**Read Chapter 18 and complete the following:

Section I: Multiple Choice Select the best answer for each question.

1. A study of voting chose 663 registered voters at random shortly after an election. Of these, 72% said they had voted in the election. Election records show that only 56% of registered voters voted in the election. Which of the following statements is true about the boldface numbers?

(a) 72% is a sample; 56% is a population.
(b) 72% and 56% are both statistics.
(c) 72% is a statistic and 56% is a parameter.
(d) 72% is a parameter and 56% is a statistic.
(e) 72% and 56% are both parameters.

statistic is a measure of the sample
parameter is a measure of the population.

2. The Gallup Poll has decided to increase the size of its random sample of voters from about 1500 people to about 4000 people right before an election. The poll is designed to estimate the proportion of voters who favor a new law banning smoking in public buildings. The effect of this increase is to

(a) reduce the bias of the estimate.
(b) increase the bias of the estimate.
(c) reduce the variability of the estimate.
(d) increase the variability of the estimate.
(e) reduce the bias and variability of the estimate.

sample size has no effect on the bias of an estimate, but large samples will reduce the variability of an estimate.

3. Suppose we select an SRS of size n = 100 from a large population having proportion $\hat{p}$ of successes. Let $\hat{p}$ be the proportion of successes in the sample. For which value of p would it be safe to use the Normal approximation to the sampling distribution of $\hat{p}$?

(a) 0.01
(b) 0.09
(c) 0.85
(d) 0.975
(e) 0.999

Both np and n(1-p) must be ≥ 10.

4. The central limit theorem is important in statistics because it allows us to use the Normal distribution to find probabilities involving the sample mean

(a) if the sample size is reasonably large (for any population).
(b) if the population is Normally distributed and the sample size is reasonably large.
(c) if the population is Normally distributed (for any sample size).
(d) if the population is Normally distributed and the population standard deviation is known (for any sample size).
(e) if the population size is reasonably large (whether the population distribution is known or not).

5. The number of undergraduates at Johns Hopkins University is approximately 2000, while the number at Ohio State University is approximately 60,000. At both schools, a simple random sample of about 3% of the undergraduates is taken. Each sample is used to estimate the proportion p of all students at that university who own an iPod. Suppose that, in fact, $p = 0.80$ at both schools. Which of the following is the best conclusion?

(a) The estimate from Johns Hopkins has less sampling variability than that from Ohio State.
(b) The estimate from Johns Hopkins has more sampling variability than that from Ohio State.
(c) The two estimates have about the same amount of sampling variability.
(d) It is impossible to make any statement about the sampling variability of the two estimates because the students surveyed were different.
(e) None of the above.

Ohio state: 3% of 60,000
1800
Johns Hopkin: 60.

A researcher initially plans to take an SRS of size n from a population that has mean 80 and standard deviation 20. If he were to double his sample size (to 2n), the standard deviation of the sampling distribution of the sample mean would be multiplied by

$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{\sigma}{\sqrt{2n}} = \frac{1}{\sqrt{2}} \cdot \frac{\sigma}{\sqrt{n}}$

(a) $\sqrt{2}$
(b) $1/\sqrt{2}$
(c) 2
(d) 1/2
(e) $1/\sqrt{2n}$

7. The student newspaper at a large university asks an SRS of 250 undergraduates, "Do you favor eliminating the carnival from the term-end celebration?" All in all, 150 of the 250 are in favor. Suppose that (unknown to you) 55% of all undergraduates favor eliminating the carnival. If you took a very large number of SRSs of size n = 250 from this population, the sampling distribution of the sample proportion would be

(a) exactly Normal with mean 0.55 and standard deviation 0.03.
(b) approximately Normal with mean 0.55 and standard deviation 0.03.
(c) exactly Normal with mean 0.60 and standard deviation 0.03.
(d) approximately Normal with mean 0.60 and standard deviation 0.03.
(e) heavily skewed with mean 0.55 and standard deviation 0.03.

$\mu_{\hat{p}} = p = 0.55$

$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{.55(0.45)}{250}} = 0.03$

8. Which of the following statements about the sampling distribution of the sample mean is incorrect?

(a) The standard deviation of the sampling distribution will decrease as the sample size increases.
(b) The standard deviation of the sampling distribution is a measure of the variability of the sample mean among repeated samples.
(c) The sample mean is an unbiased estimator of the population mean.
(d) The sampling distribution shows how the sample mean will vary in repeated samples.
(e) The sampling distribution shows how the sample was distributed around the sample mean.

sampling distribution has info about how the sample mean varies from sample to sample, not what any sample itself looks like.

9. A machine is designed to fill 16-ounce bottles of shampoo. When the machine is working properly, the amount poured into the bottles follows a Normal distribution with mean 16.05 ounces and standard deviation 0.1 ounce. Assume that the machine is working properly. If four bottles are randomly selected and the number of ounces in each bottle is measured, then there is about a 95% chance that the sample mean will fall in which of the following intervals?

