Name: _____ Date: _____

Service time measurements

Service times (minutes): 6, 7, 8, 8, 9, 10, 10, 10, 11, 12, 12, 13, 14, 15, 40. Use the median excluded quartile convention and the ordinary 1.5 IQR outlier rule.

(a) Find the five number summary. Leave the median out of both halves when finding quartiles.

Set it up: Five number summary = minimum, Q1, median, Q3, maximum. Use the median excluded convention throughout.

Work: Ordered data: 6, 7, 8, 8, 9, 10, 10, 10, 11, 12, 12, 13, 14, 15, 40. n = 15; median = 10. Lower half: 6, 7, 8, 8, 9, 10, 10. Upper half: 11, 12, 12, 13, 14, 15, 40. Their medians are Q1 = 8 and Q3 = 13.

Answer: 6, 8, 10, 13, 40.

(b) Find the IQR and the two 1.5 IQR fences. Identify any outliers.

Set it up: IQR = Q3 minus Q1. Lower fence = Q1 minus 1.5 x IQR. Upper fence = Q3 plus 1.5 x IQR.

Work: IQR = 13 minus 8 = 5. Lower = 8 minus 1.5 x 5 = 0.5. Upper = 13 plus 1.5 x 5 = 20.5.

Answer: Fences: 0.5 and 20.5. Outliers: 40. Only values strictly outside the fences are outliers.

(c) Draw a modified boxplot. Label the median and the whisker endpoints. Show outliers separately.

Set it up: Draw the box from Q1 to Q3, a line at the median, and whiskers to the smallest and largest values inside the fences.

Work: Box: 8 to 13. Median: 10. Whiskers: 6, 15. Separate outliers: 40.

Answer: The plotted whiskers end at 6 and 15.



(d) Describe the tail pattern and choose a suitable measure of center. What information does the boxplot hide?

Set it up: A long tail suggests skew. The median is resistant to outliers. A boxplot summarizes quartiles, not every observation.

Work: The high value 40 extends the right tail.

Answer: The data show a longer right tail. The median is a suitable resistant center. A boxplot alone does not show sample size, all exact values, or clusters.

Waiting time set 1

Waiting times have been grouped into equal width classes. Each lower boundary is included; each upper boundary is excluded.

Time (minutes)	Frequency	Relative frequency
10 <= x < 20	2	0.0667
20 <= x < 30	6	0.2000
30 <= x < 40	14	0.4667
40 <= x < 50	6	0.2000
50 <= x < 60	2	0.0667

(a) Complete the relative frequency column as decimals rounded to four places. State the exact and rounded totals.

Set it up: Whole group: all waiting times. Relative frequency = class frequency / total frequency.

Work: n = 30. 2/30 = 0.0667; 6/30 = 0.2000; 14/30 = 0.4667; 6/30 = 0.2000; 2/30 = 0.0667. The exact fractions sum to 1; displayed rounded values sum to 1.0001.

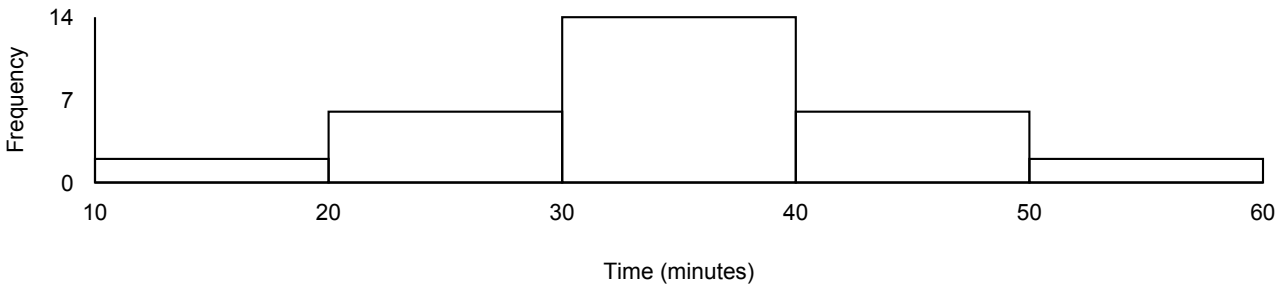
Answer: Relative frequencies: 0.0667, 0.2000, 0.4667, 0.2000, 0.0667. Exact total = 1. Rounded total = 1.0001.

(b) Draw a frequency histogram with touching bars. Label both axes.

Set it up: Horizontal axis: time classes. Vertical axis: frequency. Heights equal the class counts.

Work: Class boundaries: 10, 20, 30, 40, 50, 60. Bar heights: 2, 6, 14, 6, 2.

Answer: The completed histogram has one touching bar for each class, using the stated frequency as its height.



(c) Describe the shape. Which class contains a waiting time of 30 minutes?

Set it up: A class includes its lower boundary and excludes its upper boundary. Shape depends on where the tail extends.

Work: The heights mirror each other around the middle class. The value 30 satisfies 30 <= x < 40.

Answer: Approximately symmetric and unimodal. 30 belongs in the class 30 <= x < 40.

