

TEACHER AND STUDENT PACKET

# Extreme Values and Their Effects

NC Math 1 • NC.M1.S-ID.3



**Seven instructional sections • 30 multiple-choice items • 30 open and performance tasks**

Detailed teacher scripts, supplied datasets, original data displays, student workspaces, worked keys, rubrics, and observation records.

Reusable across multiple lessons. Choose a focused subset for each session; the 60-item bank is not a one-sitting assessment.

# Free sample | Contents

NC.M1.S-ID.3 | NC Math 1 mathematics

This sample contains 21 complete selected pages from the 123-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-15, 30-31, 61-62, 91-92

Representative activities

M01: sample PDF page(s) 16; original page(s) 15

M02: sample PDF page(s) 16; original page(s) 15

O01: sample PDF page(s) 17; original page(s) 30

O02: sample PDF page(s) 18; original page(s) 31

Selected teacher prompts and keys: original page(s) 61-62, 91-92

Using this sample

Read the preparation and access guidance before using a selected activity.  
Keep teacher keys and private preparation pages separate from student copies.  
Use the original resource contents to see the scope of the complete packet.

Complete paid download

The complete resource includes the full PDF task bank and teaching materials.

**ALIGNMENT**

# Standard, scope, and targets

**Examine the effects of extreme data points (outliers) on shape, center, and/or spread.**

- Compare distributions before and after changing an extreme value.
- Quantify effects on center and spread with consistent conventions.
- Identify outliers using a stated rule and interpret shape changes.
- Explain why unusual observations require investigation rather than automatic deletion.

Every task has its own printed neutral target. All nested scope is included; this standard has no lettered subobjectives. Course placement is NC Math 1, not a fixed grade.

**Bank navigation**

Warm-up: M01-M04 and O01-O04 (4 in each bank).

I Do: M05-M08 and O05-O08 (4 in each bank).

We Do: M09-M13 and O09-O13 (5 in each bank).

Collaborative practice: M14-M18 and O14-O18 (5 in each bank).

Independent practice: M19-M23 and O19-O23 (5 in each bank).

Small-group reteach: M24-M27 and O24-O27 (4 in each bank).

Exit ticket: M28-M30 and O28-O30 (3 in each bank).

## PLANNING AND ACCESS

## Plan for meaningful evidence

Suggested sequence: Session 1, conventions and first model; Session 2, supported construction/comparison; Session 3, independent transfer; Session 4, targeted reteach and an exit performance. Use 35-55 minute lessons flexibly. Save unused bank items for later checks.

Prerequisites: order real numbers, count repeated observations, compute a mean and median, interpret equal-interval scales, and distinguish a count from the measured units. Check these in an unscored mini-task before the selected standard task.

Materials: printed workspaces, pencil, ruler, and school-approved calculator/statistics software. For S-ID.1 every learner needs access to a tool that can produce histograms and ordinary box plots with configurable bins/quartiles or custom plotting from calculated summaries. Secure tool approval and access before assessment; no particular brand, account, or internet access is assumed.

Access: enlarge print, read directions verbatim, provide tactile or high-contrast scales, permit dictation, or use an accessible school-approved plotting tool. Keep data and task demand unchanged. Do not provide completed plots, selected summaries, or answer values as neutral supports. Log any answer-supplying cues separately.

If technology is unavailable, teach the hand construction as preparation. Record N/O for the S-ID.1 technology performance and arrange a later accessible tool session; do not treat a paper substitute as completed technology evidence.

Teacher preparation: run the chosen tool on the worked model, inspect bin endpoints and quartile defaults, and ensure learner exports can be printed or attached. These packet examples are generated illustrations; they do not document any learner's runtime activity.

## REFERENCE

## Conventions and anchor chart

Quartiles: sort the data, take the median, then take the median of each half; exclude the overall median when  $n$  is odd. Ordinary box plots use minimum and maximum whiskers even when a value is flagged. A modified box plot would use fences and separate outlier marks; do not mix the conventions. Outlier flags use values strictly below  $Q1 - 1.5 \times IQR$  or above  $Q3 + 1.5 \times IQR$ . All batches are complete fictional populations, so  $SD = \sqrt{(\sum(x - \text{mean})^2/n)}$ , not sample  $s$  with  $n - 1$ . Report decimal statistics to two places when needed, rounding halfway away from zero; keep intermediate calculations unrounded. All tasks are educational synthetic data, not measurements of children or other identifiable people.

### How to choose summaries

For roughly symmetric distributions without dominating extremes, mean and SD use all observations. For skewed distributions or strong extreme observations, median and IQR often better describe a typical value and the middle half. Always describe the shape first; the mean remains mathematically valid but may poorly describe a typical case.

