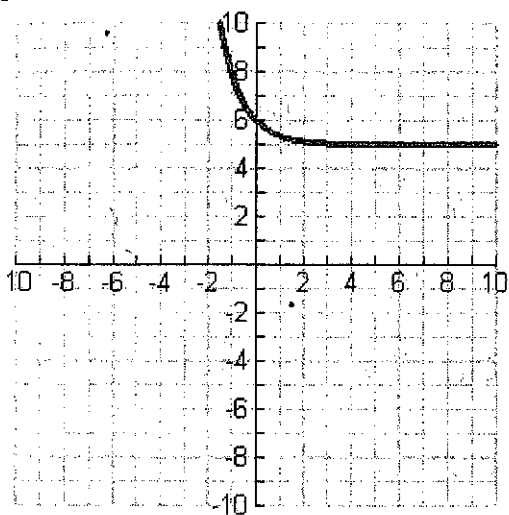


3. $y = \left(\frac{1}{3}\right)^x + 5$



Domain: \mathbb{R}

Range: $(5, \infty)$ or $y > 5$

Asymptotes: $y = 5$

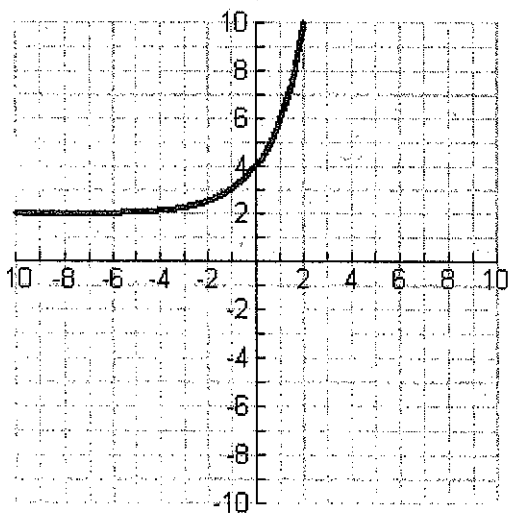
Zeros: none

y-Intercepts: $(0, 6)$

Intervals of increase and decrease

$(-\infty, \infty)$

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



Domain: \mathbb{R}

Range: $(2, \infty)$ or $y > 2$

Asymptotes: $y = 2$

Zeros: none

y-Intercepts: $(0, 4)$

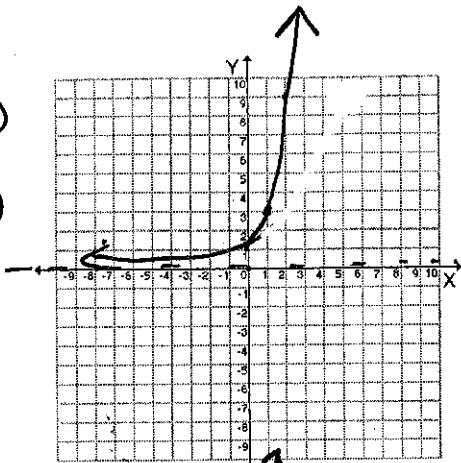
Intervals of increase and decrease

$(-\infty, \infty)$

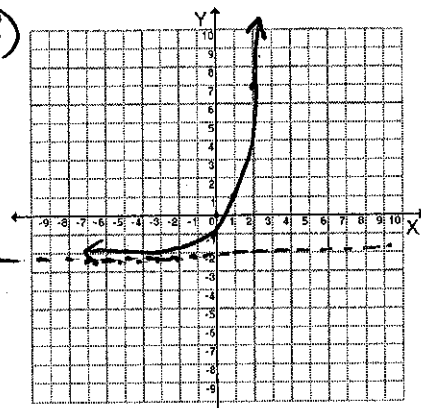
Exponential Characteristics Homework: Plot at least 5 Points for each graph & Complete the Chart:

Equation	Eqn. of Asymptote	Domain	Range	Increasing or Decreasing
1. $y = 3^x$	$y = 0$	\mathbb{R}	$(0, \infty)$	In
2. $y = 3^x - 2$	$y = -2$	\mathbb{R}	$(-2, \infty)$	In
3. $y = 3^{(x-2)}$	$y = 0$	\mathbb{R}	$(0, \infty)$	In
4. $y = 3^{(x+1)} + 2$	$y = 2$	\mathbb{R}	$(2, \infty)$	In
5. $y = 3^{-x} = \left(\frac{1}{3}\right)^x$	$y = 0$	\mathbb{R}	$(0, \infty)$	Dec
6. $y = \left(\frac{1}{3}\right)^x$	$y = 0$	\mathbb{R}	$(0, \infty)$	Dec
7. $y = \left(\frac{1}{3}\right)^x - 2$	$y = -2$	\mathbb{R}	$(-2, \infty)$	Dec
8. $y = \left(\frac{1}{3}\right)^{(x-2)}$	$y = 0$	\mathbb{R}	$(0, \infty)$	Dec
9. $y = \left(\frac{1}{3}\right)^{(x+1)} + 1$	$y = 1$	\mathbb{R}	$(1, \infty)$	Dec
10. $y = \left(\frac{1}{3}\right)^{-x} = 3^x$	$y = 0$	\mathbb{R}	$(0, \infty)$	In
11. $y = 2\left(\frac{1}{3}\right)^x$	$y = 0$	\mathbb{R}	$(0, \infty)$	Dec

