Linear vs. Nonlinear Functions

Apply the skill to decisions and designs

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

QUICK REVIEW

Constant addition per equal time interval creates a linear model, such as $H = 3t + 5$. Doubling each interval creates nonlinear growth, such as $N = 2^t$. Areas often involve squares: $A = s^2$ is nonlinear in side length. To design a linear data table, choose one rate m and use $y = mx + b$ for every row.

Worked example

Example for form 3: classify using rates.

x	y
0	3
1	5
2	7

1. Compute each consecutive slope, including the input gaps: $(5 - (3))/(1 - (0)) = 2$, $(7 - (5))/(2 - (1)) = 2$.
2. All slopes equal 2; the points lie on one line. Equal output changes alone are insufficient unless the input gaps are equal.
Answer: Linear.

Practice Problems

Show your thinking.

1. A tank log records minutes x and liters y. Is filling linear?

x	y
0	5
2	11
4	17
6	23

2. Bacteria counts y are recorded at hours x. Is the growth linear?

x	y
0	3
1	6
2	12
3	24

3. A square tile has side x and area y. Classify the model. $y = x^2$

4. A service charges 5 dollars plus 2 dollars per mile x. Classify its cost y. $y = 2x + 5$

5. Design outputs for $x = 0, 2, 4$ with starting value 3 and linear rate 4.

6. A candle log lists hours x and height y. Does one linear rate fit?

x	y
0	20
1	18
3	14

7. A delivery log has package count x and fee y. Classify the fee table.

x	y
1	4
2	7
3	10
4	14

8. A student saves 3 dollars in week 1, 6 in week 2, and 9 in week 3, with no earlier savings. Is cumulative savings linear in week number?

9. Design a nonlinear table for inputs $0, 1, 2$ using square outputs, then state its two rates.

10. A rectangle has fixed width 3 and length x. Classify its area y. $y = 3x$

Answer Key

1. Linear.
2. Nonlinear.
3. Nonlinear.
4. Linear.
5. $3, 11, 19$
6. Linear.
7. Nonlinear.
8. No; cumulative totals are $3, 9, 18$.
9. Outputs $0, 1, 4$; rates $1, 3$.
10. Linear.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Compute each consecutive slope, including the input gaps: $(11-(5))/(2-(0)) = 3$, $(17-(11))/(4-(2)) = 3$, $(23-(17))/(6-(4)) = 3$.

2. All slopes equal 3; the points lie on one line. Equal output changes alone are insufficient unless the input gaps are equal.

Problem 2

1. Compute each consecutive slope, including the input gaps: $(6-(3))/(1-(0)) = 3$, $(12-(6))/(2-(1)) = 6$, $(24-(12))/(3-(2)) = 12$.

2. These slopes are not all equal, so one straight line cannot contain all the points. Equal output changes alone are insufficient unless the input gaps are equal.

Problem 3

1. For inputs $0, 1, 2$, the outputs are $0, 1, 4$. The consecutive changes are 1 and 3.

2. When the side grows from 0 to 1 to 2, area changes by 1 then 3. The rate is not constant, so the area model is nonlinear.

Problem 4

1. For inputs $0, 1, 2$, the outputs are $5, 7, 9$. The consecutive changes are 2 and 2.

2. The fixed charge is 5 and each mile adds 2. This is $mx + b$ with constant rate 2, so the cost model is linear.

Problem 5

1. The model is $y = 4x + 3$. At $x = 0$, $y = 3$; at $x = 2$, $y = 4(2) + 3 = 11$.

2. At $x = 4$, $y = 4(4) + 3 = 19$. Each two-unit input increase adds 8, giving the required constant rate $8/2 = 4$.

Problem 6

1. Compute each consecutive slope, including the input gaps: $(18-(20))/(1-(0)) = -2$, $(14-(18))/(3-(1)) = -2$.

2. All slopes equal -2; the points lie on one line. Equal output changes alone are insufficient unless the input gaps are equal.

Problem 7

1. Compute each consecutive slope, including the input gaps: $(7-(4))/(2-(1)) = 3$, $(10-(7))/(3-(2)) = 3$, $(14-(10))/(4-(3)) = 4$.

2. These slopes are not all equal, so one straight line cannot contain all the points. Equal output changes alone are insufficient unless the input gaps are equal.

Problem 8

1. Add the deposits: after week 1, total 3; after week 2, $3 + 6 = 9$; after week 3, $9 + 9 = 18$.

2. The cumulative increases are $9 - 3 = 6$ and $18 - 9 = 9$. Since $6 \neq 9$ over equal week intervals, cumulative savings are nonlinear.

Problem 9

1. Use $y = x^2$: $0^2 = 0$, $1^2 = 1$, and $2^2 = 4$, giving $(0, 0), (1, 1), (2, 4)$.

2. The rates are $(1-0)/(1-0) = 1$ and $(4-1)/(2-1) = 3$. Because they differ, these points cannot lie on one line.

Problem 10

1. For inputs $0, 1, 2$, the outputs are $0, 3, 6$. The consecutive changes are 3 and 3.

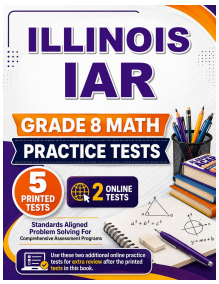
2. Each extra unit of length adds 3 square units. The formula is $y = 3x + 0$, so this area model is linear in length.

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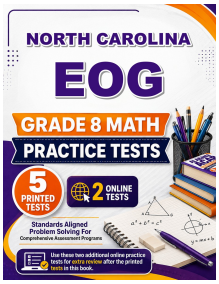
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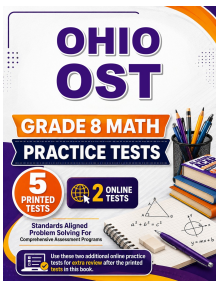
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