Histogram: use equal-width bins, state endpoint inclusion, label the measured units horizontally and frequency vertically. Adjacent bins touch. Box plot: locate the five-number summary on one uniform real-number scale. Dot plot: use one dot per observation and stack repeats. Compare groups only on the same horizontal scale.

Outlier reasoning: an outlier rule flags observations for attention. It is not proof of an error. Explain whether the value is valid for the intended population before deciding to correct, remove, or retain it.

## TEACHER DEMONSTRATION

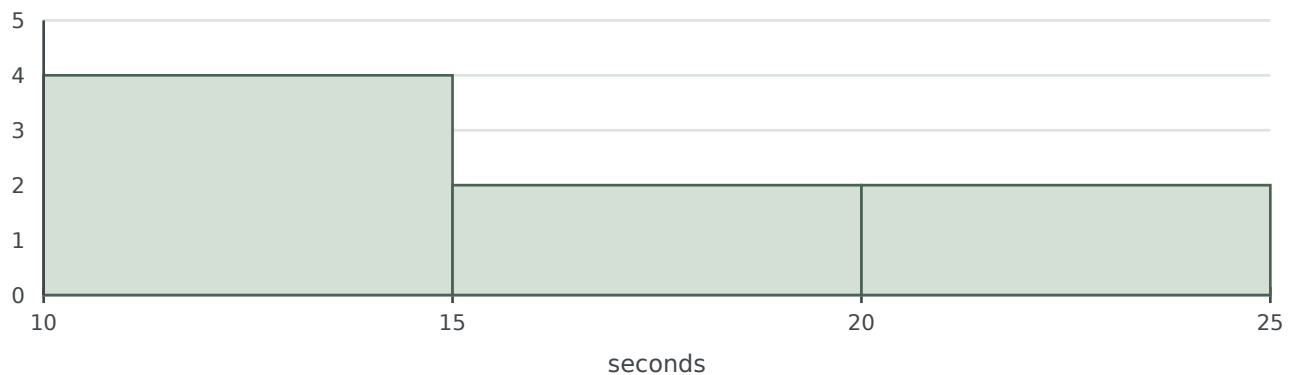
## Worked model: build and check

Fictional machine cycle times (seconds): 10, 12, 12, 14, 16, 18, 20, 22. Sort and check  $n = 8$ . Lower half 10,12,12,14 has median 12. Upper half 16,18,20,22 has median 19. Overall median  $= (12 + 19)/2 = 15.5$ . Mean  $= 124/8 = 15.5$ . IQR  $= 19 - 12 = 7$  seconds.

In the approved tool: clear a new data list; enter all eight values (keep both 12s). Select frequency histogram; set start 10, width 5, end 25 and bins  $[10,15)$ ,  $[15,20)$ ,  $[20,25)$ . Verify counts 4,2,2. Select ordinary box plot. Check min 10, Q1 12, median 15.5, Q3 19, max 22; configure quartiles or plot these coordinates in the tool. Record the settings and save both outputs.

**Frequency histogram**

Frequency

**Ordinary box plot**

## TEACHER DEMONSTRATION

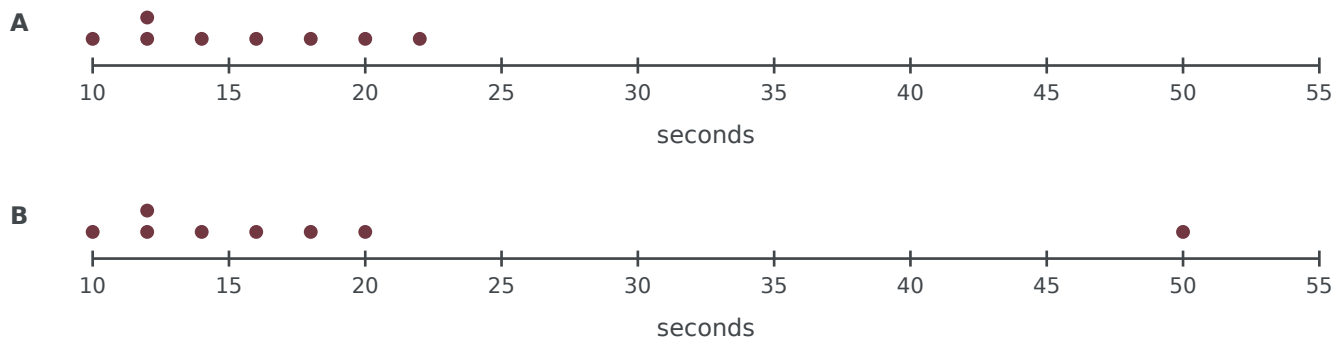
## Worked model: compare and explain

Change the last observation from 22 to 50 seconds. Original: Sorted data: 10, 12, 12, 14, 16, 18, 20, 22.  $n = 8$ ,  $\text{sum} = 124$ ;  $\text{mean} = 124/8 = 15.5$ . Five-number summary (min, Q1, median, Q3, max): (10, 12, 15, 19, 22).  $\text{IQR} = 19 - 12 = 7$ . Sum of squared deviations = 126; population  $\text{SD} = \sqrt{126/8} = 3.97$ . Range = 12. Fence interval: [1.5, 29.5].

