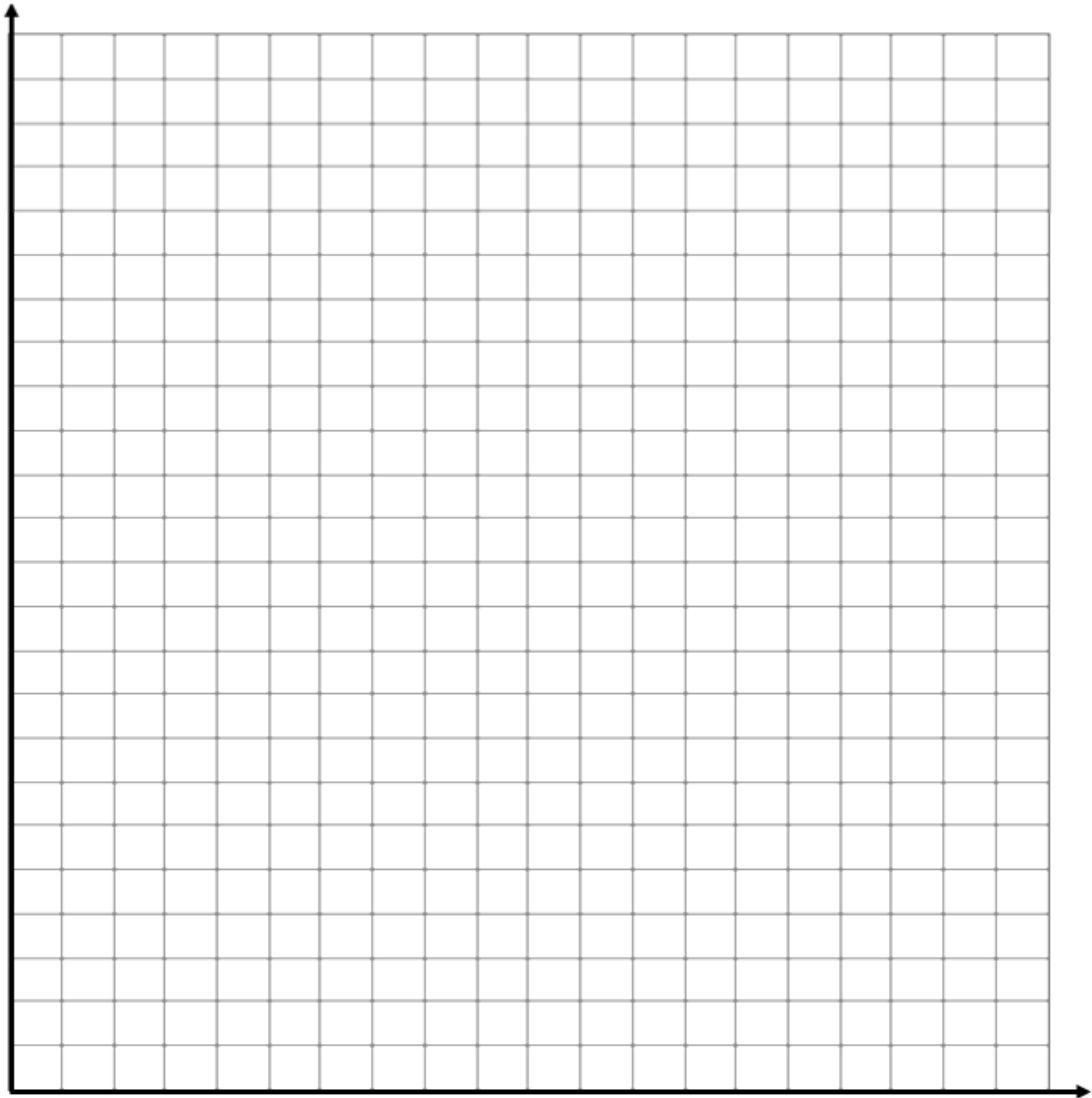


3. Use the data from your table to graph both lines on the coordinate grid below. Remember to put a scale on your graph and label each line.

p.17



1. Describe the relationship for the **TCF** graph.

a.

b.

2. Describe the relationship for the **WELLS FARGO** graph.

a.

b.

