

AC CCGPS Coordinate Algebra and Geometry
Linear and Exponential Functions
Unit 4

Standards:

- Represent and solve equations and inequalities graphically (linear and exponential)
- Understand the concept of a function and use function notation
- Interpret functions that arise in applications in term of the context
- Analyze functions using different representations
- Build new functions from existing functions
- Build a function that models a relationship between two quantities
- Construct and compare linear and exponential models and solve problems
- Interpret expressions for functions in terms of the situation they model

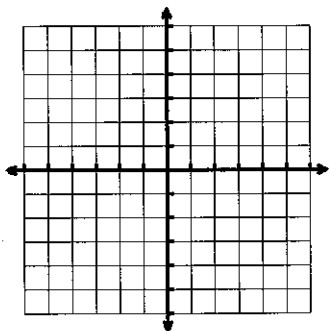
Date	Topic	Assignment
Monday November 16	Graphing Exponentials with tables of values Note pages: 1-2 in packet	Pages 3-4 in packet Graph each function only by creating a table of values. Feel free to use your graphing calculator to check your work
Tuesday November 17	Characteristics of Functions and graphing exponentials Note pages: 5-7	Pages 8-9 in packet
Wednesday November 18	Characteristics of Functions Stations	Pages 10 in packet
Thursday November 19	Writing equations of exponential functions Note page: 11	Page 12-13 in packet
Friday November 20	Universal Screening	
Monday November 30	Exponential Review-review with whiteboards	Pages 14-15 in packet
Tuesday December 1	QUICK QUIZ Solving Exponential Equations Pages 16-17	Page 18 in packet

Wednesday December 2	Solving Exponential Equations Questions and answers	Page 19
Thursday December 3	Average Rate of Change Group activity pages: 20-25	Finish group activity
Friday December 4	Average Rate of Change Group activity pages: 26-30	Finish group activity
Monday December 7	Review	Pages 31-32
Tuesday December 8	TEST	
Wednesday December 9	Transformations of Linear, Quadratic and Exponentials	
Thursday December 10	Transformations with function notation: ie- $f(x-3)+2$	
Friday December 11	QUIZ Final exam review (units 1 and 2)	
Monday December 14	Units 3 and 4 review for final exam	
Tuesday December 15	Questions??	

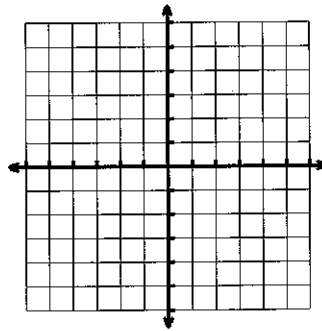
AC CCGPS Alg/Geo
Graphing Exponential Equations

Name _____

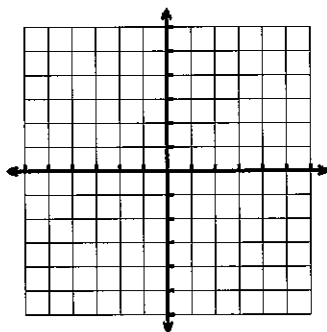
1. $y = 2^x$



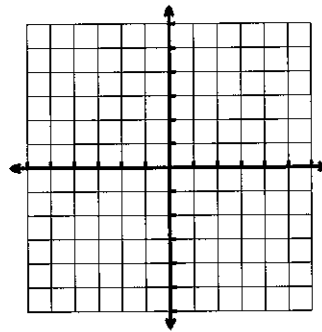
2. $y = (3)^x$



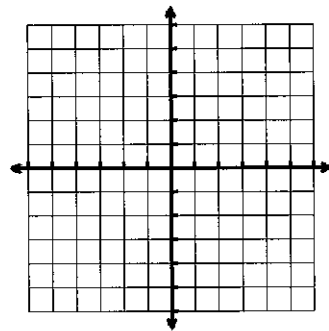
3. $y = 3^x + 2$



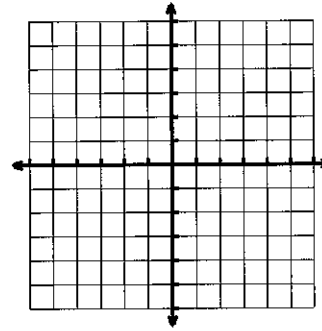
4. $y = 2^x + 1$



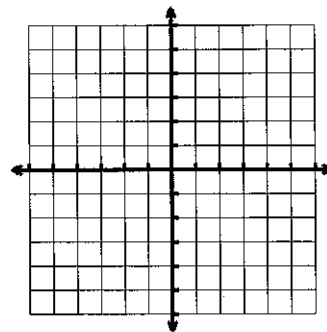
5. $y = -\left(\frac{1}{2}\right)^{x-2}$



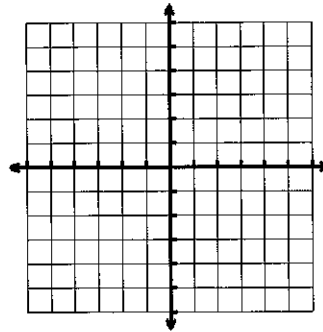
6. $y = 3^x - 2$



7. $y = \left(\frac{1}{3}\right)^x - 4$



8. $y = 2^x$



An exponential function has the form

$$y = ab^x$$

b is a positive number other than 1

If b is greater than 1

$$y = ab^x$$

b is the
"growth
factor"

exponential growth function.

In the bunny problem

a = 2 (because we initially had 2 bunnies)
b = 2 (because they were having 2 babies)
So our equation was $y = 2(2)^x$

If b is between 0 and 1

$$y = ab^x$$

b is the
"decay
factor"

exponential decay function.

In the meteorite problem:

a = 30 (we initially had 30 ounces)
b = $\frac{1}{2}$ (it was decaying by $\frac{1}{2}$)

So our equation was: $y = 30(\frac{1}{2})^x$

a = initial amount
b = growth/decay factor
x = time
y = ending amount

1. Each year the local country club sponsors a tennis tournament. Play starts with 128 participants. During each round, half of the players are eliminated. Write an equation that models this situation. _____

How many players are left after 5 rounds? _____ (you can count OR plug in 5 for your x)

2. Bacteria can multiply at an alarming rate when each bacteria splits into two new cells, thus doubling. Write an equation that models one bacteria cell that splits into two new cells every hour. _____

How many bacteria would you have after 24 hours? _____

In the following equations, identify the initial amount and growth or decay factor. CIRCLE whether it is growth or decay.

3. $y = 100(3)^x$

Initial amount =
Growth/decay factor =

4. $y = 15(.5)^x$

Initial amount =
Growth/decay factor =

5. $y = 4^x$

Initial amount =
Growth/decay factor =

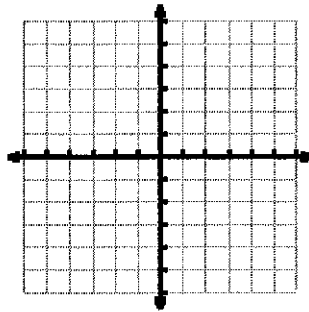
6. $y = \frac{1}{2}(\frac{3}{2})^x$

Initial amount =
Growth/decay factor =

Exponential Functions: $y = b^x$, where b is a positive number other than 1

Graph $y = 2^x$ using a t-chart.

X	Y

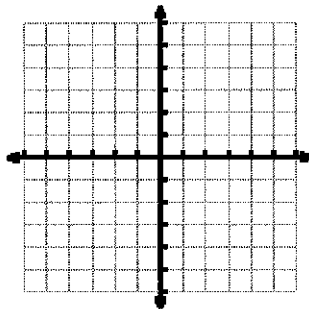


Asymptote - a line that a graph approaches as you move away from the origin; the graph hugs the asymptote

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

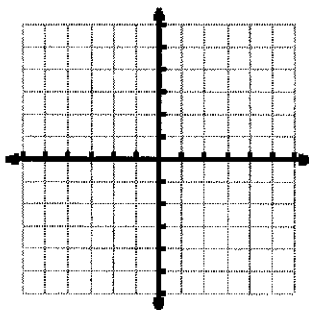
- Sketch the horizontal asymptote with a dashed line ($y = k$)
- Find the y-intercept of the graph by evaluating the function when $x=0$.
- Use a t-chart to sketch the graph of $y = ab^x$
- Transform the graph
 - Multiply y value of each coordinate in t-chart by a – move pencil to this point.
 - Shift h units horizontally
 - Shift k units vertically

1. $y = 2^x + 3$



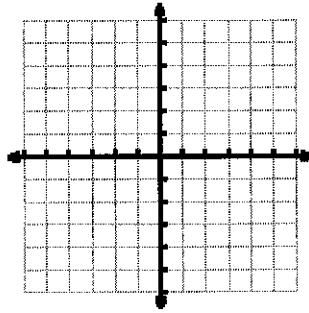
Y-intercept _____
 Asymptote _____
 Domain _____
 Range _____
 Growth or Decay
 end behavior: _____

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



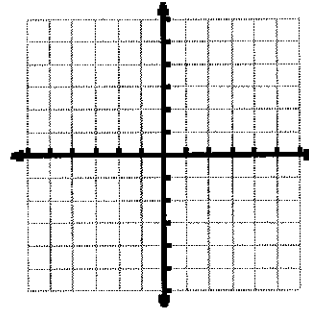
Y-intercept _____
 Asymptote _____
 Domain _____
 Range _____
 Growth or Decay
 end behavior: _____