Changed: Sorted data: 10, 12, 12, 14, 16, 18, 20, 50.  $n = 8$ ,  $\text{sum} = 152$ ;  $\text{mean} = 152/8 = 19$ . Five-number summary (min, Q1, median, Q3, max): (10, 12, 15, 19, 50).  $\text{IQR} = 19 - 12 = 7$ . Sum of squared deviations = 1176; population  $\text{SD} = \sqrt{1176/8} = 12.12$ . Range = 40. Fence interval: [1.5, 29.5].

The high tail lengthens. Mean rises from 15.5 to 19; median stays 15 and IQR stays 7. SD rises from 3.97 to 12.12 seconds; range rises from 12 to 40 seconds. The new upper fence is 29.5, so 50 is flagged. The graph alone cannot tell whether 50 is an error. Mean/SD are more affected here than median/IQR.

### Aligned dot plots



REPRODUCIBLE

# Reasoning organizer

Learner: \_\_\_\_\_ Date: \_\_\_\_\_ Task: \_\_\_\_\_

**Givens, units, and complete data****Representation / tool and settings****Calculations and checks****Contextual conclusion / limitations**

## TEACHING SCRIPT

## Warm-up

Core performance: O01. Optional bank: M01-M04, O01-O04. Suggested 8-18 minutes for the core discussion; complete tool work over a longer block as needed.

**Target: Examine outlier effects on shape, center, and spread.**

Launch: ask learners what each value measures and why repeated values count separately. First take an unprompted response to the selected M item.

Teacher language: “What must stay the same for this comparison to be fair? Show me where your statement appears in the data or graph. Which convention did you use?”

Core checkpoint for O01: A has  $n = 8$ , mean 114, median 114, IQR 10, population SD 5.59 seconds. B has mean 110.25, median 114, iqr 10, sd 13.77 seconds. Full worked calculations and graphs appear in the task key.

Watch for: dropped repeats, unequal comparison scales, inclusive bins counted twice, confusing SD with variance, and treating a center as a spread. Ask the learner to trace an actual value through the representation. For a quartile discrepancy, inspect the software convention before marking the arithmetic wrong.

Response to a gap: reconstruct the ordered list and mark its two middle positions; then split the halves. For SD, calculate each deviation, square it, average the squares over  $n$ , and take the square root. For S-ID.1, guide navigation without entering the learner’s data or selecting their final answer.

Closure and evidence: preserve the first response, note tool/settings and access supports, then ask for a short contextual conclusion. Record later prompted work separately. Select the next task according to the specific missing representation or interpretation.

## TEACHING SCRIPT

# I Do

Core performance: O05. Optional bank: M05-M08, O05-O08. Suggested 8-18 minutes for the core discussion; complete tool work over a longer block as needed.

**Target: Examine outlier effects on shape, center, and spread.**

Model: narrate the calculation or tool setting while projecting a teacher copy. Keep the original data visible; ask learners to verify one step instead of copying silently.

Teacher language: “What must stay the same for this comparison to be fair? Show me where your statement appears in the data or graph. Which convention did you use?”

Core checkpoint for O05: A has  $n = 8$ , mean 103, median 103, IQR 9, population SD 4.5 seconds. B has mean 98.5, median 103, iqr 9, sd 14.7 seconds. Full worked calculations and graphs appear in the task key.

Watch for: dropped repeats, unequal comparison scales, inclusive bins counted twice, confusing SD with variance, and treating a center as a spread. Ask the learner to trace an actual value through the representation. For a quartile discrepancy, inspect the software convention before marking the arithmetic wrong.

Response to a gap: reconstruct the ordered list and mark its two middle positions; then split the halves. For SD, calculate each deviation, square it, average the squares over  $n$ , and take the square root. For S-ID.1, guide navigation without entering the learner’s data or selecting their final answer.

Closure and evidence: preserve the first response, note tool/settings and access supports, then ask for a short contextual conclusion. Record later prompted work separately. Select the next task according to the specific missing representation or interpretation.

## TEACHING SCRIPT

# We Do

Core performance: O09. Optional bank: M09-M13, O09-O13. Suggested 8-18 minutes for the core discussion; complete tool work over a longer block as needed.

