Exponential Functions

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Goals and Objectives

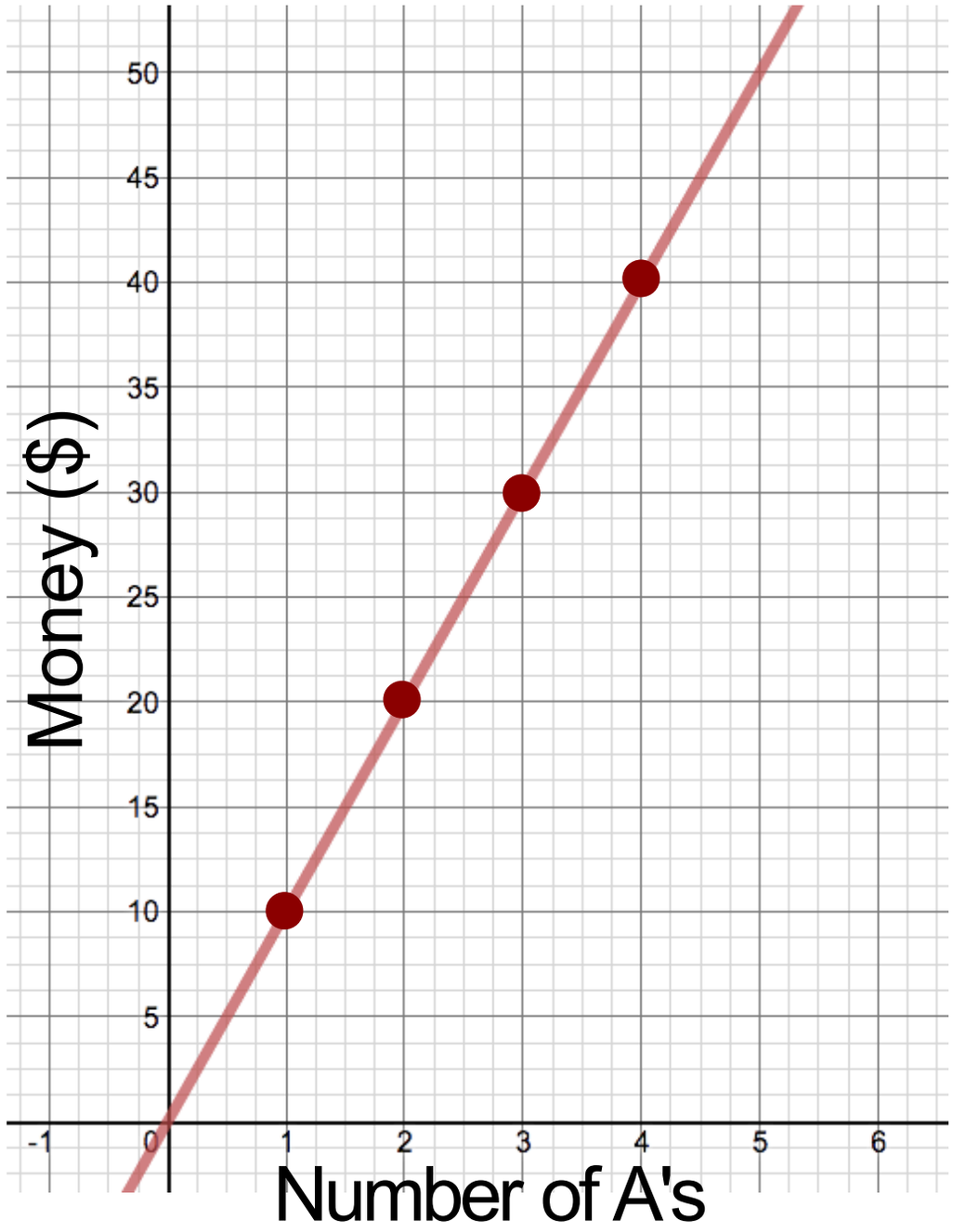
Students will be able to recognize and graph exponential functions.

Why do we need this?

Most relationships for study and research are not linear relationships. Population growth is now heavily studied around the world. Is this a linear function?
Why do we study population growth?

Exponential Functions

We have looked at linear growth, where the rate of change is constant. This is a graph of the amount of money your parents might give you based on the number of A's on your report card.



X	Y
1	$10
2	$20
3	$30
4	$40

Can we easily predict what you would get if you have 7 A's?

Exponential Functions

The equation for the previous function is
y = 10x.

What if you asked your parents to reduce the amount per A to $3, but then asked them to use the following function:

$$y = 3^x$$

Graph it!!

What would you get for 7 A's?

X	Y
1	$3
2	$9
3	$27
4	$81

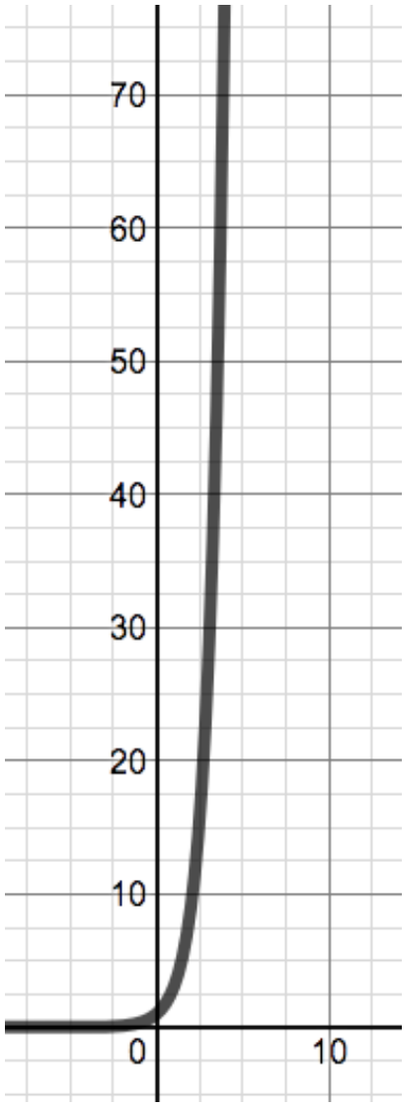
Teacher Notes

Exponential Functions

Here is the graph of your function!

