

# Term Test 1, Fall 2022: Full Solutions

AP/ADMS 2320 · Chapters 1, 2, 3, 4 and 6

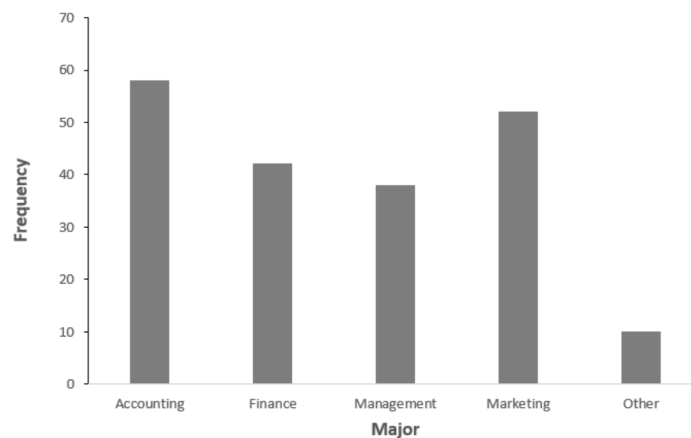
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Each part gives you the question, what it's really asking, the formula, the solution steps, the final answer in a box, and exam tips, if any. The video for each part walks through it in full.

## Question 1 (three independent parts)

### Part 1: Reconstructing data from a bar chart

**Question:** If you were only given the frequency bar chart below, would you be able to accurately reconstruct the original observations in the dataset for each major? Briefly explain.



#### What is the question really asking?

Can you read the exact count for each major off this chart?

#### Solution steps

The data is nominal (each person names a major), so the original data is just a count per major. The vertical axis only has marks every 10, so you can't read the exact heights: Finance is "a bit above 40", Marketing is "about 50", Other is "about 10".

**No. The axis isn't detailed enough to read the exact frequency of each major, so the original counts can't be reconstructed accurately.**

**Exam tip:** "A simple yes or no will not be sufficient." Say no, then give the reason (the axis scale).

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## Part 2: Types of data

**Question:** For each restaurant question, are the responses interval, nominal, or ordinal?

### Rule

- **Interval:** real numbers that measure or count
- **Ordinal:** categories with a natural order
- **Nominal:** categories with no order

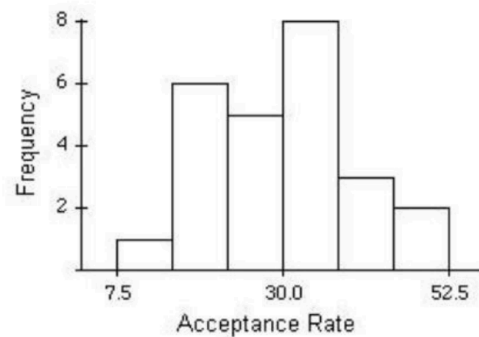
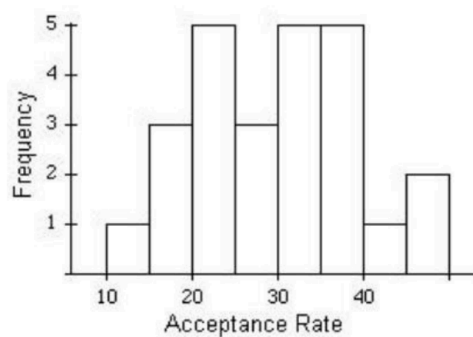
| Question                               | Type     | Why                                   |
|----------------------------------------|----------|---------------------------------------|
| a. Distance (in miles) to your home    | Interval | Miles is a measurement                |
| b. Eaten here before?                  | Nominal  | Yes / No has no order                 |
| c. Rating: excellent, good, fair, poor | Ordinal  | Ratings have a natural order          |
| d. Most attractive attribute           | Nominal  | Service, prices, food, menu: no order |

**a. Interval · b. Nominal · c. Ordinal · d. Nominal**

**Note:** the test prints part c as "excellent, good, fair, or fair". It's a typo for "poor": still ordinal.

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## Part 3: Two histograms of the same data (25 business schools)



### Read the charts first

Left endpoint included: a class like 20 to 25 means  $20 \leq x < 25$ . Left chart: classes of 5 starting at 10.