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



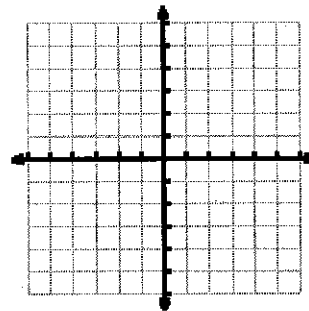
Y-intercept _____
 Asymptote _____
 Domain _____
 Range _____
 Growth or Decay _____
 end behavior: _____

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



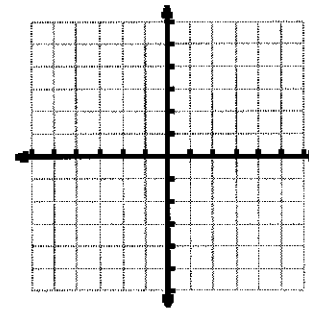
Y-intercept _____
 Asymptote _____
 Domain _____
 Range _____
 Growth or Decay _____
 end behavior: _____

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



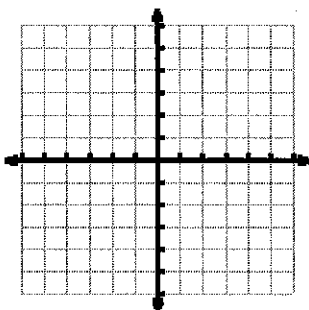
Y-intercept _____
 Asymptote _____
 Domain _____
 Range _____
 Growth or Decay _____
 end behavior: _____

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



Y-intercept _____
 Asymptote _____
 Domain _____
 Range _____
 Growth or Decay _____
 end behavior: _____

7. $y = 3 \cdot (2)^x - 4$



Y-intercept _____
 Asymptote _____
 Domain _____
 Range _____
 Growth or Decay _____
 end behavior: _____

CCGPS A
Linear and Exponential Functions

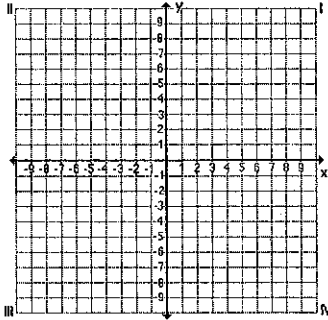
Name _____

Graph the following by using transformations from the 'parent' graph. Graph 'parent points' in pencil and then apply transformation. Connect new points with curve.

1. $y = 2^x - 4$

y - int _____
asyp _____
dom _____
range _____
growth/decay _____

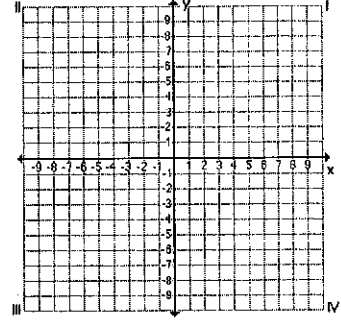
e.b.



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

y - int _____
asyp _____
dom _____
range _____
growth/decay _____

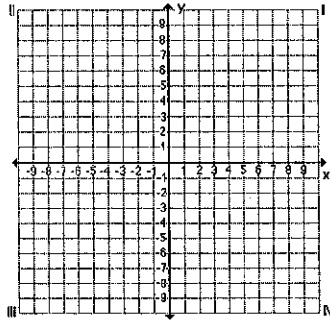
e.b.



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

y - int _____
asyp _____
dom _____
range _____
growth/decay _____

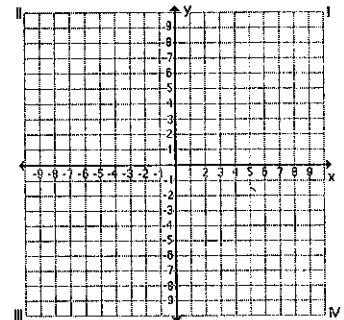
e.b.



4. $y = 3^x - 2$

y - int _____
asyp _____
dom _____
range _____
growth/decay _____

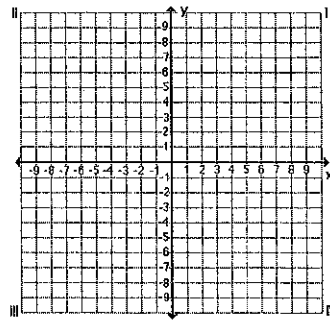
e.b.



5. $y = 3\left(\frac{1}{3}\right)^x + 4$

y - int _____
asyp _____
dom _____
range _____
growth/decay _____

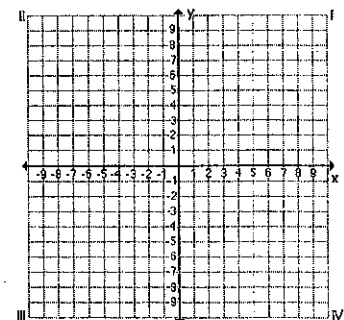
e.b.



6. $y = 2(2^x) - 3$

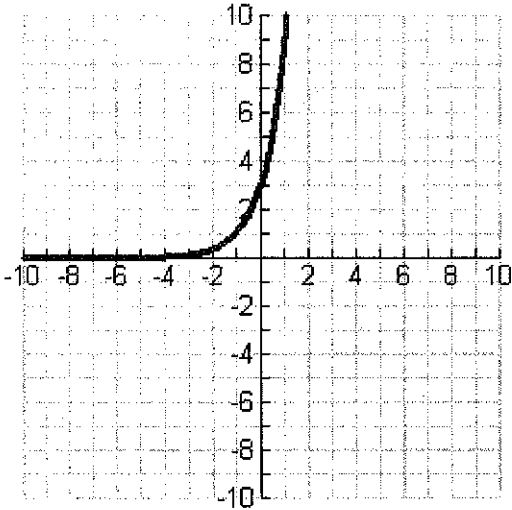
y - int _____
asyp _____
dom _____
range _____
growth/decay _____

e.b.



Analyzing Growth and Decay Exponential Functions

1. $y = 3^{x+1}$



Domain:

Range:

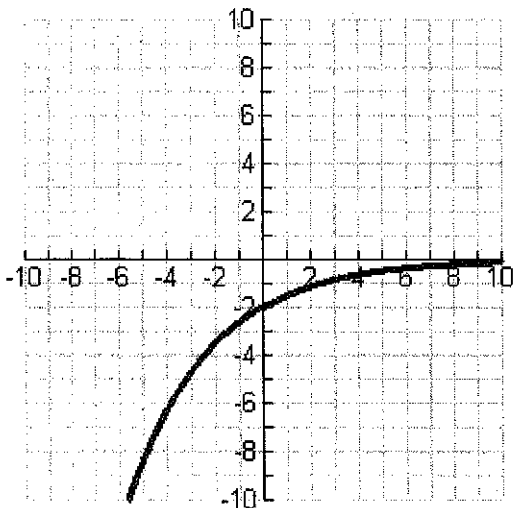
Asymptotes:

Zeros:

Intercepts:

Intervals of increase and decrease

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



Domain

Range:

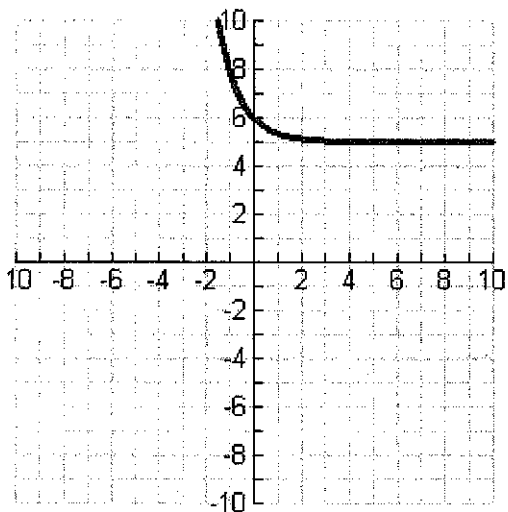
Asymptotes:

Zeros:

Intercepts:

Intervals of increase and decrease

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



Domain:

Range:

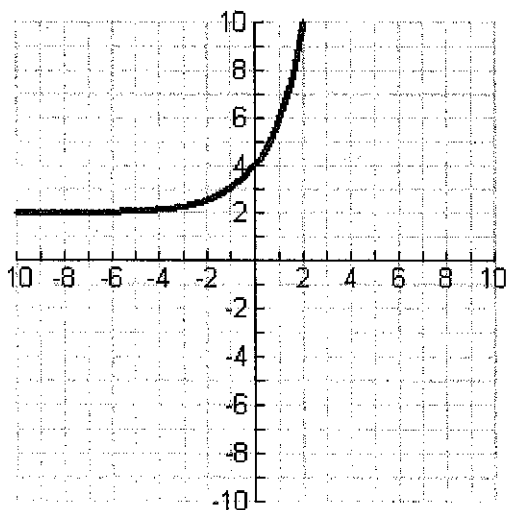
Asymptotes:

Zeros:

Intercepts:

Intervals of increase and decrease

4. $y = 2^{x+1} + 2$



Domain:

Range:

Asymptotes:

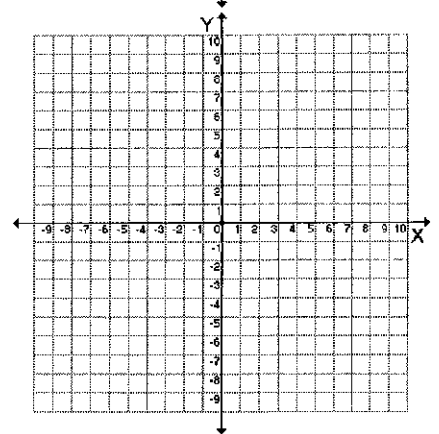
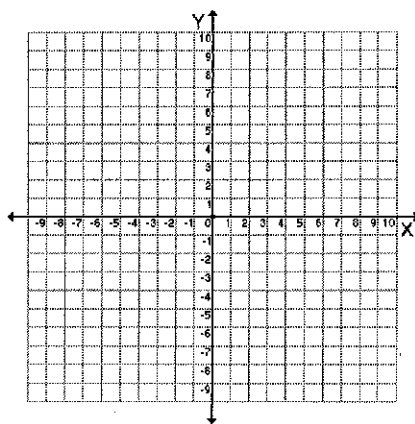
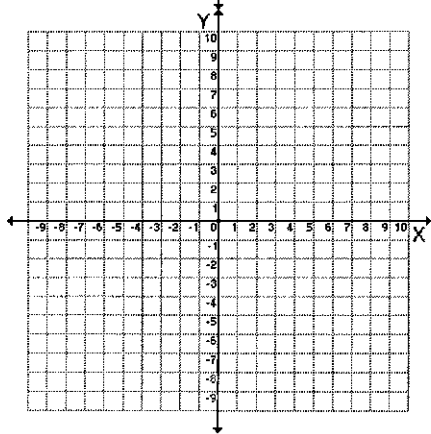
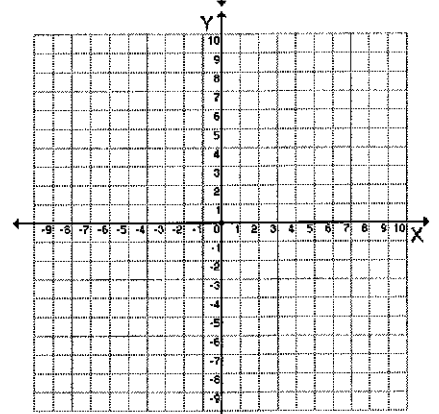
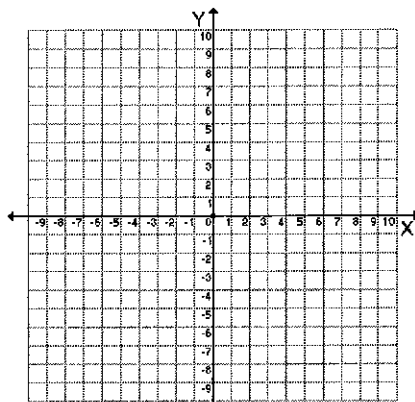
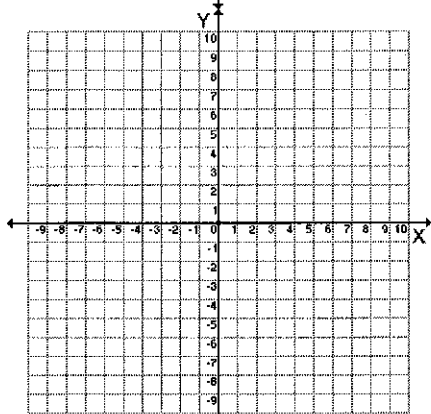
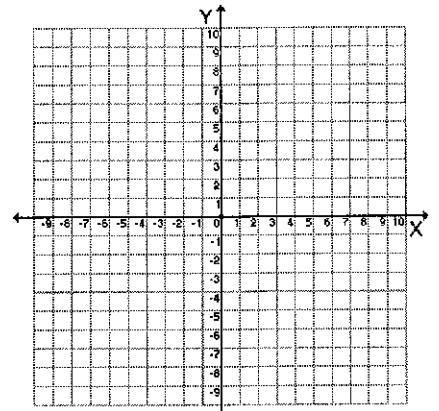
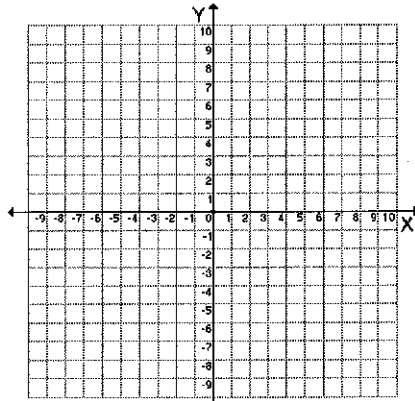
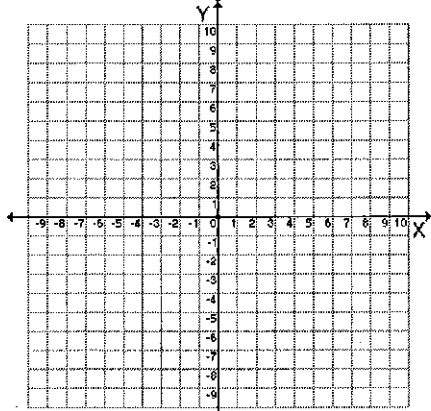
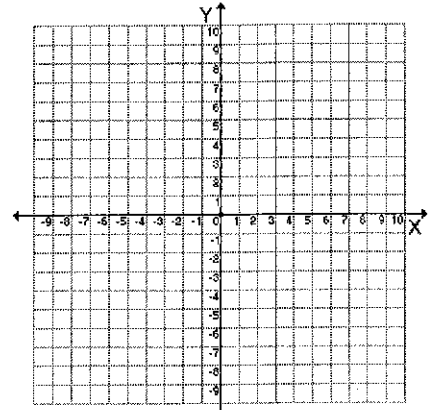
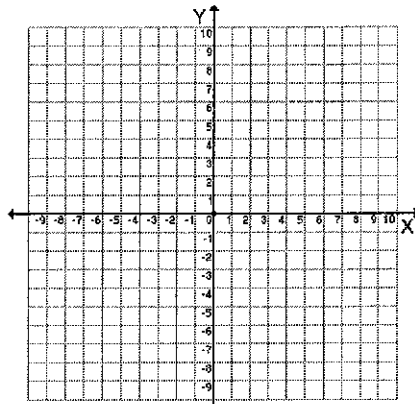
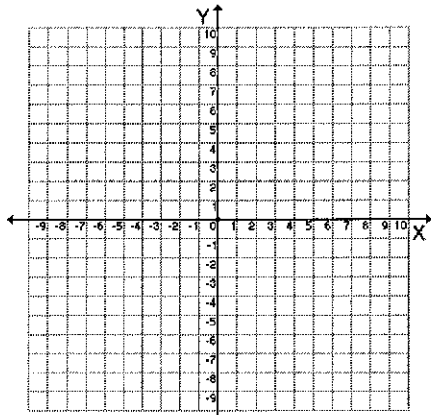
Zeros:

Intercepts:

Intervals of increase and decrease

Exponential Characteristics Homework: Plot at least 5 Points for each graph & Complete the Chart:

Equation	Eqn. of Asymptote	Domain	Range	Increasing or Decreasing
1. $y = 3^x$				
2. $y = 3^x - 2$				
3. $y = 3^{(x-2)}$				
4. $y = 3^{(x+1)} + 2$				
5. $y = 3^{-x}$				
6. $y = \left(\frac{1}{3}\right)^x$				
7. $y = \left(\frac{1}{3}\right)^x - 2$				
8. $y = \left(\frac{1}{3}\right)^{(x-2)}$				
9. $y = \left(\frac{1}{3}\right)^{(x+1)} + 1$				
10. $y = \left(\frac{1}{3}\right)^{-x}$				
11. $y = 2\left(\frac{1}{3}\right)^x$				

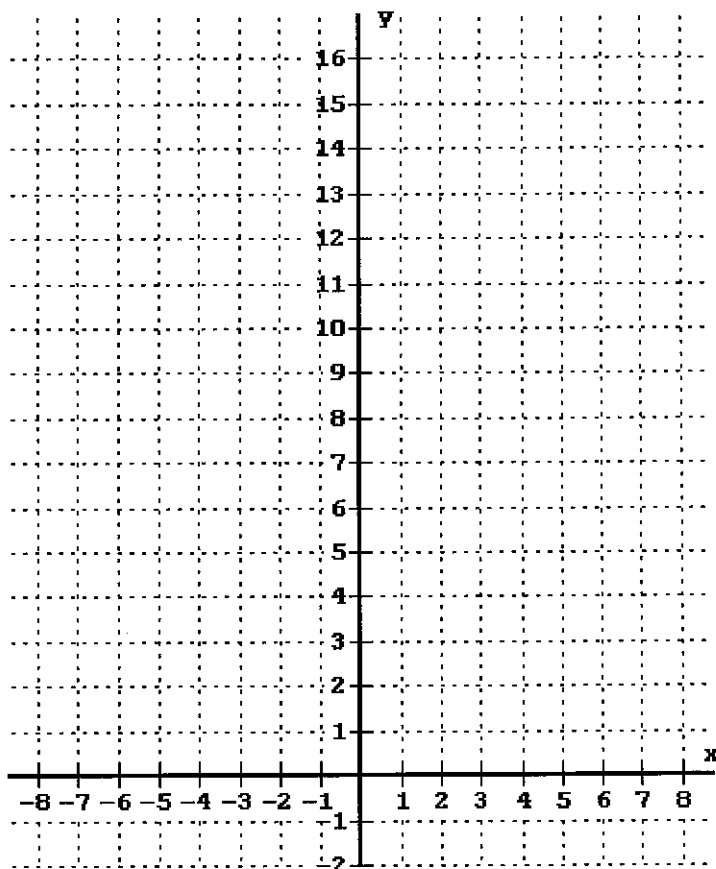


Graph the Exponential Function: $f(x) = 2^x$

1. Complete the Table.

2. Graph the function.

x	$y = 2^x$
5	$2^5 = 32$
4	
3	
2	
1	
0	
-1	$2^{-1} = \frac{1}{2^1} = \frac{1}{2}$
-2	
-3	
-4	
-5	
10	
-10	



