Welcome Back MYP Math 9!

	Assignment Effort Grade (Circle One)	Comments (What was interesting or challenging?)
Monday Date: 2/12 Topic: Nothing due... Index Laws Quiz was Friday!	0 1 2	
Tuesday Date: ______ Topic: ____________	0 1 2	
Wednesday Date: ______ Topic: ____________	0 1 2	
Thursday Date: ______ Topic: ____________	0 1 2	
Friday Date: ______ Topic: ____________	0 1 2	

Class Plan:

1. Warm-up... weekend highlight?!

2. Exponential Visual

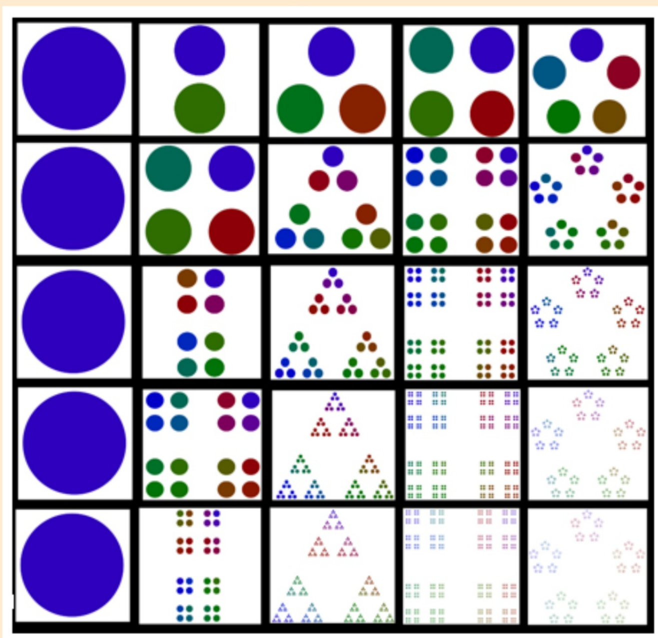
   https://saravanderwerf.com/2016/10/30/visualizing-exponential-power-logarithmic-functions/

3. Exponential Equations & Graphs

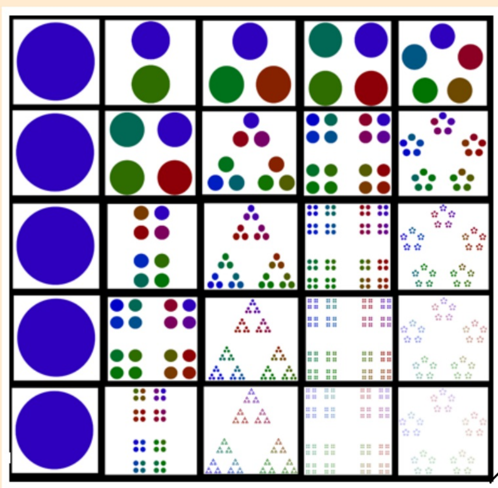
B EXPONENTIAL FUNCTIONS

C GRAPHS OF EXPONENTIAL FUNCTIONS

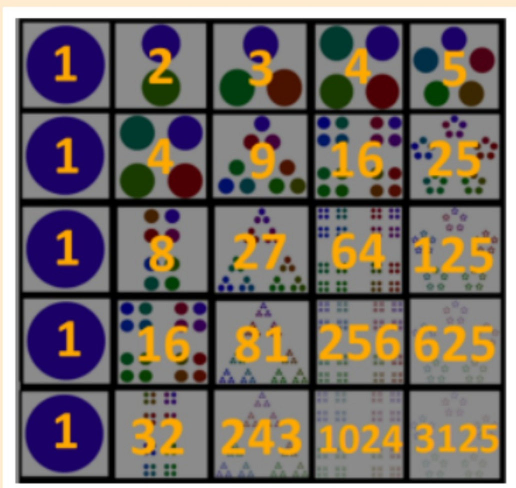
What do you notice?