Right chart: classes of 7.5 starting at 7.5.

| Left chart | 10-15 | 15-20 | 20-25 | 25-30 | 30-35 | 35-40 | 40-45 | 45-50 | Total |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Frequency  | 1     | 3     | 5     | 3     | 5     | 5     | 1     | 2     | 25    |

| Right chart | 7.5-15 | 15-22.5 | 22.5-30 | 30-37.5 | 37.5-45 | 45-52.5 | Total |
|-------------|--------|---------|---------|---------|---------|---------|-------|
| Frequency   | 1      | 6       | 5       | 8       | 3       | 2       | 25    |

**Question:** a. What percent of the schools have an acceptance rate of less than 20%?

**What is the question really asking?**

Use the chart whose classes end exactly at 20 (the left one).

**Solution steps**

Under 20:  $1 + 3 = 4$  schools.  $4 \div 25 = 0.16$

**16%**

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**Question:** b. Which interval contains fewer than half of all the observations? (20%, 35%) (22.5%, 37.5%) (30%, 45%) (25%, 40%)

**What is the question really asking?**

Half of 25 is 12.5. Which interval holds 12 or fewer schools?

**Solution steps**

- (20, 35), left chart:  $5 + 3 + 5 = 13$ , more than half
- (22.5, 37.5), right chart:  $5 + 8 = 13$ , more than half
- (30, 45), left chart:  $5 + 5 + 1 = 11$ , **fewer than half**
- (25, 40), left chart:  $3 + 5 + 5 = 13$ , more than half

**(30%, 45%): 11 of 25 schools, fewer than half**

**Exam tip:** check every option, even after one fits. "Which interval?" means you answer with the interval.

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## Question 2 (8 days of October temperatures, °C)

|             |    |    |    |    |   |    |    |    |
|-------------|----|----|----|----|---|----|----|----|
| Toronto (X) | 12 | 7  | -3 | 10 | 9 | -1 | 16 | 4  |
| London (Y)  | 15 | 18 | 8  | 4  | 1 | 9  | 6  | 11 |

In order: Toronto -3, -1, 4, 7, 9, 10, 12, 16 · London 1, 4, 6, 8, 9, 11, 15, 18 (n = 8 each)

### a. Mean and median for Toronto; which is the better "typical" value?

#### Formula

$\bar{x} = \Sigma x \div n$     median = middle value of the ordered data (average the two middle values when n is even)

#### Solution steps

- $\Sigma x = 12 + 7 - 3 + 10 + 9 - 1 + 16 + 4 = 54$ ,  $\bar{x} = 54 \div 8 = 6.75$
- Middle two of the ordered data: 7 and 9, median =  $(7 + 9) \div 2 = 8$

**Mean = 6.75 °C, Median = 8 °C. The mean is the better measure: the data is interval and there are no extreme values.**

**Exam tip:** rewrite the data in order and cross out each original value as you copy it, so none get missed. Use the median only when there are extreme values.

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### b. MAD (mean absolute deviation) for London

#### Formula

$MAD = \Sigma |y - \bar{y}| \div n$

#### Solution steps

- $\bar{y} = 72 \div 8 = 9$
- $|y - 9|$ : 6, 9, 1, 5, 8, 0, 3, 2, sum = 34
- $MAD = 34 \div 8 = 4.25$

**MAD = 4.25 °C**

**Exam tip:** the mean (9) is a step on the way, not part of the answer.

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### c. Interquartile range for London

#### Formula

Location  $L = (n + 1) \times P \div 100$ , then the value at that location.     $IQR = Q3 - Q1$

#### Solution steps

- Q1:  $L = 9 \times 0.25 = 2.25$ . Start at the 2nd value (4), go 0.25 of the way to the 3rd (6):  $4 + 0.25 \times 2 = 4.5$
- Q3:  $L = 9 \times 0.75 = 6.75$ . Start at the 6th value (11), go 0.75 of the way to the 7th (15):  $11 + 0.75 \times 4 = 14$
- $IQR = 14 - 4.5 = 9.5$

**IQR = 9.5 °C**

**Exam tip:** location first, then value. The location is a position in the ordered list, not a temperature.

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**d. Which city has relatively more variation? (London  $s = 5.6061$ )**

**What is the question really asking?**

"Relatively" means compare the coefficient of variation, not the standard deviation.