3. Where does the graph of $y = 2^x$ cross the y-axis?
That is, find the y-intercept.

4. Where does the graph of $y = 2^x$ cross the x-axis?
That is, find the x-intercept(s).

5. State the Domain

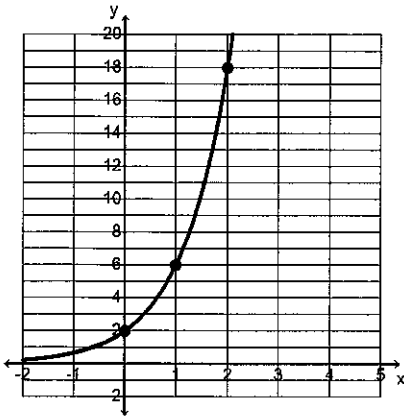
6. State the Range

Writing Exponential Equations Using a Graph – #36

Name: _____ Period: _____ Due Date: _____

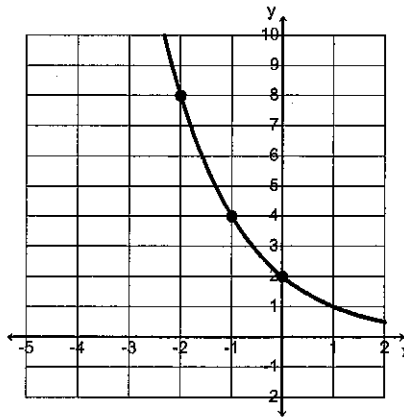
Determine the exponential equation, $f(x) = a \cdot b^x$, for each of the following graphs. State the domain and range

1. $f(x) =$



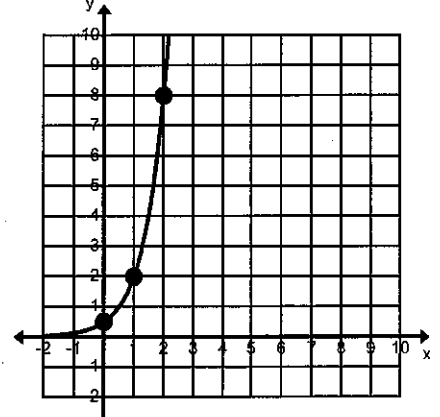
D: _____ R: _____

2. $f(x) =$



D: _____ R: _____

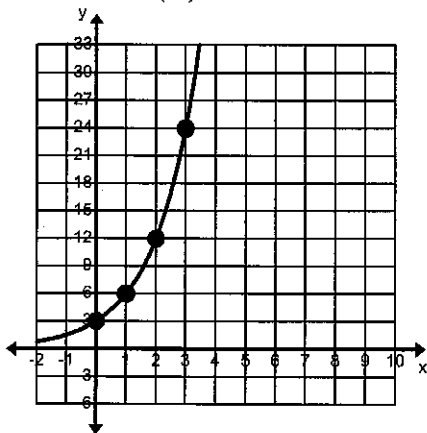
3. $f(x) =$



D: _____ R: _____

Given the following exponential graphs, write the equation, then find the rate of change for the given intervals. Which intervals produce the greatest rate of change for each graph?

4. $f(x) =$

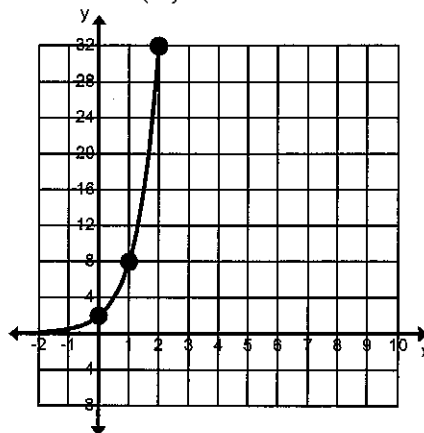


Rate of Change

[0, 1]

[2, 3]

5. $g(x) =$

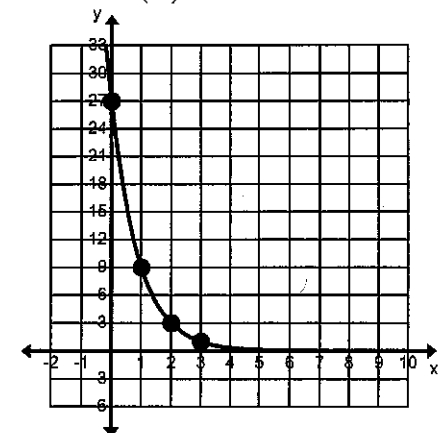


Rate of Change

[0, 2]

[1, 2]

6. $h(x) =$



Rate of Change

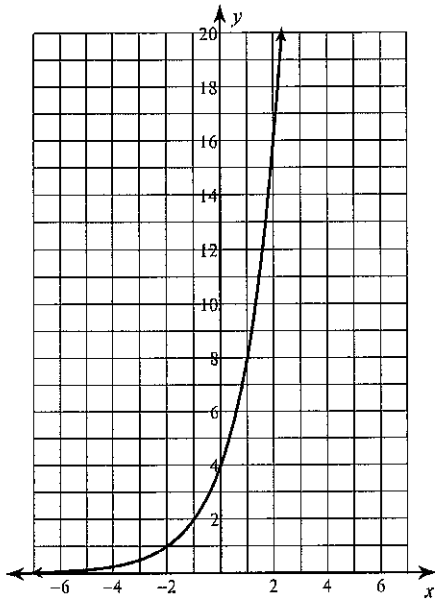
[0, 3]

[1, 3]

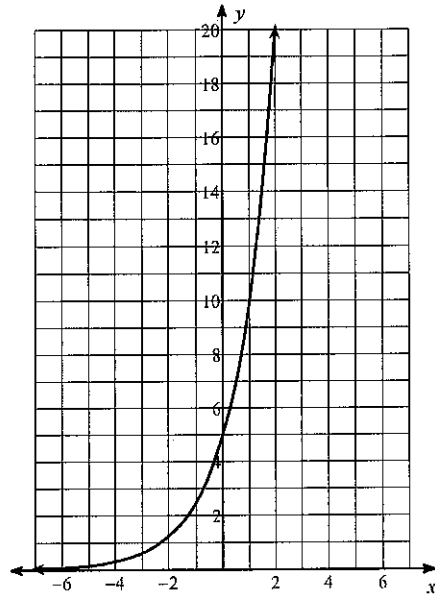
Graphing Exponential Functions

Sketch the graph of each function.

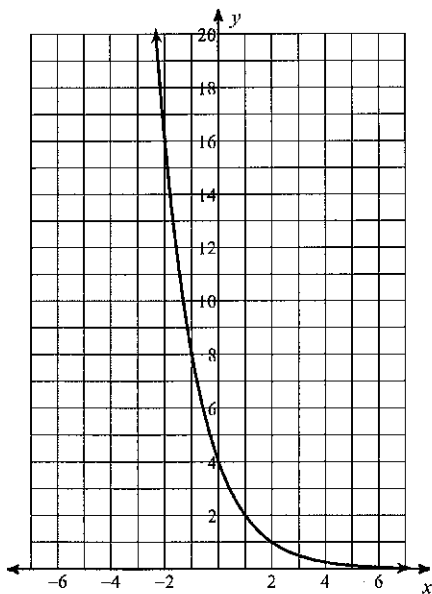
1)



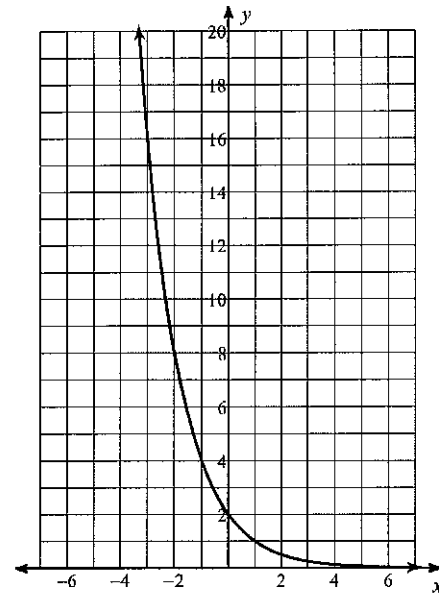
2)