**Target: Examine outlier effects on shape, center, and spread.**

Elicit: have learners propose the scale and compute one checkpoint. Wait for a reason before confirming the value.

Teacher language: “What must stay the same for this comparison to be fair? Show me where your statement appears in the data or graph. Which convention did you use?”

Core checkpoint for O09: A has  $n = 8$ , mean 117, median 117, IQR 12, population SD 5.89 grams. B has mean 113.5, median 117, iqr 12, sd 13.29 grams. Full worked calculations and graphs appear in the task key.

Watch for: dropped repeats, unequal comparison scales, inclusive bins counted twice, confusing SD with variance, and treating a center as a spread. Ask the learner to trace an actual value through the representation. For a quartile discrepancy, inspect the software convention before marking the arithmetic wrong.

Response to a gap: reconstruct the ordered list and mark its two middle positions; then split the halves. For SD, calculate each deviation, square it, average the squares over  $n$ , and take the square root. For S-ID.1, guide navigation without entering the learner’s data or selecting their final answer.

Closure and evidence: preserve the first response, note tool/settings and access supports, then ask for a short contextual conclusion. Record later prompted work separately. Select the next task according to the specific missing representation or interpretation.

## TEACHING SCRIPT

## Collaborative practice

Core performance: O14. Optional bank: M14-M18, O14-O18. Suggested 8-18 minutes for the core discussion; complete tool work over a longer block as needed.

**Target: Examine outlier effects on shape, center, and spread.**

Partner roles: one learner constructs or computes; the other checks against the original list. Switch roles for a second item and retain each learner's explanation.

Teacher language: "What must stay the same for this comparison to be fair? Show me where your statement appears in the data or graph. Which convention did you use?"

Core checkpoint for O14: A has  $n = 8$ , mean 113, median 113, IQR 7, population SD 4.74 mL. B has mean 120, median 114, iqr 9.5, sd 20.3 mL. Full worked calculations and graphs appear in the task key.

Watch for: dropped repeats, unequal comparison scales, inclusive bins counted twice, confusing SD with variance, and treating a center as a spread. Ask the learner to trace an actual value through the representation. For a quartile discrepancy, inspect the software convention before marking the arithmetic wrong.

Response to a gap: reconstruct the ordered list and mark its two middle positions; then split the halves. For SD, calculate each deviation, square it, average the squares over  $n$ , and take the square root. For S-ID.1, guide navigation without entering the learner's data or selecting their final answer.

Closure and evidence: preserve the first response, note tool/settings and access supports, then ask for a short contextual conclusion. Record later prompted work separately. Select the next task according to the specific missing representation or interpretation.

## TEACHING SCRIPT

# Independent practice

Core performance: O19. Optional bank: M19-M23, O19-O23. Suggested 8-18 minutes for the core discussion; complete tool work over a longer block as needed.

**Target: Examine outlier effects on shape, center, and spread.**

Independent evidence: provide only the task and neutral access supports. Collect the first response before discussing corrections.

Teacher language: “What must stay the same for this comparison to be fair? Show me where your statement appears in the data or graph. Which convention did you use?”

Core checkpoint for O19: A has  $n = 8$ , mean 107, median 107, IQR 9, population SD 5.81 cm. B has mean 101.67, median 106, iqr 12.5, sd 16.05 cm. Full worked calculations and graphs appear in the task key.

Watch for: dropped repeats, unequal comparison scales, inclusive bins counted twice, confusing SD with variance, and treating a center as a spread. Ask the learner to trace an actual value through the representation. For a quartile discrepancy, inspect the software convention before marking the arithmetic wrong.

Response to a gap: reconstruct the ordered list and mark its two middle positions; then split the halves. For SD, calculate each deviation, square it, average the squares over  $n$ , and take the square root. For S-ID.1, guide navigation without entering the learner’s data or selecting their final answer.

Closure and evidence: preserve the first response, note tool/settings and access supports, then ask for a short contextual conclusion. Record later prompted work separately. Select the next task according to the specific missing representation or interpretation.

## TEACHING SCRIPT

## Small-group reteach

Core performance: O24. Optional bank: M24-M27, O24-O27. Suggested 8-18 minutes for the core discussion; complete tool work over a longer block as needed.

**Target: Examine outlier effects on shape, center, and spread.**

Diagnose: compare the first response with the original data. Reteach only the missing step, then use a different unused item to check transfer.

Teacher language: “What must stay the same for this comparison to be fair? Show me where your statement appears in the data or graph. Which convention did you use?”