This is an example of exponential growth.

$$y = 3^x$$



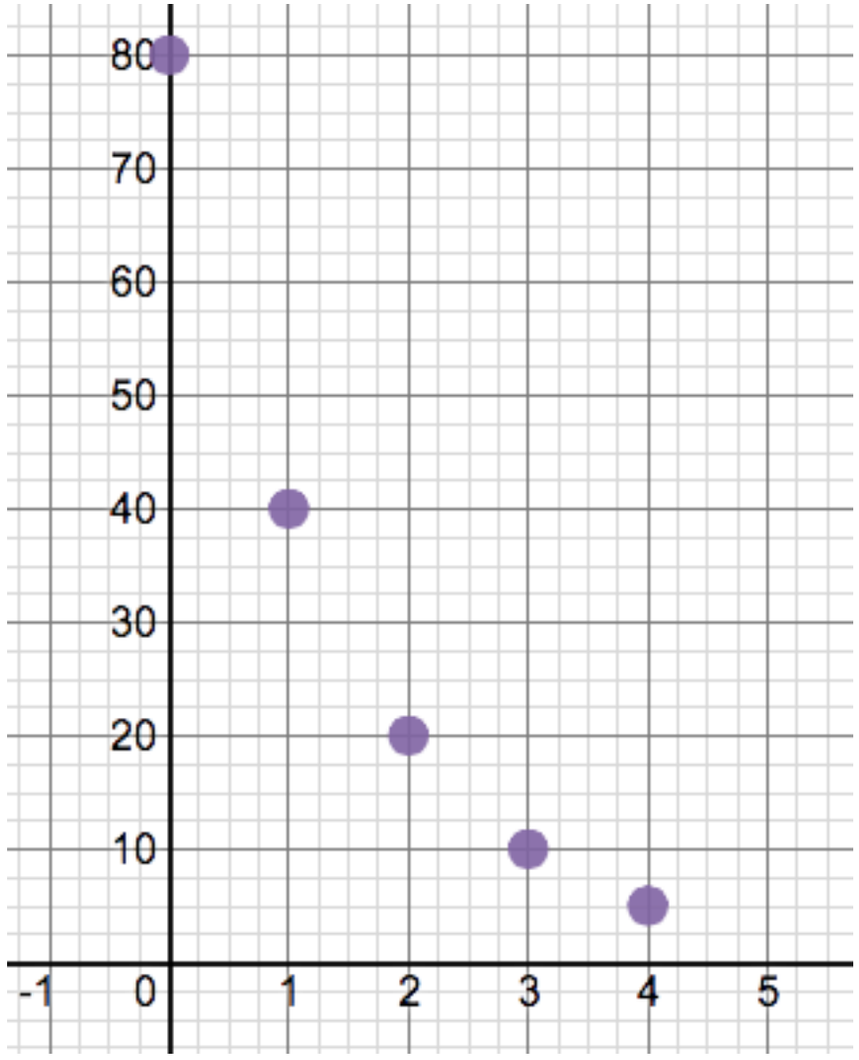
Can you find the amount for 7 A's?

Would that provide some motivation?

Exponential Functions

Now, let's look at an opposite problem:
Suppose you are given 80 M&M's and each day you eat half.
What does this graph look like?

This is an example of exponential decay.



X	Y
0	80
1	40
2	20
3	10
4	5

Teacher Notes

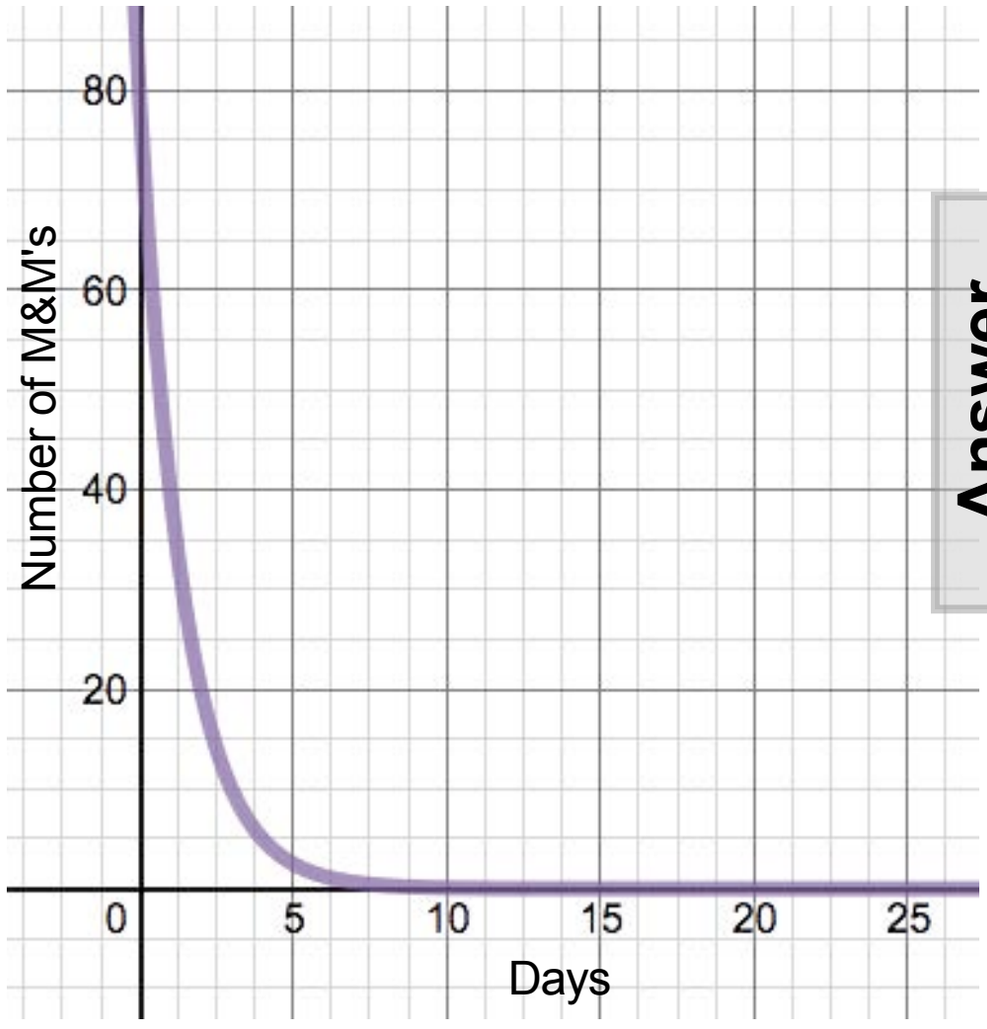
Exponential Functions

Here is a graph of the M&M problem.

1. Where does the graph cross the y-axis?

2. How many M&M's do you have on day 2, 3, 4 and 5?

3. When are all of the M&M's gone?



Answer

Exponential Functions

Now we will identify
Exponential Functions both
graphically and algebraically.

