Chapter 11

11–1. (a) H_0: $\mu \le 160$ $\quad$ H_1: $\mu > 160$

$$Z_0 = \frac{\overline{x} - \mu_0}{\sigma\sqrt{n}} = \frac{158 - 160}{3/2} = -1.333$$

The fiber is acceptable if $Z_0 > Z_{0.05} = 1.645$. Since $Z_0 = -1.33 < 1.645$, the fiber is not acceptable.

(b) $d = \frac{\mu - \mu_0}{\sigma} = \frac{165-160}{3} = 1.67$, if $n = 4$ then using the OC curves, we get $\beta \simeq 0.05$.

11–2. (a) H_0: $\mu = 90$ $\quad$ H_1: $\mu < 90$

$$Z_0 = \frac{\overline{x} - \mu_0}{\sigma\sqrt{n}} = \frac{90.48 - 90}{\sqrt{5/5}} = 0.48$$

Since Z_0 is not less than $-Z_{0.05} = -1.645$, do not reject H_0. There is no evidence that mean yield is less than 90 percent.

(b) $n = (Z_\alpha + Z_\beta)^2\sigma^2/\delta^2 = (1.645 + 1.645)^2 5/(5)^2 = 2.16 \simeq 3$. Could also use the OC curves, with $d = (\mu_0 - \mu)/\sigma = (90 - 85)/\sqrt{5} = 2.24$ and $\beta = 0.05$, also giving $n = 3$.

11–3. (a) H_0: $\mu = 0.255$ $\quad$ H_1: $\mu \neq 0.255$

$$Z_0 = \frac{\overline{x} - \mu_0}{\sigma/\sqrt{n}} = \frac{0.2546 - 0.255}{0.0001/\sqrt{10}} = -12.65$$

Since $|Z_0| = 12.65 > Z_{0.025} = 1.96$, reject H_0.

(b) $d = \frac{|\mu - \mu_0|}{\sigma} = \frac{|0.2552 - 0.225|}{0.0001} = 2$, and using the OC curves with $\alpha = 0.05$ and $\beta = 0.10$ gives $n \simeq 3$. Could also use $n \simeq (Z_{\alpha/2} + Z_\beta)^2\sigma^2/\delta^2 = (1.96 + 1.28)^2(0.0001)^2/(0.0002)^2 = 2.62 = 3$.

11–4. (a) H_0: $\mu = 74.035$ $\quad$ H_1: $\mu \neq 74.035$

$$Z_0 = \frac{\overline{x} - \mu_0}{\sigma/\sqrt{n}} = \frac{74.036 - 74.035}{0.001/\sqrt{15}} = 3.87$$

Since $Z_0 > Z_{\alpha/2} = 2.575$, reject H_0.

(b) $$n \cong \frac{(Z_{\alpha/2} + Z_\beta)^2\sigma^2}{\delta^2} = 0.712, n = 1$$

11–5. (a) H_0: $\mu = 1.000$ $\quad$ $Z_0 = \frac{\overline{x} - \mu_0}{\sigma\sqrt{n}} = \frac{1014 - 1000}{25/\sqrt{20}} = 2.50$

H_1: $\mu \neq 1.000$ $\quad$ $|Z_0| = 2.50 > Z_{0.005} = 1.96$, reject H_0.

11–6. (a) H_0: $\mu = 3500$ $\quad$ $Z_0 = \frac{\overline{x} - \mu_0}{\sigma\sqrt{n}} = \frac{3250 - 3500}{\sqrt{1000/12}} = -27.39$

H_1: $\mu \neq 3500$ $\quad$ $|Z_0| = 27.39 > Z_{0.005} = 2.575$, reject H_0.

11–7. (a) H_0: $\mu_1 = \mu_2$ $\quad Z_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = 1.349$

H_1: $\mu_1 \neq \mu_2$

Since $Z_0 < Z_{\alpha/2} = 1.96$, do not reject H_0.

(d) $d = 3.2$, $n = 10$, $\alpha = 0.05$, OC curves gives $\beta \approx 0$, therefore power ≈ 1.

11–8. μ_1 = New machine, μ_2 = Current machine

H_0: $\mu_1 - \mu_2 \leq 2$, H_1: $\mu_1 - \mu_2 > 2$

Use the t-distribution assuming equal variances: $t_0 = -5.45$, do not reject H_0.

