11-4 Linear, Quadratic, and Exponential Models

Warm Up

Lesson Presentation

Lesson Quiz

11-4 Linear, Quadratic, and Exponential Models

Warm Up

1. Find the slope and y-intercept of the line that passes through (4, 20) and (20, 24).

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11-4 Linear, Quadratic, and Exponential Models

Objectives

Compare linear, quadratic, and exponential models.

Given a set of data, decide which type of function models the data and write an equation to describe the function.

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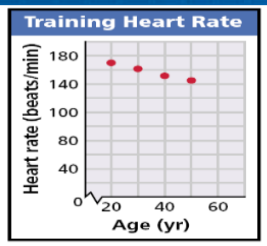
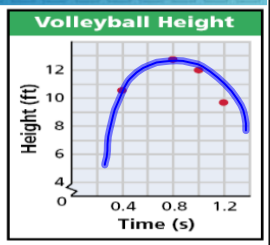
Linear

Training Heart Rate	
Age (yr)	Beats/min
20	170
30	161.5
40	153
50	144.5



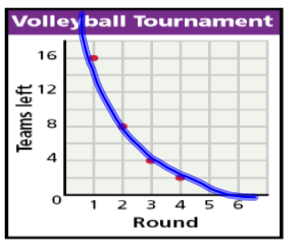
Quadratic

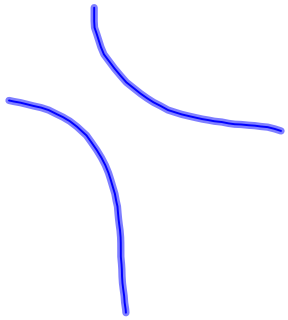
Volleyball Height	
Time (s)	Height (ft)
0.4	10.44
0.8	12.76
1	12
1.2	9.96



Exponential

Volleyball Tournament	
Round	Teams Left
1	16
2	8
3	4
4	2





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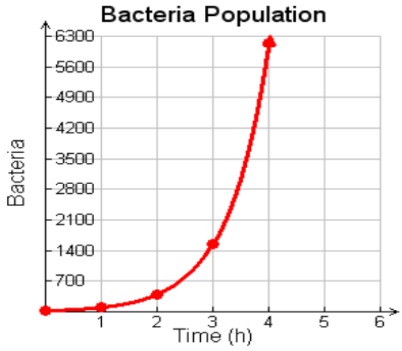
Example 1A: Graphing Data to Choose a Model

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

Time(h)	Bacteria
0	24
1	96
2	384
3	1536
4	6144



Plot the data points and connect them.

The data appear to be exponential.

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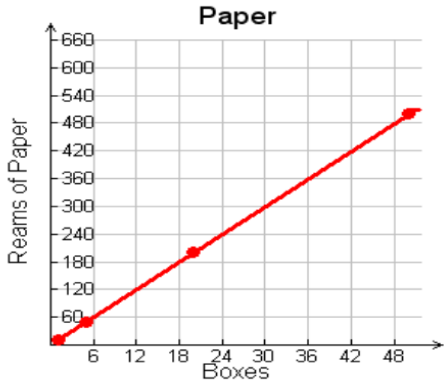
Example 1B: Graphing Data to Choose a Model

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

Boxes	Reams of paper
1	10
5	50
20	200
50	500



Plot the data points and connect them.

The data appears to be linear.

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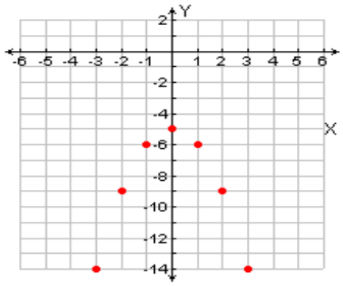
Check It Out! Example 1b

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

x	y
–3	–14
–2	–9
–1	–6
0	–5
1	–6
2	–9
3	–14



Plot the data points.

The data appears to be quadratic.

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Another way to decide which kind of relationship (if any) best describes a data set is to use patterns.

Generally you check in this order.

- Linear Fucntions have a consistent change between *x and* y (1st difference).
- Quadratic Fuctions have a consistent change in the 2nd difference.
- Exponential Models have a consistent product or quotient change.

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Example 2A: Using Patterns to Choose a Model

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

Height of golf ball	
Time (s)	Height (ft)
0	4
1	68
2	100
3	100
4	68

+ 1, + 1, + 1, + 1

+ 64, + 32, 0, –32

–32, –32, –32

For every constant change in time of +1 second, there is a constant second difference of –32.

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Example 2B: Using Patterns to Choose a Model

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

Money in CD	
Time (yr)	Amount ($)
0	1000.00
1	1169.86
2	1368.67
3	1601.04

× 1.17, × 1.17, × 1.17

For every constant change in time of + 1 year there is an approximate constant ratio of 1.17.

The data appears to be exponential.

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After deciding which model best fits the data, you can write a function. Recall the general forms of linear, quadratic, and exponential functions.

General Forms of Functions

LINEAR	QUADRATIC	EXPONENTIAL
$y = mx + b$	$y = ax^2 + bx + c$	$y = ab^x$

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The y value when $x = 0$

take power of b 1st

$$y = ab^x$$

The common ratio

(How much was it being × or ÷ by?)

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$56 = a7^1$

Example 3: *Problem-Solving Application*

Use the data in the table to describe how the number of people changes. Then write a function that models the data. Use your function to predict the number of people who received the e-mail after one week.

E-mail forwarding	
Time (Days)	Number of People Who Received the E-mail
0	8
1	56
2	392
3	2744

×7 ×7 ×7

$y = ab^x$

$y = a(7)^x$

$8 = a(7)^0$

$8 = a$

$y = 8(7)^x$

$= 8(7)^x$

$= 8(7)^7$

$= 6{,}588{,}344$

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Look Back

You chose the ordered pair (0, 8) to write the function. Check that every other ordered pair in the table satisfies your function.

$y = 8(7)^x$	
56	$8(7)^1$
56	$8(7)$
56	56 ✓

$y = 8(7)^x$	
392	$8(7)^2$
392	$8(49)$
392	392 ✓

$y = 8(7)^x$	
2744	$8(7)^3$
2744	$8(343)$
2744	2744 ✓

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Remember!

When the independent variable changes by a constant amount,

- linear functions have constant first differences.
- quadratic functions have constant second differences.
- exponential functions have a constant ratio.

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PROBLEM SOLVING

Check It Out! Example 3

Use the data in the table to describe how the oven temperature is changing. Then write a function that models the data. Use your function to predict the temperature after 1 hour.

+10

Oven Temperature				
Time (min)	0	10	20	30
Temperature (°F)	375	325	275	225

-50 -50 -50

$m = \frac{-5}{1}$

$-5x + 375$

$-5(60) + 375$

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Lesson Quiz: Part I

Which kind of model best describes each set of data?

1.

Time (s)	Height of Ball (ft)
0	200
1	184
2	136
3	56

2.

Value of Townhouse	
Age (yr)	Value ($)
0	100,000
1	102,000
2	104,040
3	106,121

3. Write a function that models the data. Use your function to predict the amount of water in the pool after 3 hours.

Water in a Swimming Pool	
Time (min)	Amount of Water (gal)
10	327
20	342
30	357
40	372

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Homework

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