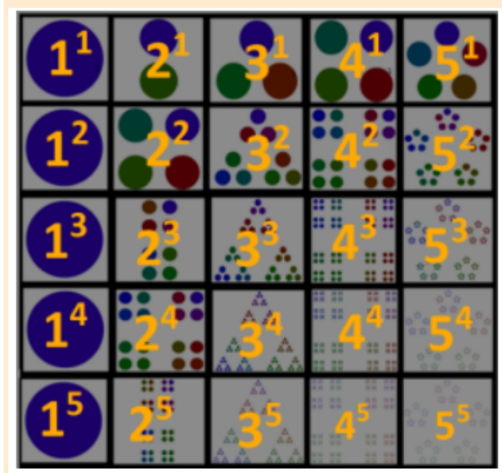


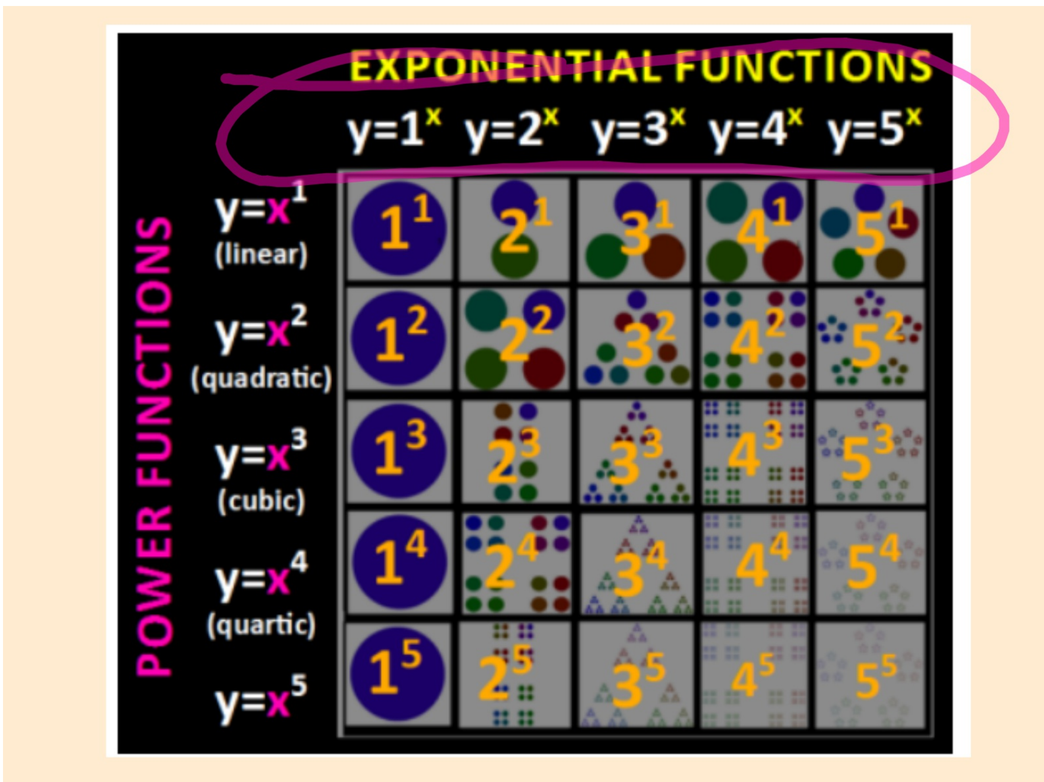
What do you notice?



	1^x	2^x	3^x	4^x	5^x
x^1	1	2	3	4	5
x^2	1^2	4 2^2	$3^2=9$	16	5^2
x^3	1^3	8 2^3	$3^3=27$	64	5^3
x^4	1	16 2^4	$3^4=81$	256	5^4
x^5	1	32 2^5	3^5	1024	3125


1 2 3 4 5
1 4 9 16 25
1 8 27 64 125
1 16 81 256 625
1 32 243 1024 3125

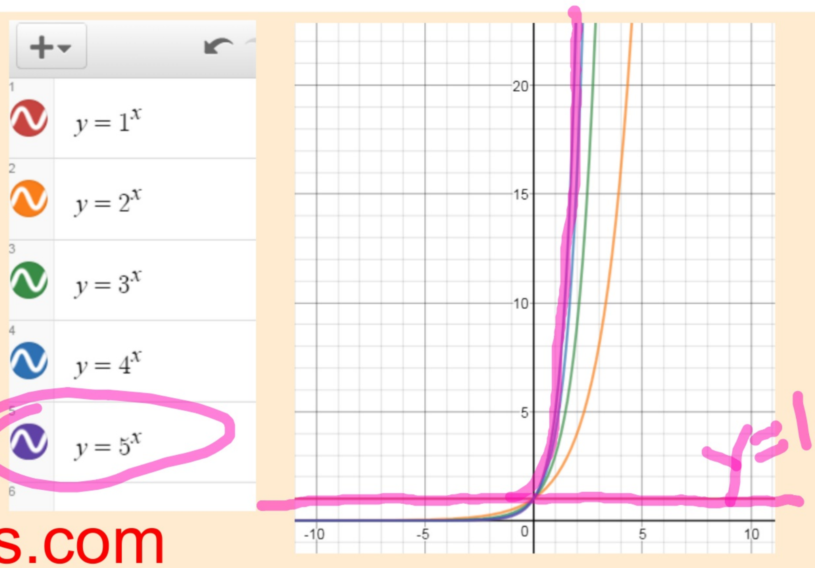

1^1 2^1 3^1 4^1 5^1
1^2 2^2 3^2 4^2 5^2
1^3 2^3 3^3 4^3 5^3
1^4 2^4 3^4 4^4 5^4
1^5 2^5 3^5 4^5 5^5