11–9. H_0: $\mu_1 - \mu_2 = 0$, $\quad Z_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = 2.656$

H_1: $\mu_1 - \mu_2 \neq 0$

Since $Z_0 > Z_{\alpha/2} = 1.645$, reject H_0.

11–10. H_0: $\mu_1 - \mu_2 = 0$, $\quad Z_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = -6.325$

H_1: $\mu_1 - \mu_2 > 0$

Since $Z_0 < Z_\alpha = 1.645$, do not reject H_0.

11–11. H_0: $\mu_1 - \mu_2 = 0$, $\quad Z_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{\sqrt{\frac{\sigma_2^2}{n_1} + \frac{\sigma_2^2}{n_2}}} = -7.25$

H_1: $\mu_1 - \mu_2 < 0$

Since $Z_0 < -Z_\alpha = -1.645$, reject H_0.

11–12. H_0: $\mu = 0$ $\quad t_0 = \dfrac{\overline{x} - \mu_0}{s/\sqrt{n}} = \dfrac{-0.168 - 0}{8.5638/\sqrt{10}} = -0.062$

H_1: $\mu \neq 0$ $\quad |t_0| = 0.062 < t_{0.025,9} = 2.2622,$ do not reject H_0.

11–13. (a) $t_0 = 1.842$, do not reject H_0.

(b) $n = 8$ is not sufficient; $n = 10$.

11–14. H_0: $\mu = 9.5$ $\quad t_0 = \dfrac{10.28 - 9.5}{2.55/\sqrt{6}} = 0.7492$

H_1: $\mu > 9.5$ $\quad t_{0.05,5} = 2.015,$ do not reject H_0.

11–15. $t_0 = 1.47$, do not reject at $\alpha = 0.05$ level of significance. It can be rejected at the $\alpha = 0.10$ level of significance.

11–16. (a) $H_0\colon \mu = 7.5 \qquad t_0 = \dfrac{6.997 - 7.5}{1.279/\sqrt{18}} = -1.112$

$H_1\colon \mu < 7.5 \qquad t_{0.05,7} = 1.895,$ do not reject H_0,

the true scrap rate is not $< 7.5\%$.

(b) $n = 5$

(c) 0.95

11–17. $n = 3$

11–18. $d = \dfrac{|\delta|}{\sigma} = \dfrac{20}{10} = 2$, $n = 3$

11–19. (a) $H_0\colon \mu_1 = \mu_2 \qquad t_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{s_p\sqrt{1/n_1 + 1/n_2}} = \dfrac{25.617 - 21.7}{0.799\sqrt{1/6 + 1/6}} = 8.49$

$H_1\colon \mu_1 > \mu_2 \qquad t_0 > t_{0.01,10} = 2.7638$

(b) $H_0\colon \mu_1 - \mu_2 = 5 \qquad t_0 = \dfrac{\overline{x}_1 - \overline{x}_2 - 5}{s_p\sqrt{1/n_1 + 1/n_2}} = 2.35,$ do not reject H_0.

$H_1\colon \mu_1 - \mu_2 > 5$

(c) Using $s_p = 0.799$ as an estimate of σ,
$d = (\mu_1 - \mu_2)/(2\sigma) = 5/2(0.799) = 3.13$, $n_1 = n_2 = 6$, $\alpha = 0.01$, OC curves give $\beta \approx 0$, so power $\simeq 1$.

(d) OC curves give $n = 5$.

11–20. $t_0 = -0.02$, do not reject H_0.

11–21. $H_0\colon \sigma_1^2 = \sigma_2^2 \qquad s_1 = 9.4186 \qquad s_1^2 = 88.71$
$H_1\colon \sigma_1^2 \neq \sigma_2^2 \qquad s_2 = 10.0222 \qquad s_2^2 = 100.44$
$\alpha = 0.05$

Reject H_0 if $F_0 > F_{0.025,9,9} = 3.18$.

$F_0 = \dfrac{88.71}{100.44} = 0.8832 \qquad \therefore$ do not reject $H_0\colon \sigma_1^2 = \sigma_2^2$.

11–22. (a) $H_0\colon \sigma_1^2 = \sigma_2^2 \qquad F_0 = s_1^2/s_2^2 = 101.17/94.73 = 1.07$
$H_1\colon \sigma_1^2 \neq \sigma_2^2 \qquad$ do not reject H_0.

