Section III. Solutions to all Chapter Exercises

Interactive Statistics 3rd Edition: Chapter 1 Full Solutions

1.1
In hypothesis testing, the purpose is to determine whether there is sufficient evidence with which to reject the null hypothesis (H_0), which generally reflects the prevailing viewpoint. The alternative hypothesis (H_1) is often what someone is hopeful that the data will support.

1.2
(a) True.
(b) True.
(c) False.
(d) False.

1.3
H_0: The 5-year survival rate for all those using the vaccine is equal to 10%.
H_1: The 5-year survival rate for all those using the vaccine is greater than 10%.

1.4
H_0: Using the new technique, the percentage of all whales leaving the area is 40%
H_1: Using the new technique, the percentage of all whales leaving the area is more than 40%

1.5
(a) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding the gun is not loaded when it is loaded. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking the gun is loaded when it is not. A Type I error may be more serious as one might accidentally shoot a loaded gun.
(b) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding the dog does not bite when it does bite. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking the dog bites when it does not. A Type I error may be more serious as we might approach a dog that could bite.
(c) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding the mall is closed when it is open. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking the mall is open when it is closed. A Type II error may be more serious as we might waste the time and gas to drive to the mall expecting it open when it is closed.
(d) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding the watch is waterproof when it is not. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking the watch is not waterproof when it is waterproof. A Type I error may be more serious as we might ruin our watch if it gets wet.

1.6
(a) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding the electricity is not turned on when it is. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking the electricity is turned on when it is not. A Type I error may be more serious as one might accidentally be electrocuted.
(b) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding the brakes are operational when they are not. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking the brakes are not operational when they are operational. A Type I error may be more serious as it may result in an accident.
(c) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding the snake is not poisonous when it is poisonous. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking the snake is poisonous when it is not poisonous. A Type I error may be more serious as it may result in getting bit by a poisonous snake.
(d) Since a Type I error is rejecting H_0 when H_0 is true, we would be concluding it is not safe to cross the street when it is safe. Since a Type II error is failing to reject H_0 when H_1 is true, we would be thinking it is safe to cross the street when it is not safe. A Type II error may be more serious as it may result in an accident.

1.7

H_0: The average tomato yield for Brand A fertilizer is the same as the average tomato yield for the more expensive Brand B fertilizer.

H_1: The average tomato yield for the more expensive Brand B fertilizer is greater than the average tomato yield for the Brand A fertilizer.

Type I Error: Spend more money on the Brand B fertilizer when it really is not better than the Brand A fertilizer regarding the average tomato yield. Type II Error: Continue to use the Brand A fertilizer when the Brand B fertilizer results in a higher tomato yield on average.

1.8

(a) Type I error: to classify a person as a drug user when he/she is not. Type II error: to classify a person as a non-drug user when he/she actually is.

(b) Since the test classifies the person as a drug user (i.e. rejects H_0) 4% of the time when the person is not a drug user (i.e. H_0 is true), the chance of a Type I error is 4%.

1.9

A Type I error is rejecting the null hypothesis when it is true. So the owner would conclude the patrons are older and the owner would spend the time and money to remodel, when the crowd is actually not older. The owner would have spent money unnecessarily and the remodeling may not appeal to some of the patrons, but in general, it is not a serious error.

1.10

Based on the article "U.S. Health Improves but Rural Areas Lag," from CNN, September 10, 2001. Summary of the article appears below. Contains many possible hypotheses.

H_0: People in Rural areas of the US are as healthy as their urban counterparts.

H_1: People in Rural areas of the US are less healthy than their urban counterparts.

Type I error: conclude that rural people are less healthy than urban people when in fact they are not.

Type II error: conclude that rural people are as healthy as urban people when in fact it isn't the case.

Summary of article: " Americans overall are healthier today than they were 25 years ago. A new government report offers some reasons: longer life expectancy, better infant survival, fewer smokers, less hypertension and lower cholesterol levels. But in small-town America, the news on health is far from good, said an annual report released Monday by the Centers for Disease Control and Prevention. Rural residents tend to smoke more, lose more teeth as they age and die sooner than suburban and many big-city counterparts, the government snapshot of the country's health shows. For instance: --10.6 percent of the wealthiest residents in rural areas and 10 percent of urban residents lacked health insurance in 1997 and 1998, compared with about 6.6 percent of suburbanites. --37.6 percent of rural residents over 65 had edentulism, a total loss of teeth, in 1997 and 1998, compared with about 25.7 percent in the suburbs and 26.8 percent in cities. --18.9 percent of children age 12 to 17 in the most rural areas were regular smokers in 1999, compared with 11 percent in urban areas and 15.9 percent in the suburbs. Rural adults also smoked at higher rates than urban or suburban adults. --46.5 of men and women in the most rural areas did not exercise, play sports or pursue active hobbies in 1997 and 1998, compared with 40.9 percent of urban dwellers and 31.1 percent of suburbanites who were not fitness-minded. The youth death rate from all causes was higher in rural areas from 1996 to 1998, as was the adult death rate.