EXPONENTIAL FUNCTIONS
y=1^x y=2^x y=3^x y=4^x y=5^x
POWER FUNCTIONS
y=x^1 (linear)
y=x^2 (quadratic)
y=x^3 (cubic)
y=x^4 (quartic)
y=x^5
1^1 2^1 3^1 4^1 5^1
1^2 2^2 3^2 4^2 5^2
1^3 2^3 3^3 4^3 5^3
1^4 2^4 3^4 4^4 5^4
1^5 2^5 3^5 4^5 5^5

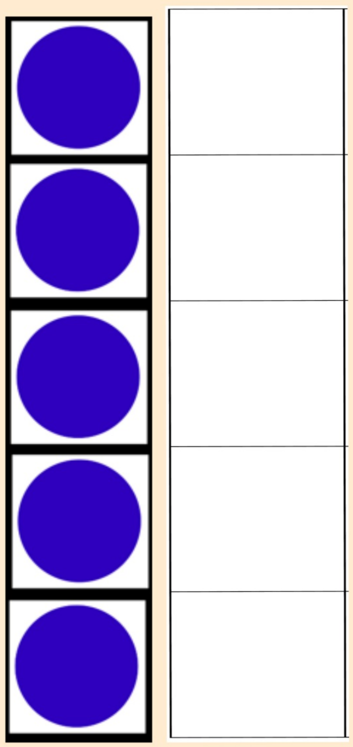
B EXPONENTIAL FUNCTIONS

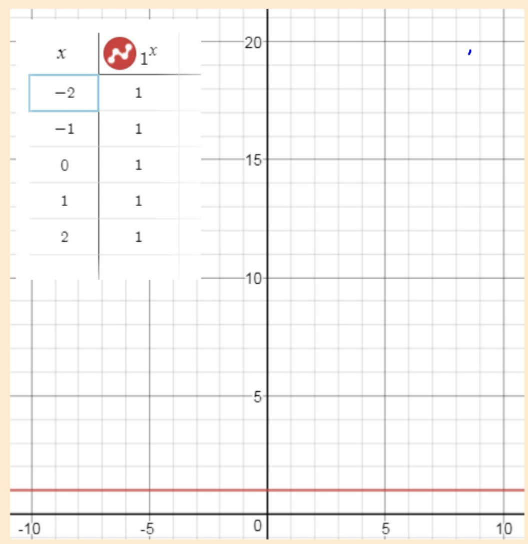
An **exponential function** is a function in which the variable occurs as part of the index or exponent.

Examples of exponential functions are $y = 5^x$, $y = 3^{x+1}$, and $y = 2^{-x} - 6$.