(a) 16.05 to 16.15 ounces
(b) 16.00 to 16.10 ounces
(c) 15.95 to 16.15 ounces
(d) 15.90 to 16.20 ounces
(e) 15.85 to 16.25 ounces

$\mu_{\bar{x}} = \mu = 16.05$

$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{0.1}{\sqrt{4}} = 0.05$

68-95-99.7 rule

within 2 S.D. of the mean

$16.05 \pm 2(0.05) = 15.95$ to 16.15

10. Suppose that you are a student aide in the library and agree to be paid according to the "random pay" system. Each week, the librarian flips a coin. If the coin comes up heads, your pay for the week is \$80. If it comes up tails, your pay for the week is \$40. You work for the library for 100 weeks. Suppose we choose an SRS of 2 weeks and calculate your average earnings. The shape of the sampling distribution of will be

$\frac{40+80}{2} = 60$

(a) Normal.
(b) approximately Normal.
(c) right-skewed.
(d) left-skewed.
(e) symmetric but not Normal.

40, 60, 80

3 possible outcomes

$\bar{x} = 40, 60, 80$

$\bar{x} = 40$ will occur 25% of the time, as will $\bar{x} = 80$. $\bar{x} = 60$ will happen 50% of the time.

Section II: Free Response Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

11. The amount that households pay service providers for access to the Internet varies quite a bit, but the mean monthly fee is $38 and the standard deviation is $10. The distribution is not Normal: many households pay a base rate for low-speed access, but some pay much more for faster connections. A sample survey asks an SRS of 500 households with Internet access how much they pay. Let be the mean amount paid.

$\mu = 38$

$\sigma = 10$ $\quad n \geq 30$

(a) What are the mean and standard deviation of the sampling distribution of $\bar{x}$?

$\mu_{\bar{x}} = 38$

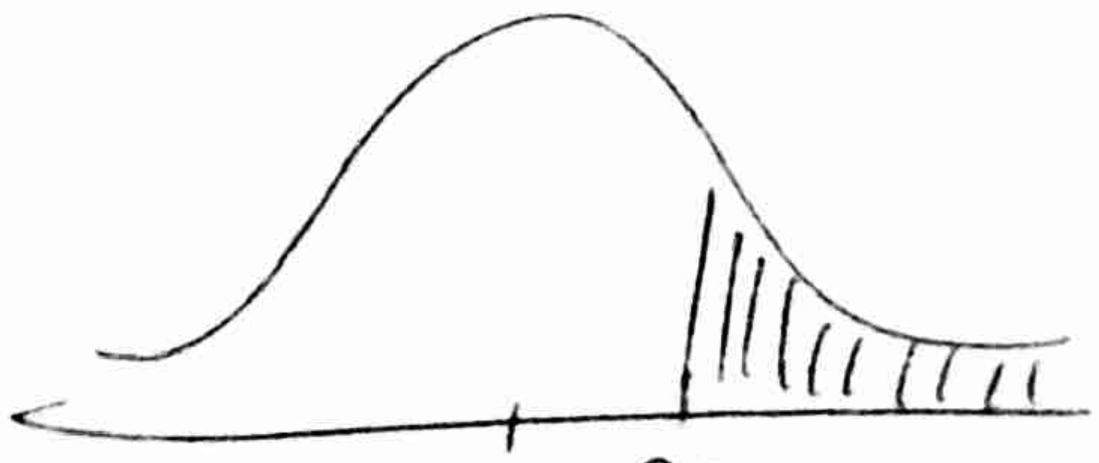
$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{10}{\sqrt{500}} = 0.4472$ b/c sample size is 500, which is less than 10% of all households with internet access.

(c) What is the shape of the sampling distribution of $\bar{x}$? Justify your answer.

B/c the sample size is large ($n = 500 \geq 30$), the distribution of $\bar{x}$ will be approximately Normal.

(c) Find the probability that the average fee paid by the sample of households exceeds $39. Show your work.

$N(38, 0.4472)$



$z = \frac{39-38}{0.4472} = 2.24$

$P(z > 2.24) = 1 - 0.9875$

$= 0.0125$

12. According to government data, 22% of American children under the age of six live in households with incomes less than the official poverty level. A study of learning in early childhood chooses an SRS of 300 children. Find the probability that more than 20% of the sample are from poverty-level households. Be sure to check that you can use the Normal approximation.

$p = 0.22$

$z = \frac{0.20 - 0.22}{0.0239}$

$= -0.84$

$\mu_{\hat{p}} = p = 0.22$

$P(z > -0.84)$

B/c 300 is less than 10% of children under the age of six

$= 1 - 0.2005$

$\sigma_{\hat{p}} = \sqrt{\frac{0.22(0.78)}{300}} = 0.0239$

$= 0.7995$

B/c $np = 300(0.22) = 66$ & $n(1-p) = 300(0.78) = 234$ ≥ 10, the sampling distribution of $\hat{p}$ can be approximated by a Normal distribution.

mulative AP Statistics Practice

1. The five-number summary for a data set is given by min = 5, Q1 = 18, median = 20, Q3 = 40, max = 75. If you wanted to construct a boxplot for the data set (that is, one that would show outliers, if any existed), what would be the maximum possible length of the right-side "whisker"?

