10

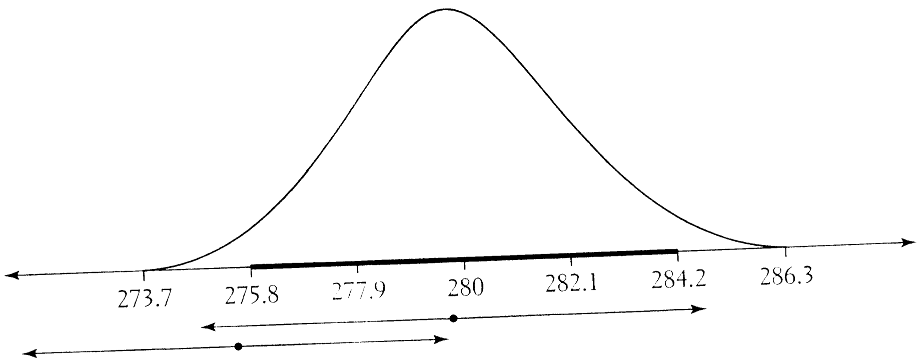
Introduction to Inference

10.1 (a) 44% to 50%.

(b) We do not have information about the whole population; we only know about a small sample. We expect our sample to give us a good estimate of the population value, but it will not be exactly correct.

(c) The procedure used gives an estimate within 3 percentage points of the true value in 95% of all samples.

10.2 (a) The sampling distribution of $\bar{x}$ is normal with mean $\mu = 280$ and standard deviation $\sigma/\sqrt{n} = 60/\sqrt{840} \approx 2.1$. (b) Below. (c) 2 standard deviations—$m \approx 4.2$. (d) Below; the confidence intervals drawn may vary, of course. (e) 95% (by the 68-95-99.7 rule).



10.3 This is a statement about the *mean* score for all young men, not about individual scores. We are attempting only to estimate the center of the population distribution; the scores for individuals are much more variable. Also, "95%" is not a probability or a proportion; it is a confidence level.

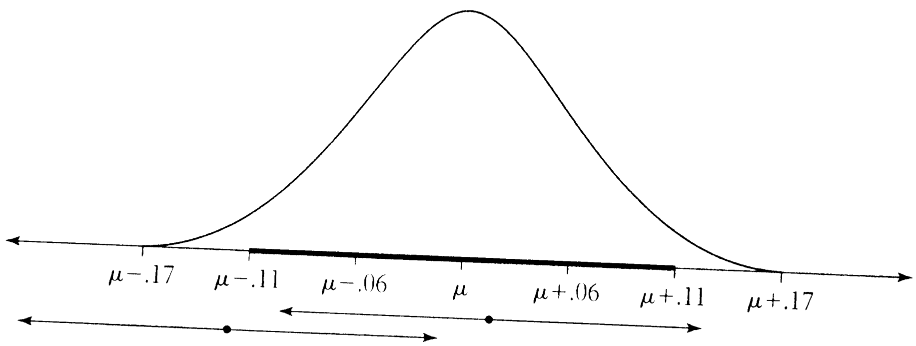
10.4 (a) The sampling distribution of $\bar{x}$ is normal with mean μ and standard deviation $\sigma/\sqrt{n} = 0.4/\sqrt{50} = 0.05657$.

(b) See the sketch on the next page. For this problem, the "numbers" below the axis would be $\mu - 0.16971$, $\mu - 0.11314$, $\mu - 0.05657$, μ, etc.

(c) $m = 0.11314$ (2 standard deviations).

(d) 95%.

(e) See the next page. The actual confidence intervals drawn may vary.



10.5 .84 ± 0.10, or .830 to .851 grams per liter.

10.6 11.78 ± 0.77, or 11.01 to 12.55 years.

10.7 (a) The distribution is slightly skewed to the right. (b) 224.002 ± 0.029, or 223.973 to 224.031.

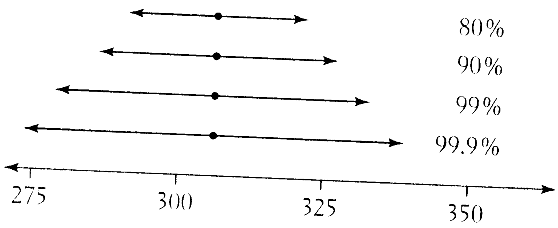
2239	01
2239	66788889
2240	01
2240	589
2241	2

10.8 $\bar{x}$ = 123.8 bu/acre, and $\sigma_{\bar{x}} = 10/\sqrt{15} \doteq 2.582$ bu/acre. (a)–(c) See the table below; the intervals are $\bar{x} \pm z^* \sigma_{\bar{x}}$. (d) The margin of error increases with the confidence level.