1.11

(a) The null hypothesis could not be rejected.

(b) No, a complaint was not registered.

(c) Yes, a Type II error may have been made. The cans are thought to contain the stated sodium content when actually they contain higher amounts of sodium on average.

1.12

(a) H_0: Septaphine is not better than Cephaline for reducing blood pressure.
H_1: Septaphine is better than Cephaline for reducing blood pressure.

(b) (i) The null hypothesis was rejected and the alternative hypothesis was supported.
(ii) A Type I error could have been made, namely, concluding Septaphine is better when it really is not better at reducing blood pressure.

1.13

If α is decreased then β will increase, so the possible value is 0.30.

1.14

If you do not reject the null hypothesis, you may be making either a Type II error or a correct decision, so the answer is (e).

1.15

(a) The significance level α is 2/30=0.067 and the level of β is 20/30=0.667.

(b) Decision Rule #2: Reject H_0 if the selected voucher is $\leq$ \$2 or is $\geq$ \$9. The significance level α is 6/30=0.20 and the level of β is 12/30=0.40. Enlarging the rejection region resulted in increasing the level of α from 0.067 to 0.20 while decreasing the level of β from 0.667 to 0.40.

1.16

(a) α = chance of a Type I error = chance of rejecting H_0 when H_0 is true
= chance of observing \$1 or \$10 from bag E
= 2/30 = 1/15 = 0.0667

(b) p-value = chance of observing \$3 or more extreme under H_0
= chance of observing $\leq$ \$3 or $\geq$ \$8 from bag E
= 12/30 = 6/15 = 0.40

(c) (i) β = chance of a Type II error = chance of failing to reject H_0 when H_1 is true
= chance of observing \$2 - \$9 from bag G
= 23/30 ~ 0.767

(ii) β = chance of a Type II error = chance of failing to reject H_0 when H_1 is true
= chance of observing \$2 - \$9 from bag H
= 23/30 ~ 0.767

1.17

No, we need a decision rule that states when we reject or fail to reject H_0.

1.18

(a) H_0: The proportion of newborns that are girls equals 0.50.
H_1: The proportion of newborns that are girls does not equal 0.50.

(b) Two-sided.

1.19

(a) False: $\alpha + \beta$ does not need to equal 1. The value of α is calculated under H_0 while the value of β is calculated under H_1.

(b) False: Type II error is the chance of failing to reject H_0 when H_1 is true.

(c) True.

(d) False: H_0 is rejected if the sample shows evidence against it.

(e) False: The sample size does not influence the alternative hypothesis. The alternative hypothesis can be one-sided no matter what the sample size.

1.20

The 0.05 indicates: (b) if H_0 is true, the chance of falsely rejecting it is 0.05.

1.21

(a) H_0: The shown box is Box A. H_1: The shown box is Box B.

(b) The direction of extreme is one-sided to the left.

(c) Reject H_0 if the selected token is \$5 or less.

(d) The significance level α = 2/25 = 0.08 which is less than 0.10.

(e) The chance of a Type II error is β = 11/25 = 0.44.

(f) Our decision is to reject H_0.

1.22

(a) The frequency plots are given below. The direction of extreme is two-sided.

Distribution in Bag A

				X				
				X				
				X				
				X				
				X				
				X				
			X	X	X			
			X	X	X			
			X	X	X			
			X	X	X			
			X	X	X			
			X	X	X			
		X	X	X	X	X		
		X	X	X	X	X		
	X	X	X	X	X	X	X	
X	X	X	X	X	X	X	X	X
2	4	6	8	10	12	14	16	18

Token Value (in \$)

Distribution in Bag B

X								X
X								X
X								X
X	X						X	X
X	X						X	X
X	X	X				X	X	X
X	X	X				X	X	X
X	X	X				X	X	X
X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X
2	4	6	8	10	12	14	16	18

Token Value (in \$)

(b) H_0: The shown bag is Bag A. H_1: The shown bag is Bag B.