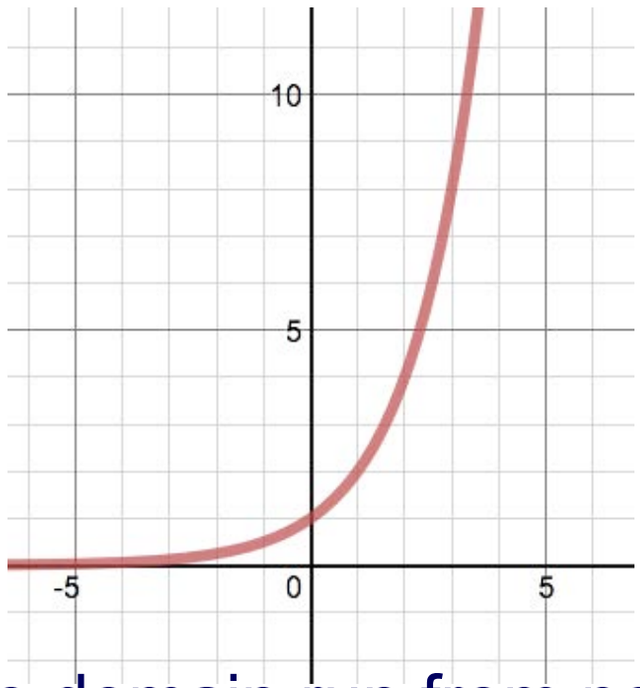
Graphically

The exponential function has a curved shape. The y-values in an exponential function will either get larger or smaller very, very quickly.

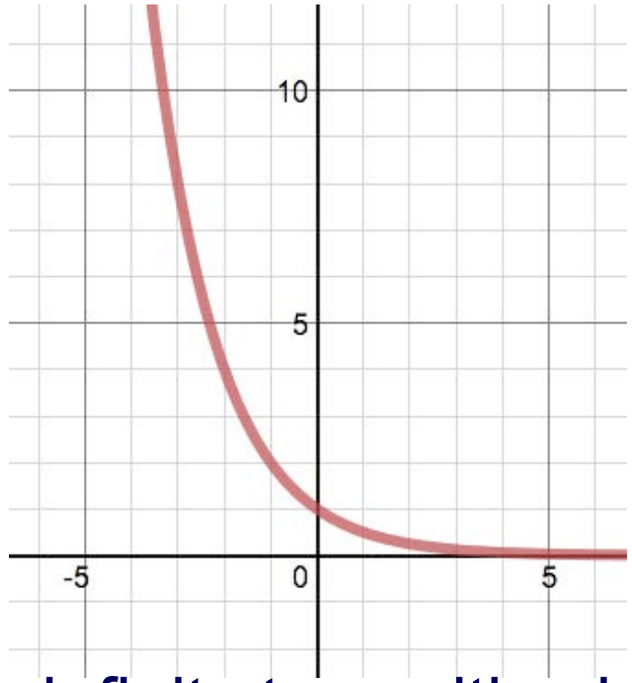
Domain: $(-\infty, \infty)$ (x values)

Range: $(0, \infty)$ (y values)

Exponential Growth



Exponential Decay

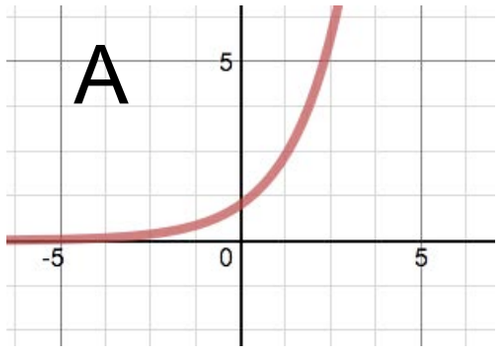


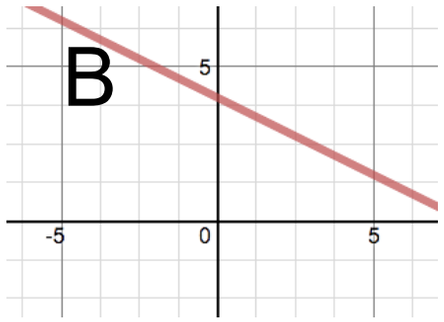
Why does the domain run from negative infinity to positive infinity?

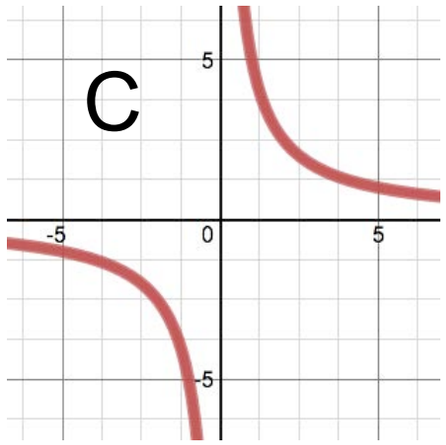
Why does the range run from 0 to positive infinity?

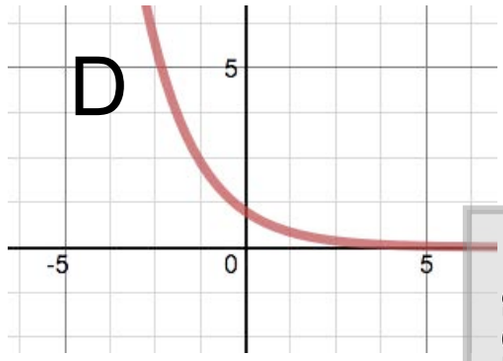
Teacher Notes

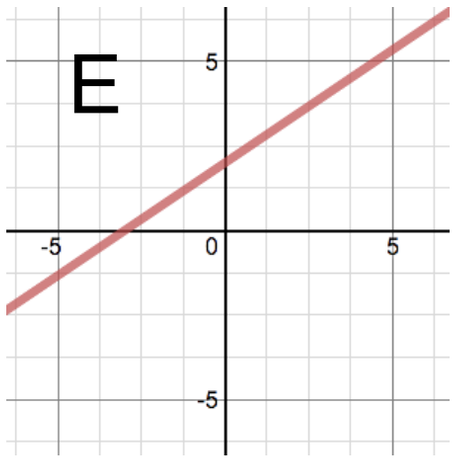
36 Which of the following are graphs of exponential growth? (You can choose more than one.)

