence to reject $H_0$. 
3. 

Obtained frequencies: 1200 responses total

<table>
<thead>
<tr>
<th></th>
<th>Sprint</th>
<th>Verizon</th>
<th>AT&amp;T</th>
<th>T-Mobile</th>
<th>Bluegrass</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>210</td>
<td>220</td>
<td>200</td>
<td>70</td>
<td>350</td>
<td></td>
</tr>
</tbody>
</table>

(a) Expected from a sample of 1200 if the given percentages were true: Multiply each stated percentage by 1200

<table>
<thead>
<tr>
<th></th>
<th>Sprint</th>
<th>Verizon</th>
<th>AT&amp;T</th>
<th>T-Mobile</th>
<th>Bluegrass</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>216</td>
<td>240</td>
<td>192</td>
<td>72</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

\[
x = \frac{(150 - 180)^2}{180} + \frac{(210 - 216)^2}{216} + \frac{(220 - 240)^2}{240} + \frac{(200 - 192)^2}{192} + \frac{(70 - 72)^2}{72} + \frac{(350 - 300)^2}{300}
\]

(b) \[
= \frac{30^2}{180} + \frac{6^2}{216} + \frac{20^2}{240} + \frac{8^2}{192} + \frac{2^2}{72} + \frac{50^2}{300} = 15.5
\]

For 6 bins, use the \( \chi^2 \)(5) curve: \( P(\chi^2(5) \geq 15.5) \approx 0.00823 = P\)-value (right-tail)

(c) If the percentages in KY were as reported, then there would be less than a 1% chance of obtaining our frequencies that differ so much from the expected values. There is strong evidence to reject that the claimed percentages are true in KY.

4. 

<table>
<thead>
<tr>
<th>Freshman (F)</th>
<th>Instruction (I)</th>
<th>Parking (Pa)</th>
<th>Campus Activities (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Soph (So)</td>
<td>32</td>
<td>113</td>
<td>170</td>
</tr>
<tr>
<td>Junior (J)</td>
<td>45</td>
<td>280</td>
<td>140</td>
</tr>
<tr>
<td>Senior (Sr)</td>
<td>106</td>
<td>380</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>203</td>
<td>833</td>
<td>464</td>
</tr>
</tbody>
</table>

(a) 

Freshman \( P(F) = \frac{180}{1500} = 12\% \) Sophomore \( P(\text{So}) = \frac{315}{1500} = 21\% \) Junior \( P(\text{J}) = \frac{465}{1500} = 31\% \) Senior \( P(\text{Sr}) = \frac{540}{1500} = 36\% \)

(b) 

Instruction \( P(\text{I}) = \frac{203}{1500} = 13.53\% \) Parking \( P(\text{Pa}) = \frac{833}{1500} = 55.53\% \) Campus Activities \( P(\text{A}) = \frac{464}{1500} = 30.93\% \)

(c) Sophomore and believe parking is most important 

\[
P(\text{So} \cap \text{Pa}) = \frac{113}{1500} = 7.53\% 
\]

Senior and believe campus activities are most important

\[
P(\text{Sr} \cap \text{A}) = \frac{54}{1500} = 3.6\% 
\]

(d) (i) \( P(\text{Pa} \mid \text{So}) = \frac{113}{315} \approx 35.87\% \)  (ii) \( P(\text{F} \mid \text{A}) = \frac{100}{464} \approx 21.55\% \)

(e) (i) \( P(\text{Pa} \mid \text{F}) = \frac{60}{180} = 33.33\% \) Among Freshmen, 33.33% choose parking.

Among those who choose parking, 13.56% are Sophomores.
Among those who choose instruction, 22.17% are Juniors.

Among juniors, 9.68% choose instruction.

Among seniors, 10% choose activities.

Among those who choose activities, 11.6% are seniors.

Dividing by the right-most totals:

<table>
<thead>
<tr>
<th></th>
<th>Instruction</th>
<th>Parking</th>
<th>Campus Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>0.1111</td>
<td>0.3333</td>
<td>0.5556</td>
</tr>
<tr>
<td>Sophomore</td>
<td>0.1016</td>
<td>0.3587</td>
<td>0.5397</td>
</tr>
<tr>
<td>Junior</td>
<td>0.0968</td>
<td>0.6022</td>
<td>0.3011</td>
</tr>
<tr>
<td>Senior</td>
<td>0.1963</td>
<td>0.7037</td>
<td>0.1</td>
</tr>
<tr>
<td>Total</td>
<td>0.1353</td>
<td>0.5553</td>
<td>0.3093</td>
</tr>
</tbody>
</table>

(f) Which class seems most likely to believe that
(i) instruction is most important  (ii) activities are most important

Seniors  Freshmen

(g) Which class seems least likely to believe that
(i) instruction is most important  (ii) parking is most important

Juniors  Freshmen

(i) $P\text{-}value = 3.3366 \times 10^{-51} = 0 \rightarrow$ Very strong evidence to reject independence; thus, choice of issue is dependent on the class.

For example, Seniors are much less likely than Freshmen to pick campus activities (about 10% to about 55.6%). Also, Seniors are much more likely than Freshmen to pick parking (about 70.4% to 33.3%).

Note though that Freshmen and Sophomores have nearly the same percentages throughout and choices may be independent when looking at just these two classes.