(c) Answers may vary. One reasonable rule is to reject H_0 is the selected token is $\leq$ \$4 or $\geq$ \$16.

(d) The significance level $\alpha = 6/50 = 0.12$.

(e) The chance of a Type II error is $\beta = 16/50 = 0.32$.

(f) (i) Fail to reject H_0.
 (ii) A Type II error.

(g) (i) Reject H_0.
 (ii) A Type I error.

1.23

(a) False. $\alpha + \beta$ does not need to equal 1. The value of α is calculated under H_0 while the value of β is calculated under H_1.

(b) False. A Type II error occurs if H_1 is true and we fail to reject H_0. Here we don't know if H_1 is true.

(c) True.

1.24

(a) H_0: The shown jar is Jar A. H_1: The shown jar is Jar B.

(b) No, the coins are of different sizes and weights. If we mixed up the contents of the shown jar and reached in to pick one coin, the coins that we are more likely to pick might be a quarter as it has a larger size as compared to say a dime. The larger coins may be more likely to be selected over the smaller coins. This will be referred to later in Chapter 2 as a length-biased sampling method.

(c) The responses are currently listed as P, N, D, and Q, but there is an ordering to them with respect to their value. So a better way to record the response would be using their worth of 1, 5, 10, or 25 cents. Correspondingly, a better picture to depict the two models for the shown jar is given below. The direction of extreme would be to the right, to the larger coin values.

Distribution in Jar A

X				X																				
X				X																				
X				X																				
X				X																				
X				X																				
X				X					X															
X				X					X															
X				X					X															X
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Coin Value (in cents)

Distribution in Jar B

									X															X
									X															X
									X															X
									X															X
									X															X
				X					X															X
				X					X															X
X				X					X															X
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Coin Value (in cents)

1.25

(a) The frequency plots are provided below:

Bag X

		X		
		X		
	X	X	X	
	X	X	X	
	X	X	X	
	X	X	X	
	X	X	X	
	X	X	X	
X	X	X	X	X
Blue	Brown	Yellow	Green	Red

Bag Y

X				X
X				X
X				X
X				X
X				X
X				X
X	X		X	X
X	X		X	X
X	X	X	X	X
Blue	Brown	Yellow	Green	Red

(b) No, the response being recorded is the color, which has no particular ordering for the outcomes. If the colors had been listed in the order of Blue, Red, Brown, Green, and Yellow, then the apparent direction of extreme would be one-sided to the left. So it is not appropriate to discuss a direction of extreme in this case.

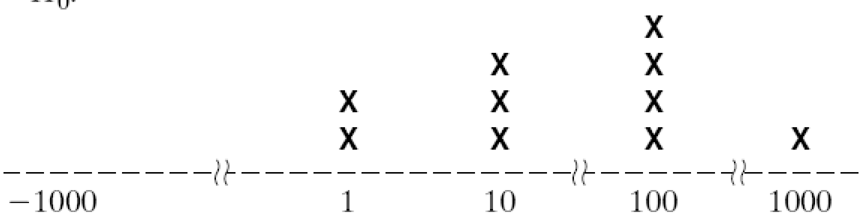
1.26
The p-value is a number between 0 and 1 which measures how likely the observed result is, or a result that is even more extreme (in the direction of H_0), assuming the null hypothesis H_0 is true.

1.27
The p-value should be small in order to reject the null hypothesis H_0. A small p-value indicates that the observed data or data even more extreme is very unlikely or unusual if the null hypothesis is true. In general, we reject H_0 if p-value is less than or equal to α, the significance level.

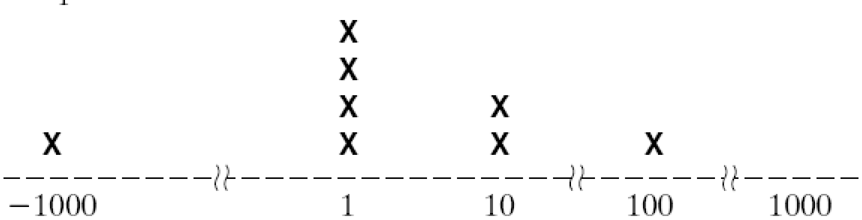
1.28
(a) It is stated there was no significant difference in the caesarean delivery rates between the two groups, so the data supported the null hypothesis H_0.
(b) The p-value would have been "large". Since the null hypothesis was not rejected, the observed data were not considered unlikely under the null hypothesis.