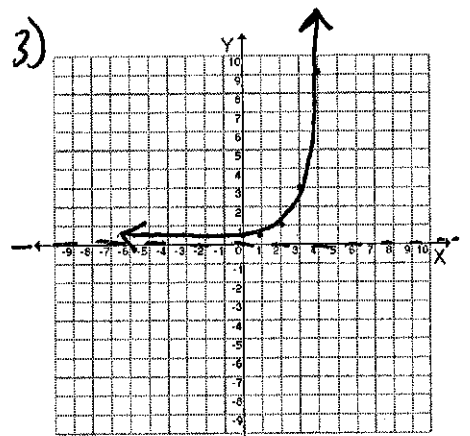
1)



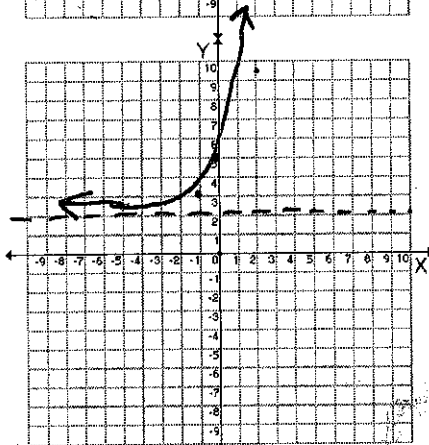
2)



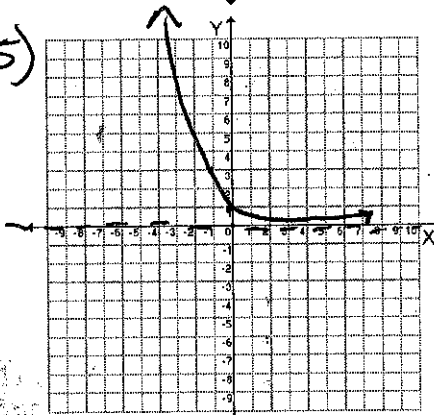
3)



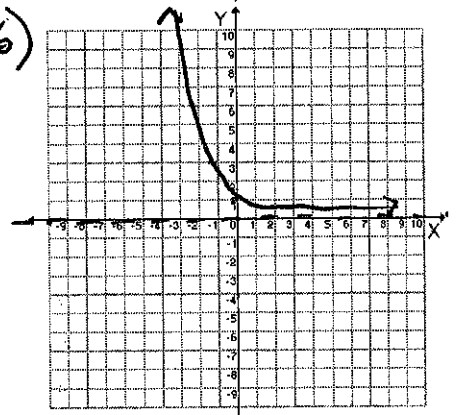
4)



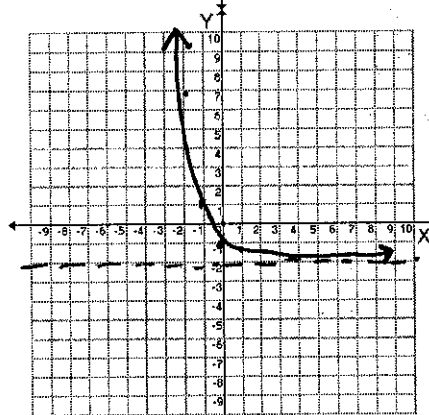
5)



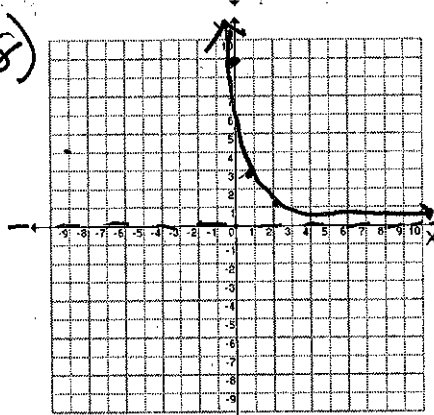
6)



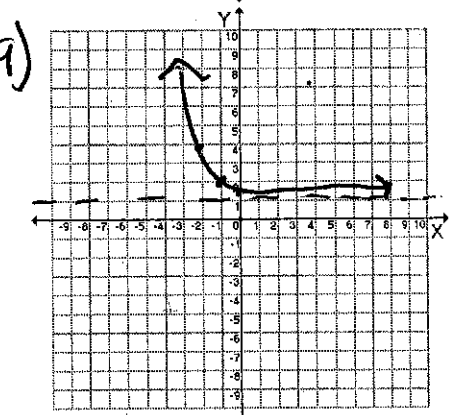
7)



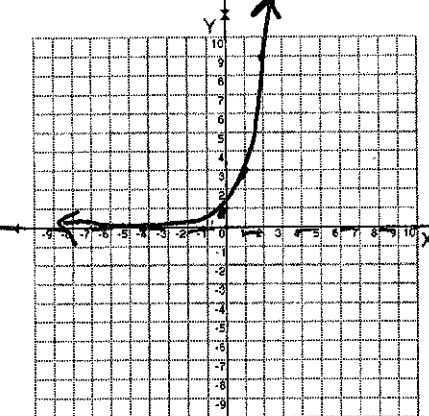
8)