Conf. Level	z^*	Interval
90%	1.645	119.6 to 128.0 bu/acre
95%	1.960	118.7 to 128.9 bu/acre
99%	2.576	117.1 to 130.5 bu/acre

10.9 With $n = 60$, $\sigma_{\bar{x}} = 10/\sqrt{60} \doteq 1.291$ bu/acre. (a) 95% confidence interval: $\bar{x} \pm 1.960\sigma_{\bar{x}}$ = 121.3 to 126.3 bu/acre. (b) Smaller: with a larger sample comes more information, which in turns gives less uncertainty ("noise") about the value of μ. (c) They will be narrower.

10.10 (a) 294 to 318.6. (b) 274.7 to 337.9. (c) Below—increasing confidence makes the interval wider.



10.11 7.91—which is half the margin of error with $n = 20$.

10.12 (a) 10.00209 to 10.00251. (b) 22 (21.64).

10.13 68 (67.95).

10.14 35 (34.57).

10.15 (a) The computations are correct. (b) Since the numbers are based on a voluntary response, rather than an SRS, the methods of this section cannot be used—the interval does not apply to the whole population.

10.16 (a) The interval was based on a method that gives correct results 95% of the time.
(b) Since the margin of error was 2%, the true value of p could be as low as 49%. The confidence interval thus contains some values of p, which give the election to Bush.
(c) The proportion of voters that favor Gore is not random—either a majority favors Gore, or they don't. Discussing probabilities about this proportion has little meaning: the "probability" the politician asked about is either 1 or 0 (respectively).

10.17 (a) We can be 99% confident that between 63% and 69% of all adults favor such an amendment. We estimate the standard deviation of the distribution of $\hat{p}$ to be about $\sqrt{(0.66)(0.34)/1664} = 0.01161$; dividing 0.03 (the margin of error) by this gives $z^* = 2.58$, the critical value for a 99% confidence interval.
(b) The survey excludes people without telephones (a large percentage of whom would be poor), so this group would be underrepresented. Also, Alaska and Hawaii are not included in the sample.

10.18 No: The interval refers to the mean math score, not to individual scores, which will be much more variable (indeed, if more than 95% of students score below 470, they are not doing very well).

10.19 If we chose many samples of size 1548, then in about 95% of those samples, the percentage found would be within ±3 percentage points of the true population percentage. That is, we are using a procedure that gives results within ±3% of the true percentage about 95% of the time.

10.20 (a) The intended population is hotel managers (perhaps specifically managers of hotels of the particular size range mentioned). However, because the sample came entirely from Chicago and Detroit, it may not do a good job of representing that larger population. There is also the problem of voluntary response.
(b) The central limit theorem allows us to say that $\bar{x}$ is approximately normal for a sample of this size ($n = 135$) no matter what the parent distribution is.
(c) 5.101 to 5.691.
(d) 4.010 to 4.876.

10.21 The sample size for women was more than twice as large as that for men. Larger sample sizes lead to smaller margins of error (with the same confidence level).

10.22 (a) The stemplot (see next page) shows no marked deviations from normality.
(b) $\bar{x} \doteq 25.67$ μm/hr, so the 90% confidence interval is $25.67 \pm 3.10 = 22.57$ to 28.77 μm/hr.
(c) Her interval is wider: To be more confident that our interval includes the true population parameter, we must allow a larger margin of error. So the margin of error for 95% confidence is larger than for 90% confidence.

1	124
1	8
2	2233
2	6789
3	034
3	55
4	0

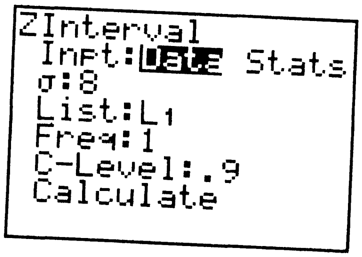
10.23 $n = \left(\frac{(1.645)(8)}{1}\right)^2 \doteq 173.19$—take $n = 174$.

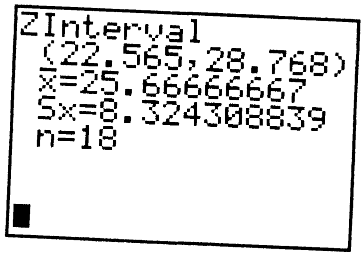
10.24 (a) $1.96\sigma/\sqrt{100} = 2.352$ points. (b) $1.96\sigma/\sqrt{10} \doteq 7.438$ points. (c) $n = (\frac{1.96\sigma}{3})^2 \doteq 61.47$—take $n = 62$, which is under the 100-student maximum.

10.25 (a) Sources of possible error mentioned in the account are: sampling error (i.e. error due to the random nature of the sampling process), variations in the wording of questions (i.e. question bias), and variations in the order of questions asked.

