Warm up:

Given the function $y = 3^x$

Translate the function to the left 2 units and down 4 units. What is the new function?

+2 to x

−4

$y = 3^{x+2} - 4$

Given the function $y = \log 4x$

Translate 7 units up and reflect over the x-axis. What is the new function?

+7

$y = -\log 4x + 7$

7-8 Curve Fitting with Exponential and Logarithmic Models

Objectives

Model data by using exponential and logarithmic functions.

Use exponential and logarithmic models to analyze and predict.

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7-8 Curve Fitting with Exponential and Logarithmic Models

Vocabulary

exponential regression
logarithmic regression

7-8 Curve Fitting with Exponential and Logarithmic Models

Analyzing data values can identify a pattern, or repeated relationship, between two quantities.

Look at this table of values for the exponential function $f(x) = 2(3^x)$.

x	−1	0	1	2	3
$f(x)$	$\frac{2}{3}$	2	6	18	54

× 3 × 3 × 3 × 3

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Notice that the *ratio* of each *y*-value and the previous one is constant. Each value is three times the one before it, so the ratio of function values is constant for equally spaced *x*-values. This data can be fit by an exponential function of the form $f(x) = ab^x$.

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If a set of values has a second difference that continues to climb each time that is when we have found an exponential relationship. If it becomes constant on the second difference then it is just quadratic.

$\frac{24}{16} = \frac{3}{2}$

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Example 1: Identifying Exponential Data

Determine whether *f* is an exponential function of *x* of the form $f(x) = ab^x$. If so, find the constant ratio.

A.

x	–1	0	1	2	3
$f(x)$	2	3	5	8	12

+1 +2 +3 +4 First Differences

+1 +1 +1

Quadratic 2nd difference is constant

B. $\frac{3}{2}$

x	–1	0	1	2	3
$f(x)$	16	24	36	54	81

+8 +12 +18 +27

4 6 9

$\frac{81}{54} = \frac{54}{36} = \frac{36}{24} = \frac{24}{16}$ Exponential

7-8 Curve Fitting with Exponential and Logarithmic Models

Check It Out! Example 1

Determine whether *y* is an exponential function of *x* of the form $f(x) = ab^x$. If so, find the constant ratio.

a.

x	–1	0	1	2	3
$f(x)$	$2.\overline{6}$	4	6	9	13.5

$1.\overline{3}$ 2 3 4.5

$.\overline{6}$ 1 1.5

Exponential

$\frac{6}{4} = \frac{3}{2}$

b.

x	–1	0	1	2	3
$f(x)$	–3	2	7	12	17

5 5 5 5

0 0 0

$-\frac{2}{3} \neq \frac{7}{2}$ Linear

You have worked with regressions before by finding linear and quadratic regressions. You can also find exponential regressions. The calculator will find the best equation fulfilling the equation $y = ab^x$

To find an exponential regression:

-Plug your points into 2 set lists
-Choose for your calculator to find an exp reg

L_1	L_2
x	y

expReg

To predict a value:
1) Put your regression equation into the y1 column
2) Put the number they want predicted in the y2 column
3) Graph them both and find the intersection. The x-value will be your prediction.

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Remember!

If you do not see r^2 and r when you calculate regression, 2nd CATALOG 0 and turn these on by selecting **DiagnosticOn.**

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7-8 Curve Fitting with Exponential and Logarithmic Models

Example 2: College Application

Find an exponential model for the data. Use the model to predict when the tuition at U.T. Austin will be $6000.

	Year	Tuition
1	1999–00	$3128
2	2000–01	$3585
3	2001–02	$3776
4	2002–03	$3950
5	2003–04	$4188
	L_1	L_2

Tuition of the University of Texas

$Y_1 = 3022.75(1.07)^x$

$Y_2 = 6000$

(10.13, 6000) 2009-2010

7-8 Curve Fitting with Exponential and Logarithmic Models

Check It Out! Example 2

Use exponential regression to find a function that models this data. When will the number of bacteria reach 2000?

Time (min)	0	1	2	3	4	5
Bacteria	200	248	312	390	489	610

$Y_1 = 199.29(1.25)^x$

$Y_2 = 2000$

10.3

7-8 Curve Fitting with Exponential and Logarithmic Models

Many natural phenomena can be modeled by natural log functions. You can use a **logarithmic regression** to find a function

Helpful Hint

Most calculators that perform logarithmic regression use ln rather than log.

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You have the same steps to finding a logarithmic regression. One thing to remember is that the calculator will actually produce the equation using a NATURAL LOG (ln), so just be aware of that.

~~log .723~~

ln .723

LnReg

7-8 Curve Fitting with Exponential and Logarithmic Models

Example 3: Application

Find a natural log model for the data. According to the model, when will the global population exceed 9,000,000,000?

Global Population Growth	
Population (billions)	Year
1	1800
2	1927
3	1960
4	1974
5	1987
6	1999

X Y
L_1 L_2

$y = 1824 + 106.48 \ln x$

2057

7-8 Curve Fitting with Exponential and Logarithmic Models

Check It Out! Example 4

Use logarithmic regression to find a function that models this data. When will the speed reach 8.0 m/s?

Time (min)	1	2	3	4	5	6	7
Speed (m/s)	0.5	2.5	3.5	4.3	4.9	5.3	5.6

$Y_1 = .587 + 2.638 \ln x$

$Y_2 = 8$

16.6 min

Homework:

p. 548 #8-13, 17, 24, 29

Present 13 and 24