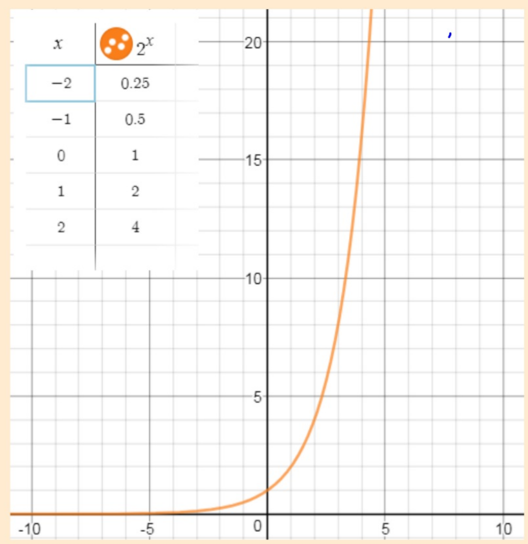


Go to: desmos.com

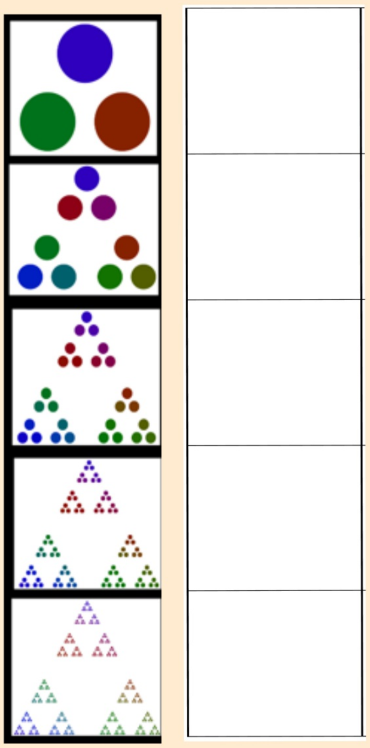


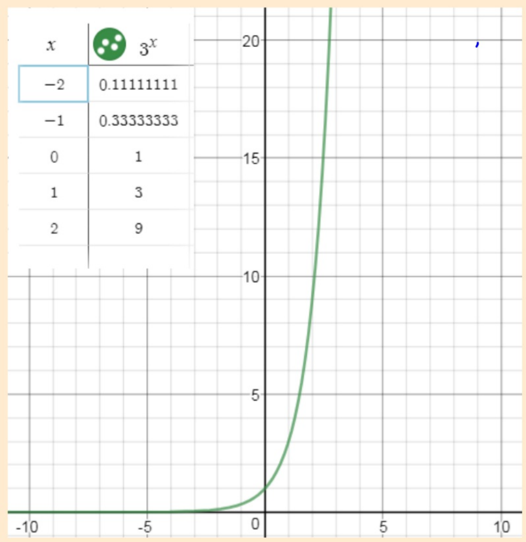


$$y = 1^x$$

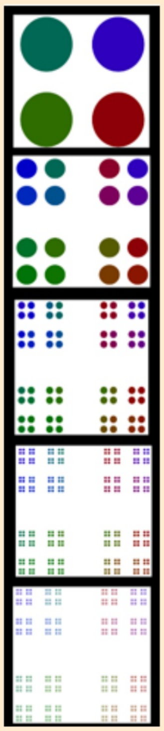


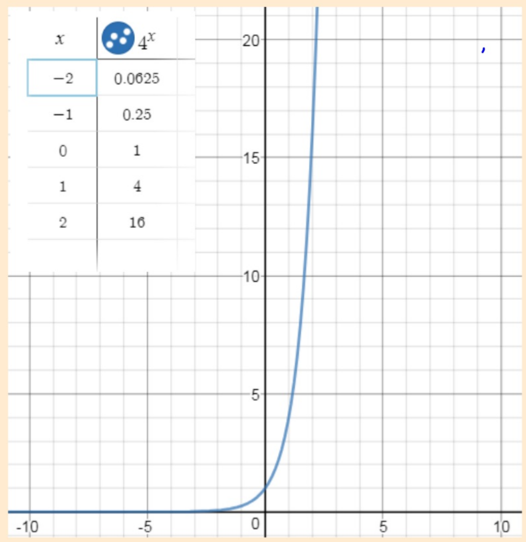
$$y = 2^x$$



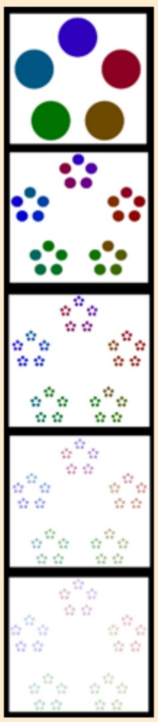


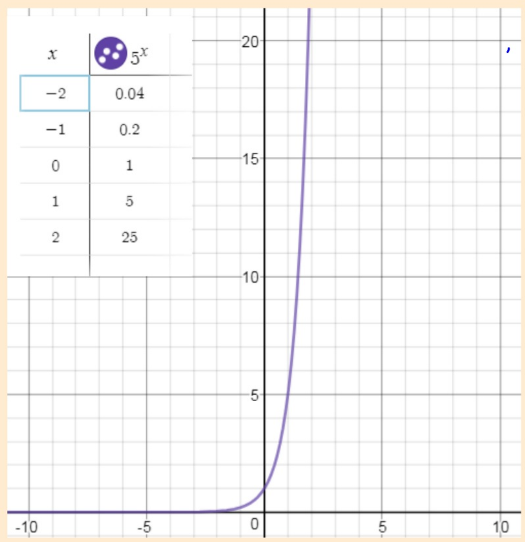
$$y = 3^x$$





$$y = 4^x$$

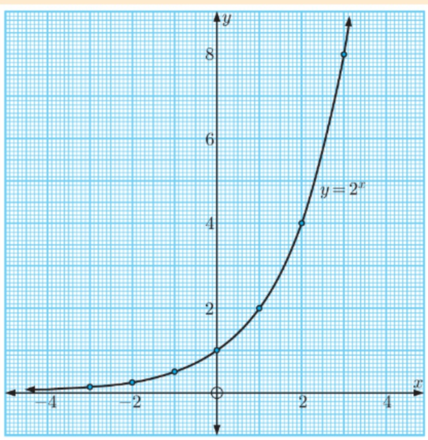




$$y = 5^{x}$$

C GRAPHS OF EXPONENTIAL FUNCTIONS

One of the simplest exponential functions is $y = 2^x$. To help graph the function, we can construct a **table of values**.



x	-3	-2	-1	0	1	2	3
y	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4	8

When $x = -3$, $y = 2^{-3} = \frac{1}{8}$

When $x = 0$, $y = 2^0 = 1$

When $x = 3$, $y = 2^3 = 8$

To the left of the y-axis, the graph gets closer to the x-axis but always lies above it. We say that the graph of $y = 2^x$ is **asymptotic** to the x-axis, or the x-axis is a **horizontal asymptote** of the graph.

To the right of the y-axis, the graph becomes very steep as the x values increase.