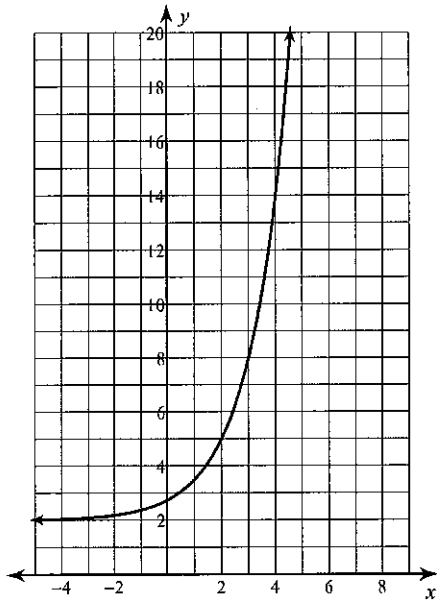
3)



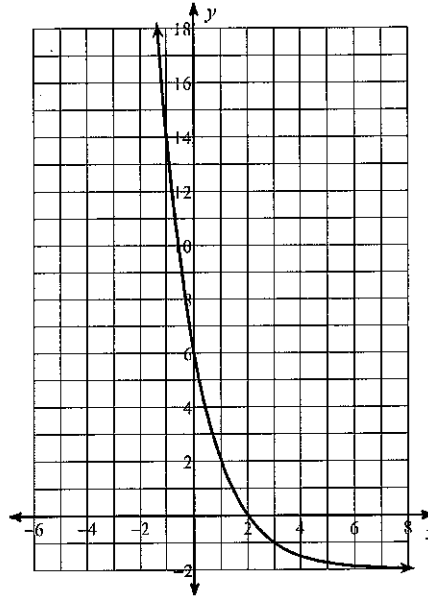
4)



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

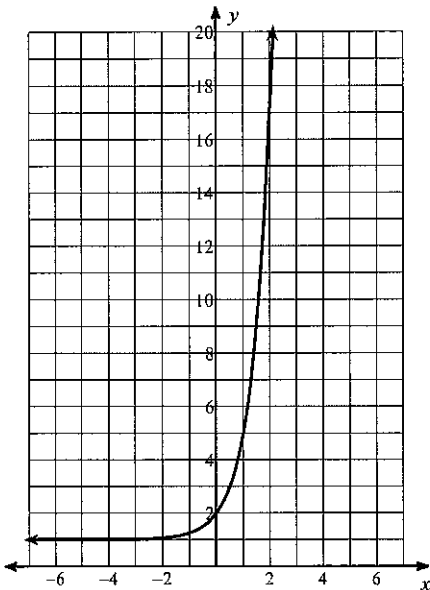


6) $y = 4 \cdot \left(\frac{1}{2}\right)^{x-1} - 2$

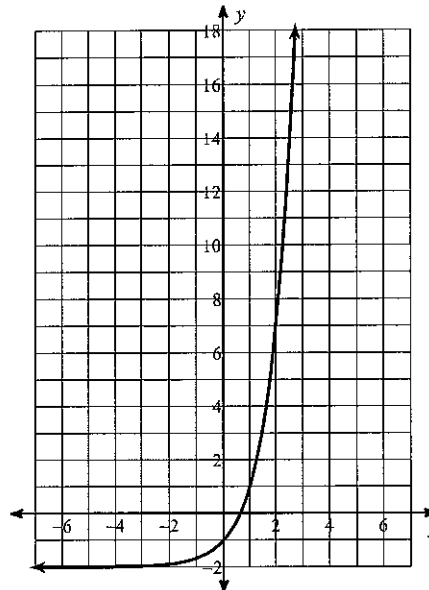


Write an equation for each graph.

7)



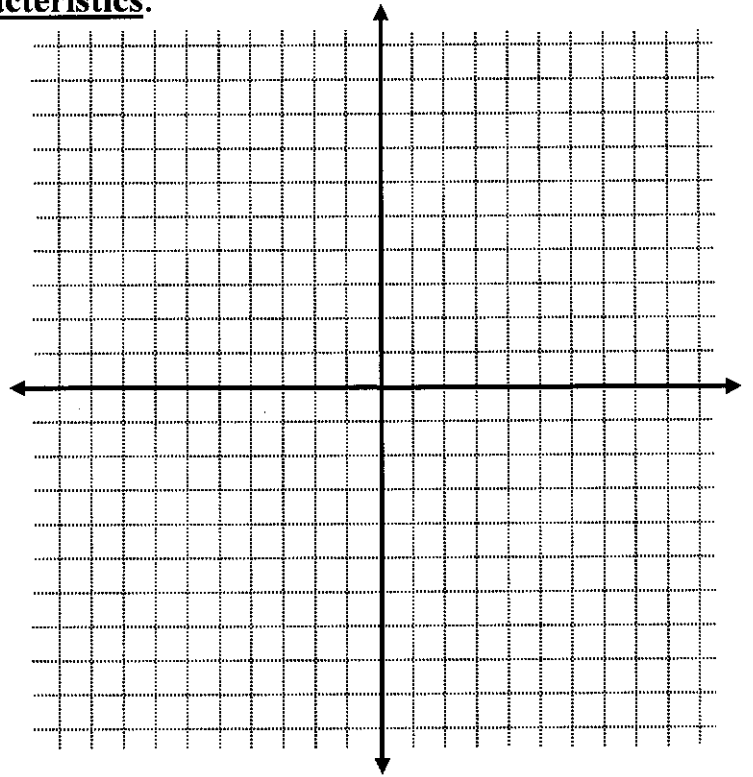
8)



Graph the functions and **list all characteristics:**

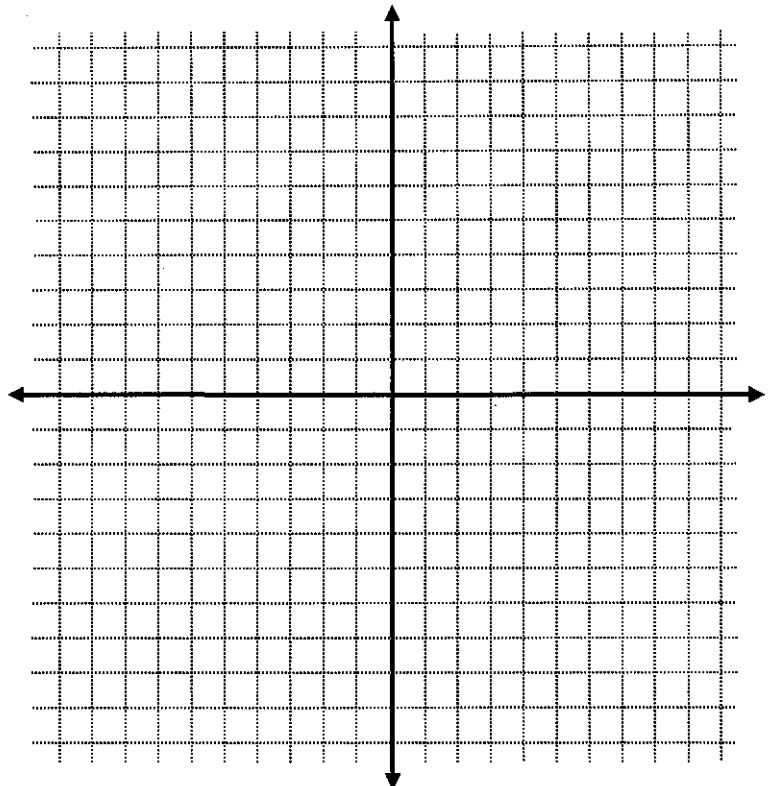
1. $f(x) = 4^x - 1$

x	y
-3	
-2	
-1	
0	
1	
2	
3	



2. $f(x) = 0.5^x$

x	y
-3	
-2	
-1	
0	
1	
2	
3	



10.4 Practice - Exponential Functions

Solve each equation.

1) $3^{1-2n} = 3^{1-3n}$

3) $4^{2a} = 1$

5) $(\frac{1}{25})^{-k} = 125^{-2k-2}$

7) $6^{2m+1} = \frac{1}{36}$

9) $6^{-3x} = 36$

11) $64^b = 2^5$

13) $(\frac{1}{4})^x = 16$

15) $4^{3a} = 4^3$

17) $36^{3x} = 216^{2x+1}$

19) $9^{2n+3} = 243$

21) $3^{3x-2} = 3^{3x+1}$

23) $3^{-2x} = 3^3$

25) $5^{m+2} = 5^{-m}$

27) $(\frac{1}{36})^{b-1} = 216$

29) $6^{2-2x} = 6^2$

31) $4 \cdot 2^{-3n-1} = \frac{1}{4}$

33) $4^{3k-3} \cdot 4^{2-2k} = 16^{-k}$

35) $9^{-2x} \cdot (\frac{1}{243})^{3x} = 243^{-x}$

37) $64^{n-2} \cdot 16^{n+2} = (\frac{1}{4})^{3n-1}$

39) $5^{-3n-3} \cdot 5^{2n} = 1$

2) $4^{2x} = \frac{1}{16}$

4) $16^{-3p} = 64^{-3p}$

6) $625^{-n-2} = \frac{1}{125}$

8) $6^{2r-3} = 6^{r-3}$

10) $5^{2n} = 5^{-n}$

12) $216^{-3v} = 36^{3v}$

14) $27^{-2n-1} = 9$

16) $4^{-3v} = 64$

18) $64^{x+2} = 16$

20) $16^{2k} = \frac{1}{64}$

22) $243^p = 27^{-3p}$

24) $4^{2n} = 4^{2-3n}$

26) $625^{2x} = 25$

28) $216^{2n} = 36$

30) $(\frac{1}{4})^{3v-2} = 64^{1-v}$

32) $\frac{216}{6^{-2a}} = 6^{3a}$

34) $32^{2p-2} \cdot 8^p = (\frac{1}{2})^{2p}$

36) $3^{2m} \cdot 3^{3m} = 1$

38) $3^{2-x} \cdot 3^{3m} = 1$

40) $4^{3r} \cdot 4^{-3r} = \frac{1}{64}$



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ALGEBRA 2

WORKSHEET SOLVING EXPONENTIAL EQUATIONS

Solve each equation for x.