1.29
(a) Frequency plots for the two completing hypotheses.

H_0:



H_1:



(b) α = chance of a Type I error = chance of rejecting H_0 when H_0 is true
= chance of observing \$1 from the winning bag
= 2/10 = 0.20
(c) β = chance of a Type II error = chance of failing to reject H_0 when H_1 is true
= chance of observing \$10 or \$100 from the losing bag
= 3/8 =0.375
(d) No, we did not actually observe a voucher.

1.30
(a) The direction of extreme is one-sided to the left, since the smaller values are more likely under H_1 and less likely under H_0.
(b) The chance of a Type I error is $\alpha = 3/15 = 0.20$ (found under the Machine A model for 2 or fewer flaws). The chance of a Type II error is $\beta = 6/15 = 0.40$ (found under the Machine B model for more than 2 flaws).
(c) The p-value is the chance of getting the observed 4 flaws or something even more extreme (less than 4 flaws), assuming the null hypothesis is true and the machine is Machine A. The p-value = 10/15 = 0.667.
(d) Since the data were not usually assuming the null hypothesis is true, that is, the p-value is larger than α, the data are not statistically significant at the level α.

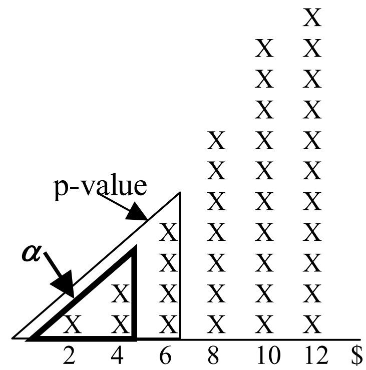
1.31

(a) The direction of extreme is one-sided to the left (to the smaller values).

(b) The chance of a Type I error is $\alpha = 1/6 = 0.1667$ (found under the Die A model for 1 or less). The chance of a Type II error is $\beta = 7/10 = 0.70$ (found under the Die B model for 2 or more).

(c) The *p*-value is the chance of getting the observed value of 2 or less, assuming the die is Die A, so the *p*-value = 2/6 = 0.333. Since this *p*-value is greater than the significance level α of 0.1667, we fail to reject H_0 and conclude that the selected die appears to be Die A.

Box I



1.32

(a) The direction of extreme is one-sided to the left. Note that the smaller values show the most support for H_1 and the least support for H_0.

(b) See pictures at the right for the circling and labeling.

  i. $\alpha = 3/35 = 0.0857$.

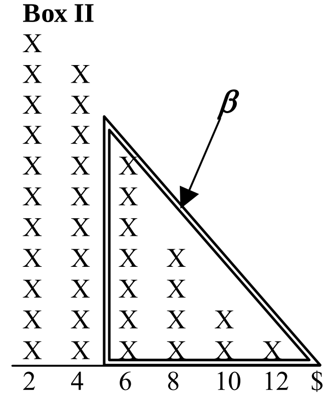
  ii. $\beta = 14/35 = 0.40$.

(c) *p*-value = 7/35 = 0.20

(d) The observed result is not statistically significant because the *p*-value is more than α.

(e) A new decision rule is reject H_0 if the observed voucher value is $6 or more extreme, that is less than or equal to $6. Using a cut-off value of $6 or more will yield a larger rejection region and thus a larger value for α. The new $\alpha^* = 7/35 = 0.20$ is larger than $\alpha = 3/35 = 0.0857$.

Box II



1.33

(a) H_0: The shown bag is Bag A. H_1: The shown bag is Bag B.

(b) The direction of extreme is two-sided.

(c) (i) The *p*-value is $4/40 = 0.10$.

  (ii) Yes, since the *p*-value is $\leq \alpha$.

  (iii) No, since the *p*-value is $> \alpha$.

(d) (i) The *p*-value is 1.

  (ii) No, since the *p*-value is $> \alpha$.

  (iii) No, since the *p*-value is $> \alpha$.

1.34

(a) Two possible *p*-values that are statistically significant at 0.01are 0.002 and 0.004. Note that any two values $0 \leq p\text{-value} \leq 0.01$ will work.

