The Exponential Function

$y = a^x$ *where a is a positive real number and the exponent is a variable*

Graph $y = a^x$ for a = 2, 5 and 10 on the same screen. Answer the following questions:

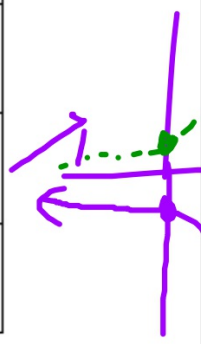
1. What is the domain and range of each function?
2. What are the x- and y- intercepts of each function?
3. What is the end behavior of each graph?
4. Do the graphs have any asymptotes?
5. For what values of a is the graph of $y = a^x$ increasing and for what values is the graph decreasing? Explain.
6. Sketch what you see.

Graph $y = a^{-x}$ for a = 2, 5 and 10 on the same screen. Answer the following questions:

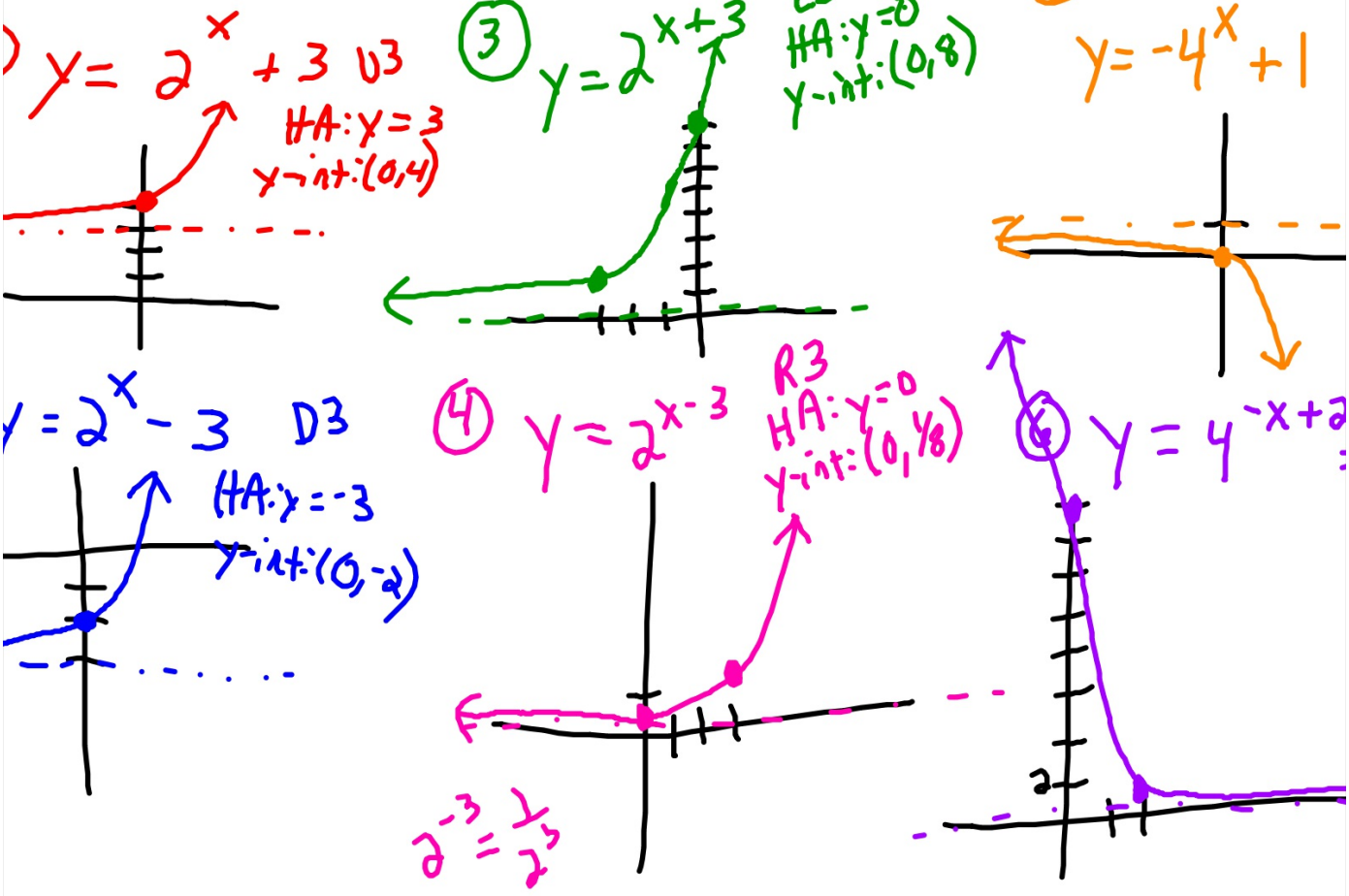
1. What is the domain and range of each function?
2. What are the x- and y- intercepts of each function?
3. What is the end behavior of each graph?
4. Do the graphs have any asymptotes?
5. For what values of a is the graph of $y = a^x$ increasing and for what values is the graph decreasing? Explain.
6. Sketch what you see.
7. How can we write the above functions with a positive exponent? Graph to verify your answer.

Recall in Chapter 1, we learned how to graph different functions using parent graphs and their transformations. We can use this idea with the parent graph of $y = a^x$, as well. Describe what changes occur with the following transformations.

Transformation	**Changes that Occur**
$y = a^x + c$	Up c
$y = a^x - c$	Down c
$y = a^{x+c}$	Left c
$y = a^{x-c}$	Right c
$y = -a^x$	Refl. x-axis
$y = a^{-x}$	Refl. y-axis



Examples (as a class):



One-to-One Property:

$$a^x = a^y \quad \textit{if and only if} \quad x = y$$

$\frac{1^x}{3^x} =$

Examples:

1. $16 = 2^{x+2}$

$2^4 = 2^{x+2}$

$4 = x + 2$

$x = 2$

2. $\left(\frac{1}{3}\right)^x = 81$

$3^{-x} = 3^4$

$-x = 4$

$x = -4$

The natural base *e*:

e is an irrational number, *e* = 2.718281828 …

Often the most convenient choice for the base of an exponential function, especially when completing real-world problems:

$$f(x) = e^x$$

Evaluate the following for $f(x) = e^x$

1. x = 6.2 492.749
2. x = -0.4 1.491
3. x = -7.1 8.251
4. x = 0.72 2.054