(b) H_0: $\mu_1 = \mu_2$ $\quad t_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{s_p\sqrt{1/n_1 + 1/n_2}} = \dfrac{12.5 - 10.2}{9.886\sqrt{1/8 + 1/9}}$

H_1: $\mu_1 > \mu_2$ $\quad = -0.48,$ do not reject.

11–23. (a) H_0: $\mu_1 = \mu_2$ $\quad s_p = \sqrt{\dfrac{1480 + 1425}{18}} = 12.704$

H_1: $\mu_1 \neq \mu_2$ $\quad t_0 = \dfrac{20.0 - 15.8}{12.704\sqrt{1/10 + 1/10}} = 0.74,$ do not reject H_0.

Reject H_0 if $|t_0| < t_{0.005,9} = 3.250$.

(b) $d = 10/[2(12.7)] = 0.39$, Power $= 0.13$, $n^* = 19$

(c) $n_1 = n_2 = 75$

11–24. (a) H_0: $\mu_1 = \mu_2$ $\quad t_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{s_p\sqrt{1/n_1 + 1/n_2}} = \dfrac{20.0 - 21.5}{1.40\sqrt{1/10 + 1/10}} = -2.40$

H_1: $\mu_1 \neq \mu_2$ $\quad$ reject H_0.

(b) Use $s_p = 1.40$ as an estimate of σ. Then $d = |\mu_1 - \mu_2|/2\sigma = 2/2(1.40) = 0.7$. If $\alpha = 0.05$ and $n_1 = n_2 = 10$, OC curves gives $\beta \simeq 0.5$. For $\beta \simeq 0.15$, we must have $n_1 = n_2 \simeq 30$.

(c) $F_0 = s_1^2/s_2^2 = 2.25/1.69 = 1.33$, do not reject H_0.

(d) $\lambda = \sigma_1/\sigma_2 = 2$, $\alpha = 0.05$, $n_1 = n_2 = 10$, OC curves give $\beta \simeq 0.50$.

11–25. H_0: $\mu_1 = \mu_2$ $\quad t_0 = \dfrac{\overline{x}_1 - \overline{x}_2}{s_p\sqrt{1/n_1 + 1/n_2}} = \dfrac{8.75 - 8.63}{0.57\sqrt{1/12 + 1/18}} = 0.56$

H_1: $\mu_1 \neq \mu_2$ $\quad$ do not reject H_0.

11–26. H_0: $\sigma^2 = 16$ $\quad$ If $\alpha = 0.05$, $\lambda = \sigma_1/\sigma_0 = 3/4$, and $\beta = 0.10$, then
H_1: $\sigma^2 < 16$ $\quad$ $n \simeq 55$. Thus $n = 10$ is not good.

For the sample of $n = 10$ given, $\chi_0^2 = \frac{(n-1)s^2}{\sigma_0^2} = \frac{9(14.69)}{16} = 8.26$. Since $\chi^2_{0.05,9} = 3.325$, do not reject H_0.

11–27. (a) H_0: $\sigma = 0.00002$ $\quad \chi_0^2 = \dfrac{(n-1)s^2}{\sigma_0^2} = \dfrac{7(0.00005)^2}{(0.00002)^2} = 43.75$

H_1: $\sigma > 0.00002$ $\quad$ Since $\chi_0^2 > \chi^2_{0.01,7} = 18.475$, reject H_0.
The claim is unjustified.

(b) A 99% one-sided lower confidence interval is $0.3078 \times 10^{-4} \le \sigma^2$.

(c) $\lambda = \sigma_1/\sigma_2 = 2$, $\alpha = 0.01$, $n = 8$, OC curves give $\beta \simeq 0.30$.

(d) $\lambda = 2$, $\beta \simeq 0.05$, $\alpha = 0.01$, OC curves give $n = 17$.

11–28. H_0: $\sigma = 0.005$
H_1: $\sigma > 0.005$

If $\alpha = 0.01$, $\beta = 0.10$, $\lambda = 0.010/0.005 = 2$, then the OC curves give $n = 14$. Assuming $n = 14$, then $\chi_0^2 = \frac{(n-1)s^2}{\sigma_0^2} = \frac{13(0.007)^2}{(0.005)^2} = 25.48 < \chi^2_{0.01,13} = 27.688$, and we do not reject. The 95% one-sided upper confidence interval is $\sigma^2 \le 0.155 \times 10^{-3}$.