Core checkpoint for O24: A has  $n = 8$ , mean 99, median 99, IQR 7, population SD 4.82 cm. B has mean 104.38, median 99, iqr 7, sd 17.65 cm. Full worked calculations and graphs appear in the task key.

Watch for: dropped repeats, unequal comparison scales, inclusive bins counted twice, confusing SD with variance, and treating a center as a spread. Ask the learner to trace an actual value through the representation. For a quartile discrepancy, inspect the software convention before marking the arithmetic wrong.

Response to a gap: reconstruct the ordered list and mark its two middle positions; then split the halves. For SD, calculate each deviation, square it, average the squares over  $n$ , and take the square root. For S-ID.1, guide navigation without entering the learner’s data or selecting their final answer.

Closure and evidence: preserve the first response, note tool/settings and access supports, then ask for a short contextual conclusion. Record later prompted work separately. Select the next task according to the specific missing representation or interpretation.

## TEACHING SCRIPT

# Exit ticket

Core performance: O28. Optional bank: M28-M30, O28-O30. Suggested 8-18 minutes for the core discussion; complete tool work over a longer block as needed.

**Target: Examine outlier effects on shape, center, and spread.**

Close: use the selected exit task without answer cues. Ask for one graph feature and one numerical statement that agree.

Teacher language: “What must stay the same for this comparison to be fair? Show me where your statement appears in the data or graph. Which convention did you use?”

Core checkpoint for O28: A has  $n = 8$ , mean 103, median 103, IQR 10, population SD 5.85 minutes. B has mean 106.75, median 103, iqr 10, sd 14.15 minutes. Full worked calculations and graphs appear in the task key.

Watch for: dropped repeats, unequal comparison scales, inclusive bins counted twice, confusing SD with variance, and treating a center as a spread. Ask the learner to trace an actual value through the representation. For a quartile discrepancy, inspect the software convention before marking the arithmetic wrong.

Response to a gap: reconstruct the ordered list and mark its two middle positions; then split the halves. For SD, calculate each deviation, square it, average the squares over  $n$ , and take the square root. For S-ID.1, guide navigation without entering the learner’s data or selecting their final answer.

Closure and evidence: preserve the first response, note tool/settings and access supports, then ask for a short contextual conclusion. Record later prompted work separately. Select the next task according to the specific missing representation or interpretation.

## MULTIPLE CHOICE

# M01 and M02

**M01 • Warm-up • Measure the effect of an extreme point on mean.**

**Fictional machine cycle times (seconds), original A: 108, 109, 110, 115, 119, 124, 125, 126. Create B: replace the largest value 126 with 158. B is 108, 109, 110, 115, 119, 124, 125, 158. What is the change B minus A in mean? Round only the final difference to two decimals.**

- A. 0.00 seconds
- B. 4.00 seconds
- C. 7.00 seconds
- D. 11.00 seconds

Reasoning / data check: \_\_\_\_\_

**M02 • Warm-up • Measure the effect of an extreme point on median.**

**Fictional machine cycle times (seconds), original A: 91, 94, 95, 96, 102, 103, 104, 107. Create B: replace the smallest value 91 with 50. B is 50, 94, 95, 96, 102, 103, 104, 107. What is the change B minus A in median? Round only the final difference to two decimals.**

- A. -5.00 seconds
- B. -2.00 seconds
- C. -6.50 seconds
- D. 0.00 seconds

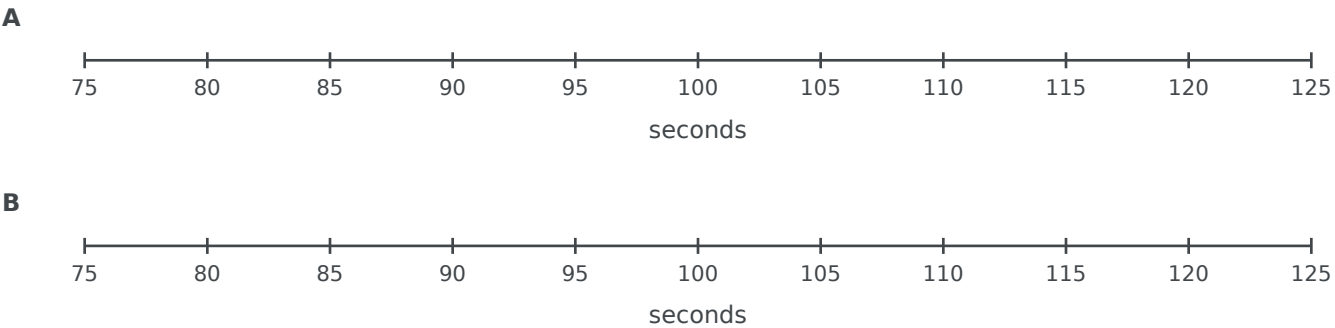
Reasoning / data check: \_\_\_\_\_

OPEN / PERFORMANCE

# 001 • Warm-up

Target: Examine outlier effects on shape, center, and spread.

