Calibration Curves, Linear Models, and Residual Limits

Student Worksheet | g11_u01_w03

Scope: These are original fictional calibration cards, not instructions for using an instrument. Use the stated model only within its supplied range.

1. A card maps concentration x to signal y: $(0, 0.010), (2, 0.170), (4, 0.330), (6, 0.490)$. Find slope using endpoints.

2. Write the endpoint line equation.

3. Use the line to predict signal at $x = 3.0$.

4. A signal is 0.250. Infer x from the line.

5. Find the residual for the $x = 2$ point using your line.

6. Find the residual for the $x = 4$ point.

7. Explain what a residual sign tells you.

8. Is $x = 9$ interpolation or extrapolation? State the model-limit concern.

9. A second card has $y = 0.075x + 0.020$. Infer x when $y = 0.245$.

10. If the signal uncertainty is ± 0.006, estimate Δx for item 9 from $\Delta x = \Delta y / m$.

11. Which line, slope 0.075 or 0.150, converts equal signal uncertainty to smaller x uncertainty?

12. A blank is 0.018 while the model intercept is 0.010. State one cautious interpretation.

13. A point at $x = 6$ has signal 0.620 but the line predicts 0.490. Calculate residual.

14. Give two possible model checks before calling item 13 an outlier.

15. A graph is linear over 0–6 units. Why is a straight trend not proof of mechanism?

16. Rearrange $y = mx + b$ to solve for m.

17. For $y = 0.410$, $b = 0.010$, and $m = 0.080$, calculate x.

18. A learner uses y/m and ignores b. State the direction of error for positive b.

19. Compare a calibration prediction and a direct observation in one sentence.

20. Write a bounded conclusion for an inferred $x = 3.00 \pm 0.08$ within the supplied range.