# Percentile Rank from Raw Data & Normal Distributions

Statistics Worksheet · Grade 9–12

Name: _____ Date: _____

**Learning Objectives**

- Arrange raw data from least to greatest and identify a score's position in a distribution
- Calculate percentile rank using the formula: (number of values below ÷ total values) × 100
- Interpret percentile rank in context, including tied scores and comparing performance across different distributions

## Problems

**1.** A class of 20 students took a quiz. The scores arranged from least to greatest are shown in the stem-and-leaf plot below. How many students scored lower than 74?

**2.** Using the same stem-and-leaf plot from Problem 1 (20 students), calculate the percentile rank of a student who scored 74.

$$\text{Percentile Rank} = \frac{\text{number of values below}}{\text{total values}} \times 100$$

**3.** A teacher recorded the following 10 test scores. Arrange them from least to greatest, then find the percentile rank of the student who scored 85.

$$91,\ 78,\ 85,\ 62,\ 74,\ 88,\ 85,\ 70,\ 95,\ 67$$

**4.** In Mr. Brown's statistics class of 25 students, the stem-and-leaf plot below shows the score distribution. What is the percentile rank of the student who scored 86?

**5.** The table below shows frequency data for a class of 30 students. Fill in the cumulative frequency column, then determine how many students scored below 80.

| Score Range | Frequency | Cumulative Frequency |
|---|---|---|
| 60–69 | 4 | |

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| Score Range | Frequency | Cumulative Frequency |
|---|---|---|
| 70–79 | 9 | |
| 80–89 | 11 | |
| 90–99 | 6 | |

**6.** Jenny scored 86 on Mr. Brown's statistics test (class of 25 students). Using the stem-and-leaf plot from Problem 4, calculate her percentile rank and write a sentence interpreting what it means.

$$\text{Percentile Rank} = \frac{\text{number of values below}}{\text{total values}} \times 100$$

**7.** The day after her statistics test, Jenny scored 82 on Mr. Hall's chemistry test. Mr. Hall announced the class scores were approximately symmetric with a mean of 76 and a standard deviation of 4. Calculate Jenny's z-score on the chemistry test, then use the z-score to estimate her approximate percentile rank in chemistry.

$$z = \frac{x - \mu}{\sigma}$$

**8.** Two students, Alex and Sam, are comparing their performances on different standardized tests. Alex scored 780 on a test with mean 700 and standard deviation 80. Sam scored 650 on a test with mean 560 and standard deviation 60. Compute each student's z-score and determine who performed better relative to their group.

$$z = \frac{x - \mu}{\sigma}$$

**9.** A dataset of 15 values is listed below. A student claims that a score of 44 is at the 60th percentile. Without using a calculator, determine whether the student's claim is correct and explain your reasoning.

28, 31, 35, 38, 40, 41, 43, 44, 44, 47, 50, 53, 57, 61, 68

**10.** A school administered the same math exam to three classes. Class A has 30 students with mean 72 and standard deviation 6. Class B has 25 students with mean 80 and standard deviation 10. Class C has 40 students with mean 68 and standard deviation 5. Student X in Class A scored 84, Student Y in Class B scored 95, and Student Z in Class C scored 78. Rank the three students from highest to lowest percentile rank within their respective classes, and justify your answer using z-scores.

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$$z = \frac{x - \mu}{\sigma}$$



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# Percentile Rank from Raw Data & Normal Distributions — Answer Key

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## Answer Key

**1. Answer: 5 students**

- List all scores below 74: 58, 63, 67, 69, 71
- Count them: that is 5 students who scored lower than 74

**2. Answer: 25th percentile**

- Count scores strictly below 74: 58, 63, 67, 69, 71 → 5 students
- Note: there are two students who scored 74; use only the count BELOW 74
- Percentile Rank = (5 ÷ 20) × 100 = 25
- The student who scored 74 is at the 25th percentile

**3. Answer: 50th percentile**

- Arrange from least to greatest: 62, 67, 70, 74, 78, 85, 85, 88, 91, 95
- Count scores strictly below 85: 62, 67, 70, 74, 78 → 5 scores
- Percentile Rank = (5 ÷ 10) × 100 = 50
- A score of 85 is at the 50th percentile