(b) Only sampling (random-chance) error is covered by the announced margin of error. The other sources of error are independent of the sampling process itself; they must be controlled by the questioner, e.g., by formulating unbiased questions that do not lead the subject in a particular direction.

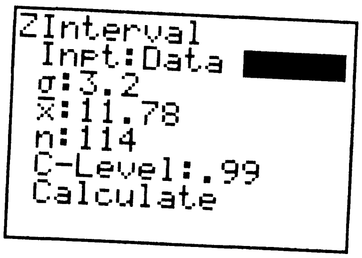
10.26 (a)

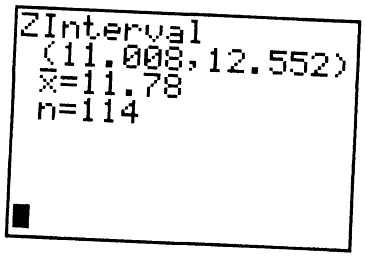




The 90% confidence interval for the mean rate of healing for newts is (22.565, 28.768).

(b)



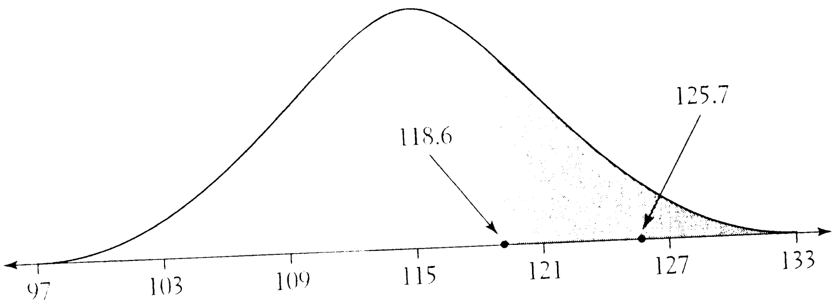


The 99% confidence interval for the mean number of years for the hotel managers is (11.01, 12.55).

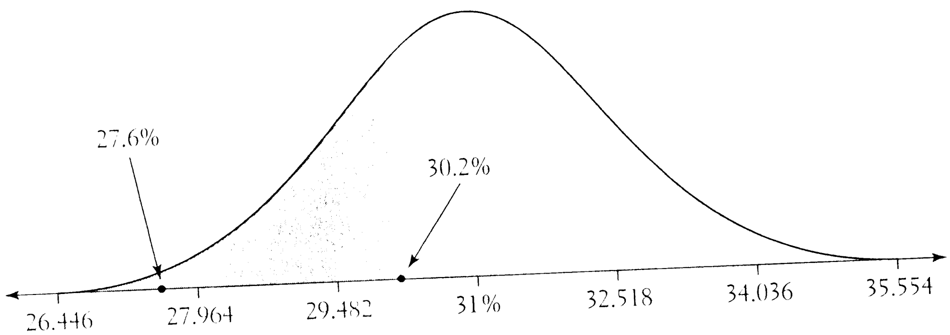
10.27 (a) $N(115, 6)$.

(b) The actual result (see facing page) lies out toward the high tail of the curve, while 118.6 is fairly close to the middle. Assuming H_0 is true, observing a value like 118.6 would not be surprising, but 125.7 is less likely, and therefore provides evidence against H_0.

(c)



10.28 (a) N(31%, 1.518%). (b) The lower percentage lies out in the low tail of the curve, while 30.2% is fairly close to the middle. Assuming H_0 is true, observing a value like 30.2% would not be surprising, but 27.6% is unlikely, and therefore provides evidence against H_0. (c) Below.



10.29 H_0: $\mu = 5$ mm; H_a: $\mu \neq 5$ mm.

10.30 H_0: $\mu = \$42{,}500$; H_a: $\mu > \$42{,}500$.

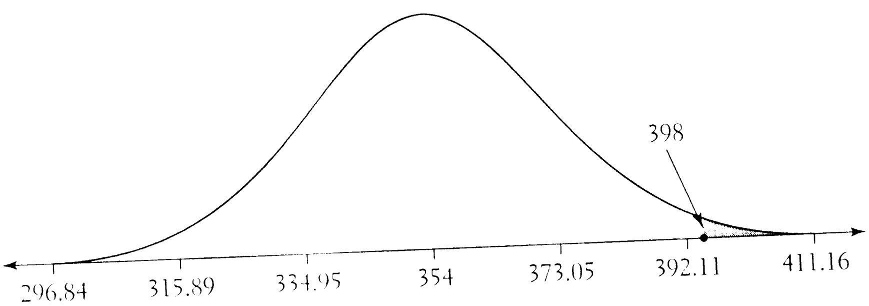
10.31 H_0: $\mu = 50$; H_a: $\mu < 50$.

