

3.5 - Transformations for Exponential Functions

Today we will INVESTIGATE:

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

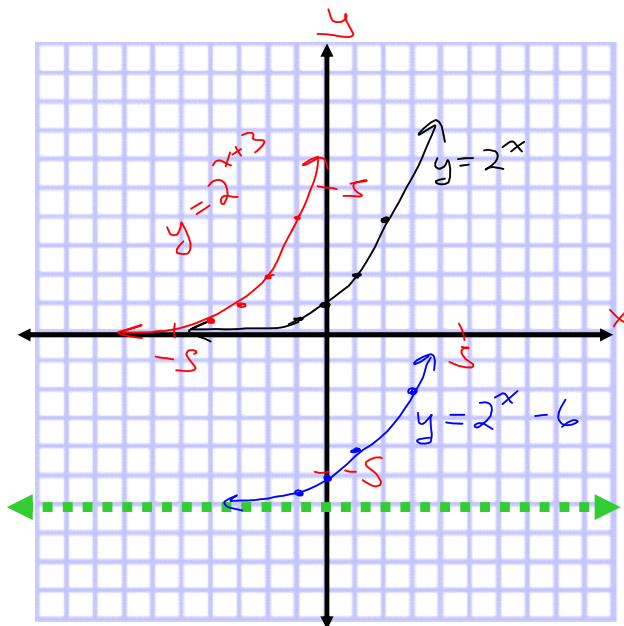
Base Functions vary for exponential. Ex. $y = 2^x$, $y = 3^x$ etc.

Ex.1

a) Graph $y=2^x$ (Base Function)

| | |
|----|---------------|
| x | y |
| -1 | $\frac{1}{2}$ |
| 0 | 1 |
| 1 | 2 |
| 2 | 4 |

KEY POINTS and Asymptote
 $y=0$



b) On the same grid graph the following and indicate the transformations.

i) $y=2^x - 6$

↗
DOWN 6

ii) $y=2^{x+3}$

↖
Left 3

c)

| | $y = 2^x$ (Base) | $y = 2^x - 6$ | $y = 2^{x+3}$ |
|-----------|-----------------------------------|------------------------------------|-----------------------------------|
| Asymptote | $y = 0$ | $y = -6$ | $y = 0$ |
| Domain | $\{x \in \mathbb{R}\}$ | $\{x \in \mathbb{R}\}$ | $\{x \in \mathbb{R}\}$ |
| Range | $\{y \in \mathbb{R} \mid y > 0\}$ | $\{y \in \mathbb{R} \mid y > -6\}$ | $\{y \in \mathbb{R} \mid y > 0\}$ |

Ex.2 $y = -2^{x-3}$

a) List the transformations

① Reflection in x-axis (vertical)

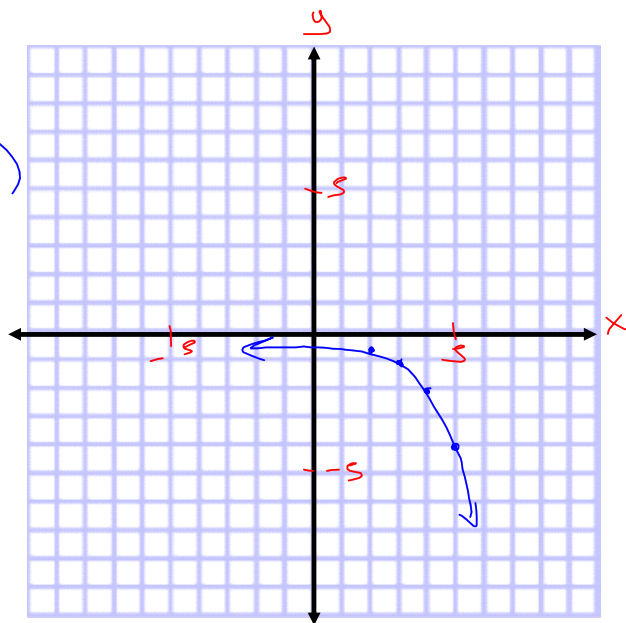
② Right 3

$$(x, y) \rightarrow (x+3, -y)$$

b) Graph

Base $y = 2^x$

- $(-1, \frac{1}{2}) \rightarrow (2, -\frac{1}{2})$
- $(0, 1) \rightarrow (3, -1)$
- $(1, 2) \rightarrow (4, -2)$
- $(2, 4) \rightarrow (5, -4)$



Ex.3

a) Graph $y = 3^x$ (Base Function)

| x | y |
|----|---------------|
| -1 | $\frac{1}{3}$ |
| 0 | 1 |
| 1 | 3 |
| 2 | 9 |

KEY POINTS and Asymptote

$y = 0$

b) On the same grid graph the following and indicate the transformations.