(b) Two possible *p*-values that are statistically significant at 0.05, but not statistically significant at 0.01 are 0.03 and 0.04. Note that any two values $0.01 < p\text{-value} \leq 0.05$ will work.

(c) Two possible *p*-values that are not statistically significant at 0.10 are 0.20 and 0.30. Note that any two values *p*-value > 0.10 but not >1 will work.

1.35

(a) All new model 100-watt light bulbs produced at Claude's plant.

(b) H_0: The population of all new model 100-watt light bulbs (produced at Claude's plant) has an average lifetime equal to 40 hours. H_1: The population of all new model 100-watt light bulbs (produced at Claude's plant) has an average lifetime greater than 40 hours.

(c) 10%

(d) The *p*-value can be any value between 0 and 0.10.

(e) Yes, if the *p*-value is less than or equal to 0.10, then the *p*-value is also less than or equal to 0.15 so it is significant at the 0.15 level. However, if we only know that the *p*-value is less than or equal to 0.10, we cannot be sure whether the *p*-value is also less than or equal to 0.05. Without further information about the value of the *p*-value we cannot determine if the data would also be significant at the 0.05 level.

1.36

(a) H_0: The shown bag is Bag A. H_1: The shown bag is Bag B.
(b) The direction of extreme is one-sided to the right, to the larger values.
(c) The p-value is $3/50 = 0.06$.
(d) Yes, the \$14 voucher is statistically significant at the 10% level as the p-value is less than or equal to 0.10.
(e) No, the \$14 voucher is not statistically significant at the 5% level as the p-value is more than 0.05.

1.37

(a) H_0
(b) p-value > 0.10
(c) We failed to reject H_0, so we could have made a Type II error.
(d) One-sided to the right. We want to see if the numbers have increased.

1.38

(a) Since the data were statistically significant, the null hypothesis was rejected and the alternative hypothesis was supported.
(b) The direction of extreme is two-sided.
(c) Answers will vary. Two possible values are 0.02 and 0.03. Note that any two values between 0 and 0.05 will work.

1.39

(a) We rejected H_0, so we could have made a Type I error.
(b) We decide that the average cost is higher than \$350 while it is really not. Maybe you decide that the cost is too high and decide to attend a different college, while in reality you could have attended this college after all.
(c) The p-value is ≤ 0.10.
(d) Yes.

1.40

(a) H_0: The population of all goats born to mother goats that were trained to walk on a treadmill has a mean birth weight of 1600 grams. H_1: The population of all goats born to mother goats that were trained to walk on a treadmill has a mean birth weight different from 1600 grams.
(b) The null hypothesis was supported at the 1% level.
(c) The p-value was more than 0.01 (but of course less than 1).
(d) Answers will vary. One possible p-value is 0.08.
(e) Yes, as now the p-value must be larger than 0.01 but less than or equal to 0.05. A value that will satisfy this statement on significance is 0.04.
(f) A Type II error could have been made.

1.41

(a) For study A, a possible p-value is 0.001; for study B, a possible p-value is 0.11; and for study C, a possible p-value is 0.03.
(b) Reject H_0 if the p-value is small, so support for H_0 is shown if the p-value is large, the largest p-value is for Study B.
(c) We rejected H_0, but it was true, so a Type I error was made.
(d) For Study A: one-sided to the right, Study B: two-sided, Study C: one-sided to the left.

1.42

(a) One-sided to the right.
(b) H_0
(c) The p-value is ≤ 0.05.
(d) Type I error.

1.43

(a) See the chart below for the alternative hypotheses.
(b) See the chart below for the possible *p*-values.
(c) The results for Study C had the most support for the null hypothesis since the *p*-value was the largest.
(d) This would be called a Type I error.

	Null Hypothesis	Alternative Hypothesis	*p*-value
Study A	The true proportion of females is equal to 0.60.	The true proportion of females is not equal to 0.60.	0.08
Study B	The average time to relief for all Treatment I users is equal to the average time to relief for all Treatment II users.	The average time to relief for all Treatment I users is less than the average time to relief for all Treatment II users.	0.005
Study C	The true average income of adults who work two jobs is equal to $70,000.	The true average income of adults who work two jobs is greater than $70,000.	0.20

1.44

(a) The alternative hypothesis could be stated in words as H_1: The proportion of all convicted persons who have been through the program and later reconvicted is lower than the national proportion of convicted persons who are released and later reconvicted.
(b) The *p*-value must be greater than 0.05 but less than or equal to 0.10. Thus there is one possible value of 0.06.