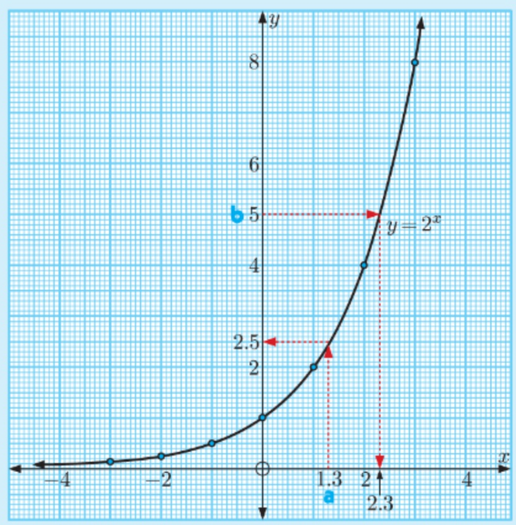
We can use the graphs of exponential functions to estimate the value of numbers raised to **decimal** powers. We can also use them to help solve exponential equations such as $2^x = 5$, which cannot easily be solved by equating indices.

Example 5 **Self Tutor**

Use the graph of $y = 2^x$ to estimate, to 1 decimal place:

a the value of $2^{1.3}$

b the solution to $2^x = 5$.



a Reading from the graph, when $x = 1.3$, $y \approx 2.5$.

$\therefore$ $2^{1.3} \approx 2.5$

b Reading from the graph, when $y = 5$, $x \approx 2.3$.

$\therefore$ the solution to $2^x = 5$ is $x \approx 2.3$

Joke break!


OF COURSE IT'S MONDAY...
...DOES THIS LOOK LIKE MY FRIDAY FACE?


EVERYBODY HATES ME

DO: Graph an Exponential Function

$$y = 2^x$$

$\{-4 \le x \le 10\}$

$\{-2 \le y \le 20\}$

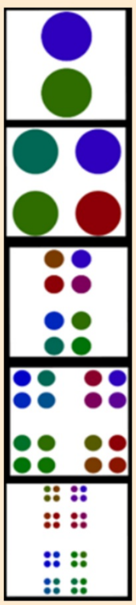
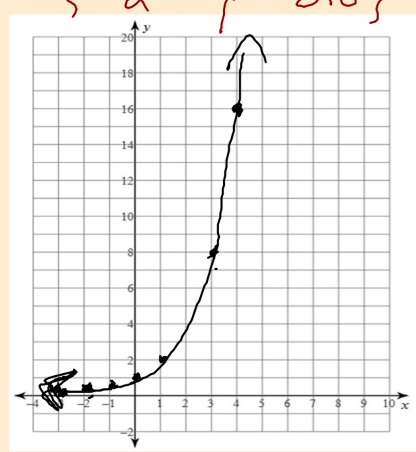


Table:

x (Stage in pattern)	y (Number of Dots)
-3	$y = 2^{-3} = \frac{1}{2^3} = \frac{1}{8} = .125$
-2	$y = 2^{-2} = \frac{1}{2^2} = .25$
-1	$y = 2^{-1} = \frac{1}{2} = .5$
0	$y = 2^0 = 1$
1	$y = 2^1 = 2$
2	$y = 2^2 = 4$
3	$y = 2^3 = 8$
4	$y = 2^4 = 16$
5	$y = 2^5 = 32$



DO: Graph an Exponential Function

{−4 ≤ x ≤ 10}

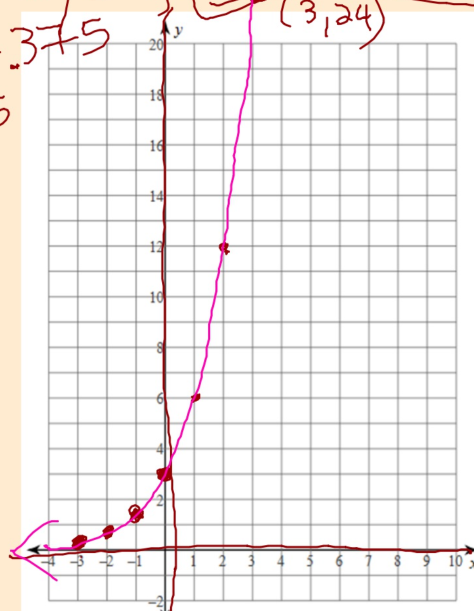
{−2 ≤ y ≤ 20}

$y = 3 \bullet (2)^x$

(3, 24)

Table:

x (Stage in pattern)	y (Number of Dots)
-3	$y = 3(2)^{-3} = \frac{3}{2^3} = \frac{3}{8} = .375$
-2	$y = 3(2)^{-2} = \frac{3}{4} = .75$
-1	$y = 3(2)^{-1} = 1.5$
0	$y = 3(2)^0 = 3$
1	$y = 3(2)^1$ 6
2	12
3	24
4	48
5	96



B **NOTES :)** **EXPONENTIAL FUNCTIONS**

What is an exponential equation?

$$y = a \cdot b^x$$

What are the parts of the equation?

a: The starting, *initial* value.
The value when x = 0 y-intercept

b: The constant multiplier, the value being multiplied repeatedly.

