5.15. In order to assess the prevalence of a drug problem among high-school students in a particular city, a random sample of 200 students from the city's five high schools were surveyed. One of the survey questions and the corresponding responses are given below.

What is your typical weekly marijuana usage?

	Category		
	None	Moderate (1–3 joints)	Heavy (4 or more joints)
Number of responses	117	62	21

Construct 95% simultaneous confidence intervals for the three proportions p_1, p_2, and $p_3 = 1 - (p_1 + p_2)$.

The following exercises may require a computer.

5.16. Use the college test data in Table 5.2 (see Example 5.4).

(a) Test the null hypothesis $H_0: \boldsymbol{\mu}' = [500, 50, 30]$ versus $H_1: \boldsymbol{\mu}' \neq [500, 50, 30]$ at the $\alpha = .05$ level of significance. Suppose $[500, 50, 30]'$ represent average scores for thousands of college students over the last 10 years. Is there reason to believe the group of students represented by the scores in Table 5.2 is scoring differently? Explain.

(b) Determine the lengths and directions for the axes of the 95% confidence ellipsoid for $\boldsymbol{\mu}$.

(c) Construct Q-Q plots from the marginal distributions of social science and history, verbal, and science scores. Also construct the three possible scatter diagrams from the pairs of observations on different variables. Do these data appear to be normally distributed? Discuss.

5.17. Measurements of x_1 = stiffness and x_2 = bending strength for a sample of $n = 30$ pieces of a particular grade of lumber are given in Table 5.6 on page 216. The units are pounds/(inches)^2. Using the data in Table 5.6:

(a) Construct and sketch a 95% confidence ellipse for the pair $[\mu_1, \mu_2]'$, where $\mu_1 = E(X_1)$ and $\mu_2 = E(X_2)$.

(b) Suppose $\mu_{10} = 2000$ and $\mu_{20} = 10{,}000$ represent "typical" values for stiffness and bending strength respectively. Given the result in (a), are the data in Table 5.6 consistent with these values? Explain.

(c) Is the bivariate normal distribution a viable population model? Explain with reference to Q-Q plots and a scatter diagram.

5.18. A wildlife ecologist measured x_1 = tail length (in millimeters) and x_2 = wing length (in millimeters) for a sample of $n = 45$ female hook-billed kites. These data are displayed in Table 5.7 on page 216. Using the data in Table 5.7:

(a) Find and sketch the 95% confidence ellipse for the population means μ_1 and μ_2. Suppose it is known that $\mu_1 = 190$ mm and $\mu_2 = 275$ mm for *male* hook-billed kites. Are these plausible values for the mean tail length and mean wing length for the female birds? Explain.

(b) Construct the simultaneous 95% T^2-intervals for μ_1 and μ_2 and the 95% Bonferroni intervals for μ_1 and μ_2. Compare the two sets of intervals. What advantage, if any, do the T^2-intervals have over the Bonferroni intervals?

TABLE 5.6 LUMBER DATA

x_1 (Stiffness: modulus of elasticity)	x_2 (Bending strength)	x_1 (Stiffness: modulus of elasticity)	x_2 (Bending strength)
1,232	4,175	1,712	7,749
1,115	6,652	1,932	6,818
2,205	7,612	1,820	9,307
1,897	10,914	1,900	6,457
1,932	10,850	2,426	10,102
1,612	7,627	1,558	7,414
1,598	6,954	1,470	7,556
1,804	8,365	1,858	7,833
1,752	9,469	1,587	8,309
2,067	6,410	2,208	9,559
2,365	10,327	1,487	6,255
1,646	7,320	2,206	10,723
1,579	8,196	2,332	5,430
1,880	9,709	2,540	12,090
1,773	10,370	2,322	10,072

SOURCE: Data courtesy of United States Forest Products Laboratory.

TABLE 5.7 BIRD DATA

x_1 (Tail length)	x_2 (Wing length)	x_1 (Tail length)	x_2 (Wing length)	x_1 (Tail length)	x_2 (Wing length)
191	284	186	266	173	271
197	285	197	285	194	280
208	288	201	295	198	300
180	273	190	282	180	272
180	275	209	305	190	292
188	280	187	285	191	286
210	283	207	297	196	285
196	288	178	268	207	286
191	271	202	271	209	303
179	257	205	285	179	261
208	289	190	280	186	262
202	285	189	277	174	245
200	272	211	310	181	250
192	282	216	305	189	262
199	280	189	274	188	258

SOURCE: Data courtesy of S. Temple.

(c) Is the bivariate normal distribution a viable population model? Explain with reference to *Q-Q* plots and a scatter diagram.

5.19. Using the data on bone mineral content in Table 1.6, construct the 95% Bonferroni intervals for the individual means. Also, find the 95% simultaneous T^2-intervals. Compare the two sets of intervals.