10.32 H_0: $\mu = 2.6$; H_a: $\mu \neq 2.6$.

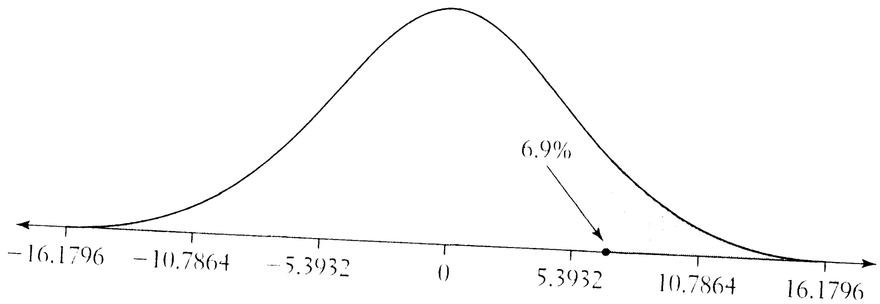
10.33 (a) The P-values are 0.2743 and 0.0373, respectively. (b) $\bar{x} = 118.6$ is significant at neither level; $\bar{x} = 125.7$ is significant at the 0.05 level, but not at the 0.01 level.

10.34 (a) The P-values are 0.2991 and 0.0125, respectively. (b) $\bar{x} = 27.6$ is significant at the 0.05 level, but not at the 0.01 level.

10.35 (a) $\bar{x} = 398$. (b) It is normal because the population distribution is normal. (c) 0.0105. (d) It is significant at $\alpha = 0.05$, but not at $\alpha = 0.01$. This is pretty convincing evidence against H_0.



10.36 (a) Because the sample size is large (central limit theorem). (b) 0.1004. (c) Not significant at $\alpha = 0.05$. The study gives *some* evidence of increased compensation, but it is not very strong—it would happen 10% of the time just by chance.



10.37 Comparing men's and women's earnings for our sample, we observe a difference so large that it would only occur in 3.8% of all samples if men and women actually earned the same amount. Based on this, we conclude that men earn more.

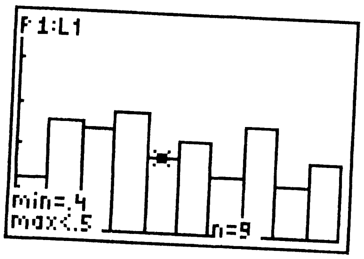
While there is almost certainly *some* difference between earnings of black and white students in our sample, it is relatively small—if blacks and whites actually earn the same amount, we would still observe a difference as big as what we saw almost half (47.6%) of the time.

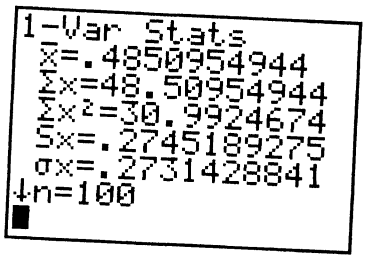
10.38 (a) H_0: $\mu = 11.5$ vs. H_a: $\mu \neq 11.5$. (b) $z = 0.367$. (c) $P = 0.714$. This is reasonable variation when the null hypothesis is true, so we do not reject H_0.

10.39 (a) H_0: $\mu = 300$ vs. H_a: $\mu < 300$. (b) $z = -0.7893$. (c) $P = 0.2150$—this is reasonable variation when the null hypothesis is true, so we do not reject H_0.

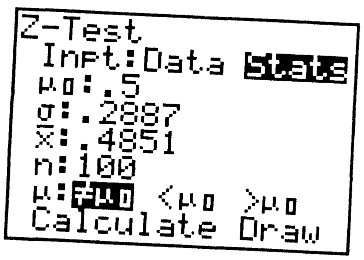
10.40 (a) $z = -2.200$. (b) Yes, because $|z| > 1.960$. (c) No, because $|z| < 2.576$. (d) $|z|$ lies between 2.054 and 2.326. The P-value falls between 0.02 and 0.04.

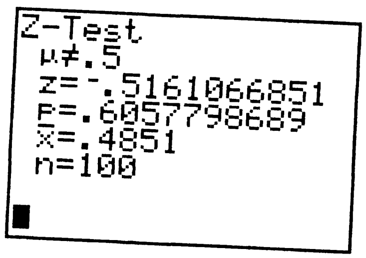
10.41 (a) The command rand(100) → L_1 generates 100 random numbers in the interval (0,1) and stores them in list L_1. Here's a histogram of our simulation, and the 1-variable statistics (your results will be slightly different):





The z test statistic is $z = -.516$, and the P-value is 0.6058. We fail to reject H_0.