(a) 33
(b) 35
(c) 45
(d) 53
(e) 55

2. The probability distribution for the number of heads in four tosses of a coin is given by

Number of heads:	0	1	2	3	4
Probability:	0.0625	0.2500	0.3750	0.2500	0.0625

The probability of getting at least one tail in four tosses of a coin is

(a) 0.2500.
(b) 0.3125.
(c) 0.6875.
(d) 0.9375.
(e) 0.0625.

3. In a certain large population of adults, the distribution of IQ scores is strongly left-skewed with a mean of 122 and a standard deviation of 5. Suppose 200 adults are randomly selected from this population for a market research study. The distribution of the sample mean of IQ scores is

(a) left-skewed with mean 122 and standard deviation 0.35.
(b) exactly Normal with mean 122 and standard deviation 5.
(c) exactly Normal with mean 122 and standard deviation 0.35.
(d) approximately Normal with mean 122 and standard deviation 5.
(e) approximately Normal with mean 122 and standard deviation 0.35.

4. A 10-question multiple-choice exam offers 5 choices for each question. Jason just guesses the answers, so he has probability 1/5 of getting any one answer correct. You want to perform a simulation to determine the number of correct answers that Jason gets. One correct way to use a table of random digits to do this is the following:

(a) One digit from the random digit table simulates one answer, with 5 = right and all other digits = wrong. Ten digits from the table simulate 10 answers.
(b) One digit from the random digit table simulates one answer, with 0 or 1 = right and all other digits = wrong. Ten digits from the table simulate 10 answers.
(c) One digit from the random digit table simulates one answer, with odd = right and even = wrong. Ten digits from the table simulate 10 answers.
(d) One digit from the random digit table simulates one answer, with 0 or 1 = right and all other digits = wrong, ignoring repeats. Ten digits from the table simulate 10 answers.
(e) Two digits from the random digit table simulate one answer, with 00 to 20 = right and 21 to 99 = wrong. Ten pairs of digits from the table simulate 10 answers.

5. Suppose we roll a fair die four tin .. The probability that a 6 occurs on exactly one of the rolls is

(a) $4\left(\frac{1}{6}\right)^3\left(\frac{5}{6}\right)^1$

(b) $\left(\frac{1}{6}\right)^3\left(\frac{5}{6}\right)^1$

(c) $4\left(\frac{1}{6}\right)^1\left(\frac{5}{6}\right)^3$

(d) $\left(\frac{1}{6}\right)^1\left(\frac{5}{6}\right)^3$

(e) $6\left(\frac{1}{6}\right)^1\left(\frac{5}{6}\right)^3$

6. You want to take an SRS of 50 of the 816 students who live in a dormitory on a college campus. You label the students 001 to 816 in alphabetical order. In the table of random digits, you read the entries

95592 94007 69769 33547 72450 16632 81194 14873

The first three students in your sample have labels

(a) 955, 929, 400.
(b) 400, 769, 769.
(c) 559, 294, 007.
(d) 929, 400, 769.
(e) 400, 769, 335.

7. The number of unbroken charcoal briquets in a 20-pound bag filled at the factory follows a Normal distribution with a mean of 450 briquets and a standard deviation of 20 briquets. The company expects that a certain number of the bags will be underfilled, so the company will replace for free the 5% of bags that have too few briquets. What is the minimum number of unbroken briquets the bag would have to contain for the company to avoid having to replace the bag for free?

(a) 404
(b) 411
(c) 418
(d) 425
(e) 448

8. You work for an advertising agency that is preparing a new television commercial to appeal to women. You have been asked to design an experiment to compare the effectiveness of three versions of the commercial. Each subject will be shown one of the three versions and then asked about her attitude toward the product. You think there may be large differences between women who are employed and those who are not. Because of these differences, you should use

(a) a block design, but not a matched pairs design.
(b) a completely randomized design.
(c) a matched pairs design.
(d) a simple random sample.
(e) a stratified random sample.