Equation: $y = 2^x$

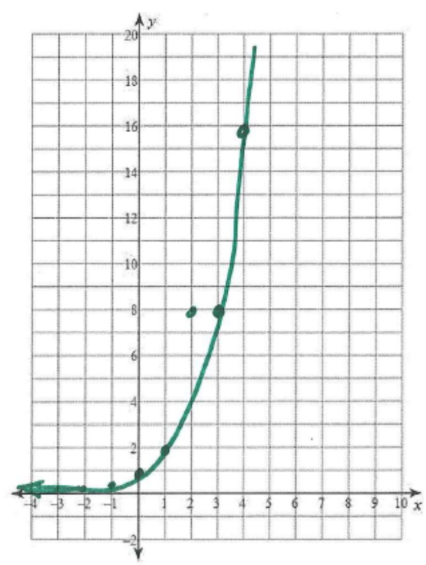
x: Stage
y: number of dots

(What does "y" equal in relation to "x"? How can I use the input to get an output?)

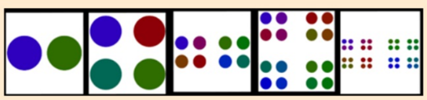
Table:

x (Stage in pattern)	y (Number of Dots)
-3	1/8
-2	1/4
-1	1/2
0	1
1	2
2	4
3	8
4	16
5	32

Graph:



C GRAPHS OF EXPONENTIAL FUNCTIONS



Use pattern, graph, table, and/or equation to make predictions.

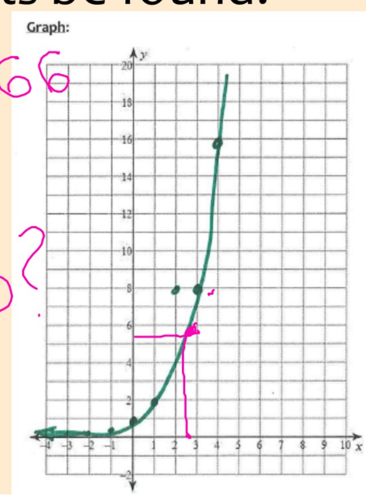
1) Approximately, how many dots in stage 2.5? How could this number of dots be found?

Table:

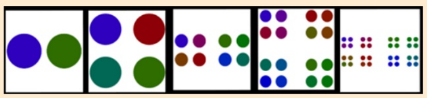
x (Stage in pattern)	y (Number of Dots)
-3	$\frac{1}{8}$
-2	$\frac{1}{4}$
-1	$\frac{1}{2}$
0	1
1	2
2	4
3	8
4	16
5	32

2^2.5 ≈ 5.66

$2^2 = 4$, $2^3 = 8$ } $2^{2.5} = 6$?



C GRAPHS OF EXPONENTIAL FUNCTIONS



Use pattern, graph, table, and/or equation to make predictions.

2) At what stage will there be...

a) 4096 dots?

$2^{12} = 4096$

b) Approximately 23 dots?

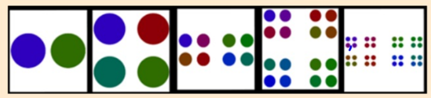
between 4 & 5

$2^{4.55}$

Table:

x (Stage in pattern)	y (Number of Dots)
-3	$\frac{1}{8}$
-2	$\frac{1}{4}$
-1	$\frac{1}{2}$
0	1
1	2
2	4
3	8
4	16
5	32

Additional Predictions

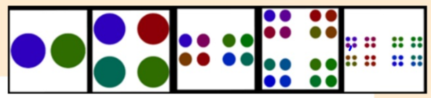


Predictions: Show work or explain how you solved. You may use the description, table, graph, or equation.

Solve for number of dots (y-value):

1. How many dots are in stage 4? 16 $y = 2^4 = 2\cdot2\cdot2\cdot2 = 16$	2. How many dots will be in stage 6? $y = 2^6$ $2\cdot2\cdot2\cdot2\cdot2\cdot2 =$ 64 dots!
3. How many dots will be in stage 10? $y = 2^{10}$ $2\cdot2\cdot2\cdot2\cdot2\cdot2\cdot2\cdot2\cdot2\cdot2$ = 1024 dots	4. Approximately, how many dots would be in stage 2.5? $y = 2^{2.5} \approx 5.7$ dots [Somewhere between stage 2+3 so between 4 + 8 dots]

Additional Predictions



Solve for stage in the pattern (x-value):

5. What stage has 16 dots? Stage 4! I looked back at the pattern!	6. When will there be 128 dots in the pattern? Stage 7. From #2 above I know 64 is stage 6. $64 \times 2 = 128$, so $y = 2^7 = 128$.
7. When will there be 4096 dots in the pattern? (12th stage) $4096 = 4(1024) = 2 \cdot 2 \cdot 1024$ This means 2 stages after stage 10. $y = 2^{12} = 4096$	8. Approximately, when will there be about 23 dots in the pattern? Between stage 4 and 5. About stage 4.5. $2^{4.5} \approx 22.6$ dots.

