

$$y = a(b)^{x-h} + k$$

Initial Value, a

$|a| > 1$ vertical stretch
 $0 < |a| < 1$ vertical shrink
 $a < 0$ reflection over
 (\ominus) x-axis

Horizontal Shift, h

If you add h, then you have a
horizontal shift right h units.
 $(x-h)$

If you subtract h, then you have
a horizontal shift left h units.
 $(x+h)$

Vertical Shift, k

*If you add k, then you
have a vertical shift
up k units.

*If you subtract k, then
you have a vertical
shift down k units.

Examples: Describe the transformations of each exponential function below.

1. $y = 3(2^x) + 1$

Growth or Decay? growth

Initial Value: 3

Base: 2

H.A: $y = 1$

y-int: $(0, 4)$

Transformations:

- vertical shift up 1
- vertical stretch by 3

2. $y = \frac{1}{2}(4^x) - 9$

Growth or Decay? growth

Initial Value: $\frac{1}{2}$

Base: 4

H.A: $y = -9$

y-int: $(0, -8.5)$

Transformations:

- vertical shift down 9
- vertical shrink by $\frac{1}{2}$

3. $y = -(3^x)$

Growth or Decay? growth

Initial Value: 1

Base: 3

H.A: $y = 0$

y-int: $(0, -1)$

Transformations:

reflection over the x-axis

1. $y = -3(5^x) + 2$

5. $y = 2(4^{x-5}) - 3$

6. $y = \frac{1}{6} \left(\frac{1}{3}\right)^{x+1} - 5$

Growth or Decay? growth

Growth or Decay? growth

Growth or Decay? decay

Initial Value: 3

Initial Value: 2

Initial Value: 1/6

Base: 5

Base: 4

Base: 1/3

H.A.: y = 2

H.A.: y = -3

H.A.: y = -5

y-int: (0, -1)

y-int: (0, -1535/512)

y-int: (0, -89/18)

Transformations:

- reflect over x-axis
- vertical stretch by 3
- vertical shift up 2

Transformations:

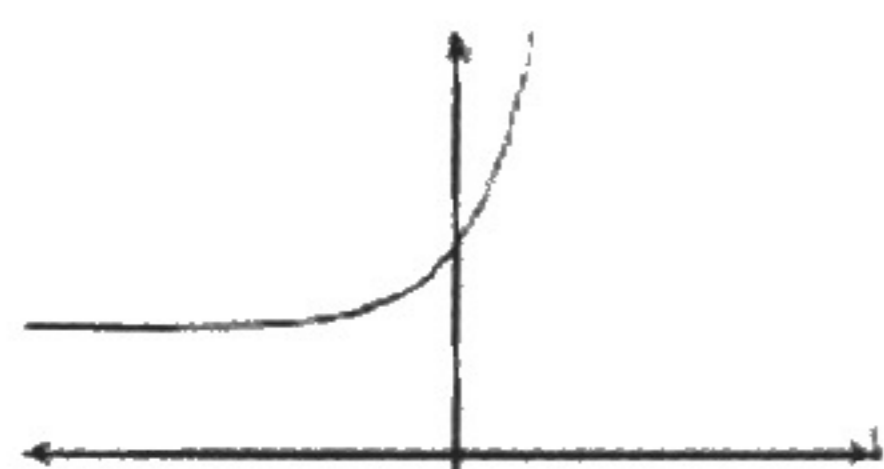
- vertical stretch by 2
- horizontal shift right 5
- vertical shift down 3

Transformations:

- vertical shrink by 1/6
- horizontal shift left 1
- vertical shift down 5

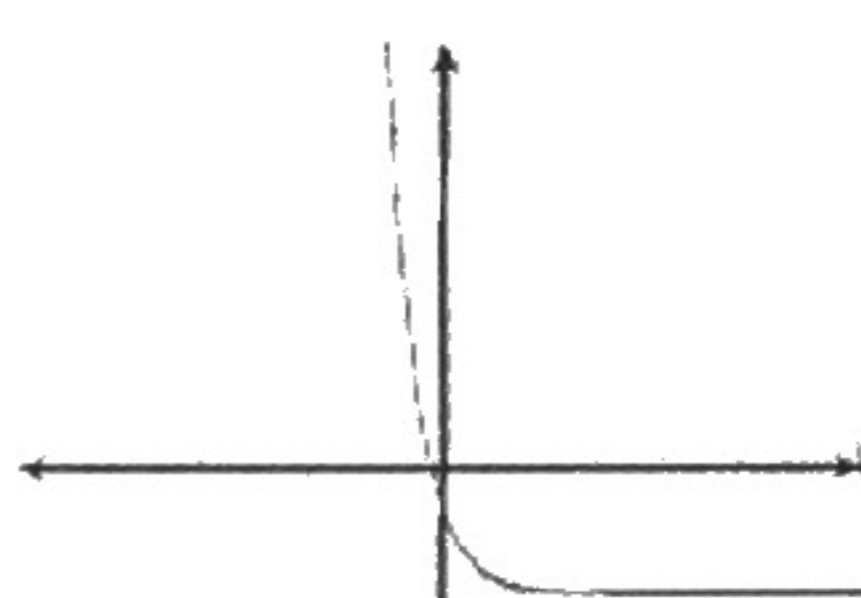
For each graph, circle what you know about the a, b, and k values in the function's equation.