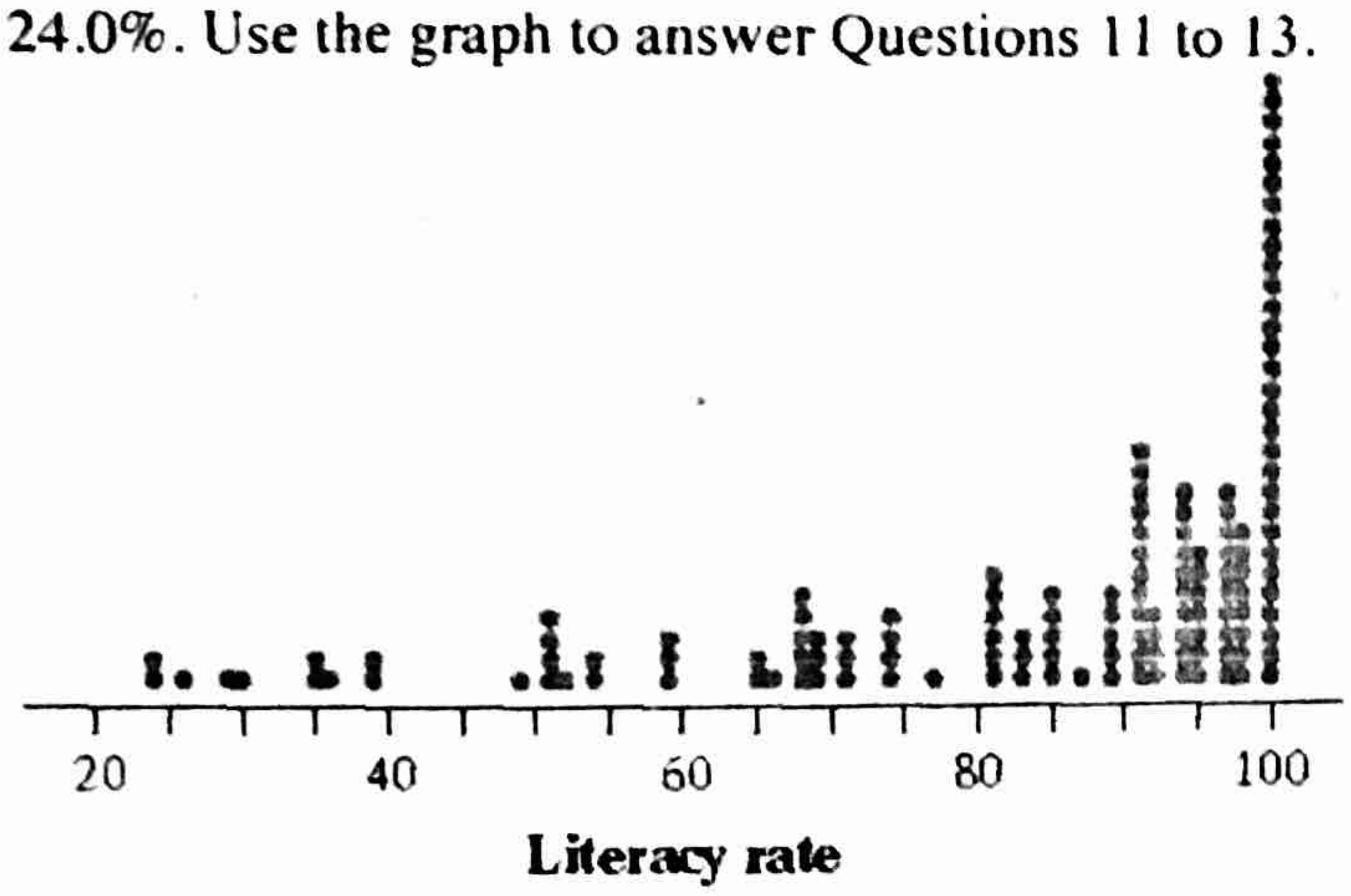
9. Suppose that you have torn a tendon and are facing surgery to repair it. The orthopedic surgeon explains the risks to you. Infection occurs in 3% of such operations, the repair fails in 14%, and both infection and failure occur together 1% of the time. What is the probability that the operation is successful for someone who has an operation that is free from infection?

(a) 0.8342 (b) 0.8400 (c) 0.8600 (d) 0.8660 (e) 0.9900

Social scientists are interested in the association between high school graduation rate (HSGR, measured as a percent) and the percent of U.S. families living in poverty (POV). Data were collected from all 50 states and the District of Columbia, and a regression analysis was conducted. The resulting least-squares regression line is given by $\widehat{POV} = 59.2 - 0.620(HSGR)$ with $r^2 = 0.802$. Based on the information, which of the following is the best interpretation for the slope of the least-squares regression line?

(a) For each 1% increase in the graduation rate, the percent of families living in poverty is predicted to decrease by approximately 0.896.
(b) For each 1% increase in the graduation rate, the percent of families living in poverty is predicted to decrease by approximately 0.802.
(c) For each 1% increase in the graduation rate, the percent of families living in poverty is predicted to decrease by approximately 0.620.
(d) For each 1% increase in the percent of families living in poverty, the graduation rate is predicted to increase by approximately 0.802.
(e) For each 1% increase in the percent of families living in poverty, the graduation rate is predicted to decrease by approximately 0.620.

Here is a dotplot of the adult literacy rates in 177 countries in a recent year, according to the United Nations. For example, the lowest literacy rate was 23.6%, in the African country of Burkina Faso. Mali had the next lowest literacy rate at 24.0%. Use the graph to answer Questions 11 to 13.