**Formula**

$$s^2 = \Sigma(x - \bar{x})^2 \div (n - 1), \quad s = \sqrt{s^2}, \quad CV = s \div \bar{x}$$

**Solution steps**

- Toronto deviations from 6.75: 5.25, 0.25, -9.75, 3.25, 2.25, -7.75, 9.25, -2.75 (check: they sum to 0)
- Squared:  $27.5625 + 0.0625 + 95.0625 + 10.5625 + 5.0625 + 60.0625 + 85.5625 + 7.5625 = 291.5$
- $s^2 = 291.5 \div 7 = 41.6429$ ,  $s = 6.4531$
- $CV \text{ Toronto} = 6.4531 \div 6.75 = 0.9560$  ·  $CV \text{ London} = 5.6061 \div 9 = 0.6229$

**Toronto:  $CV \ 0.956 > \text{London's } 0.623$ , so Toronto has relatively more variation.**

**Exam tip:** find the variance first, then take the square root. Use the shortcut formula if you prefer: same answer.

Note: the video says "covariance" where it means the coefficient of variation. The numbers are right.

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### Question 3 (Harborfront House Restaurant survey)

Let **D** = ate on a weekday (so **not D** = weekend) and **L** = ate at lunch (so **not L** = dinner).  
Given:  $P(L) = 0.39$ ,  $P(\text{not } D) = 0.27$ ,  $P(D \text{ and not } L) = 0.595$

**Set-up: build the joint probability table first**

**What is the question really asking?**

Every part comes straight from this table, so fill it in before anything else.

**Solution steps**

- $P(D) = 1 - 0.27 = 0.73$  ·  $P(\text{not } L) = 1 - 0.39 = 0.61$
- $P(D \text{ and } L) = 0.73 - 0.595 = 0.135$
- $P(\text{not } D \text{ and } L) = 0.39 - 0.135 = 0.255$
- $P(\text{not } D \text{ and not } L) = 0.27 - 0.255 = 0.015$

|                 | L (lunch) | not L (dinner) | Total |
|-----------------|-----------|----------------|-------|
| D (weekday)     | 0.135     | 0.595          | 0.73  |
| not D (weekend) | 0.255     | 0.015          | 0.27  |
| Total           | 0.39      | 0.61           | 1     |

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**Opening question: P(lunch or weekend)**

**Formula**

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

**Solution steps**

$$P(L \text{ or not } D) = 0.39 + 0.27 - 0.255 = 0.405$$

0.405

**Exam tip:** this question sits above parts a to d and is easy to skip. It's worth marks.

**Note:** the video doesn't answer this part.

**a. Are "weekend" and "dinner time" mutually exclusive?**

**Rule**

Mutually exclusive means  $P(A \text{ and } B) = 0$  .

**Solution steps**

$P(\text{not D and not L}) = 0.015$  (from the table), and  $0.015 \neq 0$

**No.  $P(\text{weekend and dinner}) = 0.015$ , which is not 0, so they are not mutually exclusive.**

**Exam tip:** "Explain mathematically" means the number has to be in your answer. A plain "no" gets no marks.

Note: the video uses 0.595 (weekday and dinner). The right number is 0.015. The conclusion is the same.

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**b.  $P(\text{weekday, given lunch})$**

**Formula**

$$P(A | B) = P(A \text{ and } B) \div P(B)$$

**Solution steps**

$$P(D | L) = 0.135 \div 0.39 = 0.34615$$

**0.3462**

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**c.  $P(\text{lunch and weekday})$**

**Solution steps**

Read it straight from the table:  $P(L \text{ and } D) = 0.135$

**0.135**

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**d. Are "weekday" and "lunch time" independent?**

**Rule**

Independent means  $P(A | B) = P(A)$  .

**Solution steps**

$$P(D | L) = 0.3462 \text{ (part b) and } P(D) = 0.73. \quad 0.3462 \neq 0.73$$

**No.  $P(\text{weekday} | \text{lunch}) = 0.3462$  is not equal to  $P(\text{weekday}) = 0.73$ , so they are not independent.**

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