1) $2^x = 2^{3x-4}$

2) $3^{2x-1} = 3$

3) $25^{x+3} = 25^{5x-7}$

4) $4^{3x-5} = 4^{8-x}$

5) $5^{x+1} = 25$

6) $3^{x-5} = 27$

7) $2^{3x-4} = 8^{x-1}$

8) $3^{2x-4} = 1$

9) $4^{x+2} = 8$

10) $9^x = 27$

11) $\left(\frac{1}{3}\right)^{x+2} = 9^{3x}$

12) $\left(\frac{1}{4}\right)^{x-1} = 32^{x+3}$

13) $18^{4x} = 18^x$

14) $125^{3-2x} = 5^{x-1}$

15) $4^{x-1} = \frac{1}{64}$

16) $\left(\frac{1}{4}\right)^x = 8^{x-1}$

17) $3^x = 3\sqrt{3}$

18) $5^x = 25\sqrt{5}$

19) $4^{2x} = 16\sqrt[3]{4}$

20) $3^{x-4} = 9\sqrt{3}$

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Average Rate of Change

Notes:

Rates are used to describe how one quantity is changing in relation to another. This is called a “rate of change” or an “average rate of change.” To illustrate this, consider the following statement: Reagan drove from Salt Lake to Bluffdale (a distance of about 28 miles) in 30 minutes.

A.) What was his average speed in miles per hour?

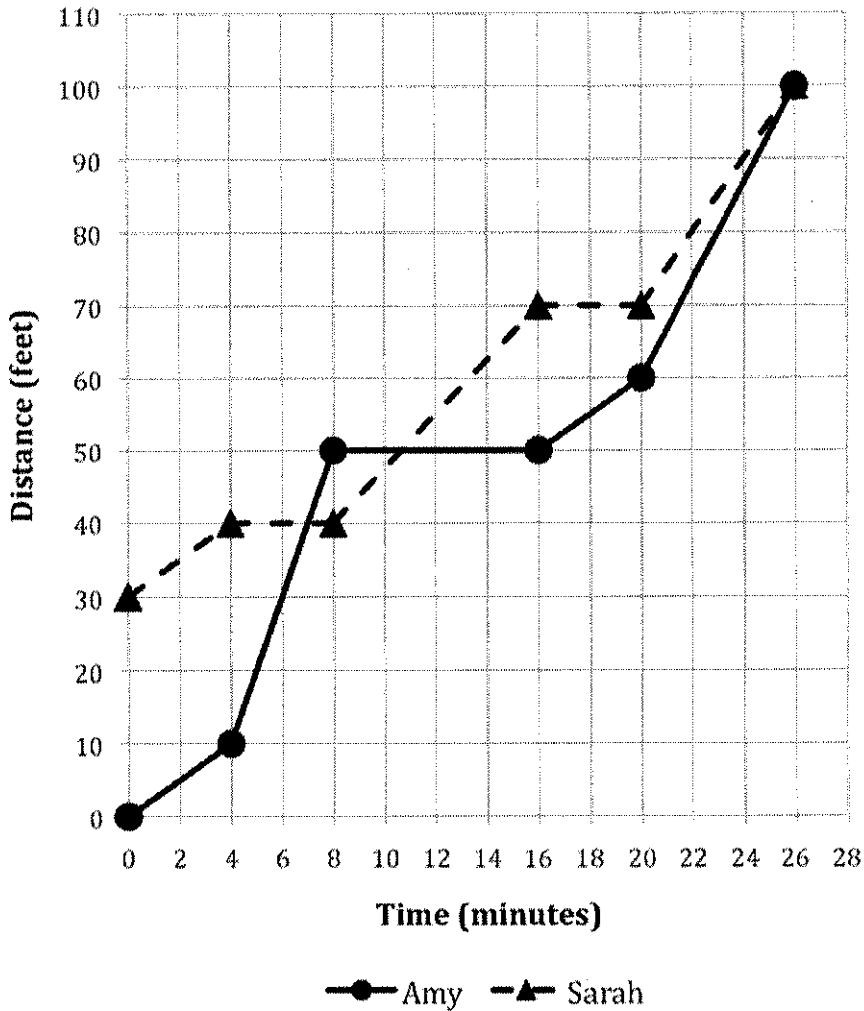
$$\frac{28 \text{ miles}}{30 \text{ min}} \cdot \frac{2}{2} = \frac{56 \text{ miles}}{1 \text{ min}}$$

B.) Does this mean that he drove that speed the entire trip? If not, what does it mean?

C.) Did he ever drive the average speed of 56 mph?

Ex: Amy and Sarah are meeting each other at the store.

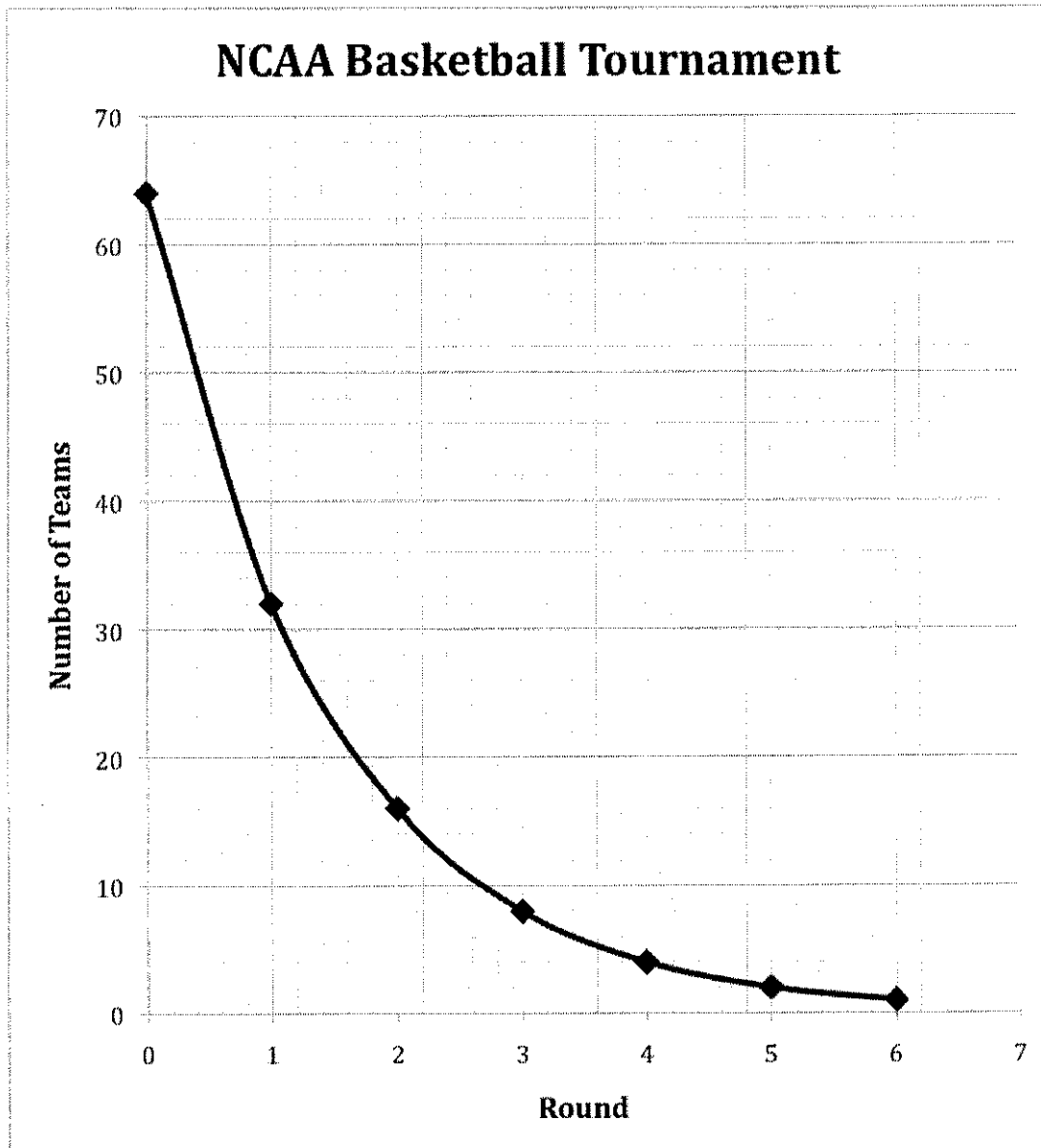
Amy and Sarah



Name: _____ Period: _____

Use the graph to answer the following questions.