11. The overall shape of this distribution is

(a) clearly skewed to the right.
(b) clearly skewed to the left.
(c) roughly symmetric.
(d) uniform.
(e) There is no clear shape.

12. The mean of this distribution (don't try to find it) will be

(a) very close to the median.
(b) greater than the median.
(c) less than the median.
(d) You can't say, because distribution isn't symmetric.
(e) You can't say, because the distribution isn't Normal.

13. Based on the shape of this distribution, what measures of center and spread would be most appropriate to report?

(a) The mean and standard deviation
(b) The mean and the interquartile range
(c) The median and the standard deviation
(d) The median and the interquartile range
(e) The mean and the range

14. The correlation between the age and height of children under the age of 12 is found to be r = 0.60. Suppose we use age x of a child to predict the height y of the child. What can we conclude?

(a) The height is generally 60% of a child's weight.
(b) About 60% of the time, age will accurately predict height.
(c) Thirty-six percent of the variation in height is accounted for by the linear model relating height to age.
(d) For every 1 year older a child is, the regression line predicts an increase of 0.6 feet in height.
(e) Thirty-six percent of the time, the least-squares regression line accurately predicts height from age.

15. An agronomist wants to test three different types of fertilizer (A, B, and C) on the yield of a new variety of wheat. The yield will be measured in bushels per acre. Six 1-acre plots of land were randomly assigned to each of the three fertilizers. The treatment, experimental unit, and response variable are, respectively,

(a) a specific fertilizer, bushels per acre, a plot of land.
(b) a plot of land, bushels per acre, a specific fertilizer.
(c) random assignment, a plot of land, wheat yield.
(d) a specific fertilizer, a plot of land, wheat yield.
(e) a specific fertilizer, the agronomist, wheat yield.

16. According to the U.S. Census, the proportion of adults in a certain county who owned their own home was 0.71. An SRS of 100 adults in a certain section of the county found that 65 owned their home. Which one of the following represents the approximate probability of obtaining a sample of 100 adults in which fewer than 65 own their home, assuming that this section of the county has the same overall proportion of adults who own their home as does the entire county?

(a) $\binom{100}{65}(0.71)^{65}(0.29)^{35}$

(b) $\binom{100}{65}(0.29)^{65}(0.71)^{35}$

(c) $P\left(Z < \dfrac{0.65 - 0.71}{\sqrt{\dfrac{(0.71)(0.29)}{100}}}\right)$

(d) $P\left(Z < \dfrac{0.65 - 0.71}{\sqrt{\dfrac{(0.65)(0.35)}{100}}}\right)$

(e) $P\left(Z < \dfrac{0.65 - 0.71}{\dfrac{(0.71)(0.29)}{\sqrt{100}}}\right)$

17. Which one of the following would be a correct interpretation if you have a z-score of +2.0 on an exam?

(a) It means that you missed two questions on the exam.
(b) It means that you got twice as many questions correct as the average student.
(c) It means that your grade was 2 points higher than the mean grade on this exam.
(d) It means that your grade was in the upper 2% of all grades on this exam.
(e) It means that your grade is 2 standard deviations above the mean for this exam.

18. Records from a random sample of dairy farms yielded the information below on the number of male and female calves born at various times of the day.

	Day	Evening	Night	Total
Males	129	15	117	**261**
Females	118	18	116	**252**
Total	**247**	**33**	**233**	**513**

What is the probability that a randomly selected calf was born in the night or was a female?

(a) $\frac{369}{513}$

(b) $\frac{485}{513}$

(c) $\frac{116}{513}$

(d) $\frac{116}{252}$

(e) $\frac{116}{233}$

19. When people order books from a popular online source, they are shipped in standard-sized boxes. Suppose that the mean weight of the boxes is 1.5 pounds with a standard deviation of 0.3 pounds, the mean weight of the packing material is 0.5 pounds with a standard deviation of 0.1 pounds, and the mean weight of the books shipped is 12 pounds with a standard deviation of 3 pounds. Assuming that the weights are independent, what is the standard deviation of the total weight of the boxes that are shipped from this source?