7.



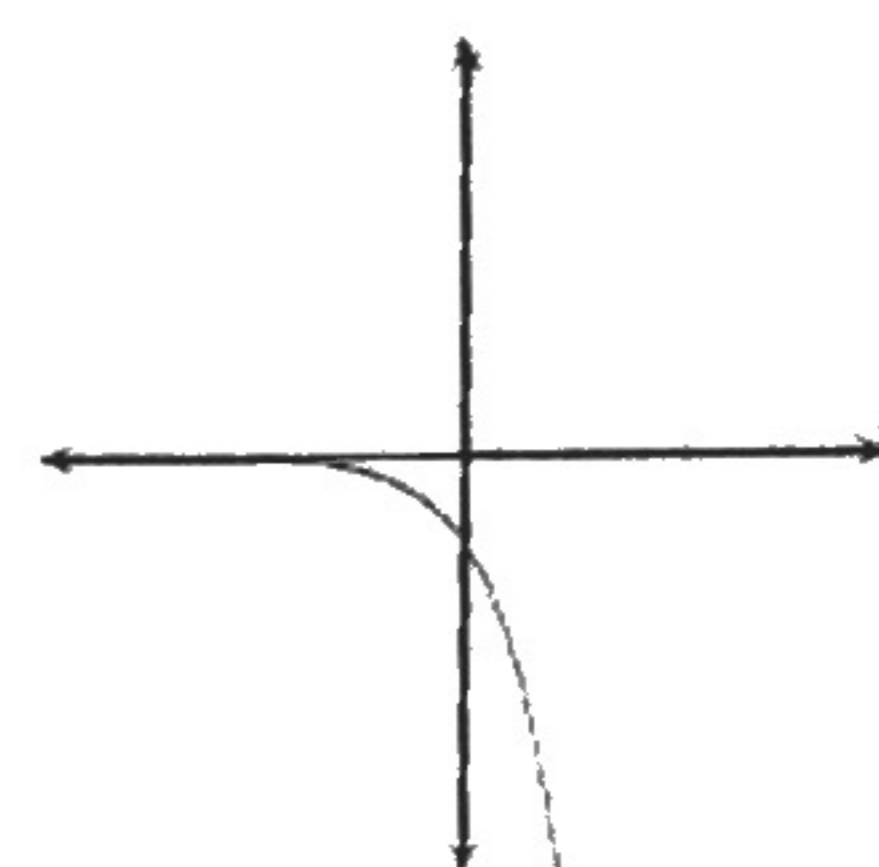
- $a < 0$, or $a > 0$?
- $b < 1$, or $b > 1$?
- $k < 0$, $k > 0$, or $k = 0$?

8.



- $a < 0$, or $a > 0$?
- $b < 1$, or $b > 1$?
- $k < 0$, $k > 0$, or $k = 0$?

9.



- $a < 0$, or $a > 0$?
- $b < 1$, or $b > 1$?
- $k < 0$, $k > 0$, or $k = 0$?

For each of the following, write the equation of the exponential function.

10. The function has an initial value of 6, decreasing exponentially by a factor of $\frac{2}{3}$, translated 4 units to the right and 1 unit up.

$f(x) = 6 \left(\frac{2}{3}\right)^{x-4} + 1$

11. The function is reflected across the x-axis, has an initial value of 10, increasing exponentially by a factor of 5, and translated 3 units down.

$f(x) = -10(5)^x - 3$

12. The function has an initial value of 16, decreasing exponentially by a factor of 0.75, and translated 6 units to the left.

$f(x) = 16(0.75)^{x+6}$

13. The function is reflected across the x-axis, increasing exponentially by a factor of 2.5, translated 3 units to the left and 5 units down.

$f(x) = -(2.5)^{x+3} - 5$