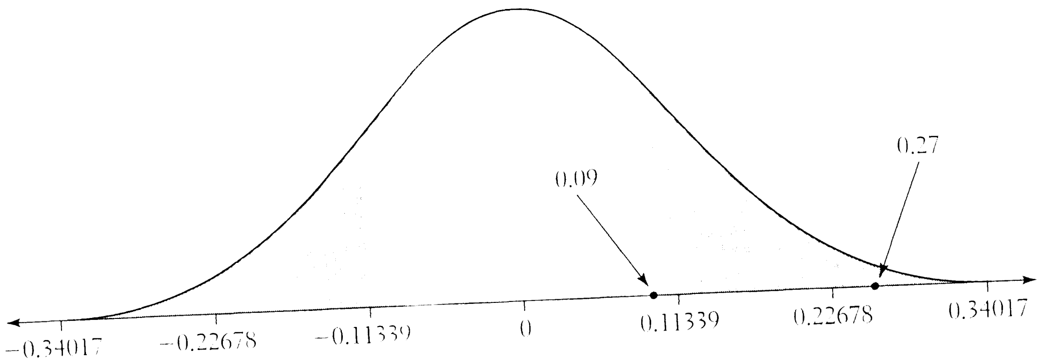
There is no evidence to suggest that the mean of the random numbers generated is different from 0.5.

10.42 (a) Yes, because $z > 1.645$. (b) Yes, because $z > 2.326$. (c) The value of z lies between 2.326 and 2.576. The P-value thus lies between 0.005 and 0.01.

10.43 (a) 99.86 to 108.41. (b) Because 105 falls in this 90% confidence interval, we cannot reject H_0: $\mu = 105$ in favor of H_a: $\mu \neq 105$.

10.44 (a) With $\bar{x} \doteq 105.84$, our 95% confidence interval for μ is $105.84 \pm (1.960)\ (15/\sqrt{31}) \doteq 105.84 \pm 5.28$, or 100.56 to 111.12 IQ points.
(b) Our hypotheses are H_0: $\mu = 100$ versus H_a: $\mu \neq 100$. Since 100 does not fall in the 95% confidence interval, we reject H_0 at the 5% level in favor of the two-sided alternative.
(c) Since the scores all came from a single school, the sample may *not* be representative of the school district as a whole.

10.45 (a) N(0, 0.11339) (below). (b) $\bar{x} = 0.27$ lies out in the tail of the curve, while 0.09 is fairly close to the middle. Assuming H_0 is true, observing a value like 0.09 would not be surprising, but 0.27 is unlikely, and therefore provides evidence against H_0. (c) $P = 0.4274$ (the shaded region below). (d) $P = 0.0173$.



10.46 H_0: $\mu = 1250$ vs. H_a: $\mu < 1250$.

10.47 H_0: $\mu = 18$ vs. H_a: $\mu < 18$.

10.48 Hypotheses: H_0: $\mu = -0.545$ vs. H_a: $\mu > -0.545$. Test statistic: $z = 1.957$. P-value: $P = 0.0252$. We conclude that the mean freezing point really is higher, and thus the supplier *is* apparently adding water.

10.49 (a) No, because $|z| < 1.960$. (b) No, because $|z| < 1.645$.

10.50 $P = 0.1292$. Although this sample showed *some* difference in market share between pioneers with patents or trade secrets and those without, the difference was small enough that it could have arisen merely by chance. The observed difference would occur in about 13% of all samples even if there were *no* difference between the two types of pioneer companies.

10.51 Significance at the 1% level means that the P-value for the test is less than 0.01. So, it must also be less than 0.05. A result that is significant at the 5% level, by contrast, may or may not be significant at the 1% level.

10.52 The explanation is not correct; either H_0 is true (in which case the "probability" that H_0 is true equals 1) or H_0 is false (in which case this "probability" is 0). "Statistically significant at the

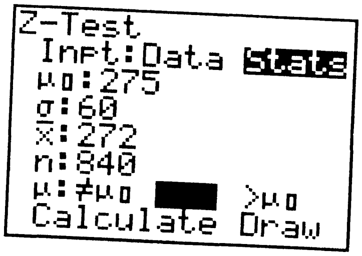
$\alpha = 0.05$ level" means that *if* H_0 is true, we have observed outcomes that occur less than 5% of the time.

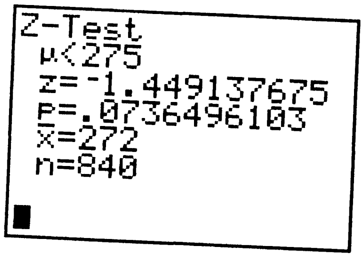
10.53 (a) Reject H_0 if $z > 1.645$. (b) Reject H_0 if $|z| > 1.96$. (c) For tests at a fixed significance level (α), we reject H_0 when we observe values of our statistic that are so extreme (far from the mean, or other "center" of the sampling distribution) that they would rarely occur when H_0 is true. (Specifically, they occur with probability no greater than α.) For a two-sided alternative, we split the rejection region—this set of extreme values—into two pieces, while with a one-sided alternative, all the extreme values are in one piece, which is twice as large (in area) as either of the two pieces used for the two-sided test.