(a) 1.84
(b) 2.60
(c) 3.02
(d) 3.40
(e) 9.10

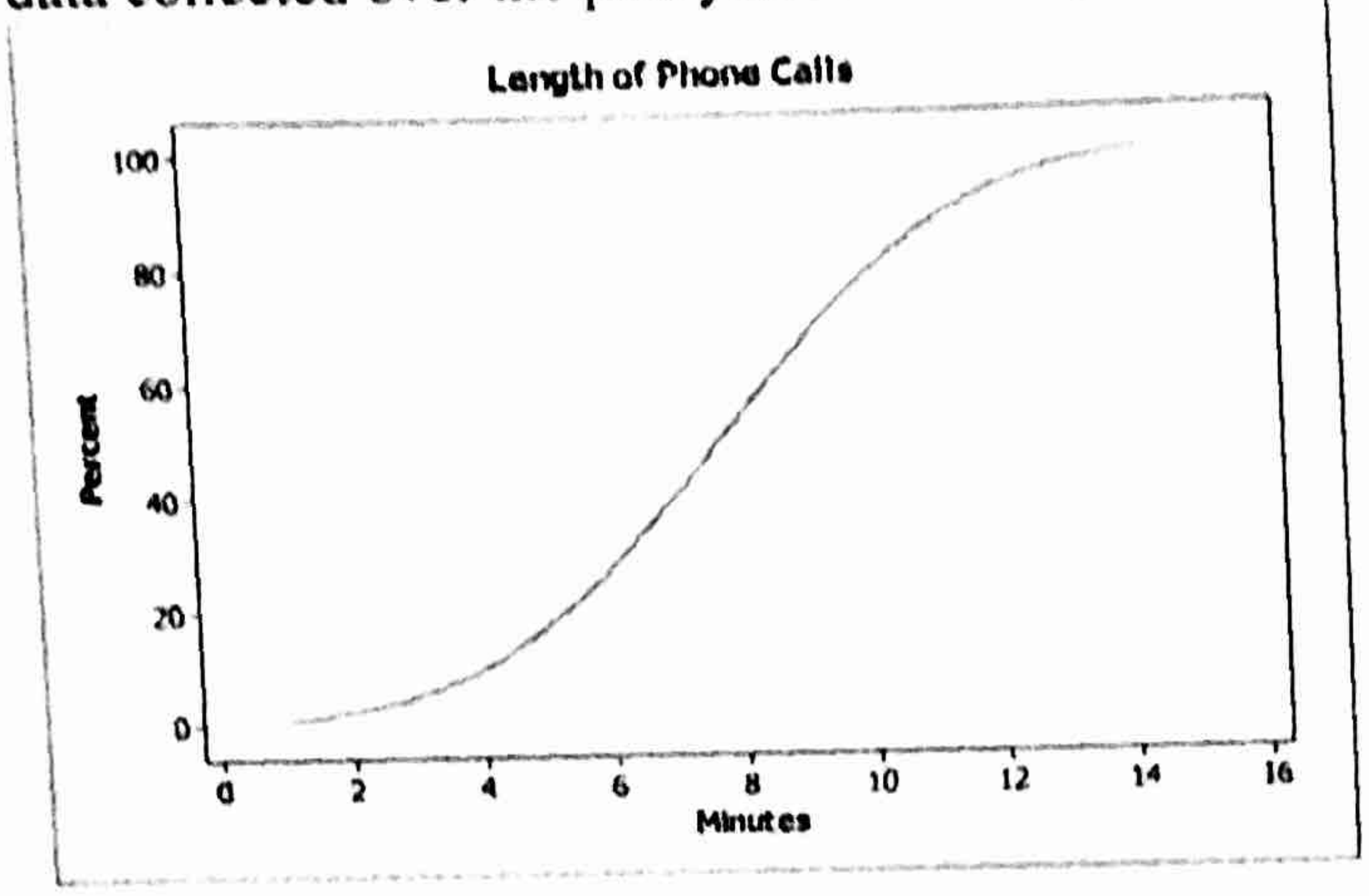
20. A grocery chain runs a prize game by giving each customer a ticket that may win a prize when the box is scratched off. Printed on the ticket is a dollar value ($500, $100, $25) or the statement "This ticket is not a winner." Monetary prizes can be redeemed for groceries at the store. Here is the probability distribution of the amount won on a randomly selected ticket:

Amount won:	$500	$100	$25	$0
Probability:	0.01	0.05	0.20	0.74

Which of the following are the mean and standard deviation, respectively, of the winnings?

(a) $15.00, $2900.00
(b) $15.00, $53.85
(c) $15.00, $26.93
(d) $156.25, $53.85
(e) $156.25, $26.93

21. A large company is interested in improving the efficiency of its customer service and decides to examine the length of the business phone calls made to clients by its sales staff. A cumulative relative frequency graph is shown below from data collected over the past year. According to the graph, the shortest 80% of calls will take how long to complete?



(a) Less than 10 minutes
(b) At least 10 minutes
(c) Exactly 10 minutes
(d) At least 5.5 minutes
(e) Less than 5.5 minutes

Section II: Free Response Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

22. A health worker is interested in determining if omega-3 fish oil can help reduce cholesterol in adults. She obtains permission to examine the health records of 200 people in a large medical clinic and classifies them according to whether or not they take omega-3 fish oil. She also obtains their latest cholesterol readings and finds that the mean cholesterol reading for those who are taking omega-3 fish oil is 18 points lower than the mean for the group not taking omega-3 fish oil.

(a) Is this an observational study or an experiment? Justify your answer.

observation study b/c no treatments were imposed on the subjects.

(b) Explain the concept of confounding in the context of this study and give one example of a variable that could be confounded with whether or not people take omega-3 fish oil.

