Using a Linear Model

Apply the skill to decisions and designs

Name _____ **Date** _____ **Score** _____ / 10

QUICK REVIEW

Models support planning when their units and limits are respected. A cost model $C = 4h + 9$ has rate 4 dollars per hour and fixed charge 9 dollars. For a change between two inputs, subtract predictions or use $m\Delta x$. For whole objects, round only when the context requires it, and explicitly test the resulting whole-number choice.

Worked example

Example for form 3: use the prediction rule. Use $\widehat{y} = 2x + 7$. Predict the output at $x = 3$.

1. Substitute $x = 3$ into the fitted rule: $\widehat{y} = 2(3) + 7$. The product is 6.

2. Combine the intercept to get $6 + 7 = 13$. This is the model prediction at the requested input, not a guaranteed measured result.

Answer: $\widehat{y} = 13$

Practice Problems

Show your thinking.

1. A fare model gives dollars y for miles x. Use $\widehat{y} = 3x + 6$. Predict the output at $x = 7$.

2. A tank model gives liters y after minutes x. Use $\widehat{y} = -4x + 60$. Predict the output at $x = 8$.

3. A plant model gives height in cm after x days. Describe its rate and starting prediction. Use $\widehat{y} = 2x + 9$. State the signed rate and initial predicted output.

4. A training model predicts score y after x sessions. Compare the actual score. Use $\widehat{y} = 3x + 10$. At $x = 5$ the actual output is 28. Find actual minus predicted.

5. A savings model gives dollars y after x weeks. Estimate the week for the target. Use $\widehat{y} = 5x + 15$. Find x when $\widehat{y} = 60$.

6. A trip model gives km y at minute x. Find the distance increase. Use $\widehat{y} = 2x + 3$. Find the predicted change from $x = 4$ to $x = 9$.

7. A resale model gives hundreds of dollars y at age x years. Find the value change. Use $\widehat{y} = -2x + 30$. Find the predicted change from $x = 3$ to $x = 8$.

8. A designer checks a rental-dollar estimate for x hours. Use $\widehat{y} = 4x + 8$. A learner predicts 28 at $x = 5$. Check the prediction.

9. A van costs $C = 7n + 12$ dollars for whole-number delivery count n. With a 50 dollar budget, what is the maximum count?

10. A fitted model $\widehat{y} = 2x + 5$ used data only for $1 \le x \le 6$. Predict at $x = 4$ and classify a prediction at $x = 10$.

Answer Key

1. $\widehat{y} = 27$
2. $\widehat{y} = 28$
3. Rate 2; initial output 9.
4. 3
5. $x = 9$
6. 10
7. -10
8. Correct prediction: 28.
9. 5 deliveries.
10. 13; input 10 requires extrapolation.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Substitute $x = 7$ into the fitted rule: $\widehat{y} = 3(7) + 6$. The product is 21.

2. Combine the intercept to get $21 + 6 = 27$. This is the model prediction at the requested input, not a guaranteed measured result.

Problem 2

1. Substitute $x = 8$ into the fitted rule: $\widehat{y} = -4(8) + 60$. The product is -32.

2. Combine the intercept to get $-32 + 60 = 28$. This is the model prediction at the requested input, not a guaranteed measured result.

Problem 3

1. At $x = 0$, $\widehat{y} = 2(0) + 9 = 9$. At $x = 1$, the prediction is 11.

2. The one-unit change is $11 - (9) = 2$. Thus the coefficient 2 is the signed rate and the constant 9 is the starting prediction.

Problem 4

1. The predicted output at this input is $\widehat{y} = 3(5) + 10 = 25$. Use this, not the intercept alone.

2. The residual is $y - \widehat{y} = 28 - (25) = 3$. The actual result is above the prediction.

Problem 5

1. Set the target equal to the prediction: $60 = 5x + 15$. Subtract the intercept: $45 = 5x$.

2. Divide by 5 to obtain $x = 45/5 = 9$. Checking gives $5(9) + 15 = 60$, the requested model output.

Problem 6

1. The endpoint predictions are $\widehat{y}(4) = 2(4) + 3 = 11$ and $\widehat{y}(9) = 2(9) + 3 = 21$.

2. Subtract final minus initial: $21 - (11) = 10$. Equivalently, rate times input change is $2(9 - 4) = 10$.

Problem 7

1. The endpoint predictions are $\widehat{y}(3) = -2(3) + 30 = 24$ and $\widehat{y}(8) = -2(8) + 30 = 14$.

2. Subtract final minus initial: $14 - (24) = -10$. Equivalently, rate times input change is $-2(8 - 3) = -10$.

Problem 8

1. Substitute the specified input into the full model: $\widehat{y} = 4(5) + 8 = 28$.

2. The claimed value differs by $28 - (28) = 0$. It agrees with the model.

Problem 9

1. The budget condition is $7n + 12 \leq 50$, so $7n \leq 38$ and $n \leq 38/7 \approx 5.43$.

2. Use the lower whole number, $n = 5$: $7(5) + 12 = 47 \leq 50$. Six would cost $7(6) + 12 = 54 > 50$, so five is the maximum.

Problem 10

1. The prediction inside the measured range is $\widehat{y}(4) = 2(4) + 5 = 13$. The inequality $1 \leq 4 \leq 6$ confirms interpolation.

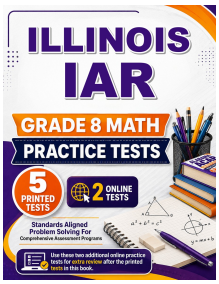
2. Input 10 is larger than the maximum measured input 6. Predicting there is extrapolation and may be unreliable even though the equation can be evaluated.

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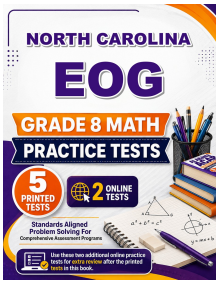
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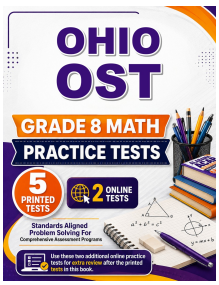
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