10.54 (a) Test H_0: $\mu = 7$ mg vs. H_a: $\mu \neq 7$ mg; since 7 is not in the interval (1.9 to 6.5 mg), we have evidence against H_0. (b) No, since 5 is in the interval.

10.55 (a) H_0: $\mu = 450$, H_a: $\mu > 450$. (b) $z = 2.46$. (c) $P = 0.007$. This represents rather strong evidence against the null hypothesis; if H_0 were true, then the observed value of $\bar{x}$ would occur in less than 1% of all samples. We therefore reject H_0. There is strong evidence against the claim that the mean math score for all California seniors is no more than 450.

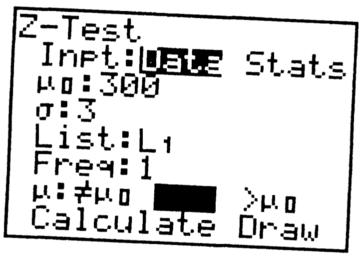
10.56 (a) In Example 10.14, H_0: $\mu = 275$, H_a: $\mu < 275$, and $\sigma = 60$. Specifying a z test and entering 272 for the sample mean, the TI-83 screens that specify the information and present the results of the test are shown below. We specified "Calculate."

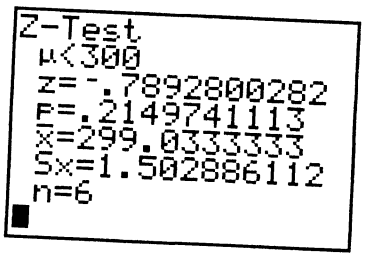




The results, $z = -1.45$ and P-value $= .0736$, agree with the results in Example 10.14.

(c) H_0: $\mu_0 = 300$, H_a: $\mu < 300$, and $\sigma = 3$. Entering the data into list L_1 and specifying a z test, here are the TI-83 screens that specify the information and present the results of the test. Again, we specified "Calculate."





The test statistic is $z = -.789$, and the P-value is 0.215. There is insufficient evidence to conclude that the mean contents of cola bottles is less than 300.

10.57 (a) $z = 1.64$; not significant at 5% level ($P = 0.0505$). (b) $z = 1.65$; significant at 5% level ($P = 0.0495$).

10.58 (a) $P = 0.3821$. (b) $P = 0.1714$. (c) $P = 0.0014$.

10.59 $n = 100$: 452.24 to 503.76. $n = 1{,}000$: 469.85 to 486.15. $n = 10{,}000$: 475.42 to 480.58.

10.60 No—the percentage was based on a voluntary response sample, and so cannot be assumed to be a fair representation of the population. Such a poll is likely to draw a higher-than-actual proportion of people with a strong opinion, especially a strong negative opinion.

10.61 (a) No—in a sample of size 500, we expect to see about 5 people who have a "P-value" of 0.01 or less. These four *might* have ESP, or they may simply be among the "lucky" ones we expect to see.
(b) The researcher should repeat the procedure on these four to see if they again perform well.

10.62 A test of significance answers question (b).

10.63 We might conclude that customers prefer design A, but perhaps not "strongly." Because the sample size is so large, this statistically significant difference may not be of any practical importance.

10.64 (a) 0.05. (b) Out of 77 tests, we can expect to see about 3 or 4 (3.85, to be precise) significant tests at the 5% level.

10.65 (a) The P-values indicate that the results observed would happen very rarely if H_0 were true; specifically, if drivers with radar detectors were the same as those without, the "before radar" speeds would be this different less than 1% of the time and "at radar" speeds would be this different less than 0.01% of the time. Since these results are so unlikely when H_0 is true, we conclude that H_0 is not true.
(b) In order for a 2-mph difference to be statistically significant (with small sample sizes), there must be little variation in the speeds; that is, those with radar detectors must all be driving at speeds very close to 70 mph, whereas those without detectors are all traveling very close to 68 mph.

0.66 (a) H_0: the patient is ill (or "the patient should see a doctor"); H_a: the patient is healthy (or "the patient should not see a doctor"). A Type I error means a false negative—clearing a patient who should be referred to a doctor. A Type II error is a false positive—sending a healthy patient to the doctor.
(b) One might wish to lower the probability of a false negative so that most ill patients are treated. On the other hand, if money is an issue, or there is concern about sending too many patients to see the doctor, lowering the probability of false positives might be desirable.