- 1.) How far from the store is Amy at the beginning?
- 2.) How far from the store is Sarah at the beginning?
- 3.) How long does it take to get to the store?
- 4.) What happens between 6 and 7 minutes?
- 5.) Where is Amy moving faster?
- 6.) Where is Sarah moving faster?
- 7.) What is the speed of Amy between 4 and 8 minutes?
- 8.) What is the speed of Sarah 8 and 16 minutes?
- 9.) What is Amy doing during 8 and 16 minutes?
- 10.) What is Amy's average speed for the whole trip?
- 11.) What is Sarah's average speed for the whole trip?



Use the graph to answer the following questions.

- 1.) How many teams are there when the tournament starts?
- 2.) How many rounds occur before there is a winner?
- 3.) What is the rate of change between the 1st and 2nd round?
- 4.) What is the rate of change between the 2nd and 3rd round?
- 5.) What is the rate of change between the 3rd and 4th round?

Name: _____ Period: _____

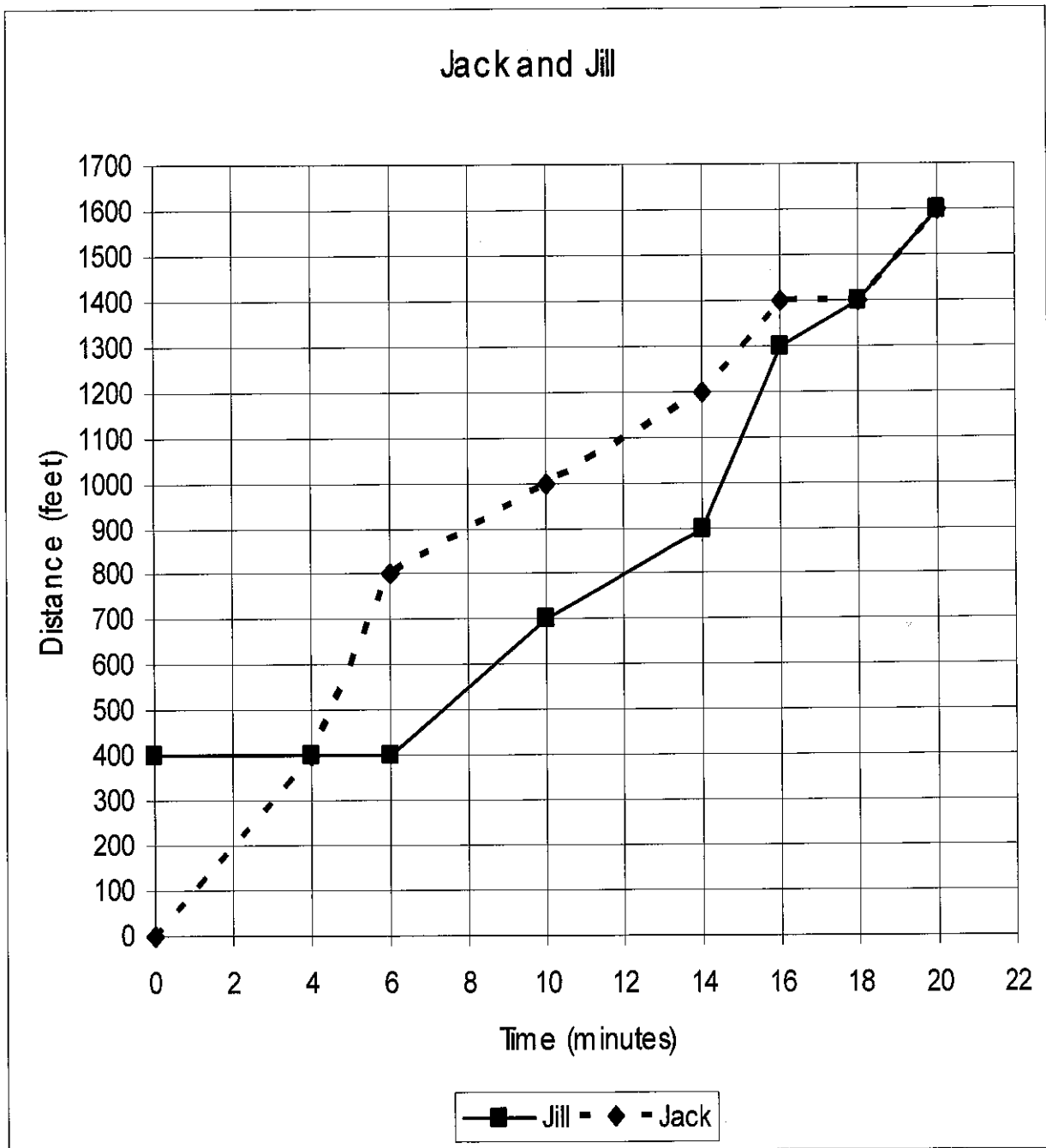
- 6.) What is the average rate of change between the 1st and 4th round?

- 7.) What is the average rate of change from the beginning of the tournament to the end?

- 8.) The NCAA tournament chairman is considering adding another round to the tournament so more teams can participate. How many teams would start the tournament?

3.4 Average Rate of Change

The graph below shows Jack and Jill's trip up the hill.



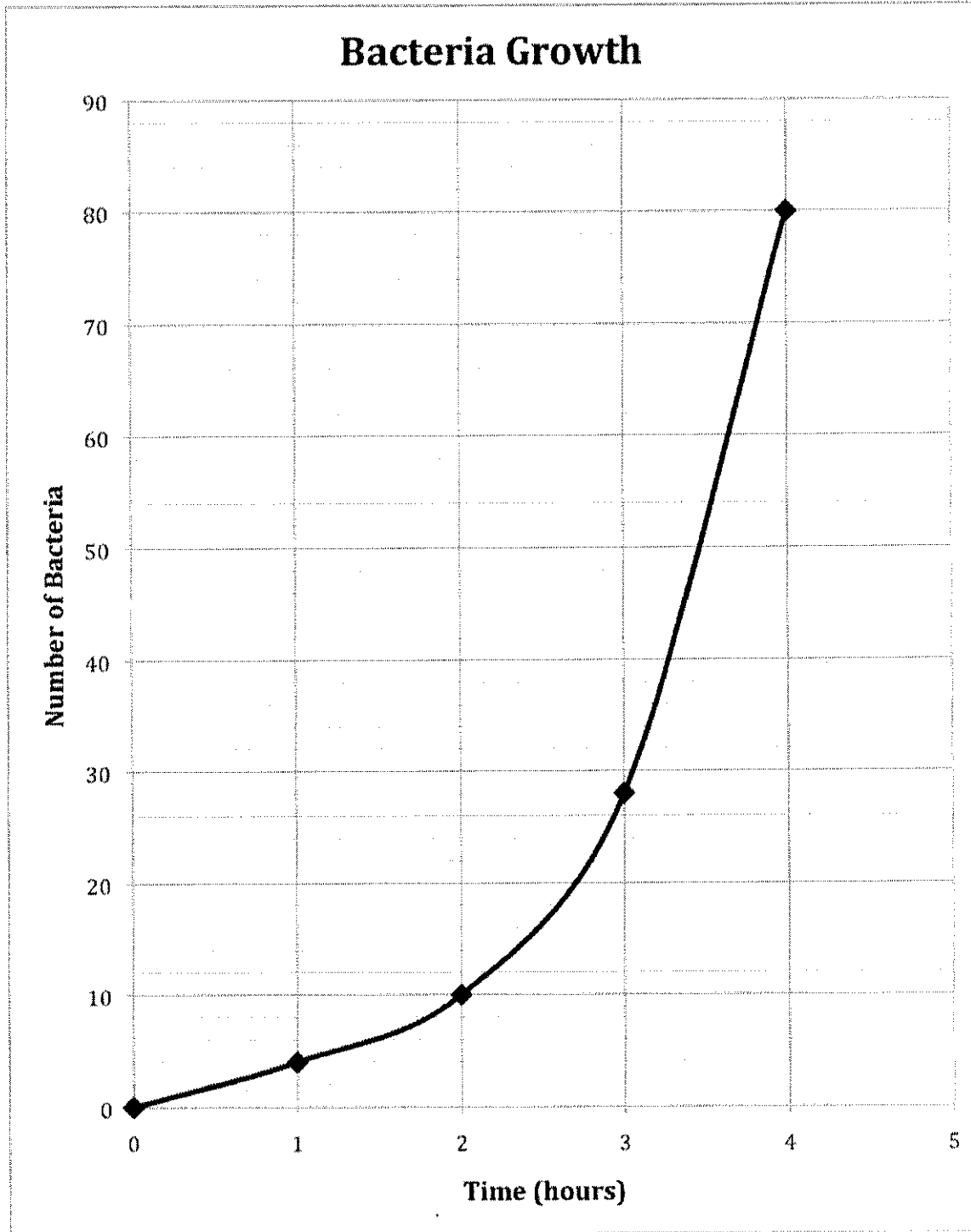
Use the graph to answer the following questions:

1. How far from the hill is Jack at the beginning?
2. How far from the hill is Jill at the beginning?

Name: _____ Period: _____

3. How long does the trip take?
4. What is Jill doing for the first 6 minutes?
5. What happens at minute 4?
6. What is happening in the last 2 minutes?
7. Where is Jack moving fastest?
8. Where is Jill moving fastest?
9. What is the speed of Jack between 10 and 14 minutes?
10. What is the speed of Jill between 6 and 10 minutes?
11. What is Jack doing during 16 and 18 minutes?
12. What is Jill's average speed for the whole trip?
13. What is Jack's average speed for the whole trip?