The original complete fictional batch of machine cycle times (seconds) is A: 106, 108, 110, 111, 117, 118, 120, 122. For a sensitivity study, replace the smallest value 106 with 76; B: 76, 108, 110, 111, 117, 118, 120, 122. Construct aligned dot plots for A and B. Calculate mean, median, IQR, population SD, and range before and after. Calculate B minus A for each. Describe how shape changes and explain which summaries move most. Test the new extreme against B’s  $1.5 \times \text{IQR}$  fences. Explain why an outlier flag alone is not permission to delete a measurement; give one reason to retain it and one reason to investigate it. Construct aligned plots: one dot per observation



Calculations: use the continuation sheet if needed

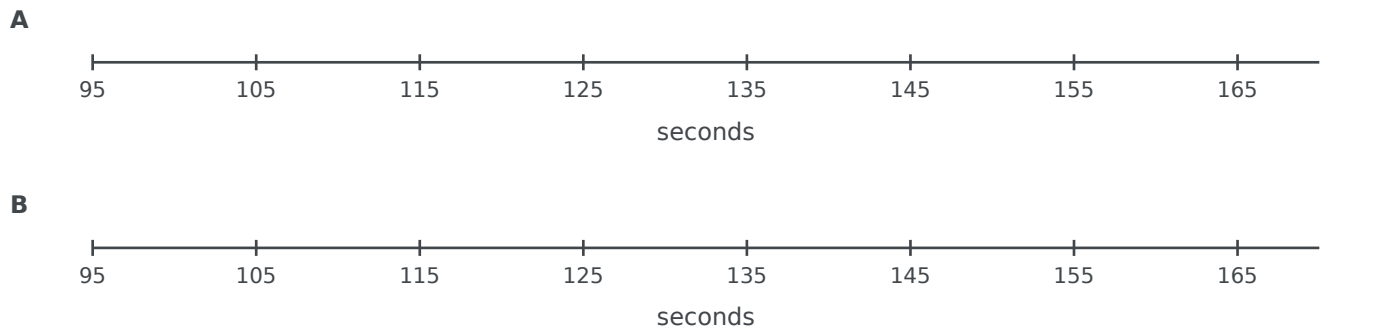
Shape, contextual comparison, and explanation

OPEN / PERFORMANCE

# 002 • Warm-up

Target: Examine outlier effects on shape, center, and spread.

The original complete fictional batch of machine cycle times (seconds) is A: 97, 99, 100, 103, 109, 112, 113, 115. For a sensitivity study, add the value 166; B: 97, 99, 100, 103, 109, 112, 113, 115, 166. Construct aligned dot plots for A and B. Calculate mean, median, IQR, population SD, and range before and after. Calculate B minus A for each. Describe how shape changes and explain which summaries move most. Test the new extreme against B’s  $1.5 \times \text{IQR}$  fences. Explain why an outlier flag alone is not permission to delete a measurement; give one reason to retain it and one reason to investigate it. Construct aligned plots: one dot per observation



Calculations: use the continuation sheet if needed

Shape, contextual comparison, and explanation

## TEACHER KEY

**M01 • worked key****M01 target: Measure the effect of an extreme point on mean.****Answer B: 4.00 seconds**

Original A: Sorted data: 108, 109, 110, 115, 119, 124, 125, 126.  $n = 8$ ,  $\text{sum} = 936$ ;  $\text{mean} = 936/8 = 117$ . Five-number summary (min, Q1, median, Q3, max): (108, 109.5, 117, 124.5, 126).  $\text{IQR} = 124.5 - 109.5 = 15$ . Sum of squared deviations = 396; population  $\text{SD} = \sqrt{(396/8)} = 7.04$ . Range = 18. Fence interval: [87, 147]. Changed B: Sorted data: 108, 109, 110, 115, 119, 124, 125, 158.  $n = 8$ ,  $\text{sum} = 968$ ;  $\text{mean} = 968/8 = 121$ . Five-number summary (min, Q1, median, Q3, max): (108, 109.5, 117, 124.5, 158).  $\text{IQR} = 124.5 - 109.5 = 15$ . Sum of squared deviations = 1868; population  $\text{SD} = \sqrt{(1868/8)} = 15.28$ . Range = 50. Fence interval: [87, 147]. B - A for mean = 4 seconds, calculated before rounding. A: 0 differs from the recomputed 4; check the stated statistic, operation, and rounding rather than infer a misconception from this choice alone. B: agrees with the calculation. C: 7 differs from the recomputed 4; check the stated statistic, operation, and rounding rather than infer a misconception from this choice alone. D: 11 differs from the recomputed 4; check the stated statistic, operation, and rounding rather than infer a misconception from this choice alone.