Exercises... 23B Exponential Functions & 23C Graphs WS

Write equation

Is this an exponential pattern? If so, state the constant multiplier.

1) 1, 5, 25, 125, ...

$a = 1$

$b = 5$

$y = 5^x$

2) 2, 6, 18, 54, ...

$a = 2$

$b = 3$

$y = 2 \cdot 3^x$

Is this an exponential pattern? If so, state the constant multiplier.

3) $-3, -18, -108, -648, \ldots$

4) $3, 6, 12, 24, \ldots$

Is this an exponential pattern? If so, state the constant multiplier.

5) $1, \ 9, \ 25, \ 49, \ldots$

6) $-10, \ -8, \ -5, \ -1, \ldots$

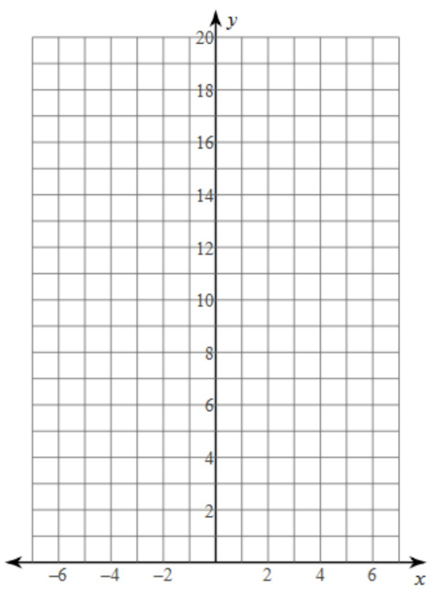
Is this an exponential pattern? If so, state the constant multiplier.

7) $-4, \ -16, \ -64, \ -256, \ldots$

8) $1, \ -2, \ 4, \ -8, \ldots$

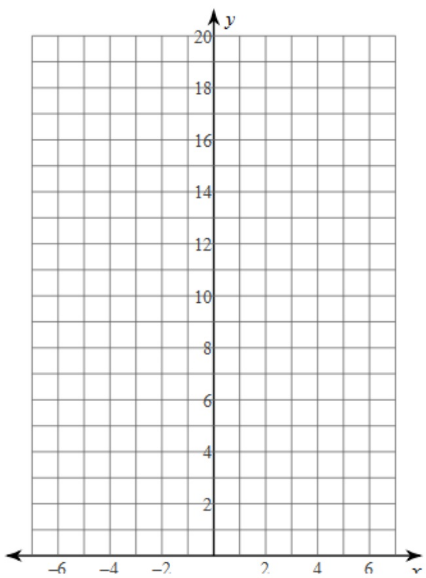
Create and table and sketch the graph of each function.

9) $y = 3^x$



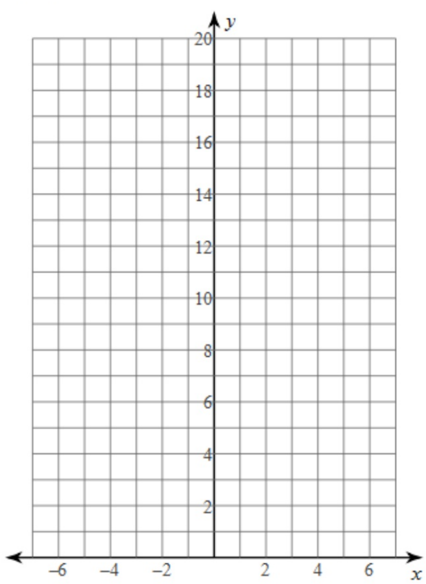
Create and table and sketch the graph of each function.

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



Create a table and sketch the graph of each function.

11) $y = 5 \cdot 2^x$



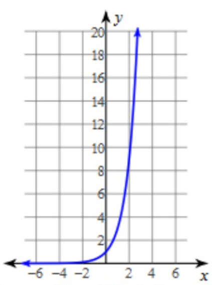
12) What do you notice about the parts of an exponential equation?

SOLUTIONS

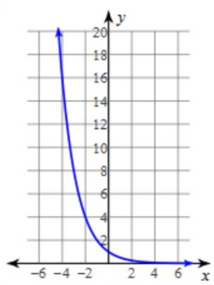
Answers to 23B Exponential Functions and 23C Graphs (ID: 1)

1) $r = 5$
2) $r = 3$
3) $r = 6$
4) $r = 2$
5) Not geometric
6) Not geometric
7) $r = 4$
8) $r = -2$

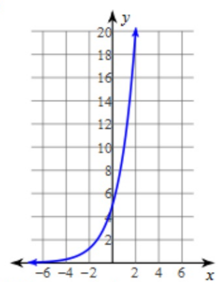
9)



10)



11)



12) I noticed that the coefficient is y-intercept, the base is the constant multiplier, and the variable must be the exponent to be an exponential function

SOLUTIONS

Is this an exponential pattern? If so, state the multiplier.