The graph below shows the number of bacteria in a colony is growing.



Use the graph to answer the following questions.

14.) How many bacteria were there to start?

15.) What is the rate of change between 1 and 2 hours? $\frac{2 \text{ bacteria}}{1 \text{ hr}}$

Name: _____ Period: _____

16.) What is the rate of change between 2 and 3 hours?

17.) Which interval of time has the biggest rate of change?

18.) What is the average rate of change between 1 and 3 hours?

19.) What is the average rate of change from 0 to 4 hours?

Notes - 3.4B Rate of Change

Ex: What is the average rate of change of the function $g(x) = 6 - 2x$

A.) Over the interval $[2, 6]$?

B.) Over the interval $[5, 7]$?

C.) Do you think it is true that $g(x)$ will have a constant average rate of change over *any* interval? Why or why not?

Ex: What is the average rate of change of the function $f(x) = 2^x$

A.) Over the interval $[1, 4]$?

B.) Over the interval $[3, 5]$?

C.) Do you think it is true that $f(x)$ will have a constant average rate of change over any interval? Why or why not?

Ex: Given a table, find the rate of change for each interval.

x	y
-3	4
-2	1
-1	0
0	1
1	4
2	9
3	16

A.) $[0, 3]$

B.) $[-2, 1]$

C.) $[-3, -1]$

3.4B Rate of Change

For each of the following functions, is the average rate of change over the given interval positive or negative? Justify your answer.

1.) $f(x) = 3 - 2x$ over the interval $[2, 3]$.

2.) $h(x) = 0.5^x$ over the interval $[-1, 0]$.

3.) $g(x) = 1.5^x$ over the interval $[-1, 0]$.

4.) $k(x) = 4 + 3x$ over the interval $[-2, 3]$.

5.) $m(x) = 7 - 3x$ over the interval $[2, 5]$.

Given a table, find the rate of change for each interval.

11.)

x	y
-2	-1
-1	-5
0	0
1	.5
2	1
3	1.5
4	2

A.) $[1, 4]$

B.) $[-2, 2]$

C.) $[0, 3]$

12.)

x	y
-3	13
-2	9
-1	5
0	1
1	-3
2	-7
3	-11

A.) $[-2, 0]$

B.) $[1, 3]$

C.) [-3, 1]

13.)

x	y
-3	10
-2	5
-1	2
0	1
1	2
2	5
3	10

A.) [1, 3]

B.) [-1, 1]

C.) [-3, 0]

14.)

x	y
-2	-8
-1	-1
0	0
1	1
2	8
3	27
4	64

A.) [-2, 4]

B.) [-1, 3]

C.) [0, 2]

15.)

x	y
-4	.125
-3	.25
-2	.5
-1	1
0	2
1	4
2	8

A.) [-2, 2]

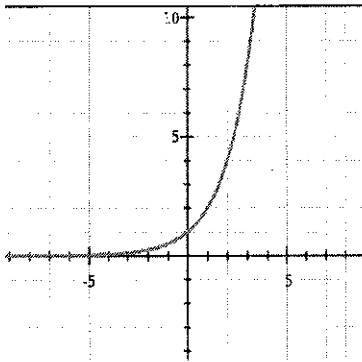
B.) [-4, 1]

C.) [-3, 0]

WS#1 Part 2: Analyzing Characteristics (Rate of Change and End Behavior)

1.

$$f(x) = 2^x$$

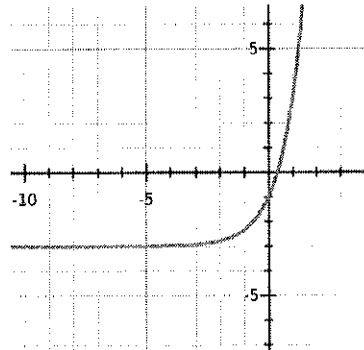


Rate of change for $-2 \leq x \leq 2$:

End Behavior: $\begin{cases} \text{as } x \rightarrow -\infty, f(x) \rightarrow \underline{\hspace{2cm}} \\ \text{as } x \rightarrow \infty, f(x) \rightarrow \underline{\hspace{2cm}} \end{cases}$

2.

$$f(x) = 2(3)^x - 3$$

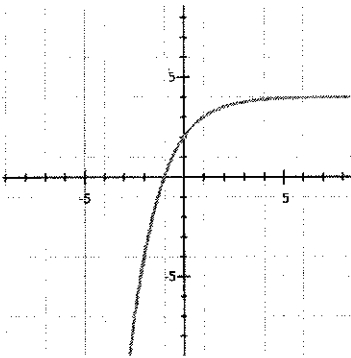


Rate of change for $-2 \leq x \leq 2$:

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3.

$$f(x) = -2(1/2)^x - 4$$

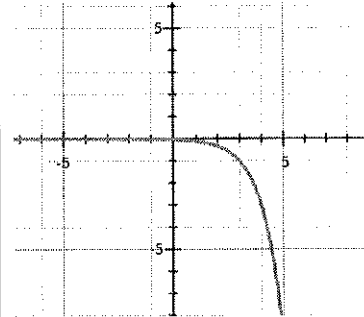


Rate of change for $-2 \leq x \leq 2$:

End Behavior: $\begin{cases} \text{as } x \rightarrow -\infty, f(x) \rightarrow \underline{\hspace{2cm}} \\ \text{as } x \rightarrow \infty, f(x) \rightarrow \underline{\hspace{2cm}} \end{cases}$

4.

$$f(x) = -(3)^{x-3}$$

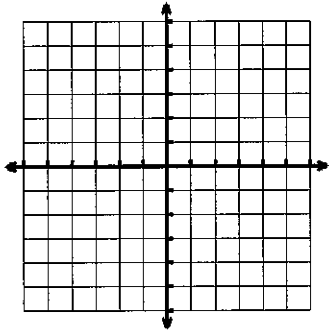


Rate of change for $-2 \leq x \leq 2$:

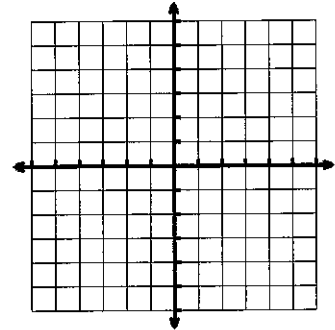
End Behavior: $\begin{cases} \text{as } x \rightarrow -\infty, f(x) \rightarrow \underline{\hspace{2cm}} \\ \text{as } x \rightarrow \infty, f(x) \rightarrow \underline{\hspace{2cm}} \end{cases}$

Sketch a graph of each function. Include the asymptote and y-intercept. State the domain and range. Is the graph a growth or decay function? Is the graph increasing or decreasing?

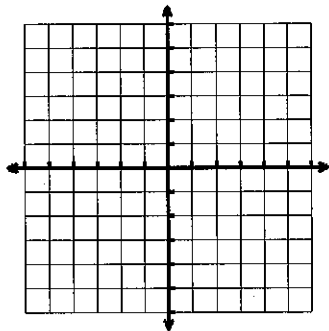
1. $y = 2^x$



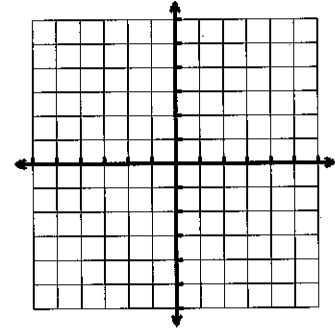
2. $y = \left(\frac{1}{3}\right)^x$



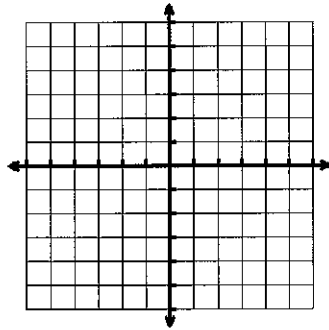
3. $y = 3^{x-1} + 2$



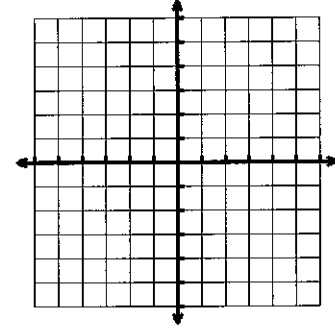
4. $y = -2^x + 1$



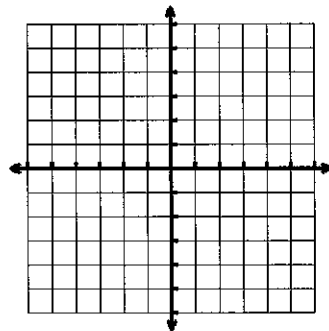
5. $y = -\left(\frac{1}{2}\right)^{x-2}$



6. $y = 3^x - 2$



7. $y = \left(\frac{1}{3}\right)^x - 4$



8. $y = 2^{-x}$