(d) Estimate the mean with class midpoints. Can you recover the exact raw mean or exact median from this table alone?

Set it up: Estimated mean = sum of (class midpoint times frequency) / total count.

Work: Midpoints: 15, 25, 35, 45, 55. Weighted total = (15 x 2) + (25 x 6) + (35 x 14) + (45 x 6) + (55 x 2) = 1050. Estimate = 1050/30 = 35.000.

Answer: Estimated mean = 35.000 minutes. Neither the exact raw mean nor the exact median can be recovered. For the approximately symmetric distribution, a mean is reasonable.

Two study methods

A college wants to compare two study methods for all 480 students in its introductory statistics course. It randomly selects 60 of these students, then randomly assigns 30 to video practice and 30 to workbook practice. After two weeks, every selected student takes the same 100 point quiz. The response is the quiz score.

(a) Is this an experiment or an observational study? Explain.

Set it up: An experiment assigns a treatment. An observational study records a condition without assigning it.

Work: The researchers randomly assigned video or workbook practice.

Answer: It is a randomized experiment. Study method is the assigned treatment.

(b) Identify the population, sample, explanatory variable and response variable.

Set it up: Population = target group. Sample = observed group. Explanatory variable = study method. Response = quiz score.

Work: Population: 480 course students. Sample: 60 selected students. Explanatory variable has two categories: video and workbook. Response is the score on the same quiz.

Answer: Population 480; sample 60; explanatory variable study method; response quiz score out of 100.

(c) Explain what random selection and random assignment each help justify. Do they guarantee a better score?

Set it up: Random selection supports representing the target population. Random assignment helps balance other influences, called confounding variables, between the groups.

Work: The sample was randomly selected from the 480 students, and the 60 were randomly assigned to methods.

Answer: The design supports generalization to these course students and a causal treatment comparison under proper implementation. Neither random step guarantees a particular score or removes all error.

Choose the whole group

Participants attended a workshop at one of four centers. Use the same table for every part. Select one participant at random from the group named in each prompt.

Center	Completed	Did not complete	Total
North	14	6	20
South	9	11	20
East	18	12	30
West	9	1	10
Total	50	30	80

(a) A participant is chosen from ALL 80 participants. What is the probability that the participant is from East AND completed the workshop? Round to four decimal places.

Set it up: Whole group: all participants. Joint probability = overlap count / grand total.

Work: Overlap = 18. Grand total = 80. P(East and completed) = 18/80 = 0.2250.

Answer: 0.2250.

(b) A participant is chosen ONLY from East. What is the probability that the participant completed the workshop? Round to four decimal places.

Set it up: Whole group: participants from this center only. Conditional probability = completed in the row / row total.

Work: East total = 30; completed = 18. P(completed given East) = 18/30 = 0.6000.

Answer: 0.6000.

(c) A participant is chosen ONLY from those who completed. What is the probability that the participant is from East? Round to four decimal places.

Set it up: Whole group: all participants who completed. Reverse conditional probability = this center and completed / completed total.

Work: Completed total = 50; overlap = 18. P(East given completed) = 18/50 = 0.3600.

Answer: 0.3600.

(d) A participant is chosen from ALL 80 participants. What is the probability that the participant is from East OR completed, or both? Round to four decimal places.

Set it up: Whole group: all participants. Union probability = (row total plus completed total minus overlap) / grand total.

Work: P(East or completed) = (30 + 50 minus 18)/80 = 62/80 = 0.7750.

Answer: 0.7750.

Workshop comparison 2

Use this workshop table to compare completion rates. All rows have positive totals. The table gives no information about assignment to centers.

Center	Completed	Did not complete	Total
North	18	12	30
South	12	8	20
East	6	4	10
West	24	16	40
Total	60	40	100

(a) Find the overall probability of completion, rounded to four decimal places.

Set it up: Whole group: all participants. Overall probability = completed total / grand total.

Work: Completed = 60; total = 100. P(completed) = 60/100 = 0.6000.

Answer: 0.6000.

(b) Find the completion probability within EACH center, rounded to four decimal places.

Set it up: Whole group: the selected center only. Divide completed in each row by that row total.

Work: North: 18/30 = 0.6000; South: 12/20 = 0.6000; East: 6/10 = 0.6000; West: 24/40 = 0.6000.

Answer: The four conditional rates are North 0.6000, South 0.6000, East 0.6000, West 0.6000.

(c) Are center and completion independent in this table? Compare at least two conditional probabilities with the overall probability.

Set it up: For every center with a positive row total, compare the exact conditional rate to the exact overall rate.

Work: North: 18/30 = 60/100. South: 12/20 = 60/100. East and West also equal the overall rate.

Answer: Independent in this table: every row rate equals the overall rate.

(d) Can this table establish that the center CAUSED a change in completion? Explain.

Set it up: Check whether random assignment or another design justifies a causal conclusion. A table by itself gives counts.

Work: No assignment procedure or control of other influences is stated. Differences could also reflect participant differences.

Answer: No. The table alone does not establish cause and effect, whether the rates match or differ.