11–29. (a) H_0: $\sigma^2 = 0.5$ $\quad \chi_0^2 = \dfrac{(n-1)s^2}{\sigma_0^2} = \dfrac{11(0.10388)}{0.5} = 2.28$, reject H_0.
H_1: $\sigma^2 \ne 0.5$

(b) $\lambda = \sigma/\sigma_0 = 1/0.707 = 1.414$, $\beta \approx 0.58$

11–30. H_0: $\sigma_1^2 = \sigma_2^2$ $\quad F_0 = s_1^2/s_2^2 = 2.25 \times 10^{-4}/3.24 \times 10^{-4}$
H_1: $\sigma_1^2 \ne \sigma_2^2$ $\quad = 0.69$, do not reject H_0.

Since $\sigma_1^2 = \sigma_2^2$, the test on means in Exercise 11–7 is appropriate. If $\lambda = \sigma_1/\sigma_2 = \sqrt{2.5} = 1.58$, then using $\alpha = 0.01$, $\beta = 0.10$, the OC curves give $n \simeq 75$.

11–31. H_0: $\sigma_1^2 = \sigma_2^2$ $\quad F_0 = s_1^2/s_2^2 = 0.9027/0.0294 = 30.69$
H_1: $\sigma_1^2 > \sigma_2^2$ $\quad F_0 > F_{0.01,8,10} = 5.06$, so reject H_0.

If $\lambda = \sqrt{4} = 2$, $\alpha = 0.01$, and taking $n_1 \simeq n_2 = 10$ (say), we get $\beta \simeq 0.65$.

11–32. (b) H_0: $\mu_1 - \mu_2 = 0$, $\quad t_0 = \dfrac{(0.984 - 0.907)}{\sqrt{11.37(\frac{1}{25} + \frac{1}{30})}} = 0.0843$, do not reject H_0.
H_1: $\mu_1 - \mu_2 \ne 0$

11–33. H_0: $\mu_d = 0$ $\quad t_0 = \dfrac{\bar{d} - 0}{s_d/\sqrt{n}} = \dfrac{5.0 - 0}{15.846/\sqrt{10}} = 0.998$,

H_1: $\mu_d \ne 0$ $\quad$ do not reject H_0.

11–34. Using $\mu_D = \mu_A - \mu_B$, $t_0 = -1.91$, do not reject H_0.

11–35. H_0: $\mu_d = 0$
H_1: $\mu_d \ne 0$

Reject H_0 if $|t_0| > t_{0.025,5} = 2.571$.

$$t_0 = \frac{3 - 0}{1.41/\sqrt{6}} = 5.21 \quad \therefore \text{reject } H_0$$

11–36. $t_0 = 2.39$, reject H_0.

11–37. H_0: $p = 0.70$, H_1: $p \neq 0.70$; $Z_0 = \frac{(699-700)}{\sqrt{1000(0.7)(0.3)}} = 0.586$, do not reject H_0.

11–38. H_0: $p = 0.025$, H_1: $p \neq 0.025$; $Z_0 = \frac{(18-200)}{\sqrt{8000(0.975)(0.025)}} = -13.03$, reject H_0.

11–39. The "best" test will maximize the probability that H_0 is rejected, so we want to

$$\max Z_0 = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\sigma_1^2/n_1 + \sigma_2^2/n_2}}$$
$$\text{subject to } n_1 + n_2 = N.$$

Since for a given sample, $\overline{X}_1 - \overline{X}_2$ is fixed, this is equivalent to

$$\min L = \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}$$
$$\text{subject to } n_1 + n_2 = N.$$

Since $n_2 = n_1 - N$, we have

$$\min L = \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{N - n_1}$$

and from $dL/dn_1 = 0$ we find

$$\frac{\sigma_1}{\sigma_2} = \frac{n_1}{n_2},$$

which says that the observations should be assigned to the populations in the same ratio as the standard deviations.

11–40. $z_0 = 6.26$, reject H_0.

11–41. H_0: $p_1 = p_2$, H_1: $p_1 < p_2$; $Z_0 = \frac{(0.01-0.021)}{\sqrt{0.016(0.984)(\frac{1}{1000}+\frac{1}{1200})}} = -2.023$, do not reject H_0.

11–42. H_0: $p_1 = p_2$, H_1: $p_1 \neq p_2$; $Z_0 = \frac{(0.042-0.064)}{\sqrt{0.053(0.947)(\frac{2}{500})}} = -1.55$, do not reject H_0.