Two variables are confounded when their effects on the cholesterol level cannot be distinguished from one another. For example, people who take omega-3 fish oil might also exercise more. Researchers would not know whether it was the omega-3 fish oil or the exercise that was the real explanation for lower cholesterol.

(c) Researchers find that the 18-point difference in the mean cholesterol readings of the two groups is statistically significant. Can they conclude that omega-3 fish oil is the cause? Why or why not?

no. even though the difference was statistically significant, this wasn't an experiment and taking fish oil is possibly confounded w/ exercise.

There are four major blood types in humans: O, A, B, and AB. In a study conducted using blood specimens from the Blood Bank of Hawaii, individuals were classified according to blood type and ethnic group. The ethnic groups were Hawaiian, Hawaiian-White, Hawaiian-Chinese, and White. Suppose that a blood bank specimen is selected at random.

	Ethnic Group				
Blood type	Hawaiians	Hawaiian-White	Hawaiian-Chinese	White	Total
O	1903	4469	2206	53,759	**62,337**
A	2490	4671	2368	50,008	**59,537**
B	178	606	568	16,252	**17,604**
AB	99	236	243	5001	**5579**
Total	**4670**	**9982**	**5385**	**125,020**	**145,057**

(a) Find the probability that the specimen contains type O blood or comes from the Hawaiian-Chinese ethnic group. Show your work.

$$P(\text{type O or Hawaiian-chinese}) = \frac{62337 + 5385 - 2206}{145057}$$

$$= \frac{65516}{145057} = 0.452$$

(b) What is the probability that the specimen contains type AB blood, given that it comes from the Hawaiian ethnic group? Show your work.

$$P(\text{type AB} \mid \text{Hawaiian}) = \frac{99}{4670} = 0.021$$

(c) Are the events "type B blood" and "Hawaiian ethnic group" independent? Give appropriate statistical evidence to support your answer.

$$P(\text{Hawaiian}) = \frac{4670}{145057} = 0.032$$

$$P(\text{Hawaiian} \mid \text{type B}) = \frac{178}{17604} = 0.010$$

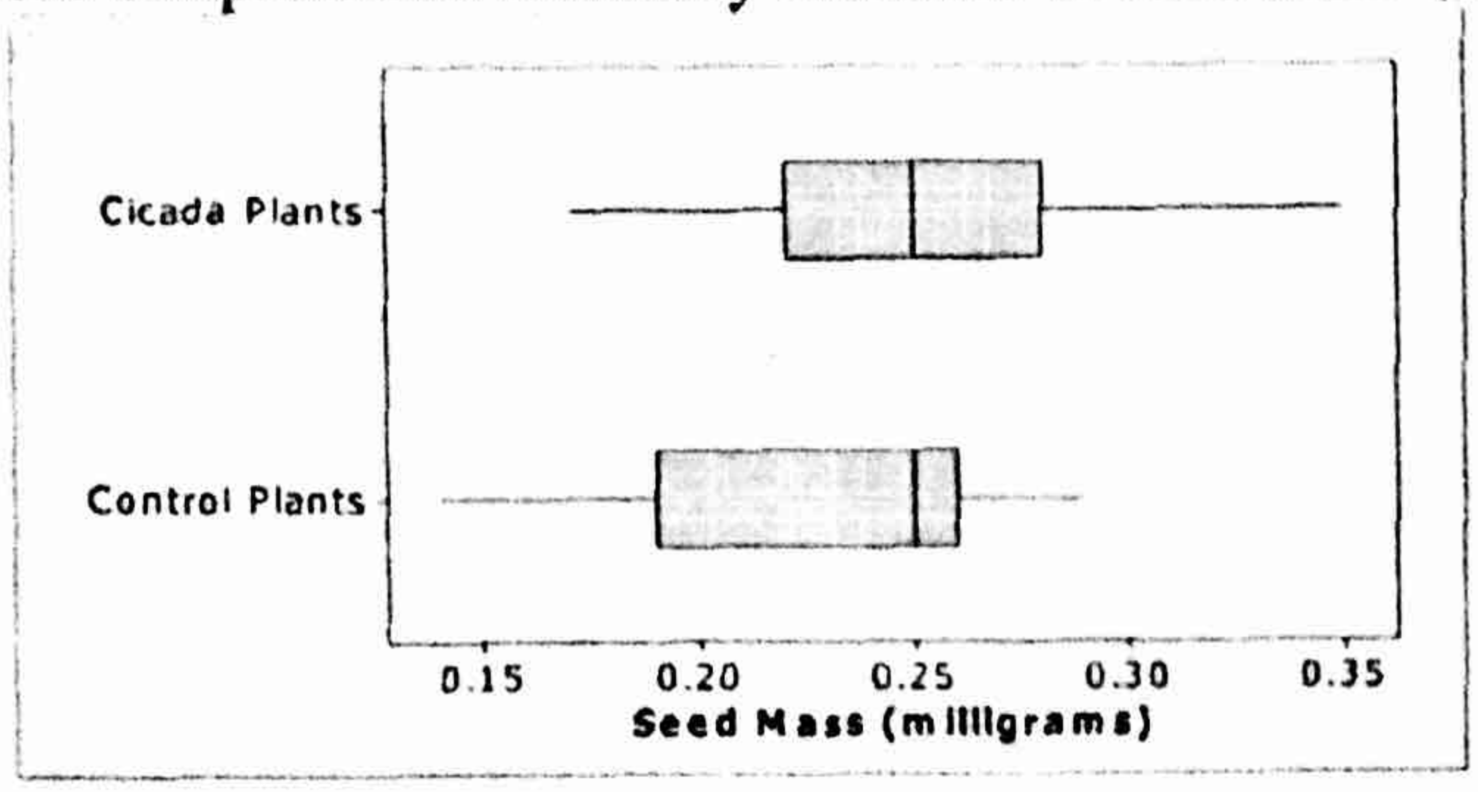
B/c these probabilities are not equal, the 2 events are not independent.