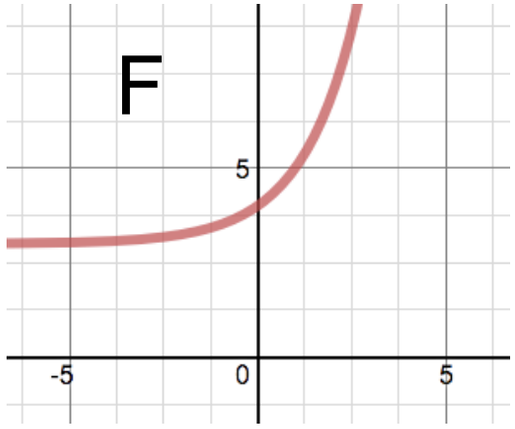


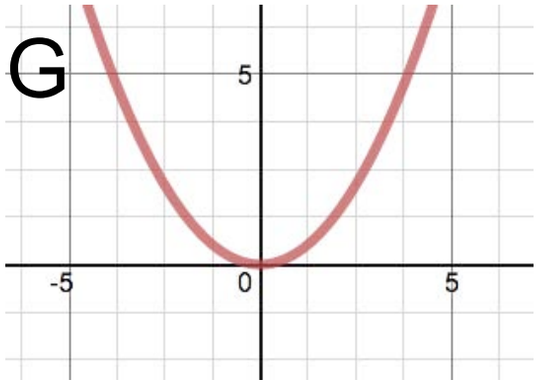


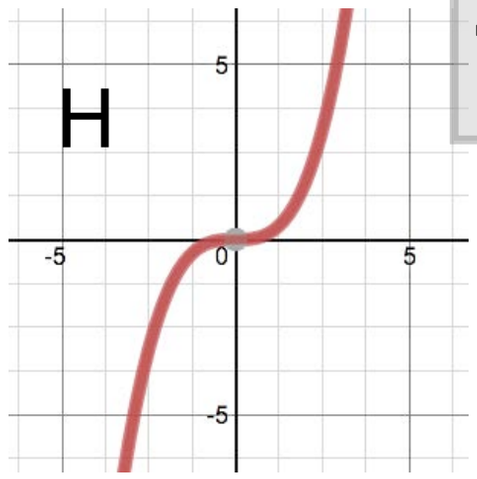








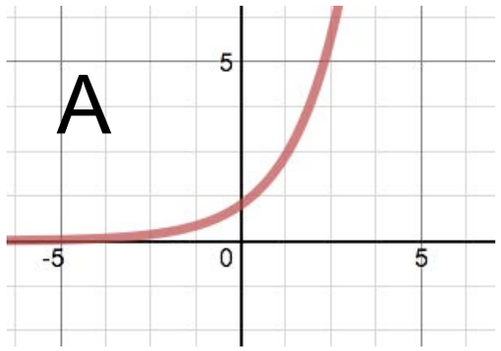




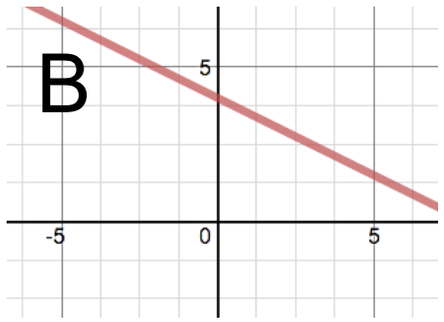
Answer

37 Which of the following are graphs of exponential decay? (You can choose more than one.)

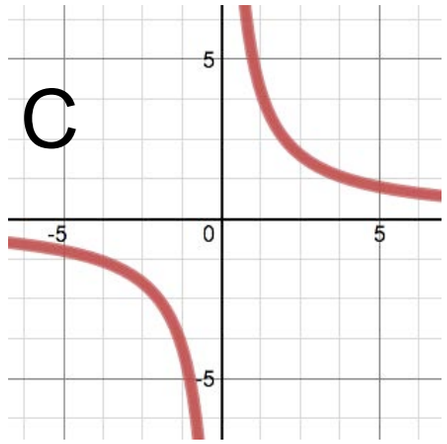
A



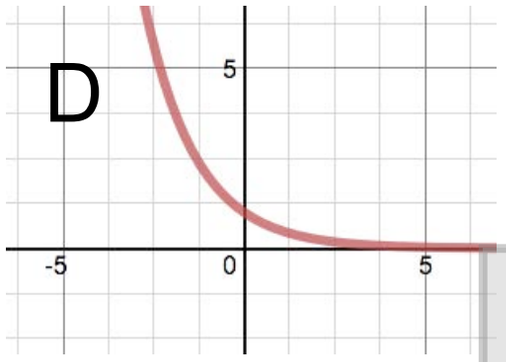
B



C



D



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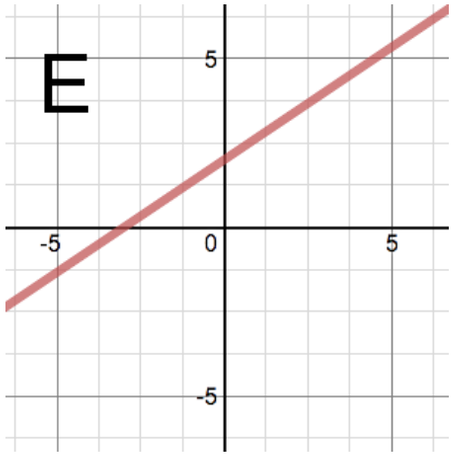

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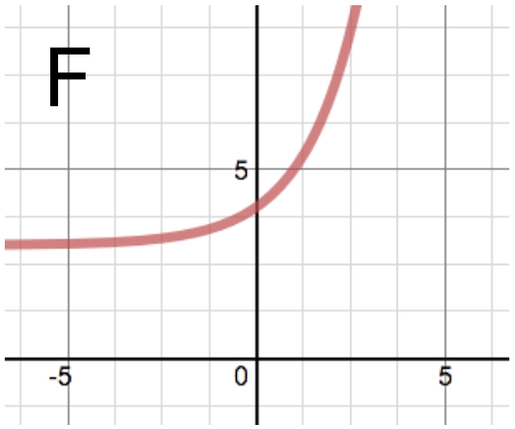