11–43. Let $2\sigma^2 = \sigma_1^2/n_1 + \sigma_2^2/n_2$ be the specified sample variance. If we minimize $c_1n_1 + c_2n_2$ subject to the constraint $\sigma_1^2/n_1 + \sigma_2^2/n_2 = 2\sigma^2$, we obtain the solution

$$\frac{n_1}{n_2} = \sqrt{\frac{\sigma_1^2 c_2}{\sigma_2^2 c_1}}.$$

11–44. H_0: $\mu_1 = 2\mu_2$
H_1: $\mu_1 > 2\mu_2$

$$Z_0 = \frac{\overline{X}_1 - 2\overline{X}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{4\sigma_2^2}{n_2}}}$$

11–45. H_0: $\sigma^2 = \sigma_0^2$
H_1: $\sigma^2 \neq \sigma_0^2$

$$\beta = P\left(\chi^2_{1-\alpha/2,n-1} \leq \frac{(n-1)S^2}{\sigma_0^2} \leq \chi^2_{\alpha/2,n-1} \middle| \sigma^2 = \sigma_1^2 \neq \sigma_0^2\right)$$
$$= P\left(\frac{\sigma_0^2}{\sigma_1^2}\chi^2_{1-\alpha/2,n-1} \leq \frac{(n-1)S^2}{\sigma_1^2} \leq \frac{\sigma_0^2}{\sigma_1^2}\chi^2_{\alpha/2,n-1}\right)$$

which can be evaluated using tables of χ^2.

11–46. H_0: $\sigma_1^2 = \sigma_2^2$
H_1: $\sigma_1^2 \neq \sigma_2^2$

$$\beta = P\left(F_{1-\alpha/2,u,v} \leq \frac{S_1^2}{S_2^2} \leq F_{\alpha/2,u,v} \middle| \frac{\sigma_1^2}{\sigma_2^2}\right)$$
$$= P\left(\frac{\sigma_2^2}{\sigma_1^2}F_{1-\alpha/2,u,v} \leq \frac{S_1^2}{S_2^2}\frac{\sigma_2^2}{\sigma_1^2} \leq \frac{\sigma_2^2}{\sigma_1^2}F_{\alpha/2,u,v}\right)$$

Since $(\sigma_2^2/\sigma_1^2)(S_1^2/S_2^2)$ follows an F-distribution, β may be evaluated by using tables of F.

11–47. (a) Assume the class intervals are defined as follows:

Class Interval	O_i	E_i	$(O_i - E_i)^2/E_i$
$-\infty < X < 11$	6	6.15	0.004
$11 \leq X < 16$	11	10.50	0.024
$16 \leq X < 21$	16	19.04	0.485
$21 \leq X < 26$	28	24.68	0.447
$26 \leq X < 31$	22	24.54	0.263
$31 \leq X < 36$	19	14.63	1.305
$36 \leq X < 41$	11	12.36	0.150
$41 \leq X$	4	5.10	0.237
			$\chi_0^2 = 2.915$

The expected frequencies are obtained by evaluating $n[\Phi(\frac{c_i - \overline{x}}{s}) - \Phi(\frac{c_{i-1}-\overline{x}}{s})]$ where c_i is the upper boundary of cell i. For our problem,

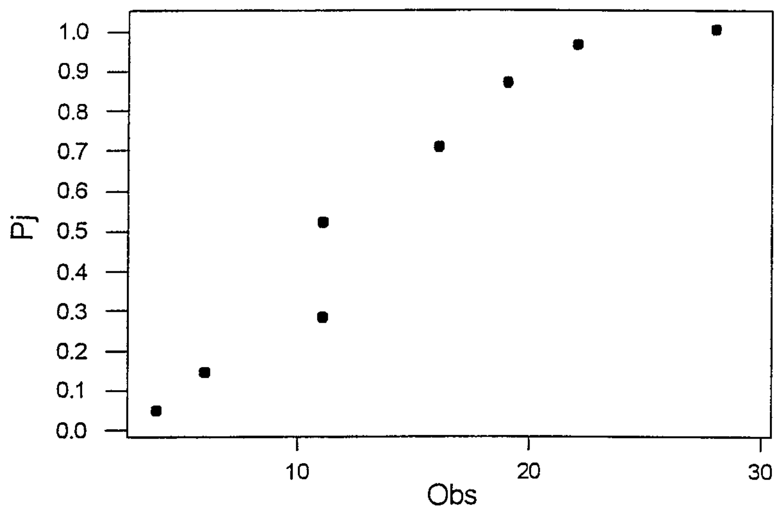
$$E_i = 117\left[\Phi\left(\frac{c_i - 25.61}{9.02}\right) - \Phi\left(\frac{c_{i-1} - 25.61}{9.02}\right)\right].$$

Since $\chi_0^2 = 2.915 < \chi_{0.05,5}^2 = 11.070$, do not reject H_0.