i) $y = 3^{2x}$

① H.C. b.a.f.o. 2

ii) $y = -2(3^x)$

- ① Refl. in x-axis
- ② V.S. b.a.f.o. 2

iii) $y = \left(\frac{1}{3}\right)^{2x}$

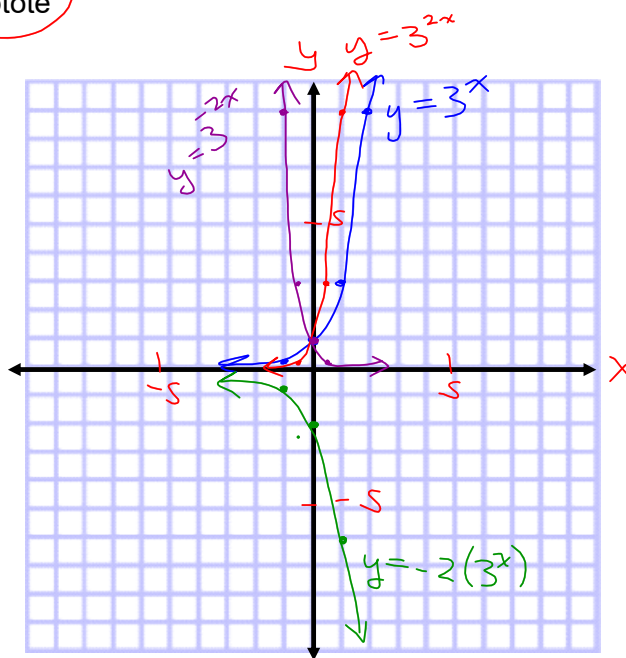
Note: Can be rewritten

$$y = (\frac{1}{3})^{2x} = 3^{-2x}$$

Base $y = 3^x$

① H.C. b.a.f.o. 2

② Horiz Refl. in y-axis



Ex. 4 Graph $y = 2^{-3x-6} + 3$

Base $y = 2^x$

Always
FACTOR!

$$y = 2^{-3(x+2)} + 3$$

- ① Horiz refl. in y-axis
- ② H.C. base 3
- ③ UP 3
- ④ LEFT 2

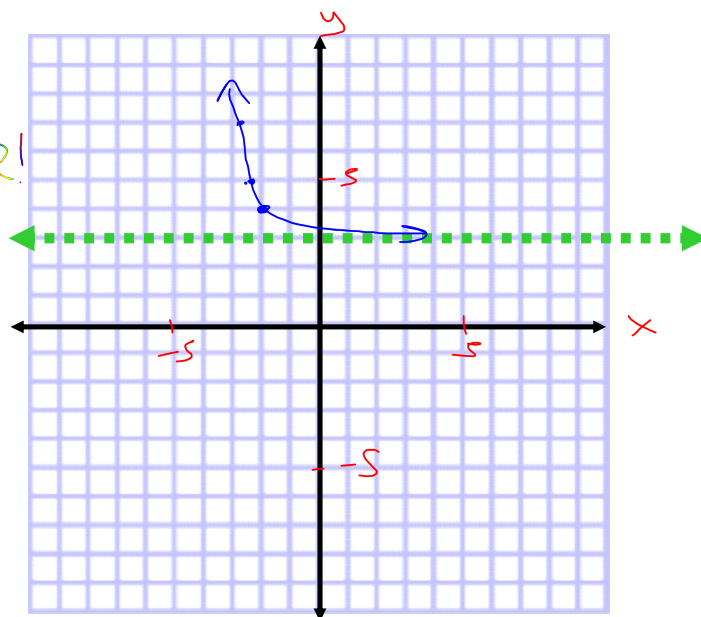
$$(x, y) \rightarrow \left(-\frac{x}{3}-2, y+3\right)$$

$$\left(-1, \frac{1}{2}\right) \rightarrow \left(-\frac{5}{3}, \frac{7}{2}\right)$$

$$(0, 1) \rightarrow (-2, 4)$$

$$(1, 2) \rightarrow \left(-\frac{7}{3}, 5\right)$$

$$(2, 4) \rightarrow \left(-\frac{8}{3}, 7\right)$$



Ex.5

a) Name another function that is equivalent to $f(x) = 3^{2+x}$

$$= 3^2 \cdot 3^x$$

$$= 9 \cdot 3^x$$

b) What are the transformations that occur in each to give the same final function?

$$f(x) = 3^{2+x}$$

$$= 3^{x+2}$$

$$f(x) = 9(3^x)$$

① V.S. before 9

① Left + 2

Ex. 6

a) Write several transformed equations with a base of 2 that passes through the point (0,2).

① $y = 2 \cdot 2^x$ ③ $y = 2^{x+1}$ ⑤ $y = 2 \cdot 2^{-x}$

② $y = 2^x + 1$ ④ $y = 2^{-x} + 1$

b) Prove algebraically, if any of the above equations give the same graph.

$$① \quad y = 2 \cdot 2^x$$

$$= 2^{1+x}$$

$$③ \quad y = 2^{x+1}$$

Same

Homework: Pg 195 C1,C2,1,4,6-8,10,12, 13