10.67 (a) Reject H_0 if $z < -2.326$. (b) 0.01 (the significance level). (c) We accept H_0 if $\bar{x} \ge 270.185$, so when $\mu = 270$, $P(\text{Type II error}) = P(x \ge 270.185)$ $P(\frac{\bar{x} - 270}{60/\sqrt{840}} \ge \frac{270.185 - 270}{60/\sqrt{840}}) = 0.4644$.

10.68 (a) 0.50. (b) 0.1841. (c) 0.0013.

10.69 (a) Type I error: concluding that the local mean income exceeds $45,000 when in fact it does not (and therefore, opening your restaurant in a locale that will not support it). Type II error: concluding that the local mean income does not exceed $45,000 when in fact it does (and therefore, deciding not to open your restaurant in a locale that would support it).

(b) Type I error is more serious. If you opened your restaurant in an inappropriate area, then you would sustain a financial loss before you recognized the mistake. If you failed to open your restaurant in an appropriate area, then you would miss out on an opportunity to earn a profit there, but you would not necessarily lose money (e.g., if you chose another appropriate location in its place).

(c) H_0: $\mu = 45{,}000$, H_a: $\mu > 45{,}000$.

(d) $\alpha = 0.01$ would be most appropriate, because it would minimize your probability of committing a Type I error.

(e) In order to reject H_0 at level $\alpha = 0.01$, we must have $z \geq 2.326$, or $\bar{x} \geq 45{,}000 + (2.326)(5000/\sqrt{50}) = 46645$. The sample mean would have to be at least \$46,645.

(f) $P(\text{fail to reject } H_0 \text{ when } \mu = 47{,}000) = P(\bar{x} < 46645 \text{ when } \mu = 47{,}000)$

$$= P(Z < \tfrac{46645 - 47000}{5000/\sqrt{50}}) = P(Z < -0.5) = .3085.$$

When $\mu = 47{,}000$, the probability of committing a Type II error is .3085, or about 31%.

10.70 (a) Reject H_0 if $\bar{x} \geq 0.5202$. (b) 0.9666.

10.71 $z \geq 2.326$ is equivalent to $\bar{x} \geq 450 + 2.326\ (100/\sqrt{500}) \doteq 460.4$, so the power is

$$P(\text{reject } H_0 \text{ when } \mu = 460) = P(\bar{x} \geq 460.4 \text{ when } \mu = 460)$$

$$= P(Z \geq \tfrac{460.4 - 460}{100/\sqrt{500}}) = P(Z \geq 0.0894) = 0.4644.$$

This is quite a bit less than the "80% power" standard; this test is not very sensitive to a 10-point increase in the mean score.

10.72 (a) Reject H_0 if $\bar{x} \leq 297.985$, so the power against $\mu = 299$ is 0.2037. (b) The power against $\mu = 295$ is 0.9926. (c) The power against $\mu = 290$ would be greater—it is further from μ_0 (300), sc it is easier to distinguish from the null hypothesis.

10.73 (a) 0.5086. (b) 0.9543.

10.74 (a) Reject if $\bar{x} \geq 299.77$ or $\bar{x} \leq 250.23$. (b) Power: 0.85632. (c) $1 - 0.85632 = 0.14368$.

10.75 (a) We reject H_0 if $\bar{x} \geq 131.46$ or $\bar{x} \leq 124.54$. Power: 0.9246. (b) Power: 0.9246 (same a (a)). Over 90% of the time, this test will detect a difference of 6 (in either the positive or nega tive direction). (c) The power would be higher—it is easier to detect greater differences thai smaller ones.

10.76 A test having low power may do a good job of not incorrectly rejecting the null hypothesis, but it is likely to accept H_0 even when some alternative is correct, simply because it is difficult to distinguish between H_0 and "nearby" alternatives.

10.77 (a) The test rejects H_0 when $|z| \geq 2.576$. The test statistic is

$$z = \frac{0.8404 - 0.86}{0.0068/\sqrt{3}} = -4.99.$$

We therefore reject H_0 (most emphatically: the P-value of the test is approximately 6×10^{-7}!).

(b) The test rejects H_0 when either $z \geq 2.576$ (that is, $\bar{x} \geq 0.86 + (2.576)(0.0068/\sqrt{3}) = 0.870$) or $z \leq -2.576$ (that is, $\bar{x} \leq 0.86 - (2.576)(0.0068/\sqrt{3}) = 0.850$). These are disjoint events, so the power is the sum of their probabilities, computed under thc assumption that $\mu = 0.845$ is true. We have

$$P(\bar{x} \geq 0.870 \text{ when } \mu = 0.845) = P(Z \geq \frac{0.870 - 0.845}{0.0068/\sqrt{3}}) = P(Z \geq 6.37) \approx 0,$$

$$P(\bar{x} \leq 0.850 \text{ when } \mu = 0.845) = P(Z \leq \frac{0.850 - 0.845}{0.0068/\sqrt{3}}) = P(Z \leq 1.27) = 0.8980.$$

The power is thus 0.8980, or approximately 0.9.