(b) To use normal probability paper for data expressed in a histogram, find the cumulative probability associated with each interval, and plot this against the upper boundary of each cell.

Cell Upper Bound	Observed Frequency	P_j
11	6	0.051
16	11	0.145
21	16	0.282
26	28	0.521
31	22	0.709
36	19	0.872
41	11	0.966
45	4	1.006

Normal probability plot.



11–48. Estimate $\hat{\lambda} = \overline{x} = 4.9775$. The expected frequencies are

Defects	0	1	2	3	4	5	6	7	8	9	10	11	12
O_i	4	13	34	56	70	70	58	42	25	15	9	3	1
E_i	2.76	13.72	34.15	56.66	70.50	70.50	70.18	58.22	41.40	25.76	14.25	3.21	1.33

Three cells have expected values less than 5, so they are combined with other cells to get:

Defects	0–1	2	3	4	5	6	7	8	9	10–12
O_i	17	34	56	70	70	58	42	25	15	13
E_i	16.48	34.15	56.66	70.50	70.50	70.18	58.22	41.40	25.76	18.79

$\chi_0^2 = 1.8846$, $\chi^2_{0.05,8} = 15.51$, do not reject H_0, the data could follow a Poisson distribution.

11–49.

x	O_i	E_i	$(O_i - E_i)^2/E_i$
0	967	1000	1.089
1	1008	1000	0.064
2	975	1000	0.625
3	1022	1000	0.484
4	1003	1000	0.009
5	989	1000	0.121
6	1001	1000	0.001
7	981	1000	0.361
8	1043	1000	1.849
9	1011	1000	0.121

$\chi_0^2 = 4.724 < \chi^2_{0.05,9} = 16.919$. Therefore, do not reject H_0.

11–50. (a) Assume that data given are the midpoints of the class intervals.

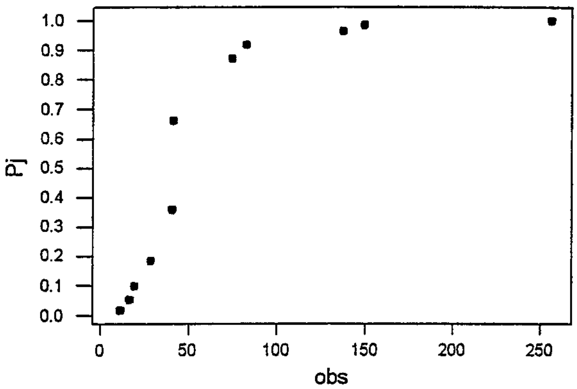
Class Interval	O_i	E_i	$(O_i - E_i)^2/E_i$
$X < 2.095$	0	1.79*	
$2.095 \le X < 2.105$	16	6.65	6.77
$2.105 \le X < 2.115$	28	22.18	1.53
$2.115 \le X < 2.125$	41	56.39	4.20
$2.125 \le X < 2.135$	74	108.92	11.19
$2.135 \le X < 2.145$	149	159.60	0.70
$2.145 \le X < 2.155$	256	178.02	34.16
$2.155 \le X < 2.165$	137	150.81	1.26
$2.165 \le X < 2.175$	82	96.56	2.20
$2.175 \le X < 2.185$	40	47.59	1.21
$2.185 \le X < 2.195$	19	18.09	0.04
$2.195 \le X < 2.205$	11	5.12	3.31
$2.205 \le X$	0	1.28*	

*Group into next cell

$\chi_0^2 = 66.57 > \chi^2_{0.05,8} = 15.507$, reject H_0.

