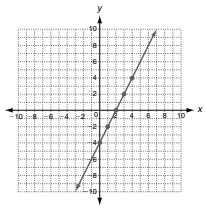
LESSON 11-4

Practice A

Linear, Quadratic, and Exponential Models

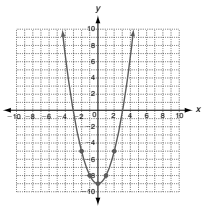
Graph each data set. Write *linear*, *quadratic*, or *exponential*.

1. {(0, −4), (1, −2), (2, 0), (3, 2), (4, 4)}



linear

2. {(−2, −5), (−1, −8), (0, −9), (1, −8), (2, −5)}



quadratic

Look for a pattern in each data set. Write *linear*, *quadratic*, or *exponential*.

3.

x	y
0	3
1	6
2	12
3	24

exponential

4.

x	y
−2	−10
−1	−8
0	−6
1	−4

linear

5.

x	y
0	2
1	6
2	12
3	20

quadratic

6. The data in the table show the price of apples at a local store over several years.

Year	1	2	3	4
Cost ($)	0.45	0.90	1.35	1.80

a. Which model best describes the data for apples? linear

b. Write the function that models the data for apples. $y = 0.45x$

c. Predict the cost of apples in year 8. $3.60

7. The data in the table show the price of a game over several years.

Year	0	1	2	3
Cost ($)	5.00	6.00	7.20	8.64

a. Which model best describes the data for the game? exponential

b. Write the function that models the data for the game. $y = 5(1.2)^x$

c. Predict the cost of the game in year 7. Round the cost to the nearest cent. $17.92

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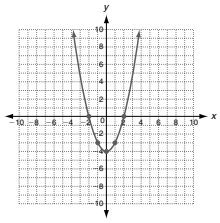
LESSON 11-4

Practice B

Linear, Quadratic, and Exponential Models

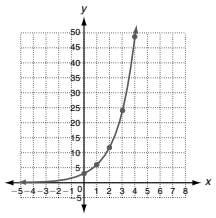
Graph each data set. Which kind of model best describes the data?

1. {(−2, 0), (−1, −3), (0, −4), (1, −3), (2, 0)}



quadratic

2. {(0, 3), (1, 6), (2, 12), (3, 24), (4, 48)}



exponential

Look for a pattern in each data set to determine which kind of model best describes the data.

3. {(−5, 9), (−4, 0), (−3, −7), (−2, −12)} quadratic

4. {(−2, 9), (−1, 13), (0, 17), (1, 21)} linear

5. {(1, 4), (2, 6), (3, 9), (4, 13.5)} exponential

6. {(0, 4), (2, 12), (4, 36), (6, 76)} quadratic

7. $\left\{(1, 17), \left(3, 8\frac{1}{2}\right), \left(5, 4\frac{1}{4}\right), \left(7, 2\frac{1}{8}\right)\right\}$ exponential

8. Use the data in the table to describe how the restaurant's sales are changing. Then write a function that models the data. Use your function to predict the amount of sales after 8 years.

Restaurant				
Year	0	1	2	3
Sales ($)	20,000	19,000	18,050	17,147.50

The sales decrease by 5% each month;

$y = 20{,}000(0.95)^x$; ≈$13,268.41

9. Use the data in the table to describe how the clothing store's sales are changing. Then write a function that models the data. Use your function to predict the amount of sales after 10 years.

Clothing Store				
Year	0	1	2	3
Sales ($)	15,000	15,750	16,500	17,250

The sales increase by $750 every year;

$y = 750x + 15{,}000$; $22,500

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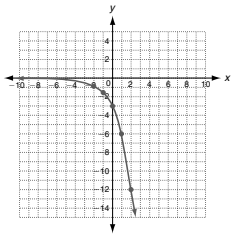
LESSON 11-4

Practice C

Linear, Quadratic, and Exponential Models

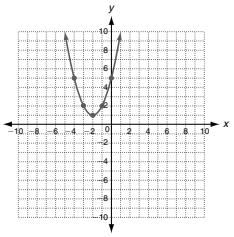
Graph each data set. Which kind of model best describes the data?

1. $\left\{\left(-2, -\frac{3}{4}\right), \left(-1, -\frac{3}{2}\right), (0, -3), (1, -6), (2, -12)\right\}$



exponential

2. {(−4, 5), (−3, 2), (−2, 1), (−1, 2), (0, 5)}



quadratic

Look for a pattern in each data set to determine which kind of model best describes the data.

3. {(−4, −2), (−2, 1), (0, 4), (2, 7), (4, 10)} linear

4. {(3, 225), (4, 337.5), (5, 506.25), (6, 759.375)} exponential

5. {(0, −8), (1, −15), (2, −16), (3, −11), (4, 0)} quadratic

6. $\left\{\left(\frac{1}{2}, 6\right), \left(1, 1\frac{1}{2}\right), \left(1\frac{1}{2}, \frac{3}{8}\right), \left(2, \frac{3}{32}\right)\right\}$ exponential

7. Use the data in the table to describe how the restaurant's sales are changing. Then write a function that models the data. Use your function to predict the amount of sales after 10 years.