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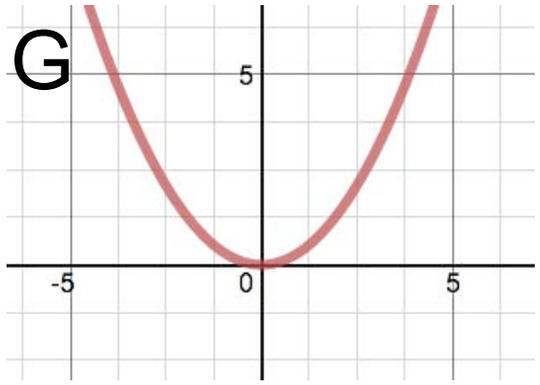
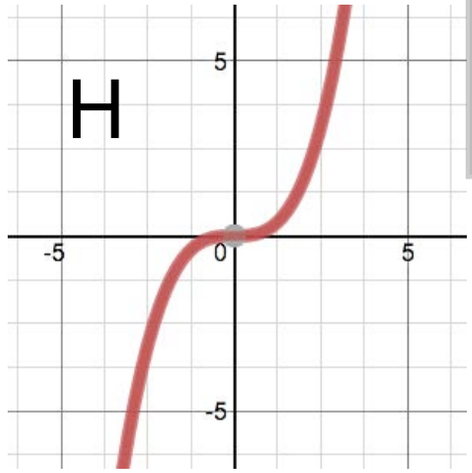


H



Answer

General Form of Exponential Functions

The general form of an exponential function is

$$f(x) = ab^x + c$$

where x is the variable and a, b, and c are constants.

b is the base in the exponential expression and represents the growth rate for the function.

If **b > 1** then the function shows exponential growth.
If **0 < b < 1** then the function shows exponential decay.

y = c is the horizontal asymptote.
(0, a + c) is the y-intercept.
(As with all functions, to find the y-intercept, let x = 0.)

Teacher Notes

38 For the exponential function, identify a, b, and c. Does the equation represent growthordecay?

$$y = 3(2)^x + 4$$

A Growth

B Decay

Answer

39 For the same function, what is the equation of the horizontal asymptote?

$$y = 3(2)^x + 4$$

A $y = 2$

B $y = 3$

C $y = 4$

D $y = 5$

Answer

40 Now, find the y-intercept:

$$y = 3(2)^x + 4$$

A (0, 3)

B (0, 4)

C (0, 7)

D (0, 9)

Answer

41 In this exponential equation, identify a, b, and c. Does it represent growth or decay?

$$y = (0.2)^x + 3$$

A Growth

B Decay

Answer

42 Which of the following is the equation of the horizontal asymptote?

$$y = (0.2)^x + 3$$

A y = 0.2

B y = 1

C y = 3

D y = 4

Answer

43 Find the y-intercept for the same function:

$$y = (0.2)^x + 3$$

A (0, 0.2)

B (0, 1)

C (0, 3)

D (0, 4)

Answer

44 Does the following exponential function represent growth or decay?

$$y = 4(3)^{-x}$$

A Growth

B Decay

Answer

45 Find the horizontal asymptote for the function:

$$y = 4(3)^{-x}$$

A $y = 0$

B $y = 1$

C $y = 3$

D $y = 4$

Answer

46 For the same function, what is the y-intercept?

$$y = 4(3)^{-x}$$

A (0, 0)

B (0, 1)

C (0, 3)

D (0, 4)

Answer

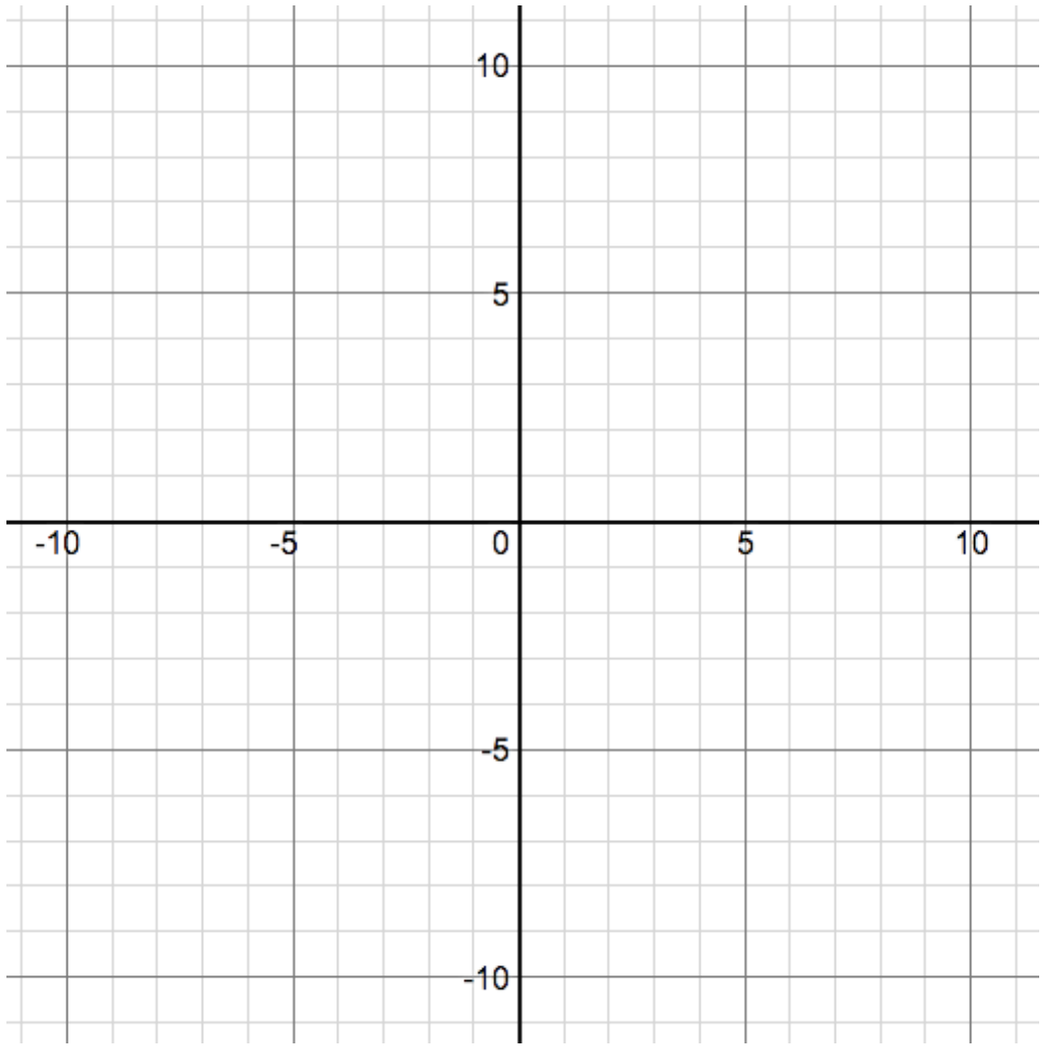
Graphing Exponential Functions

$$f(x) = 3(1.2)^x + 2$$

To sketch the graph of an exponential function, use the values for a, b and c.