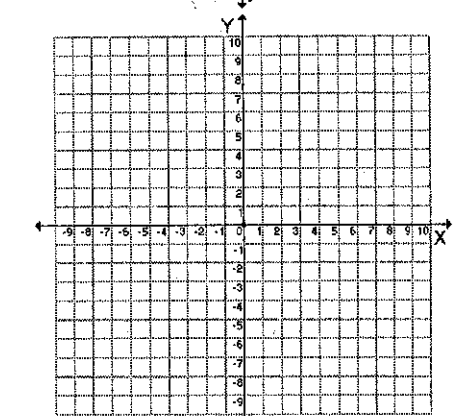
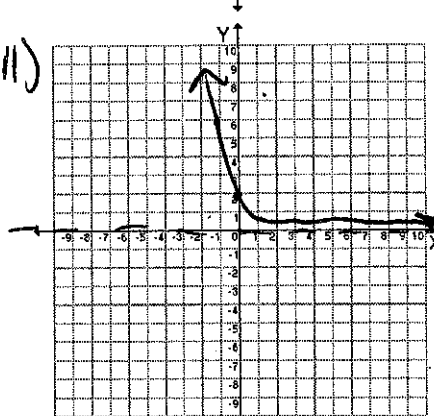
9)



10)



11)

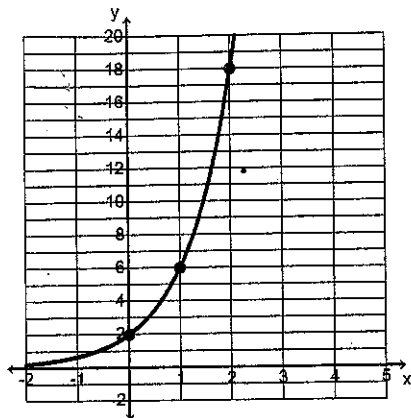


Writing Exponential Equations Using a Graph - #36

Name: Key Period: _____ Due Date: _____

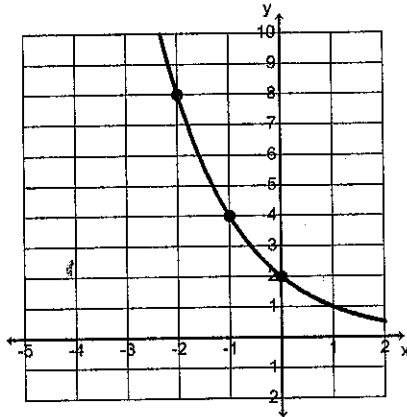
Determine the exponential equation, $f(x) = a \cdot b^x$, for each of the following graphs. State the domain and range

1. $f(x) = 2(3)^x$



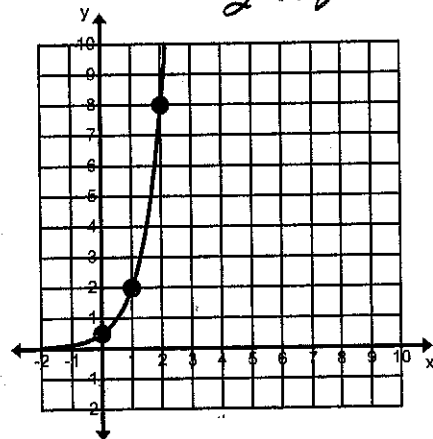
D: \mathbb{R} R: $(0, \infty)$

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



D: \mathbb{R} R: $(0, \infty)$

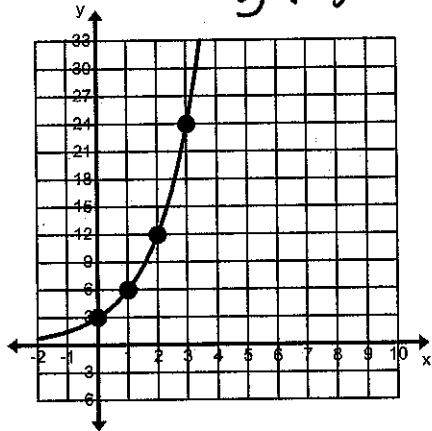
3. $f(x) = \frac{1}{2}\left(\frac{1}{4}\right)^x$



D: \mathbb{R} R: $(0, \infty)$

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?