Year	0	1	2	3
Sales ($)	420,000	436,800	454,272	472,442.88

The sales are increasing by 4% each year;

$y = 420{,}000(1.04)^x$; ≈$621,702.60

8. Use the data in the table to describe how the total cost of the freezer changes over time. Then write a function that models the data. Use your function to predict the total cost of the freezer after 5 years.

Cost to operate 17.0 ft³ freezer				
Month	0	1	2	3
Total Cost ($)	450.00	457.51	465.02	472.53

The cost is increasing by $7.51 each month;

$y = 7.51x + 450$; $487.55

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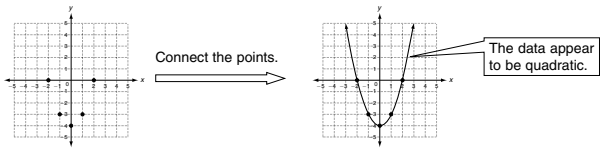
LESSON 11-4

Reteach

Linear, Quadratic, and Exponential Models

Graph to decide whether data is best modeled by a linear, quadratic or exponential function.

Graph (−2, 0), (−1, −3), (0, −4), (1, −3), (2, 0). What kind of model best describes the data?



You can also look at patterns in data to determine the correct model.

Linear functions have constant 1st differences.

x	y	
2	5	
4	2	−3
6	−1	−3
8	−4	−3

Quadratic functions have constant 2nd differences.

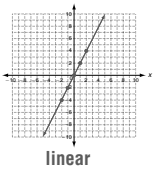
x	y		
1	−8		
2	−5	+3	
3	0	+5	+2
4	7	+7	+2

Exponential functions have a constant ratio.

x	y	
0	−2	
1	−8	×4
2	−32	×4
3	−128	×4

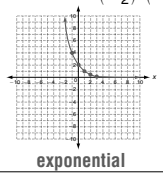
Graph each data set. Which kind of model best describes the data?

1. (−2, −4), (−1, −2), (0, 0), (1, 2), (2, 4)



linear

2. $(-1, 4), (0, 2), (1, 1), \left(2, \frac{1}{2}\right), \left(3, \frac{1}{4}\right)$



exponential

Look for a pattern in each data set to determine which kind of model best describes the data.

3.

x	y
0	6
1	12
2	24
3	48

exponential

4.

x	y
0	10
1	18
2	28
3	40

quadratic

5.

x	y
3	4
6	−2
9	−8
12	−14

linear

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LESSON 11-4

Reteach

Linear, Quadratic, and Exponential Models (continued)

After deciding which model fits best, you can write a function.

Linear	Quadratic	Exponential
$y = mx + b$	$y = ax^2 + bx + c$	$y = ab^x$

Use the data in the table to describe how the software's cost is changing. Then write a function to model the data.

Computer Software				
Year	0	1	2	3
Cost ($)	80.00	72.00	64.80	58.32

Step 1: Determine whether data is linear, quadratic, or exponential.

Check differences:

x	y	
0	80.00	
1	72.00	−8
2	64.80	−7.20
3	58.32	−6.48

(+0.8, +0.72)

First differences are not constant. Second differences are not constant.

Check ratio:

x	y	
0	80.00	
1	72.00	×0.9
2	64.80	×0.9
3	58.32	×0.9

Ratio is constant. Use an exponential model.

Step 2: Write the function.

Use $y = ab^x$

$y = a(0.9)^x$ *Substitute the constant ratio 0.9, for b.*

$80 = a(0.9)^0$ *Substitute the ordered pair (0, 80) for x and y.*

$80 = a(1)$ *Simplify $(0.9)^0$.*

$80 = a$ *The value of a is 80.*

$y = 80(0.9)^x$ *Write the function.*

Describe the model that best fits the data below. Then write a function to model the data.

6.

x	y
0	1
1	4
2	16
3	64

model: exponential

function: $y = 1(4)^x$

7.

x	y
0	7
1	10
2	13
3	16

model: linear

function: $y = 3x + 7$

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LESSON 11-4

Challenge

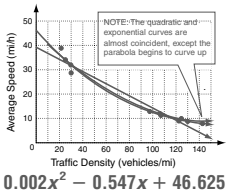
Highway Traffic

If you've ridden in a car on a highway, you've probably noticed that the speed of traffic slows down when there are more cars on the road. The data at right was gathered to research this phenomenon.

Traffic Density (vehicles/mi)	Average Speed (mi/h)
20.4	38.8
26.5	34.0
29.5	31.8
30.0	28.8
97.0	12.3
106.2	10.6
106.7	11.4
107.2	10.3
121.7	8.5
123.9	9.8
130.5	8.6
141.3	7.7

None of the models you have studied fits this data exactly. Furthermore, the values of the independent variable don't change by a constant amount, so you can't check for constant differences or constant ratios. You'll use a graphing calculator to find models instead.