1) 1, 5, 25, 125, ...

$\frac{5}{1} = 5 \quad \frac{25}{5} = 5 \quad \frac{125}{25} = 5$

2) 2, 6, 18, 54, ...

$\frac{6}{2} = 3 \quad \frac{18}{6} = 3 \quad \frac{54}{18} = 3$

3) −3, −18, −108, −648, ...

$\frac{-18}{-3} = 6 \quad \frac{-108}{-18} = 6 \quad \frac{-648}{-108} = 6$

4) 3, 6, 12, 24, ...

$\frac{6}{3} = 2 \quad \frac{12}{6} = 2 \quad \frac{24}{12} = 2$

5) 1, 9, 25, 49, ...

$1^2 \; 3^2 \; 5^2 \; 7^2$

$\frac{9}{1} = 9 \quad \frac{25}{9} \neq 9$ ... NOT AN EXPONENTIAL PATTERN

6) −10, −8, −5, −1, ...

+2 +3 +4

NOT AN EXPONENTIAL PATTERN

7) −4, −16, −64, −256, ...

$\frac{-16}{-4} = 4 \quad \frac{-64}{4} = 4 \quad \frac{-256}{-64} = 4$

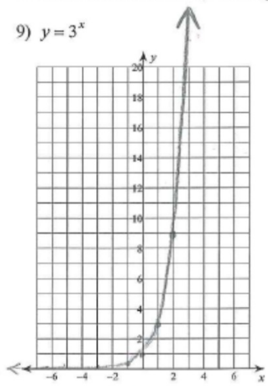
8) 1, −2, 4, −8, ...

$\frac{-2}{1} = -2 \quad \frac{4}{-2} = -2 \quad \frac{-8}{4} = -2$

SOLUTIONS

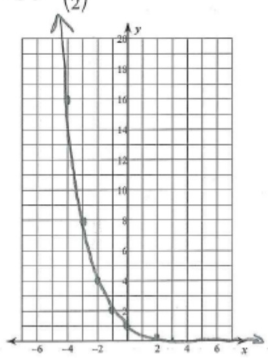
Create and table and sketch the graph of each function.

9) $y = 3^x$



x	$y = 3^x$
-3	$3^{-3} = \frac{1}{3^3} = \frac{1}{27}$
-2	$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$
-1	$3^{-1} = \frac{1}{3}$
0	$3^0 = 1$
1	3^1
2	$3^2 = 9$
3	$3^3 = 27$

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



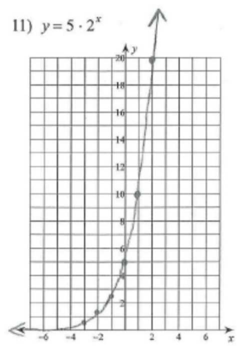
$-4 \quad \left(\frac{1}{2}\right)^{-4} = \left(\frac{2}{1}\right)^4$ 16

x	y
-3	$\left(\frac{1}{2}\right)^{-3} = \left(\frac{2}{1}\right)^3 = 8$
-2	$\left(\frac{1}{2}\right)^{-2} = \left(\frac{2}{1}\right)^2 = 4$
-1	$\left(\frac{1}{2}\right)^{-1} = (2)$
0	$\left(\frac{1}{2}\right)^0 = 1$
1	$\left(\frac{1}{2}\right)^1 = \frac{1}{2}$
2	$\left(\frac{1}{2}\right)^2 = \frac{1}{4}$
3	$\left(\frac{1}{2}\right)^3 = \frac{1}{8}$

SOLUTIONS

Create a table and sketch the graph of each function.

11) $y = 5 \cdot 2^x$



x	y
−3	$5 \cdot 2^{-3} = 5 \cdot \frac{1}{2^3} = \frac{5}{8}$
−2	$5 \cdot 2^{-2} = 5 \cdot \frac{1}{2^2} = \frac{5}{4}$
−1	$5 \cdot 2^{-1} = 5 \cdot \frac{1}{2} = \frac{5}{2}$
0	$5 \cdot 2^0 = 5 \cdot 1 = 5$
1	$5 \cdot 2^1 = 10$
2	$5 \cdot 2^2 = 5 \cdot 4 = 20$
3	$5 \cdot 2^3 = 5 \cdot 8 = 40$

12) $y = 5 \cdot 2^x$ ← variable as EXP = EXPONENTIAL EQUATION

← the base is the CONSTANT MULTIPLIER

↑ coefficient is the Y-INTERCEPT