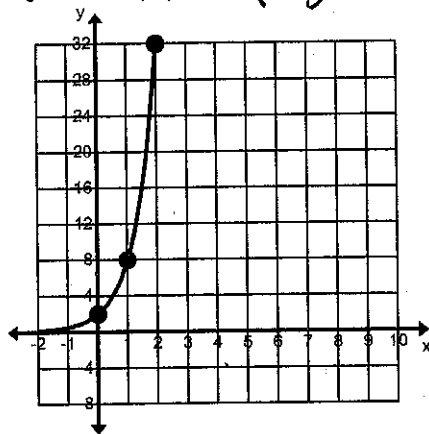
4. $f(x) = 3(2)^x$



Rate of Change

$[0, 1]$ $(0, 3)$ $(1, 6)$
 $m = \frac{6-3}{1-0} = \boxed{3}$

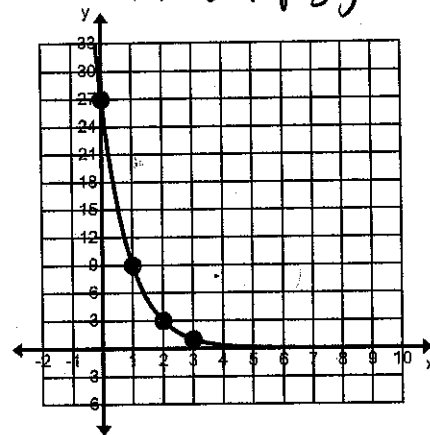
5. $g(x) = 2(4)^x$



Rate of Change

$[0, 2]$ $(0, 2)$ $(2, 32)$
 $m = \frac{32-2}{2-0} = \boxed{15}$

6. $h(x) = 27\left(\frac{1}{3}\right)^x$



Rate of Change

$[0, 3]$ $(0, 27)$ $(3, 1)$
 $m = \frac{1-27}{3-0} = \boxed{-9}$

* $[2, 3]$ $(2, 12)$ $(3, 24)$
 $m = \frac{24-12}{3-2} = \boxed{12}$

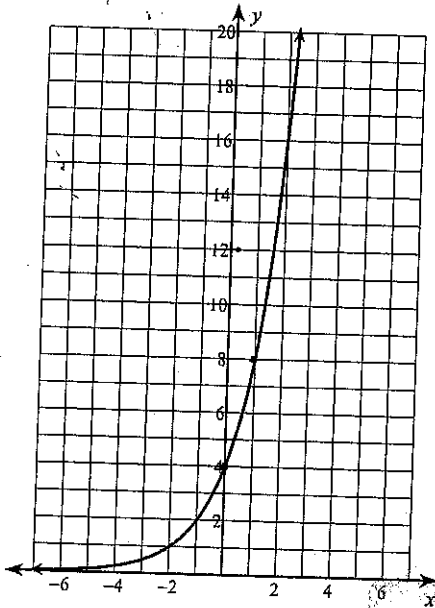
* $[1, 2]$ $(1, 8)$ $(2, 32)$
 $m = \frac{32-8}{2-1} = \boxed{24}$

* $[1, 3]$ $(1, 9)$ $(3, 1)$
 $m = \frac{1-9}{3-1} = \frac{-8}{2} = \boxed{-4}$

Graphing Exponential Functions

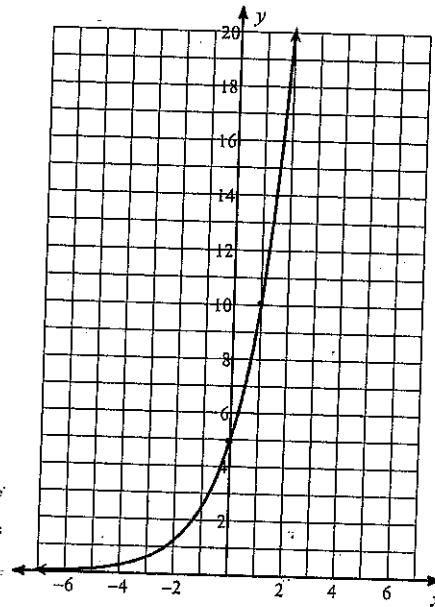
Sketch the graph of each function.

1)



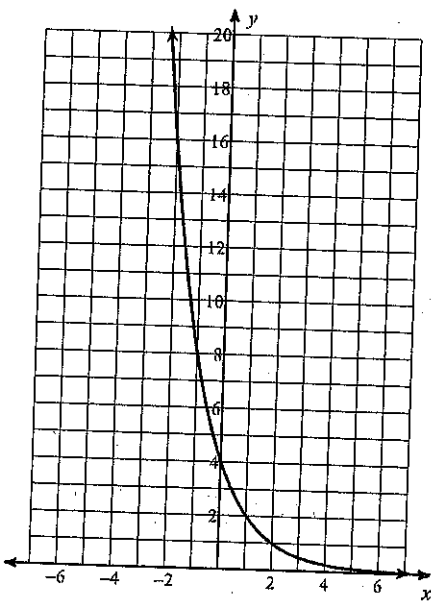
$$y = 4(2)^x$$

2)



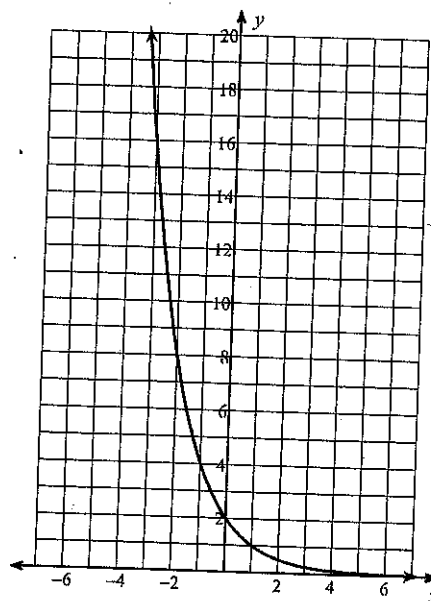
$$y = 5(2)^x$$

3)



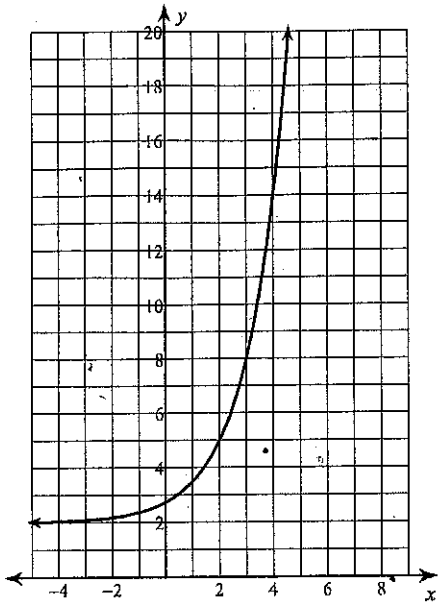
$$y = 4\left(\frac{1}{2}\right)^x$$

4)