10.78 (a) H_0: $\mu = 32$ mpg; H_a: $\mu > 32$ mpg. (b) H_0: $\mu = 24$; H_a: $\mu \neq 24$.

10.79 (a) The plot is reasonably symmetric for such a small sample. (b) 26.06 to 34.74. (c) H_0: $\mu = 25$ vs. H_a: $\mu > 25$; $z = 2.44$; P-value = .007. This is strong evidence against H_0.

2	034
2	
3	01124
3	6
4	3

10.80 Confidence interval: 12.384 to 13.416. Since the sample size is relatively small, we require that the population distribution not be too nonnormal (although a sample of size 26 will overcome quite a bit of skewness). We also assume that the babies are an SRS from the population.

10.81 (a) H_0: $\mu = 32$ vs. H_a: $\mu > 32$. (b) $z = 1.8639$; P-value is 0.0312. This is strong evidence against H_0—observations this extreme would only occur in about 3 out of 100 samples if H_0 were true.

10.82 (a) Margin of error decreases. (b) The P-value decreases (the evidence against H_0 becomes stronger). (c) The power increases (the test becomes better at distinguishing between the null and alternative hypotheses).

10.83 No—"$P = 0.03$" *does* mean that the null hypothesis is unlikely, but only in the sense that the evidence (from the sample) would not occur very often if H_0 were true. P is a probability associated with the sample, not the null hypothesis; H_0 is either true or it isn't.

10.84 Yes—significance tests allow us to discriminate between random differences ("chance variation") that might occur when the null hypothesis is true, and differences that are unlikely to occur when H_0 is true.

10.85 (a) The difference observed in the study would occur in less than 1% of all samples if the two populations actually have the same proportion.

(b) The interval is constructed using a method that is correct (i.e., contains the actual proportion) 95% of the time.

(c) No—treatments were not randomly assigned, but instead were chosen by the mothers. Mothers who choose to attend a job training program may be more inclined to get themselves out of welfare.

10.86 (a) $z = \frac{135.2 - 115}{30/\sqrt{20}} \doteq 3.01$, which gives $P = 0.0013$. We reject H_0 and conclude that the older students do have a higher mean score.

(b) We assume the 20 students were an SRS, and that the population is (nearly) normal—near enough that the distribution of $\bar{x}$ is close to normal. The assumption that we have an SRS is more important.

10.87 $z = \frac{123.8 - 120}{10/\sqrt{40}} \doteq 2.40$, which gives $P = 0.0164$. This is strong evidence that this year's mean is different. Slight nonnormality will not be a problem since we have a reasonably large sample size (greater than 30).

10.88 (a) No treatments were imposed on the subjects (patients). This was merely an observational study.

(b) The observed association (whatever it may be) between cell phone use and the incidence of gliomas was insufficiently strong for us to conclude that it was due to an effect other than random chance. In other words, the observed association *may* have been due to a connection between cell phone use and the incidence of gliomas, but it could just as easily have been the result of chance alone.

(c) At the 5% level, one would *expect* one in every 20 tests to produce a statistically significant result by chance alone.

10.89 (a) "Exaggeration" in this case would mean that the mean breaking strength of the company's chairs was actually *less* than the claimed value of 300 pounds. Letting μ = the mean breaking strength of all chairs produced by the company, we let H_0: $\mu = 300$, H_a: $\mu < 300$.

(b) Type I error: concluding that the company's claim is exaggerated ($\mu < 300$) when in fact it is legitimate ($\mu = 300$). Type II error: concluding that the company's claim is legitimate when in fact it is invalid. Type II error would be more serious in this case, because allowing the company to continue the "false advertising" of its chairs' strength could lead to injuries, lawsuits, and other serious consequences.

(c) In order to reject H_0 at level $\alpha = 0.05$, we must have $z \le -1.645$, or $\bar{x} \le 300 + (-1.645)(15/\sqrt{30}) = 295.495$. All values of $\bar{x}$ at or below 295.495 pounds would cause us to reject H_0.

(d) $P(\text{Type II error}) = P(\text{fail to reject } H_0 \text{ when } \mu = 270) = P(\bar{x} > 295.495 \text{ when } \mu = 270)$

$$= P\left(Z > \frac{295.495 - 270}{15/\sqrt{30}}\right) = P(Z > 9.31) \approx 0.$$