(d) Now suppose that two blood bank specimens are selected at random. Find the probability that at least one of the specimens contains type A blood from the White ethnic group.

1 − P(neither are type A from ~~bel~~ white ethnic group)

$$= 1 - (1 - 0.345)^2 = 0.571$$

24. Every 17 years, swarms of cicadas emerge from the ground in the eastern United States, live for about six weeks, and then die. (There are several different "broods," so we experience cicada eruptions more often than every 17 years.) There are so many cicadas that their dead bodies can serve as fertilizer and increase plant growth. In a study, a researcher added 10 dead cicadas under 39 randomly selected plants in a natural plot of American bellflowers on the forest floor, leaving other plants undisturbed. One of the response variables measured was the size of seeds produced by the plants. Here are the boxplots and summary statistics of seed mass (in milligrams) for 39 cicada plants and 33 undisturbed (control) plants:



Variable	n	Minimum	Q_1	Median	Q_3	Maximum
Cicada plants	39	0.17	0.22	0.25	0.28	0.35
Control plants	33	0.14	0.19	0.25	0.26	0.29

(a) Write a few sentences comparing the distributions of seed mass for the two groups of plants.

The distribution of seed mass for the cicada plants is roughly symmetric while the distribution of seed mass for the control plants is skewed to the ~~right~~ left. The median seed mass is the same for both groups. The cicada plants had a bigger range in seed mass, but the control plants had a bigger IQR. Neither group had any outliers.

(b) Based on the graphical displays, which distribution has the larger mean? Justify your answer.

The distribution of seed mass for the cicada plants has the higher mean.

skewed to the left

mean < median

(c) Explain the purpose of the random assignment in this study.

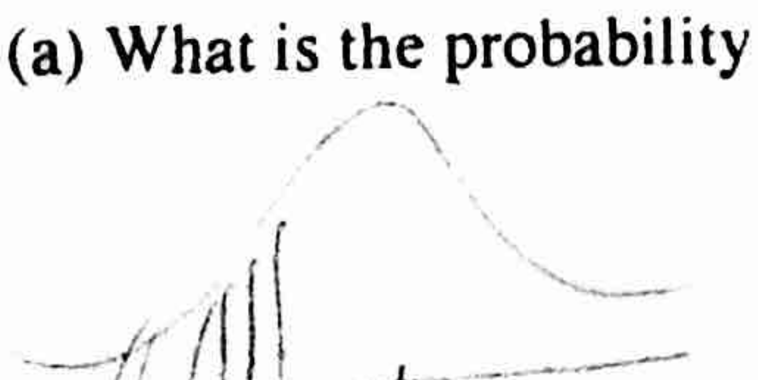
The purpose of the random assignment is to create 2 groups of plants that are roughly equivalent at the beginning of the experiment. The random assigment should balance out the effects of other variables among the 2 treatments.

(d) Name one benefit and one drawback of only using American bellflowers in the study?

Controlling a source of variability is a benefit of using only American bellflowers. Different types of flowers will have different seed masses, making the response more variable if other types of plants were used. However, using only American bellflowers means that we can't make inference about the effects of cicadas on other types of plants

25. In a city library, the mean number of pages in a novel is 525 with a standard deviation of 200. Approximately 30% of the novels have fewer than 400 pages. Suppose that you randomly select 50 novels from the library.

(a) What is the probability that the total number of pages is fewer than 25,000? Show your work.



500 525

$P(\bar{x} < 25000/50) = P(\bar{x} < 500)$

b/c the sample size is large ($n = 50 \geq 30$) the distribution of $\bar{x}$ is ~ Normal w/

$\mu_{\bar{x}} = \mu = 525$

$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{200}{\sqrt{50}} = 28.28$

$z = \frac{500 - 525}{28.28} = -0.88$

$P(z < -0.88) = \boxed{0.1894}$