Evidence: a selected letter alone is recognition evidence. Ask for the calculation or graph feature supporting the choice before attributing a specific misconception. Use the matching performance task to examine construction and explanation.

## TEACHER KEY

**M02 • worked key****M02 target: Measure the effect of an extreme point on median.****Answer D: 0.00 seconds**

Original A: Sorted data: 91, 94, 95, 96, 102, 103, 104, 107.  $n = 8$ ,  $\text{sum} = 792$ ;  $\text{mean} = 792/8 = 99$ . Five-number summary (min, Q1, median, Q3, max): (91, 94.5, 99, 103.5, 107).  $\text{IQR} = 103.5 - 94.5 = 9$ . Sum of squared deviations = 228; population  $\text{SD} = \sqrt{(228/8)} = 5.34$ . Range = 16. Fence interval: [81, 117]. Changed B: Sorted data: 50, 94, 95, 96, 102, 103, 104, 107.  $n = 8$ ,  $\text{sum} = 751$ ;  $\text{mean} = 751/8 = 93.88$ . Five-number summary (min, Q1, median, Q3, max): (50, 94.5, 99, 103.5, 107).  $\text{IQR} = 103.5 - 94.5 = 9$ . Sum of squared deviations = 2354.88; population  $\text{SD} = \sqrt{(2354.88/8)} = 17.16$ . Range = 57. Fence interval: [81, 117]. B - A for median = 0 seconds, calculated before rounding. A: -5 differs from the recomputed 0; check the stated statistic, operation, and rounding rather than infer a misconception from this choice alone. B: -2 differs from the recomputed 0; check the stated statistic, operation, and rounding rather than infer a misconception from this choice alone. C: -6.5 differs from the recomputed 0; check the stated statistic, operation, and rounding rather than infer a misconception from this choice alone. D: agrees with the calculation.

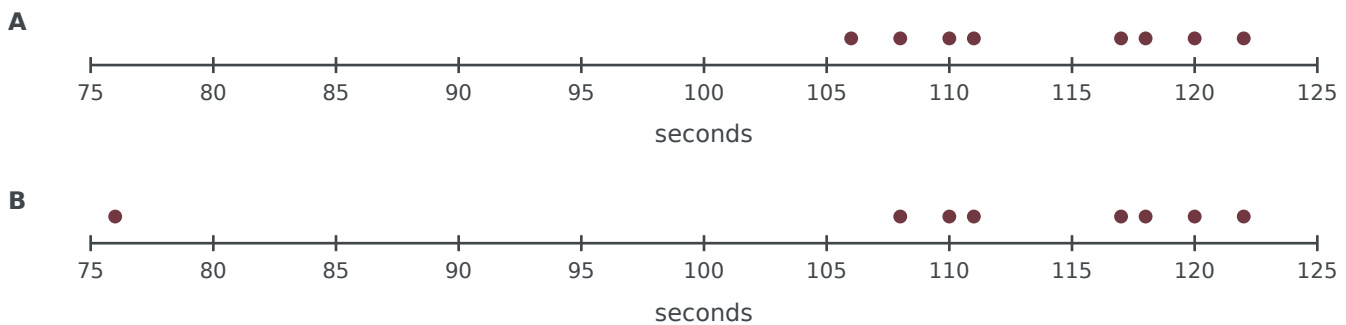
Evidence: a selected letter alone is recognition evidence. Ask for the calculation or graph feature supporting the choice before attributing a specific misconception. Use the matching performance task to examine construction and explanation.