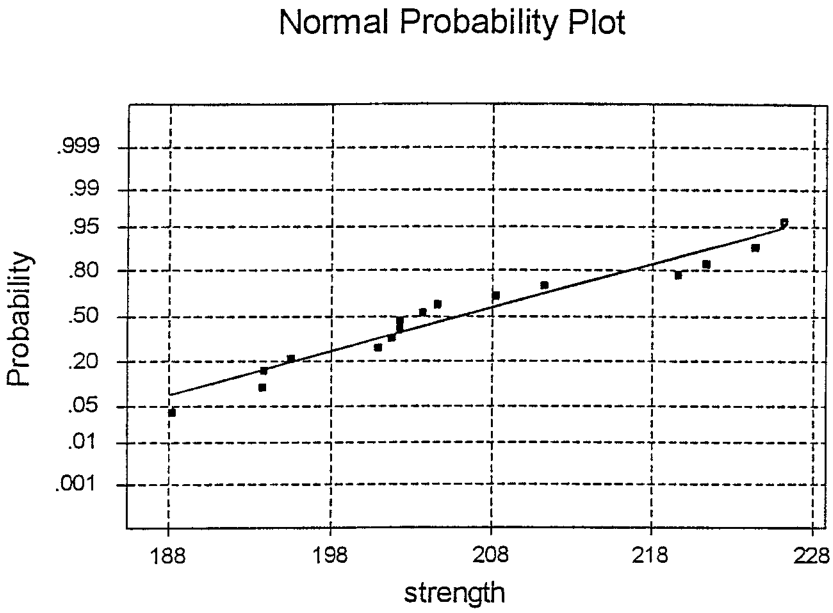
(b)

Upper Cell Bound	Observed Frequency	P_j
2.105	16	0.019
2.115	28	0.052
2.125	41	0.100
2.135	74	0.186
2.145	149	0.361
2.155	256	0.661
2.165	137	0.872
2.175	82	0.918
2.185	40	0.965
2.195	19	0.987
2.205	11	1.000



11–51.

$X_{(j)}$	$P_{(j)}$	$X_{(j)}$	$P_{(j)}$
188.12	0.0313	203.62	0.5313
193.71	0.0938	204.55	0.5938
193.73	0.1563	208.15	0.6563
195.45	0.2188	211.14	0.7188
200.81	0.2813	219.54	0.7813
201.63	0.3438	221.31	0.8438
202.20	0.4063	224.39	0.9063
202.21	0.4688	226.16	0.9688



11–52. $\chi_0^2 = 11.649 < \chi^2_{0.05,6} = 12.592$. Do not reject.

11–53. $\chi_0^2 = 0.0331 < \chi^2_{0.05,1} = 3.841$. Do not reject.

11–54. $\chi_0^2 = 25.554 < \chi^2_{0.05,9} = 16.919$. Reject H_0.

11–55. $\chi_0^2 = 2.465 < \chi^2_{0.05,4} = 9.488$. Do not reject.

11–56. $\chi_0^2 = 10.706 > \chi^2_{0.05,3} = 7.81$. Reject H_0.

11–57. The observed and expected frequencies are

	IA	A	Total
L	216	245	461
	170.08	290.92	
M	226	409	635
	234.28	400.72	
H	114	297	411
	151.64	259.36	
Total	556	951	1507

$\chi_0^2 = 34.909$, reject H_0. Based on this data, physical activity is not independent of socioeconomic status.

11–58. $\chi_0^2 = 13.6289 < \chi^2_{0.05.8} = 15.507$. Do not reject.

11–59. Expected Frequencies:

17	62	55	$\hat{\mu}_1 = 0.304$	$\hat{\mu}_1 = 0.127$
22	81	71	$\hat{\mu}_2 = 0.394$	$\hat{\mu}_2 = 0.465$
17	62	54	$\hat{\mu}_3 = 0.302$	$\hat{\mu}_3 = 0.408$

$$\chi_0^2 = \sum_{i=1}^{3}\sum_{j=1}^{3}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} = 2.88 + 1.61 + 0.16 + 2.23 + 0.79 + 13.17 + 0 + 5.23 + 6 = 22.06$$

$$\chi^2_{0.05,4} = 9.488$$

$\therefore$ reject H_0, pricing strategy and facility conditions are not independent

11–60. (a)

	Non Defective	Defective				
Machine 1	468	32	500	$\Rightarrow$	473.5	26.5
Machine 2	479	21	500		473.5	26.5
	947	53	1000			

$$\chi_0^2 = 0.064 + 1.141 + 0.013 + 1.41 = 2.897$$

$\chi^2_{0.05,1} = 3.841$, do not reject H_0, the populations do not differ

(b) homogeneity

(c) yes