1) Identify horizontal asymptote
   (y = c)
2) Determine if base shows decay or growth
3) Graph y-intercept (0, a + c)
4) Sketch graph

Try it!

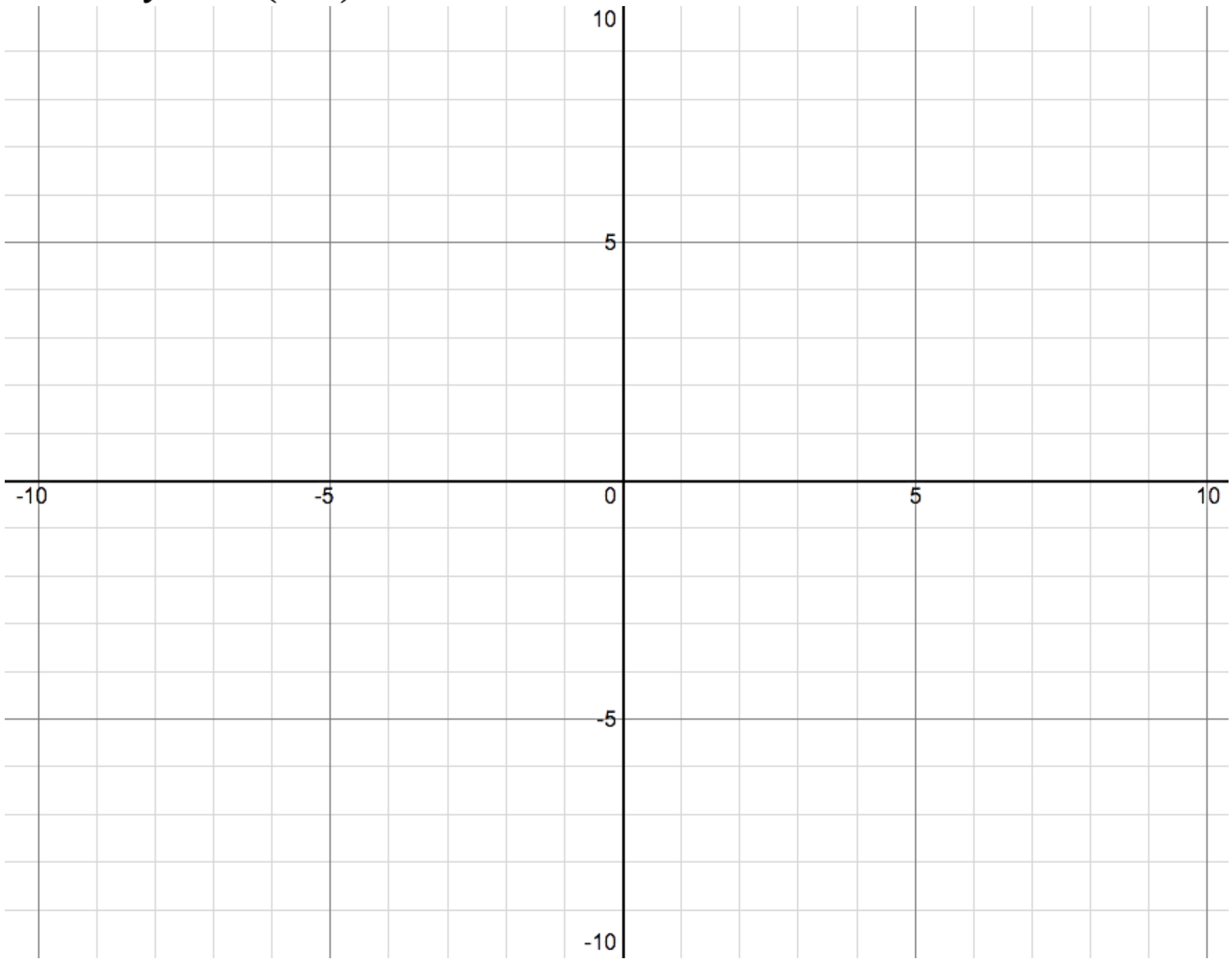


Answer

Note: A horizontal asymptote is the horizontal line y = c that the function cannot pass.