1.45

(a) True.
(b) False.

1.46

(a) False. The *p*-value is the chance of getting the observed value or values more extreme *assuming* that H_0 is true.
(b) True. The *p*-value of 0.04 was less than the significance level of 0.05, so the decision is to reject H_0.
(c) True. When we reject H_0, we say that the results are statistically significant.
(d) True. If the results are statistically significant at the 0.05 level (i.e. the *p*-value was less than 0.05), then the results will also be significant at the 0.10 level (as the *p*-value will also be less than 0.10).

1.47

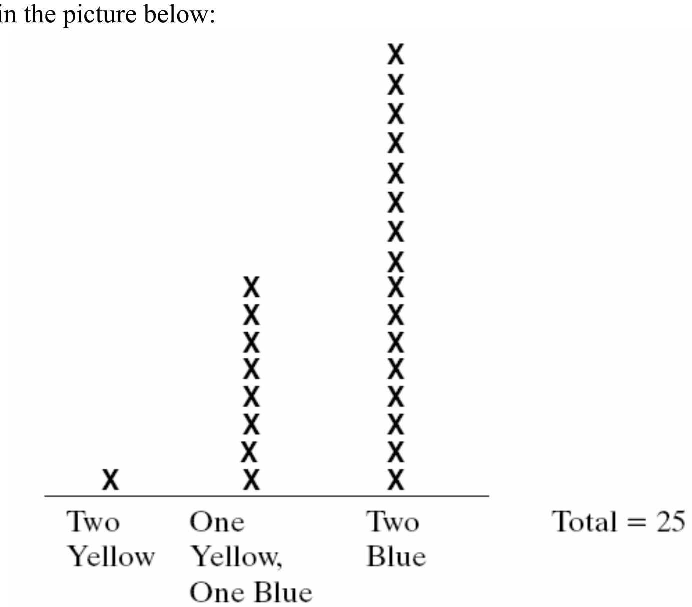
(c) to be statistically significant at the 5% level means the *p*-value is less than or equal to 0.05. However, we do not know if the *p*-value is less than or equal to 0.01 or if it is between 0.01 and 0.05, so the answer is "sometimes yes" (if the *p*-value is also $\leq$ 0.01) and "sometimes no" (if the *p*-value is > 0.01).

1.48

(a) Type I error: The subject does not have ESP but you conclude he does.
(b) Type II error: The subject has ESP but you conclude he does not.
(c) Level of significance is the chance of rejecting Ho when Ho is true. If the subject does not have ESP (i.e., H_0 is true) then the chance that he correctly identifies the card (and we reject H_0) is 1 in 52, 1/52 = 0.019.
(d) The chance of a Type II error is the chance we fail to reject H_0 when H_0 is true. If the subject has perfect ESP, then the chance he correctly identifies the card is 1 or 100%. He will correctly identify it, so the chance of a Type II error is 0.
(e) The *p*-value calculates the chance of getting the observed result (here 0 correct answers) or something more extreme, in the direction of H_0 (namely, 1 correct answer), under the assumption that H_0 is true (the person does not have ESP). If the subject does not have ESP, the chance of incorrectly identifying the card is 51/52 = 0.981 and the chance of correctly identifying it is 1/52 = 0.019. So the *p*-value is 51/52 + 1/52 = 1.
(f) No, the null hypothesis is either true or false (correct or not). The individual either has ESP or does not. The *p*-value depends on the sample.

1.49

(a) You observed a yellow ball, which is the most extreme result that you could get. With only one observation there is no more extreme than observing a yellow. So the *p*-value is the chance of observing a yellow ball under the null hypothesis, which is 1/5 = 0.20. Since the *p*-value is larger than 10%, the result is not statistically significant.
(b) The data consists of selecting two balls with replacement (and the order is not important). The possible outcomes are shown in the picture below:



We observed one yellow and one blue ball. Results that are even more extreme would be observing two yellow balls. So the *p*-value is (1+8)/25 = 0.36. Since the *p*-value is larger than 10%, the result is not statistically significant.

1.50

(a) H_0: The percentage of Republicans who are in favor of the death penalty is equal to the percentage of Democrats who are in favor of the death penalty.
H_1: The percentage of Republicans who are in favor of the death penalty is larger than the percentage of Democrats who are in favor of the death penalty.
(b) It would be a one-sided rejection region since we are looking for a particular direction (larger than), and not just any difference.
(c) The result could be statistically significant if the *p*-value were $\leq \alpha$.
(d) The difference of 2% would probably not be practically significant.

