

Answer Key: Data Visualization Advanced

Grade 7 Mathematics - Hard Difficulty
Total Marks: 120

Section A: Visual Interpretation Challenges

Question 1: Pie Chart Puzzle

Total: 7 marks

a. Calculate students in each subject (4 marks)

- Total degrees in circle = 360°
- Math angle = 100° , Science angle = 120°
- Remaining degrees = $360^\circ - 100^\circ - 120^\circ = 140^\circ$
- Arts angle = English angle = $140^\circ \div 2 = 70^\circ$ each

Number of students: - Math: $(100^\circ/360^\circ) \times 360 = 100$ students - Science: $(120^\circ/360^\circ) \times 360 = 120$ students
- Arts: $(70^\circ/360^\circ) \times 360 = 70$ students - English: $(70^\circ/360^\circ) \times 360 = 70$ students

b. Verify claim about Math students (3 marks)

- $1/4$ of 360 students = 90 students
- Math has 100 students
- Since $100 > 90$, the claim "More than $1/4$ prefer Math" is **mathematically correct**

Question 2: Waffle Diagram Logic Trap

Total: 5 marks

a. Verify laptop claim (2 marks)

- Laptop: 40 squares = 40%
- Tablet: 24 squares = 24%
- $40 \div 24 = 1.67$ (not exactly 2)
- **Claim is false** - laptops are preferred by 1.67 times as many people, not exactly twice

b. Identify logical error (3 marks)

- Smartphones: 28 squares = 28%
- Tablets: 24 squares = 24%
- Combined: $28\% + 24\% = 52\%$
- **Error:** 52% is not exactly half (50%)
- The company rounded or made an approximation error

Section B: Construction and Analysis

Question 3: Scatter Diagram Detective Work

Total: 7 marks

a. **Explain contradictory data points (4 marks)** Possible explanations:

- **Individual differences:** Some students are naturally better test-takers regardless of sleep
- **Study quality:** The 5-hour student may have studied more effectively
- **Other factors:** Stress levels, breakfast, prior knowledge, test anxiety
- **Data collection error:** Misreported sleep hours or test scores

b. **Predict score for 7.5 hours (3 marks)**

- Looking at trend: 7 hours \approx 80-90, 8 hours \approx 90-100
- Predicted range: **85-95%**
- Method: Linear interpolation between existing data points
- Justification: Strong positive correlation suggests this range is reasonable

Question 4: Histogram Frequency Trick

Total: 8 marks

a. **Identify misleading elements and calculate frequency density (5 marks)** Misleading because: Unequal intervals shown with equal bar widths distorts frequency density

Interval widths: - 0-20: width = 20 - 20-35: width = 15

- 35-55: width = 20 - 55-80: width = 25

Frequency density = frequency \div class width: - 0-20: $5 \div 20 = 0.25$ - 20-35: $10 \div 15 = 0.67$ - 35-55: $10 \div 20 = 0.50$

- 55-80: $5 \div 25 = 0.20$

b. **Redesign with correct proportions (3 marks)** Bar widths should be proportional to interval widths:

- 0-20: width 4 units ($20 \div 5$), height 5
- 20-35: width 3 units ($15 \div 5$), height 10
- 35-55: width 4 units ($20 \div 5$), height 10
- 55-80: width 5 units ($25 \div 5$), height 5

Section C: Multi-Step Problem Solving

Question 5: Data Representation Strategy Game

Total: 12 marks

a. **Create frequency tables (6 marks)**

(i) **Histogram with 5 equal intervals:** Range: $16-65 = 49$, so interval width = $49 \div 5 \approx 10$

Interval Frequency

16-25 6

26-35 5

36-45 4

46-55 3

56-65 2

(ii) **Pie chart with 4 age groups:** | Age Group | Count | Percentage | Angle | | — — — | — — — | — — — | — — — | |
 16-25 | 6 | 30% | 108° | | 26-35 | 5 | 25% | 90° | | 36-50 | 6 | 30% | 108° | | 51-65 | 3 | 15% | 54° |

- b. **Best for “young adults” claim (3 marks) Pie chart with strategic grouping:** Group 16-35 as “young adults” (55% of total) This clearly shows majority are young adults
- c. **Best for “broad age appeal” (3 marks)**
Histogram with equal intervals: Shows relatively even distribution across age ranges Demonstrates consistent appeal across different age groups

Question 6: Misleading Chart Challenge

Total: 13 marks

- a. **Calculate weighted average (4 marks)** Weighted average = $\Sigma(\text{hours} \times \text{sample size}) \div \text{total sample size} = (8.2 \times 50 + 6.8 \times 200 + 4.5 \times 300 + 3.2 \times 100) \div (50 + 200 + 300 + 100) = (410 + 1360 + 1350 + 320) \div 650 = 3340 \div 650 = \mathbf{5.14 \text{ hours}}$
- b. **Three major errors (6 marks)**
 - 1. **Ignores sample sizes:** Should weight by number of people in each group
 - 2. **Wrong chart type:** Pie charts show parts of whole, not independent measurements
 - 3. **Misleading proportions:** Raw hours don’t represent population proportions
- c. **Recommended chart type (3 marks) Bar chart or column chart** showing:
 - X-axis: Age groups
 - Y-axis: Average daily hours
 - Bar heights proportional to usage hours
 - Include sample sizes as labels