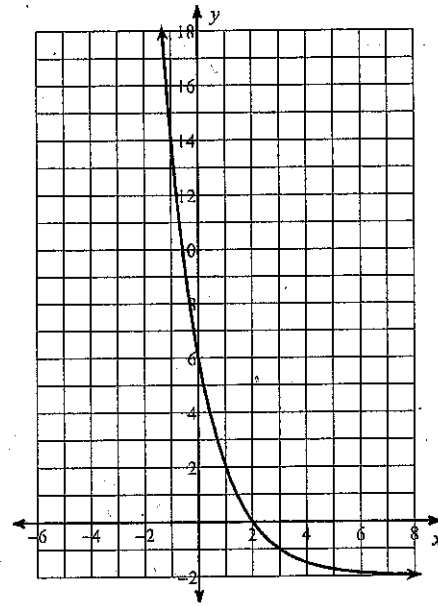


$$y = 2\left(\frac{1}{2}\right)^x$$

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

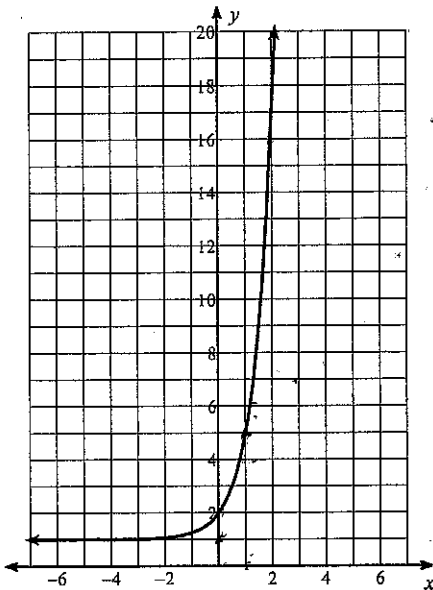


6) $y = 4 \cdot \left(\frac{1}{2}\right)^{x-1} - 2$



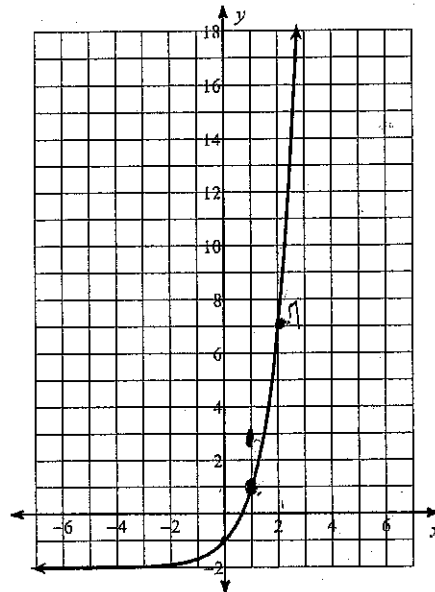
Write an equation for each graph.

7)



$y = (4)^x + 1$

8)



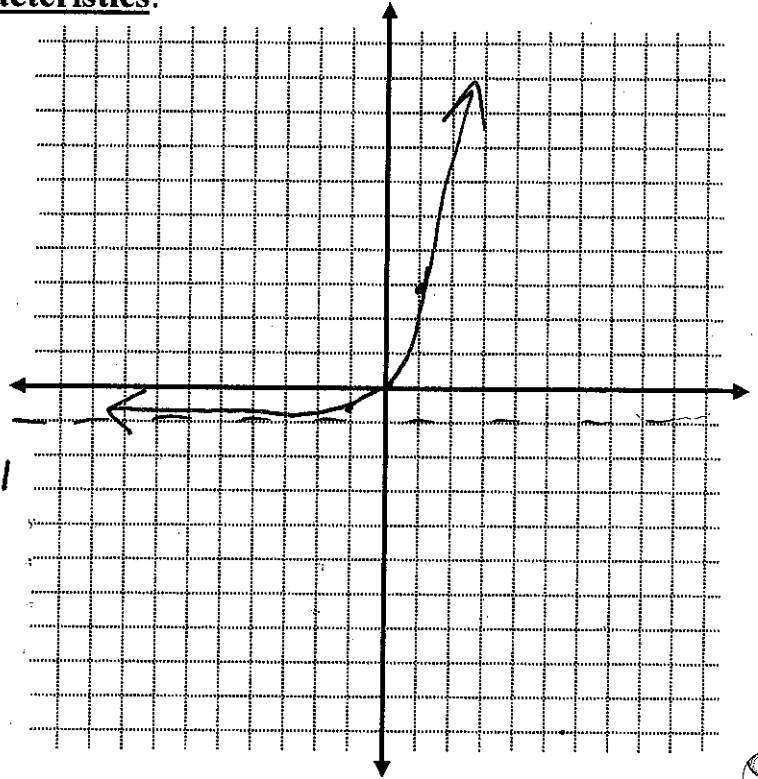
$y = (3)^x - 2$

Graph the functions and list all characteristics:

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

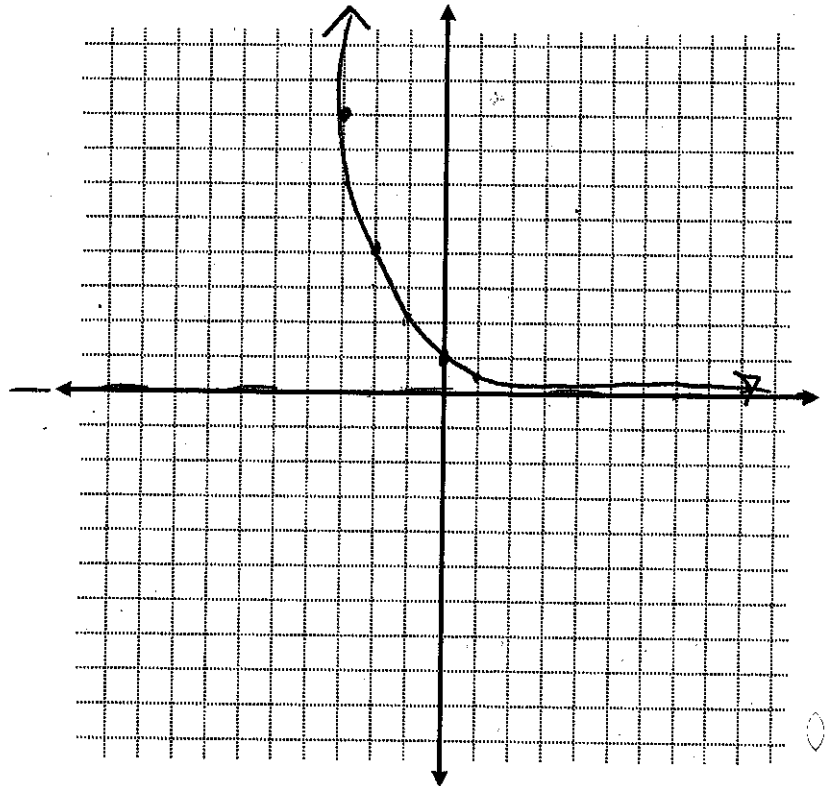
x	y
-3	-0.98
-2	-0.93
-1	-0.75
0	0
1	3
2	15
3	63

D: \mathbb{R}
 R: $(-1, \infty)$
 zeros: $(0, 0)$
 y-inter: $(0, 0)$
 end behavior:
 $x \rightarrow -\infty, f(x) \rightarrow -1$
 $x \rightarrow \infty, f(x) \rightarrow \infty$
 increase:
 $(-\infty, \infty)$