1.51
Statement (a) since the effect is small so we would need a larger sample size to detect it.

1.52
The significance level is set at 0.05. For n=1: the decision rule is reject H_0 if the result is $\geq$ \$60 and the corresponding β is 12/20 = 0.60. For n=2: the decision rule is reject H_0 if the result is $\geq$ \$45 and the corresponding β is 53/190 = 0.28. As the sample size is increased, the level of β decreased from 0.60 to 0.28.

1.53
(a) (i) α = chance of observing an average $\geq$ 45 from bag A = 4+2+1/190 = 0.0368
(ii) 45
(iii) β = 0.2789
(iv) The chance that we decide that the bag shown is bag A, while it really is bag B is 0.28 (or 28%).
(b) (i) First note that the observed average voucher value is \$35, so we have: p-value = chance of observing an average of \$35 or more extreme under H_0 = 17+9+4+2+1/190 = 0.1737
(ii) p-value $\leq$ α so we reject H_0
(iii) 20+17+9+4+2+1/190 = 0.2789
(iv) p-value > α so we fail to reject H_0
(v) The cut-off value is the average of \$35, since we rejected H_0 for \$35 and we failed to reject H_0 for \$30.

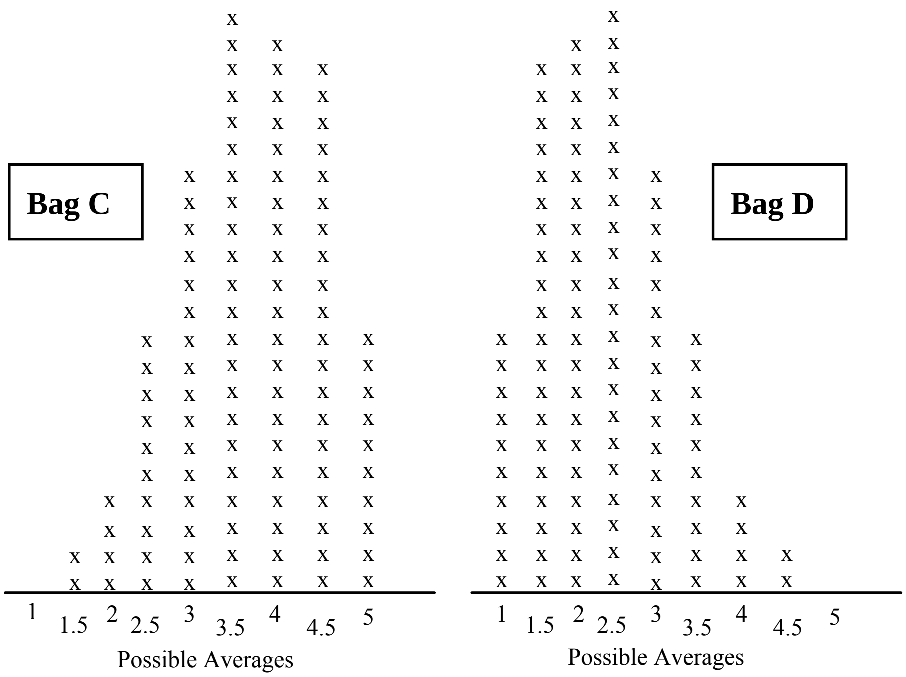
1.54
(a) The first table shows the possible samples, possible averages, and their frequencies of occurring.

Possible Samples	**Average**	**Frequency if Bag C**	**Frequency if Bag D**
1,1	1	0	10
1,2	1.5	2	20
1,3	2	3	15
1,4	2.5	4	10
1,5	3	5	5
2,2	2	1	6
2,3	2.5	6	12
2,4	3	8	8
2,5	3.5	10	4
3,3	3	3	3
3,4	3.5	12	6
3,5	4	15	3
4,4	4	6	1
4,5	4.5	20	2
5,5	5	10	0

The next table combines the entries in the first table according to the different possible averages.