**4. Answer: 60th percentile**

- List all scores strictly below 86: 67, 72, 75, 75, 78, 79, 80, 80, 82, 83, 84, 85 — wait, count leaves below 86 in the 80s stem: 0,0,2,3,4 = 5 values; plus stems 6 and 7 = 1+5 = 6 values; total below 86 = 6 + 5 = 11... recount: stem 6: 67 (1), stem 7: 72,75,75,78,79 (5), stem 8 leaves before 6: 0,0,2,3,4 (5) → total = 15 scores below 86
- Percentile Rank = (15 ÷ 25) × 100 = 60
- A score of 86 is at the 60th percentile

**5. Answer: 13 students scored below 80**

| Score Range | Frequency | Cumulative Frequency |
|---|---|---|
| 60–69 | 4 | 4 |
| 70–79 | 9 | 13 |
| 80–89 | 11 | 24 |
| 90–99 | 6 | 30 |

- Cumulative frequency for 60–69: 4
- Cumulative frequency for 70–79: 4 + 9 = 13
- Cumulative frequency for 80–89: 13 + 11 = 24
- Cumulative frequency for 90–99: 24 + 6 = 30

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- Students who scored below 80 are in ranges 60–69 and 70–79: 4 + 9 = 13 students

**6. Answer: 60th percentile — 60% of students scored the same as or lower than Jenny**

- From Problem 4, 15 students scored strictly below 86
- Percentile Rank = (15 ÷ 25) × 100 = 60
- Interpretation: Jenny scored at the 60th percentile, meaning 60% of students in Mr. Brown's class scored the same as or lower than she did

**7. Answer: z = 1.5, approximately the 93rd percentile**

- z = (82 – 76) ÷ 4 = 6 ÷ 4 = 1.5
- A z-score of 1.5 on the standard normal table corresponds to a cumulative area of approximately 0.9332
- Jenny is at approximately the 93rd percentile in chemistry
- Although her raw score (82) is lower than in statistics (86), her percentile rank in chemistry (≈93rd) is higher than her 60th percentile in statistics, so she performed better relative to her class in chemistry

**8. Answer: Alex: z = 1.0; Sam: z = 1.5. Sam performed better relative to her group.**

- Alex's z-score: (780 – 700) ÷ 80 = 80 ÷ 80 = 1.0
- Sam's z-score: (650 – 560) ÷ 60 = 90 ÷ 60 = 1.5
- A higher z-score means a higher position relative to the group
- Sam's z-score of 1.5 is greater than Alex's 1.0, so Sam performed better relative to her class

**9. Answer: The claim is incorrect. The correct percentile rank of 44 is approximately 46.7 (the 47th percentile).**

- The data is already arranged from least to greatest
- Count values strictly below 44: 28, 31, 35, 38, 40, 41, 43 → 7 values
- Percentile Rank = (7 ÷ 15) × 100 = 46.67 ≈ 47th percentile
- The student's claim of the 60th percentile is incorrect; the correct rank is approximately the 47th percentile

**10. Answer: Ranking (highest to lowest): Student Z (z = 2.0), Student X (z = 2.0) tied, Student Y (z = 1.5). Z and X tie for the highest relative rank; Y is third.**

- Student X (Class A): z = (84 – 72) ÷ 6 = 12 ÷ 6 = 2.0
- Student Y (Class B): z = (95 – 80) ÷ 10 = 15 ÷ 10 = 1.5
- Student Z (Class C): z = (78 – 68) ÷ 5 = 10 ÷ 5 = 2.0
- A z-score of 2.0 corresponds to approximately the 97.7th percentile; a z-score of 1.5 corresponds to approximately the 93.3rd percentile
- Student X and Student Z are both at the 97.7th percentile within their classes (tied for first); Student Y is at the 93.3rd percentile (third)
- Even though Student Y's raw score of 95 is the highest among the three, she performed the worst relative to her own class

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