2. When a law firm represents a group of people in a class action lawsuit and wins that lawsuit, the firm receives a percentage of the group's monetary settlement. That settlement amount is based on the total number of people in the group—the larger the group and the larger the settlement, the more money the firm will receive.

   A law firm is trying to decide whether to represent car owners in a class action lawsuit against the manufacturer of a certain make and model for a particular defect. If 5 percent or less of the cars of this make and model have the defect, the firm will not recover its expenses. Therefore, the firm will handle the lawsuit only if it is convinced that more than 5 percent of cars of this make and model have the defect. The firm plans to take a random sample of 1,000 people who bought this car and ask them if they experienced this defect in their cars.

   (a) Define the parameter of interest and state the null and alternative hypotheses that the law firm should test.

   (b) In the context of this situation, describe Type I and Type II errors and describe the consequences of each of these for the law firm.

3. Men's shirt sizes are determined by their neck sizes. Suppose that men's neck sizes are approximately normally distributed with mean 15.7 inches and standard deviation 0.7 inch. A retailer sells men's shirts in sizes S, M, L, XL, where the shirt sizes are defined in the table below.

Shirt size	Neck size
S	$14 \leq$ neck size < 15
M	$15 \leq$ neck size < 16
L	$16 \leq$ neck size < 17
XL	$17 \leq$ neck size < 18

   (a) Because the retailer only stocks the sizes listed above, what proportion of customers will find that the retailer does not carry any shirts in their sizes? Show your work.

   (b) Using a sketch of a normal curve, illustrate the proportion of men whose shirt size is M. Calculate this proportion.

   (c) Of 12 randomly selected customers, what is the probability that exactly 4 will request size M ? Show your work.

4. Because of concerns about employee stress, a large company is conducting a study to compare two programs (tai chi or yoga) that may help employees reduce their stress levels. Tai chi is a 1,200-year-old practice, originating in China, that consists of slow, fluid movements. Yoga is a practice, originating in India, that consists of breathing exercises and movements designed to stretch and relax muscles. The company has assembled a group of volunteer employees to participate in the study during the first half of their lunch hour each day for a 10-week period. Each volunteer will be assigned at random to one of the two programs. Volunteers will have their stress levels measured just before beginning the program and 10 weeks later at the completion of it.

   (a) A group of volunteers who work together ask to be assigned to the same program so that they can participate in that program together. Give an example of a problem that might arise if this is permitted. Explain to this volunteer group why random assignment to the two programs will address this problem.

   (b) Someone proposes that a control group be included in the design as well. The stress level would be measured for each volunteer assigned to the control group at the start of the study and again 10 weeks later. What additional information, if any, would this provide about the effectiveness of the two programs?

   (c) Is it reasonable to generalize the findings of this study to all employees of this company? Explain.

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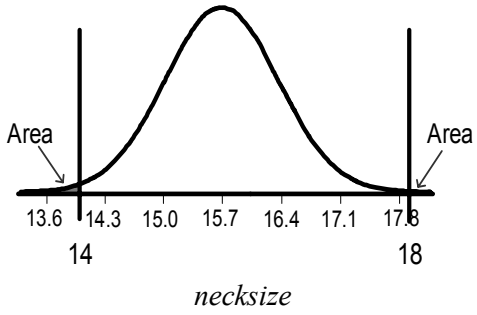
Question 3

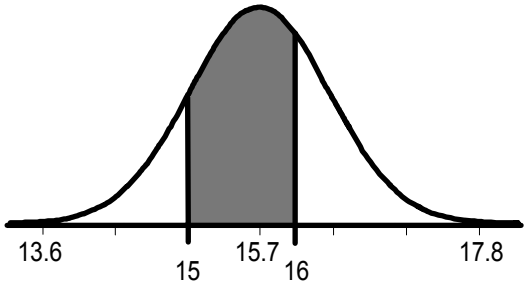
Solution

Part (a):

$$
\begin{aligned}
&P(necksize < 14 \ \ or \ \ necksize \geq 18) \\
&= P(necksize < 14) + P(necksize \geq 18) \\
&= P\left(z < \frac{14 - 15.7}{0.7}\right) + P\left(z \geq \frac{18 - 15.7}{0.7}\right) \\
&= P(z < -2.429) + P(z \geq 3.286) \\
&= 0.00758 + 0.00051 \\
&= 0.00809
\end{aligned}
$$



Part (b):



$$
\begin{aligned}
&P(15 \leq necksize < 16) \\
&= P\left(\frac{15 - 15.7}{0.7} \leq z < \frac{16 - 15.7}{0.7}\right) \\
&= P(-1.000 \leq z < 0.429) \\
&= 0.50723
\end{aligned}
$$

Part (c):

X = number of customers who request size M
X is binomial with $n = 12$ customers and $p = 0.5072$

$$P(X = 4) = {}_{12}C_4 (0.5072)^4 (0.4928)^8 = 495(0.06618)(0.00348) = 0.1139$$

Question 3 (cont'd)

Scoring

Each part is scored as either essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is essentially correct (E) if the response

1. recognizes the need to look at neck sizes below 14 and above 18
2. correctly computes the two tail probabilities (except for minor arithmetic or transcription errors) and adds those probabilities

Part (a) is partially correct (P) if the response

considers only neck sizes below 14 (or above 18) but computes that corresponding tail area correctly
OR
recognizes the need to look at neck sizes below 14 and above 18 but does not compute both tail probabilities correctly
OR
recognizes the need to look at neck sizes below 14 and above 18 but approximates tail probabilities using the Empirical Rule
OR
computes the proportion of customers that will find the store carries their size
(i.e., 1 – correct answer)
OR
States the correct answer (0.0081) without supporting work

NOTE: A normal curve with correct regions shaded showing both correct end points (14 and 18) and the mean and the standard deviation may be used for element 1.

Part (b) is essentially correct (E) if

1. the appropriate probability is illustrated using a normal curve in which the end points are identified and the mean and standard deviation are implied
2. the required probability is correctly computed (except for minor arithmetic errors)

Part (b) is partially correct (P) if only one of the above elements is correct.

NOTES:

(1) If part (a) was not essentially correct because the student interchanged the mean and standard deviation, and the same values for mean and standard deviation are used in part (b), then part (b) can be considered essentially correct if the probability calculated is correct for the mean and standard deviation used.

(2) A reasonable approximation using the Empirical Rule in part (b) is only acceptable if the computation in part (a) is done correctly (i.e., without using the Empirical Rule).

Question 3 (cont'd)

Part (c) is essentially correct (E) if

1. the student recognized the setting as binomial
2. the probability calculated in part (b) is used for p
3. work is shown — that is, the correct values for n and x are given and the desired probability calculated, or the binomial formula is correctly evaluated.

Part (c) is partially correct (P) if

the student recognizes the situation as binomial and identifies p from part (b) but does not compute the desired probability

OR

the student computes the probability as either $(0.5072)^4 (0.4928)^8$ or $\binom{12}{4}(0.5072)^4$

OR

the student gives the correct probability of 0.1139 but work is not shown

NOTE: Rounding the probability in part (b) for use in part (c) is acceptable.

4 Complete Response (3E)

All three parts essentially correct

3 Substantial Response (2E 1P)

Two parts essentially correct and one part partially correct

2 Developing Response (2E 0P or 1E 2P or 3P)

Two parts essentially correct and no parts partially correct
OR
One part essentially correct and two parts partially correct
OR
Three parts partially correct

1 Minimal Response (1E 1P or 1E 0P or 0E 2P)

One part essentially correct and either zero or one parts partially correct
OR
No parts essentially correct and two parts partially correct