Average	**Frequency if Bag C**	**Frequency if Bag D**
1	0	10
1.5	2	20
2	4	21
2.5	10	22
3	16	16
3.5	22	10
4	21	4
4.5	20	2
5	10	0
Total	105	105

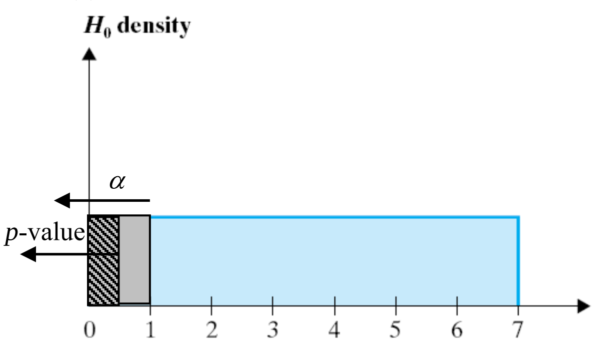
The corresponding frequency plots are given next.

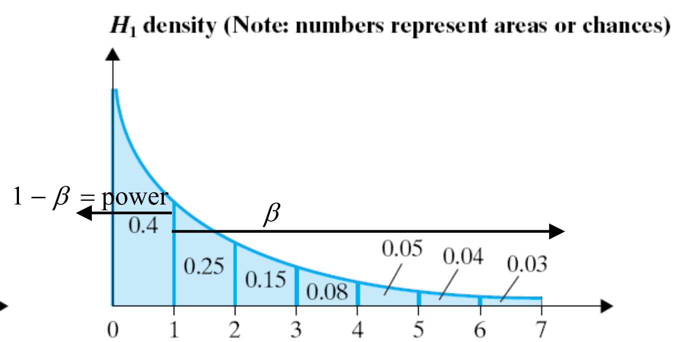


(b) For the decision rule to reject the null hypothesis if the average is $\leq$ \$2, we have the significance level α is 6/105=0.057 and the level of β is 54/105=0.514.
(c) If you observe an average of \$3, the *p*-value would be the chance of observing \$3 or less, which is *p*-value = 32/105 = 0.305.

1.55
(a) 20 nCr 2 = 190
(b) 20 nCr 3 = 1140

1.56
(a) The height must be 1/(base) = 1/7 or 0.1429.
(b)

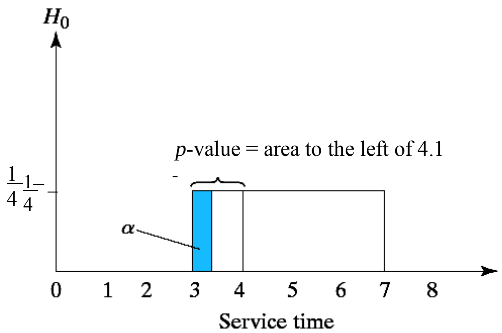


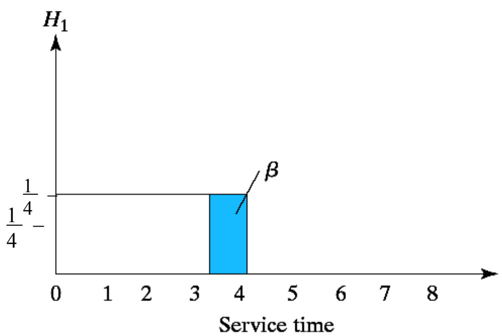


(i) $\alpha = (1)(1/7) = 1/7 = 0.1429$, as represented by the light grey shaded rectangle from 1 and to the left under the H_0 density.
(ii) $\beta = 0.25 + 0.15 + 0.08 + 0.05 + 0.04 + 0.03 = 0.60$ (or from $1 - 0.40$), as represented by the area to the right of 1 under the H_1 density.
(iii) Power $= 1 - \beta = 1 - 0.60 = 0.40$, as represented by the area to the left of 1 under the H_0 density.
(c) The *p*-value is $(0.5)(1/7) = 0.0714$, as represented by the black striped rectangle from 0.5 and to the left under the H_0 density.
(d) (ii) Increasing the sample size would lead to a reduction in the chance of committing a Type II error.
(e) False.

1.57

(a) The sketches are provided below.





(b) (i) See the shaded area marked as α above.

(ii) $\alpha = (0.4)(1/4) = 0.1$

(iii) See the shaded area marked as β above.

(iv) Power = $1 - \beta = 1 - (0.6)(1/4) = 1 - (6/10)(1/4) = 1 - 0.15 = 0.85$.

(c) (i) See the shaded area marked as the p-value above.

(ii) p-value = $(1.1)(1/4) = 0.275$.

(d) No, the p-value $> 0.1 = \alpha$.