Graphing Exponential Functions

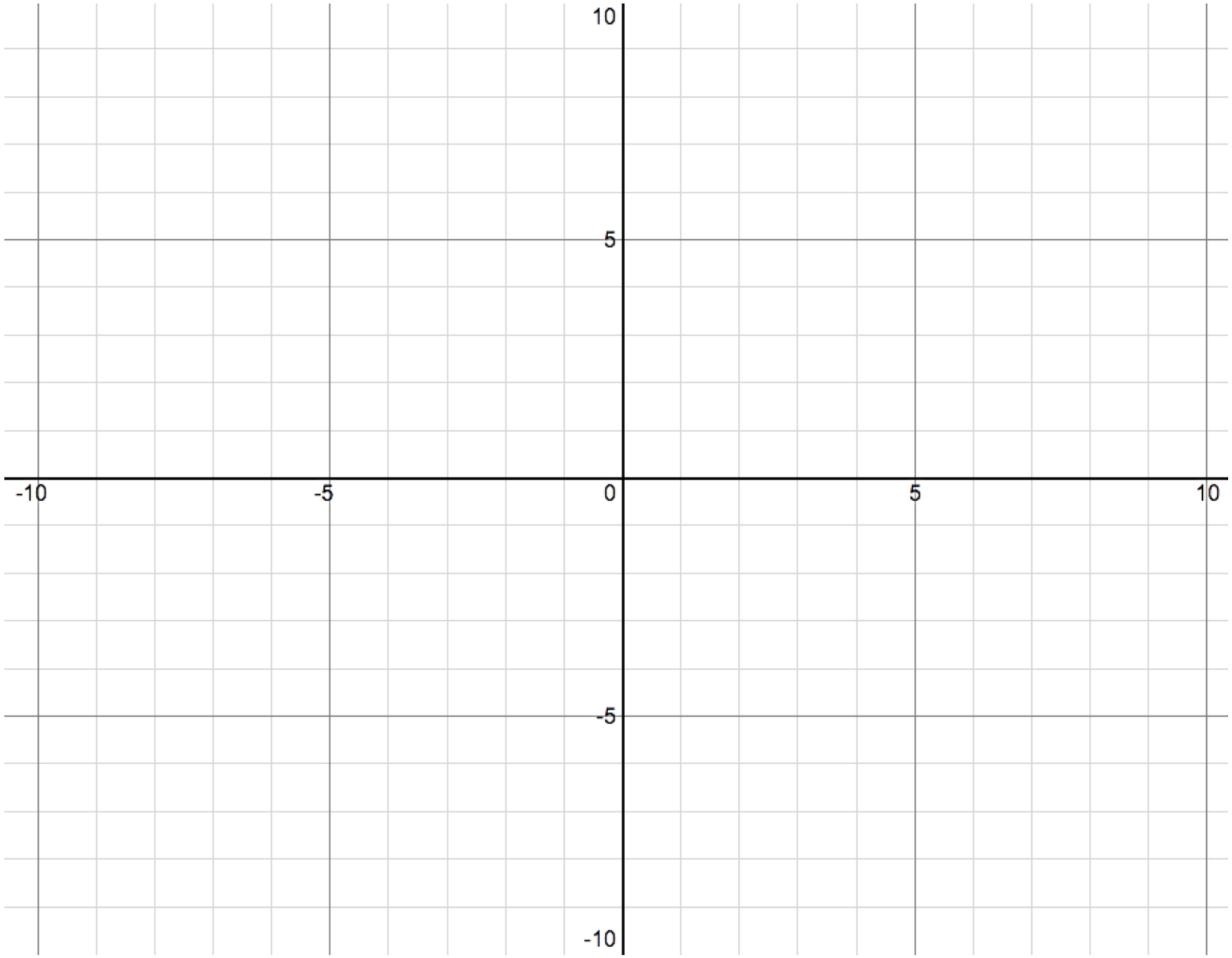
Graph: $y = 2(1.3)^x$



Answer

Graphing Exponential Functions

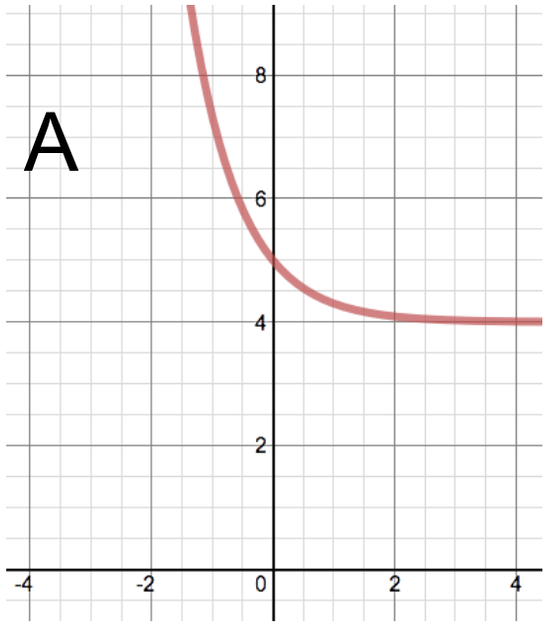
Graph: $y = (1.3)^x + 2$



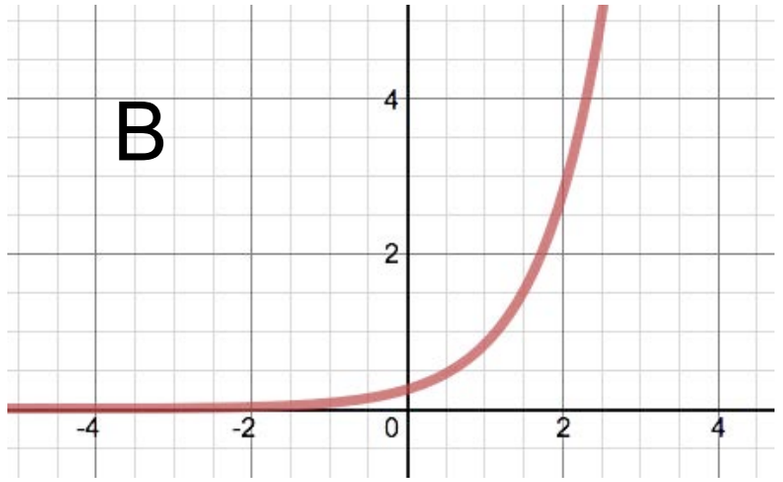
Answer

47 Identify the graph of: $y = 4(0.3)^x$

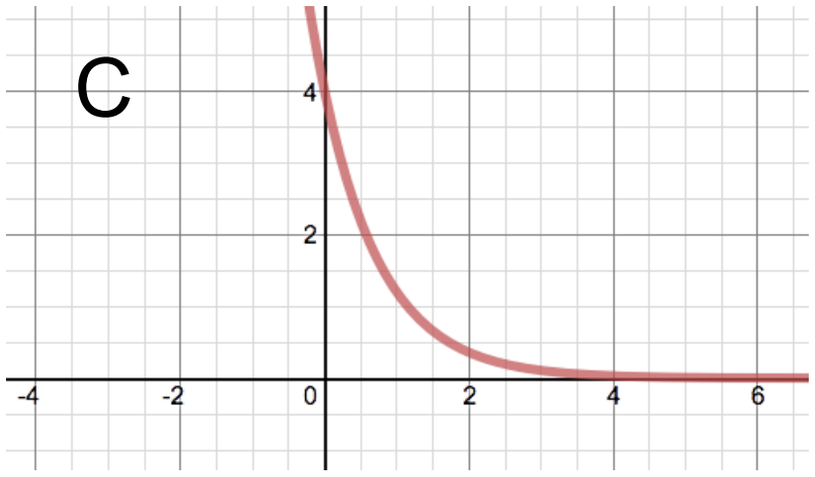