Question 7: Advanced Correlation Analysis

Total: 7 marks

- a. **Correlation strength (3 marks) Strong positive correlation** (approximately 0.7-0.8)
 - Clear upward trend with most points following the pattern
 - Few outliers, general linear relationship visible
 - Strong enough to make reasonable predictions
- b. **Identify logical fallacy (4 marks) Fallacy:** Confusing correlation with causation **Counterarguments:**
 - Other factors affect grades: natural ability, teaching quality, prior knowledge
 - Reverse causation possible: good students may choose to study more
 - Lurking variables: family support, socioeconomic status, health

Section D: Critical Thinking Extensions

Question 8: Perfect Data Presentation

Total: 12 marks

- a. **Three different representations (9 marks)**

School Board (formal): - Bar chart with exact percentages labeled - Professional color scheme, clear axis labels
- Include trend line and statistical summary

Parents (accessible): - Simple pie chart with friendly colors - Focus on “Most days show good attendance” - Minimize Friday’s lower number, emphasize overall positive

Students (engaging): - Creative visual like attendance “thermometer” - Gamification elements, progress indicators - Challenge format: “Can we get Friday to 85%?”

b. Predict misinterpretations (3 marks)

- **Board:** May focus only on Friday drop, miss overall trend
- **Parents:** May not notice day-to-day variations
- **Students:** May see it as game rather than serious issue

Question 9: Data Transformation Logic

Total: 10 marks

a. Pie chart angles (4 marks)

- Spring: $(28/100) \times 360^\circ = 100.8^\circ$
- Summer: $(40/100) \times 360^\circ = 144^\circ$
- Autumn: $(16/100) \times 360^\circ = 57.6^\circ$
- Winter: $(16/100) \times 360^\circ = 57.6^\circ$

b. Scale to 250 people (3 marks)

- Spring: $28\% \times 250 = 70$ people
- Summer: $40\% \times 250 = 100$ people
- Autumn: $16\% \times 250 = 40$ people
- Winter: $16\% \times 250 = 40$ people

c. Create grouped histogram (3 marks)

- Warm seasons (Spring + Summer): 70 people (68%)
- Cool seasons (Autumn + Winter): 40 people (32%)
- Frequency ratio: 1.75:1 (warm:cool)

Question 10: Statistical Reasoning Challenge

Total: 12 marks

a. Three statistical problems (6 marks)

1. **Different sample sizes:** 50 vs 500 people - not comparable
2. **Selection bias:** Who chose to continue using the app?
3. **No control group:** Were these the same people? Other factors?

b. Design reliable study (6 marks) Improved design:

- **Same participants:** Track same 200 people before/after
- **Control group:** 100 use app, 100 don't
- **Duration:** Measure for 3 months consistently
- **Data collection:** Automatic tracking, not self-reported

- **Chart type:** Line graph showing progress over time
 - **Controls:** Similar age, activity level, motivation
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Teaching Notes

Common Mistakes to Watch For:

- **Pie chart calculations:** Students often forget total degrees = 360°
- **Frequency density:** Confusing frequency with frequency density in histograms
- **Correlation vs causation:** Assuming correlation implies cause-and-effect
- **Scale awareness:** Not noticing when axes or intervals are misleading
- **Sample size importance:** Ignoring how sample size affects reliability

Extension Activities:

- **Real data collection:** Have students survey classmates and create multiple representations
- **Media analysis:** Find misleading charts in newspapers/websites and critique them
- **Chart makeover:** Take a poorly designed chart and improve it
- **Prediction games:** Use scatter plots to make and test predictions

Assessment Criteria:

- **Excellent (100-120 marks):** Demonstrates sophisticated understanding of data representation, identifies subtle misleading elements, provides nuanced explanations
- **Good (80-99 marks):** Shows solid grasp of chart types and calculations, recognizes obvious errors, explains reasoning clearly
- **Satisfactory (60-79 marks):** Can perform basic calculations and interpretations, may miss some misleading elements
- **Needs Support (<60 marks):** Struggles with chart interpretation, calculation errors, requires additional practice with fundamentals

Key Misconceptions to Address:

- **“Bigger bars always mean more important”:** Teach about frequency density and appropriate scaling
 - **“Correlation means causation”:** Emphasize lurking variables and alternative explanations
 - **“All charts show the same information equally well”:** Demonstrate how chart choice affects interpretation
 - **“Visual representations are always accurate”:** Develop critical analysis skills for misleading graphics
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This answer key corresponds to: data-visualization-advanced.md