## TEACHER KEY

## 001 • worked key

**Target: Examine outlier effects on shape, center, and spread.**

Original A: Sorted data: 106, 108, 110, 111, 117, 118, 120, 122.  $n = 8$ ,  $\text{sum} = 912$ ;  $\text{mean} = 912/8 = 114$ . Five-number summary (min, Q1, median, Q3, max): (106, 109, 114, 119, 122).  $\text{IQR} = 119 - 109 = 10$ . Sum of squared deviations = 250; population  $\text{SD} = \sqrt{(250/8)} = 5.59$ . Range = 16. Fence interval: [94, 134]. Changed B: Sorted data: 76, 108, 110, 111, 117, 118, 120, 122.  $n = 8$ ,  $\text{sum} = 882$ ;  $\text{mean} = 882/8 = 110.25$ . Five-number summary (min, Q1, median, Q3, max): (76, 109, 114, 119, 122).  $\text{IQR} = 119 - 109 = 10$ . Sum of squared deviations = 1517.5; population  $\text{SD} = \sqrt{(1517.5/8)} = 13.77$ . Range = 46. Fence interval: [94, 134]. Changes B - A: mean: -3.75 seconds; median: 0 seconds; iqr: 0 seconds; sd: 8.18 seconds; range: 30 seconds. A is symmetric; B develops a long left tail. The mean moves toward 76; the range and SD increase. Compare the numerical changes rather than claiming that every resistant statistic is always unchanged. The median and IQR use positions and generally move less here; adding a value can change their positions. New extreme 76 is outside B's fence interval [94, 134] and is flagged. Retain it if it is a genuine measurement in the intended population; investigate units, instrument behavior, or entry records if accuracy is uncertain. Correct an error only with evidence. These are fictional batches, so the sensitivity study itself cannot establish why an extreme happened.

**Aligned dot plots**

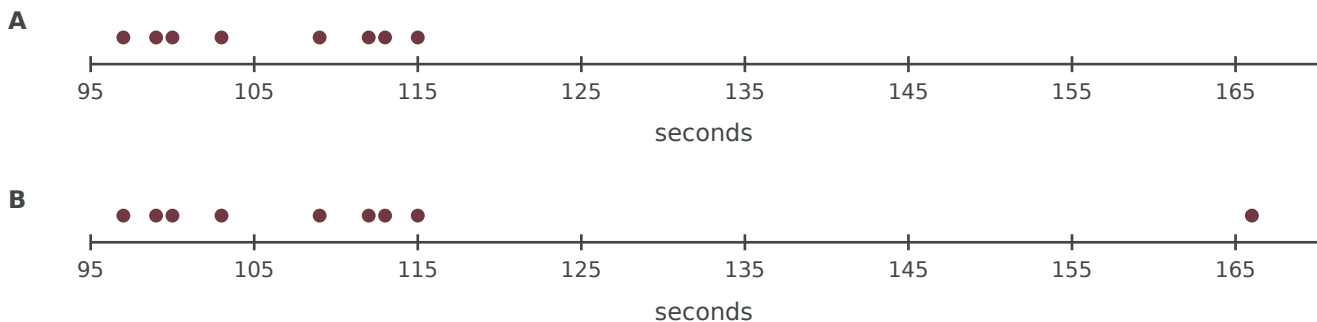
Assess: accurate representation; correct calculations/conventions; reasoning tied to evidence; contextual conclusion with units. Accept equivalent exact calculations and defensible explanations. Use the dimension rubric; record actual tool use separately where required.

## TEACHER KEY

## 002 • worked key

**Target: Examine outlier effects on shape, center, and spread.**

Original A: Sorted data: 97, 99, 100, 103, 109, 112, 113, 115.  $n = 8$ ,  $\text{sum} = 848$ ;  $\text{mean} = 848/8 = 106$ . Five-number summary (min, Q1, median, Q3, max): (97, 99.5, 106, 112.5, 115).  $\text{IQR} = 112.5 - 99.5 = 13$ . Sum of squared deviations = 350; population  $\text{SD} = \sqrt{(350/8)} = 6.61$ . Range = 18. Fence interval: [80, 132]. Changed B: Sorted data: 97, 99, 100, 103, 109, 112, 113, 115, 166.  $n = 9$ ,  $\text{sum} = 1014$ ;  $\text{mean} = 1014/9 = 112.67$ . Five-number summary (min, Q1, median, Q3, max): (97, 99.5, 109, 114, 166).  $\text{IQR} = 114 - 99.5 = 14.5$ . Sum of squared deviations = 3550; population  $\text{SD} = \sqrt{(3550/9)} = 19.86$ . Range = 69. Fence interval: [77.75, 135.75]. Changes B - A: mean: 6.67 seconds; median: 3 seconds; iqr: 1.5 seconds; sd: 13.25 seconds; range: 51 seconds. A is symmetric; B develops a long right tail. The mean moves toward 166; the range and SD increase. Compare the numerical changes rather than claiming that every resistant statistic is always unchanged. The median and IQR use positions and generally move less here; adding a value can change their positions. New extreme 166 is outside B's fence interval [77.75, 135.75] and is flagged. Retain it if it is a genuine measurement in the intended population; investigate units, instrument behavior, or entry records if accuracy is uncertain. Correct an error only with evidence. These are fictional batches, so the sensitivity study itself cannot establish why an extreme happened.

**Aligned dot plots**

Assess: accurate representation; correct calculations/conventions; reasoning tied to evidence; contextual conclusion with units. Accept equivalent exact calculations and defensible explanations. Use the dimension rubric; record actual tool use separately where required.