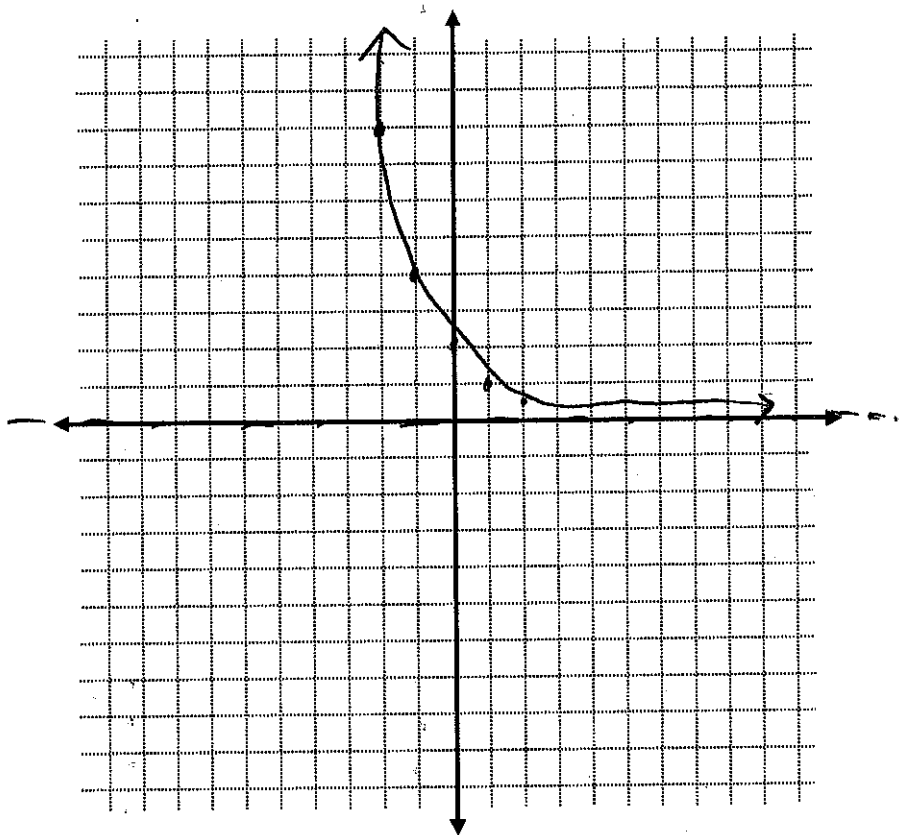
2. $f(x) = 0.5^x$

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



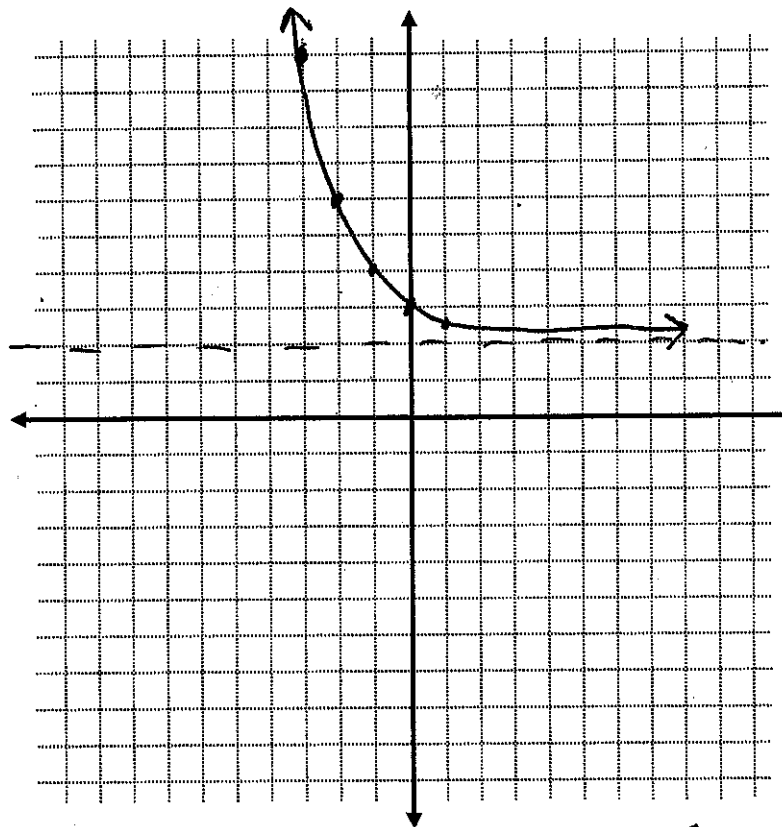
3. $f(x) = 2\left(\frac{1}{2}\right)^x$

x	y
-3	16
-2	8
-1	4
0	2
1	1
2	$\frac{1}{2}$
3	.25



4. $f(x) = 2^{-x} + 2$

x	y
-3	10
-2	6
-1	4
0	3
1	2.5
2	2.25
3	2.125



Properties of Exponents and Solving Exponential Equations (with Like Bases) WS

There are 5 basic properties of exponents

1. $a^n a^m = a^{n+m}$

2. $(a^n)^m = a^{n \cdot m}$

3. $a^0 = 1$

4. $\frac{a^n}{a^m} = a^{n-m}$

5. $a^{-n} = \frac{1}{a^n}$

Use these properties to simplify the following problems.

1. $(x^3 y^4)(x^2 y^5) =$
 $x^5 y^9$

6. $\frac{x^{2y}}{x^y} = x^y$

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

7. $\frac{3x^3 y^8}{81x^4 y^5} = \frac{1 \cdot y^3}{27x} = \frac{y^3}{27x}$

3. $(x^6 y^2 z^{15})^0 = 1$

8. $(2^x)(2^x) = 2^{2x}$ or 4^x

4. $(x^7)^y = x^{7y}$

9. $2^x + 2^x = 2(2^x)$

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

10. $\frac{3^x + 3^x}{3^x} = \frac{2(3^x)}{(3^x)} = 2$

answers: 1) $x^5 y^9$ 2) $x^6 y^3$ 3) 1 4) x^{7y} 5) x^{5y} 6) x^y 7) $\frac{y^3}{27x}$ 8) 2^{2x} or 4^x 9) $2(2^x)$ 10) 2

The properties of exponents can be used to solve exponential equations. The first step is to rewrite the equation so that the bases on both sides of the equation are the same. If the bases on both sides are the same, then the exponents must be equal. For instance,

$$3^{x+1} = 9^x$$

both bases can be made the same...

$$3^{x+1} = (3^2)^x$$

using the exponent properties...

$$3^{x+1} = 3^{2x}$$

if the bases are the same, then the exponents must be equal, so...

$$x+1 = 2x$$

and $x = 1$

Try these problems:

1. $2^x = 8$

$$2^x = 2^3 \quad \boxed{x=3}$$

2. $3^{x+5} = 9^2$

$$3^{x+5} = 3^{2(2)}$$

$$x+5 = 4 \quad \boxed{x=-1}$$

3. $5^{2x+3} = \frac{1}{125}$

$$5^{2x+3} = 5^{-3}$$

$$2x = -6 \quad \boxed{x=-3}$$

4. $\left(\frac{1}{2}\right)^{x+4} = 8^{x-1}$

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

$$-x-4 = 3x-3 \rightarrow -4x = 1 \rightarrow \boxed{x = -\frac{1}{4}}$$

5. $\left(\frac{1}{9}\right)^{x-2} = 81^{5-x}$

$$9^{-(x-2)} = 9^{2(5-x)}$$

$$-x+2 = 10-2x \rightarrow \boxed{x=8}$$

6. $8^{7x} = 16^{3x+9}$

$$2^{3(7x)} = 2^{4(3x+9)}$$

$$21x = 12x + 36$$

$$9x = 36 \quad \boxed{x=4}$$

7. $7^{3x+5} = 7^{x-3}$

$$3x+5 = x-3$$

$$2x = -8 \quad \boxed{x=-4}$$

8. $\left(\frac{1}{7}\right)^x = 7^{x+4}$

$$7^{-x} = 7^{x+4}$$

$$-2x = 4 \quad \boxed{x=-2}$$

9. $10^{3x+5} = 10^{x-3}$

$$3x+5 = x-3$$

$$2x = -8 \quad \boxed{x=-4}$$

10. $27^{7x} = 81^{3x+9}$

$$3^{3(7x)} = 3^{4(3x+9)}$$

$$21x = 12x + 36$$

$$\boxed{x=4}$$

Think about these:

11. If $2^x = 8$ yields $x=3$ and $2^x = 16$ yields $x=4$, what would $2^x = 10$ yield?

12. How would you solve $5^x = 37$?

answers: 1) 3 2) -1 3) -3 4) -1/4 5) 8 6) 4 7) -4 8) -2 9) -4 10) 4

$$1) 1-2n = 1-3n$$

$$0 = -n$$

$$n = 0$$

$$2) 2^{2(x)} = 2^{-4}$$

$$4x = -4$$

$$x = -1$$

3) skip

$$4) 4^{2(-3p)} = 4^{3(-3p)}$$

$$-6p = -9p$$

$$3p = 0$$

$$p = 0$$

$$5) 5^{2(k)} = 5^{3(-2k-2)}$$

$$2k = -6k - 6$$

$$8k = -6$$

$$k = -3/4$$

$$6) 5^{4(-n-2)} = 5^{-3}$$

$$-4n - 8 = -3$$

$$-4n = 5$$

$$n = -5/4$$

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$$7) 6^{2n+1} = 6^{-2}$$

$$2n = -3$$

$$n = -3/2$$

$$8) 2r-3 = r-3$$

$$r = 0$$

$$9) -3x = 2$$

$$x = -2/3$$

$$10) 2n = -n$$

$$n = 0$$

$$11) 2^{6b} = 2^5$$

$$b = 5/6$$

$$12) 6^{3(-3v)} = 6^{2(3v)}$$

$$-9v = 6v$$

$$v = 0$$

$$13) 4^{-x} = 4^2$$

$$x = -2$$

$$14) 3^{3(-2n-1)} = 3^2$$

$$-6n - 3 = 2$$

$$-6n = 5$$

$$n = -5/6$$

$$15) 3a = 3$$

$$a = 1$$

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

$$-3v = 3$$

$$v = -1$$

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

$$6x = 6x + 1$$

$$\emptyset$$

$$18) 4^{3(x+2)} = 4^2$$

$$3x + 6 = 2$$

$$3x = -4$$

$$x = -4/3$$

$$19) 3^{2(2n+3)} = 3^5$$

$$4n + 6 = 5$$

$$4n = -1$$

$$n = -1/4$$

$$20) 4^{2(2k)} = 4^{-3}$$

$$4k = -3$$

$$k = -3/4$$

$$21) 3x-2 = 3x+1$$

$$\emptyset$$

$$22) \quad 3^{5p} = 3^{3(-2p)}$$
$$5p = -6p$$
$$\emptyset$$

$$23) \quad -2x = 3$$
$$x = -\frac{3}{2}$$

$$24) \quad 2n = 2 - 3n$$
$$5n = 2$$
$$n = \frac{2}{5}$$

$$25) \quad m + 2 = -m$$
$$2 = -2m$$
$$m = -1$$

$$26) \quad 5^{4(2x)} = 5^2$$
$$8x = 2$$
$$x = \frac{1}{4}$$

$$27) \quad 4^{-2(b-1)} = 4^3$$
$$-2b + 2 = 3$$
$$-2b = 1$$
$$b = -\frac{1}{2}$$

$$28) \quad 6^{3(2n)} = 6^2$$
$$6n = 2$$
$$n = \frac{1}{3}$$

$$29) \quad 2 - 2x = 2$$
$$x = 0$$

$$30) \quad 4^{-(3v-2)} = 4^{3(1-v)}$$
$$-3v + 2 = 3 - 3v$$
$$\emptyset$$

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

32)

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ALGEBRA 2

WORKSHEET SOLVING EXPONENTIAL EQUATIONS

Solve each equation for x.

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

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

3) $25^{x+3} = 25^{5x-7}$
 $x = \frac{-10}{4} = 5/2$

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

$3x-5 = 8-x$
 $4x = 13$
 $x = 13/4$

5) $5^{x+1} = 25^2$
 $x = 1$

6) $3^{x-5} = 27^3$
 $x = 8$

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

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

9) $4^{x+2} = 8$
 $2^{2(x+2)} = 2^3$
 $x = 1/2$

10) $9^x = 27$
 $3^{2x} = 3^3$
 $x = 3/2$

11) $(\frac{1}{3})^{x+2} = 9^{3x}$
 $3^{-(x+2)} = 3^{2(3x)}$
 $x = 2/7$

12) $(\frac{1}{4})^{x-1} = 32^{x+3}$
 $2^{-2(x-1)} = 2^{5(x+3)}$
 $x = -13/7$

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

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

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

16) $(\frac{1}{4})^x = 8^{x-1}$
 $2^{-2x} = 2^{3(x-1)}$
 $-2x = 3x-3$
 $x = \frac{-3}{-5} = 3/5$

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

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

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

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

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) ~~$(\frac{1}{3})^{x+2} = 9^{3x}$~~

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

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

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

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

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

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

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

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

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

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) ~~$(\frac{1}{3})^{x+2} = 9^{3x}$~~

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

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

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

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

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

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

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

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

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