1. Enter the data into lists **L1** and **L2** on your calculator, and make a scatter plot. (Review Technology Lab 4-5 on page 262 of your textbook if you forget how.) Sketch the scatter plot below.
2. Based on the shape of the scatter plot, which kind of model do you think will best describe the data?
   exponential or quadratic
3. Press STAT and select the **CALC** menu. Select **LinReg(ax+b)** and press ENTER to find a linear model. Write the equation here, rounding to the thousandths.
   $y = -0.251x + 39.469$
4. Press Y=, enter the equation for the linear model, and press GRAPH. Sketch the line on your graph above.



5. Repeat step 3, but select **QuadReg** to find a quadratic model. Write the equation here.
   $y = 0.002x^2 - 0.547x + 46.625$
6. Graph the quadratic equation, and sketch it above.
7. Repeat step 3, but select **ExpReg** to find an exponential model. Write the equation here.
   $y = 46.700(0.987)^x$
8. Graph the exponential equation, and sketch it above.
9. From the graphs of the three models, which model(s) seems to fit best? Explain your choice(s).
   Exponential or quadratic; either model is a good fit for the curvature of the scatter plot.
10. Use each model to predict the average speed of traffic when the traffic density is 180 vehicles per mile.
    linear: −5.711 mi/h quadratic: 12.965 mi/h exponential: 4.430 mi/h
11. From your answers to question 10, which model(s) seems to fit best? Explain your choice(s).
    Exponential only as traffic density continues to increases, the linear model gives negative speeds and the quadratic model gives increasing speeds.

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LESSON 11-4

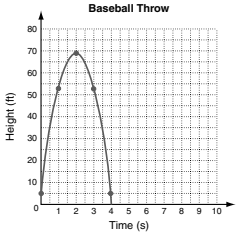
Problem Solving

Linear, Quadratic, and Exponential Models

Write the correct answer.

1. The table shows the height of a baseball for different times after it was thrown. Graph the data. Which kind of model best describes the data?

Height of Baseball					
Time (s)	0	1	2	3	4
Height (ft)	5	53	69	53	5



quadratic

2. The table shows the cost of peaches. Look for a pattern and determine which kind of model best describes the data. Then write a function that models the data.

Cost of Peaches				
Pounds	1	2	3	4
Cost ($)	1.29	2.58	3.87	5.16

linear

$y = 1.29x$

3. The table shows the number of computers in a school for four years.

Number of Computers				
Year	'00	'01	'02	'03
Computers	14	28	56	112

Write a function to model the data. Then use the function to predict how many computers the school will have in 2006 if the pattern continues.

$y = 14(2)^x$; 896

The chart shows the ticket sales for movies on two different screens at one theater over four days. Select the best answer.

	Screen 1	Screen 2
Day 1	400	3000
Day 2	440	2400
Day 3	480	1920
Day 4	520	1536

4. Which kind of model best describes the ticket sales for the movie on screen 1?
   (A) linear C exponential
   B quadratic D none of these
5. Which function describes the data for screen 1?
   F $y = 40x^2$ H $y = 400x$
   (G) $y = 40x + 400$ J $y = 400(40)^x$
6. Which kind of model best describes the ticket sales for the movie on screen 2?
   A linear (C) exponential
   B quadratic D none of these
7. Which function describes the data for screen 2?
   F $y = -600x + 3000$
   G $y = 600x^2 + 2400$
   (H) $y = 3000(0.8)^x$
   J $y = 3000(1.25)^x$

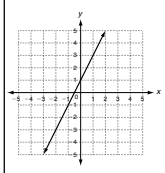
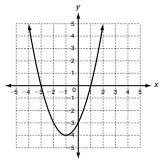
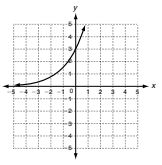
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LESSON 11-4

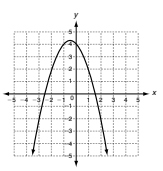
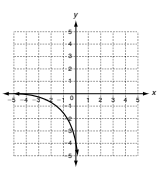
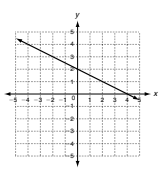
Reading Strategies

Use a Table

Use the table below to help you learn the characteristics of each data model and how to tell them apart.

Model	Linear	Quadratic	Exponential
Pattern (*y*-values)	constant first differences	constant second differences	constant ratios
Graph			
Equation	$y = mx + b$	$y = ax^2 + bx + c$	$y = ab^x$

Identify each of the following as *linear, quadratic,* or *exponential.*

1. $y = 6(2)^x$ exponential
2. $y = 4x + 6$ linear
3. $y = 2x^2 + 5x + 3$ quadratic
4.  quadratic
5.  exponential
6.  linear
7.

x	−6	−7	−8	−9	−10
y	17	20	23	26	29

linear

8.

x	1	3	5	7	9
y	4	12	28	52	84

quadratic

9.

x	5	4	3	2	1
y	128	64	32	16	8

exponential

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