A



B



C



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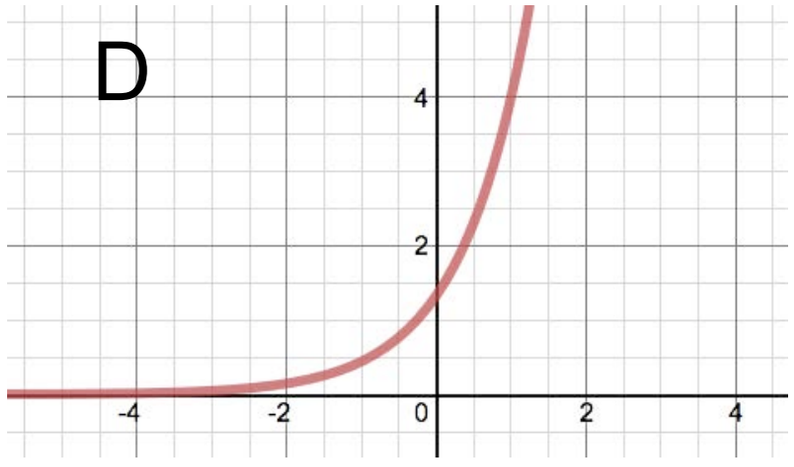
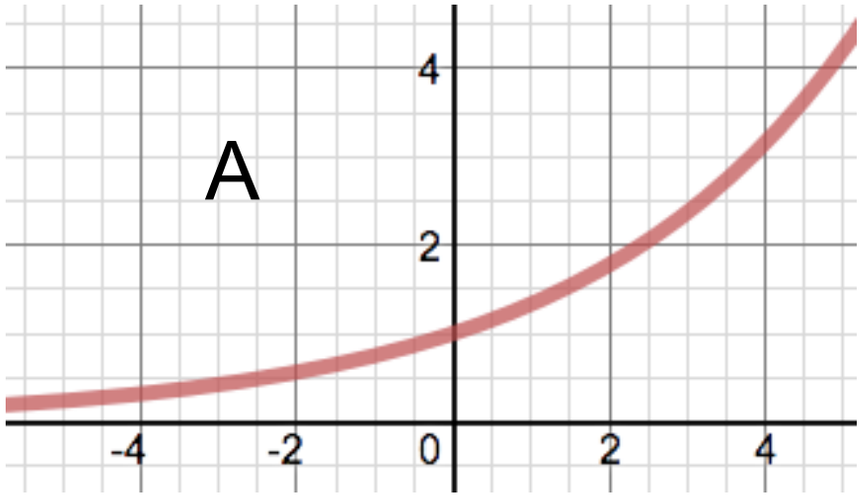
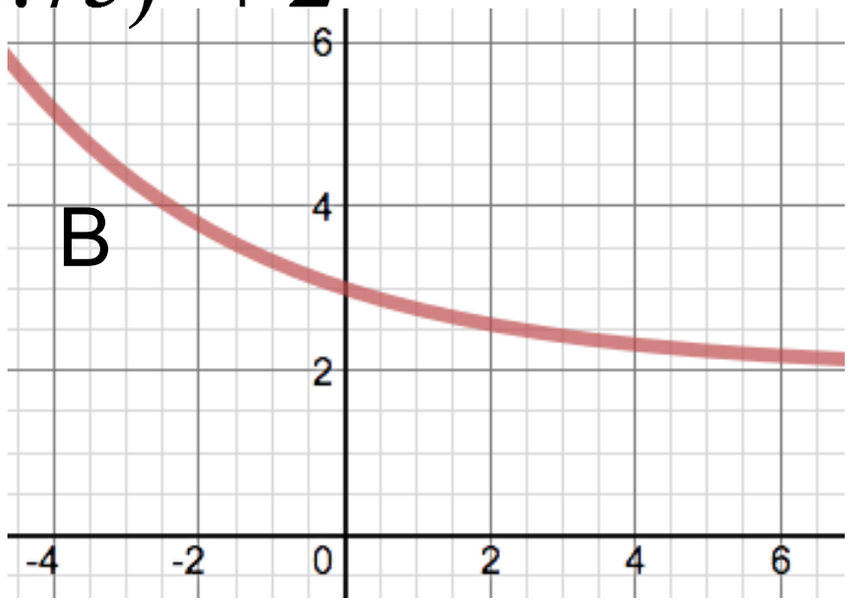
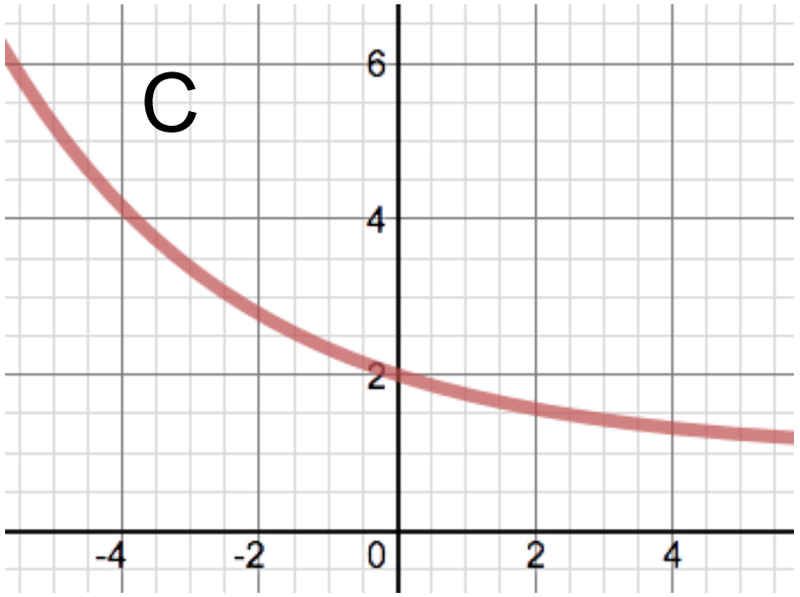


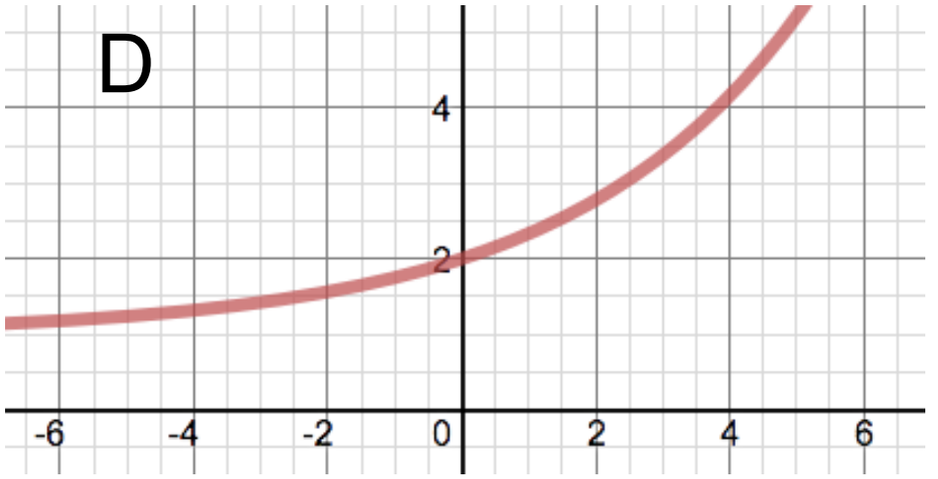
Answer

48 Identify the graph of: $y = (0.75)^x + 2$









Answer