3. For how many years is it better to invest their money at...

TCF? _____

Wells Fargo? _____

4. Express each of your answers in #3 as an inequality.
Let x = number of years.

TCF _____

Wells Fargo _____

CW p.18-21 (1,2,6,7,12,15abcde)**P** p.18-21 (all)**p.18**

Linear Function	Exponential Function
$f(x) = mx + b$	$f(x) = a \cdot b^x$
b is the <i>starting value</i> , m is the <i>rate</i> or the <i>slope</i> . m is positive for growth, negative for decay.	a is the <i>starting value</i> , b is the <i>growth rate</i> . $b > 1$ for growth, $0 < b < 1$ for decay.
If the growth or decay involves increasing or decreasing by a fixed number (constant difference), use a linear function	If the growth or decay is expressed using multiplication (including words like “doubling” or “halving”) use an exponential function.

For 1-6, decide whether the word problem represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

- 1.** A gym’s customers must pay \$50 for a membership, plus \$3 for each time they use the gym.

Linear or exponential?

$f(x) =$

- 2.** There are 20,000 owls in the wild. Every decade, the number of owls is halved.

Linear or exponential?

$f(x) =$

- 3.** A library has 8000 books, and is adding 500 more books each year.

Linear or exponential?

$f(x) =$

- 4.** At the start of a carnival, you have 50 ride tickets. Each time you ride the roller coaster, you have to pay 6 tickets.

Linear or exponential?

$f(x) =$

- 5.** A bank account starts with \$10. Every month, the amount of money in the account is tripled.

Linear or exponential?

$f(x) =$

- 6.** As a reward, you ask for a penny the first day and to double the amount each day for 30 days.

Linear or exponential?

$f(x) =$

For 7-12, decide whether the table represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

7.

x	0	1	2	3	4	5	6	7
y	12	8	4	0	-4	-8	-12	-16

Linear or exponential?

$f(x) =$

8.

x	0	1	2	3	4	5	6	7
y	10	5	2.5	1.25	0.625	0.3125	0.15625	0.078125

Linear or exponential?

$f(x) =$

9.

x	0	1	2	3	4	5	6	7
y	2	5	8	11	14	17	20	23

Linear or exponential?

$f(x) =$

10.

x	0	1	2	3	4	5	6	7
y	0.4	0.6	0.9	1.35	2.025	3.0375	4.55625	6.834375

Linear or exponential?

$f(x) =$

11.

x	0	1	2	3	4	5	6	7
y	3	6	12	24	48	96	192	384

Linear or exponential?

$f(x) =$

12.

x	0	1	2	3	4	5	6	7
y	50	35	24.5	17.15	12.005	8.4035	5.88245	4.117715

Linear or exponential?

$f(x) =$

For 13-14, **WITHOUT A CALCULATOR** make a table for the linear or exponential function.

13.

x	$f(x) = \frac{1}{2}x + 8$
0	
1	
2	
3	
4	
5	
6	

14.

answer in fractions

x	$f(x) = 8 \cdot \left(\frac{1}{2}\right)^x$
0	
1	
2	
3	
4	
5	
6	

15. A science experiment involves periodically measuring the number of mold cells present on a piece of bread. At the start of the experiment, there are 50 mold cells. Each time a periodic observation is made, the number of mold cells triples. For example, at observation #1, there are 150 mold cells.

p.20

a) Is this a linear or exponential function? Explain how you know.

b) Write an equation for the number of mold cells present, where x stands for the observation number.

c) Fill in the missing outputs for the table.

$x =$ observation number	0	1	2	3	4	5
$y =$ mold cell count	50	150				

d) Suppose that the mold begins to be visible as green coloration when the mold cell count exceeds 100,000. On which observation will this happen?

e) What will be the mold cell count on the 20th observation? When you find the answer on your calculator, it will be so large that it displays in scientific notation. Rewrite the answer in decimal notation.

- 16.** Julie gets a pre-paid cell phone. Initially she has a \$40.00 balance on the phone. Each minute of talking costs \$0.15. Let x stand for the amount of time in minutes that Julie has talked on the phone, and let $f(x)$ stand for the remaining dollar value of the phone.
- a)** Is this a linear or exponential function? Explain how you know.
- b)** Write an equation that represents Julie's situation.
- c)** Find the value of $f(0)$ and explain its meaning in terms of the cell phone.
- d)** Find the value of $f(100)$ and explain its meaning in terms of the cell phone.
- e)** Find the value of x that makes $f(x) = 10$, and explain its meaning in terms of the cell phone.
- f)** Find the value of x that makes $f(x) = 0$, and explain its meaning in terms of the cell phone.

IF**Box 10**Checking: p.14-15

Write an equation in $y = a(b)^x$ to model the situation. Then, use your equation to answer the question.

You have \$5,000 saved in a bank that earns 3% annual interest. How much money is in the bank after 22 years?

There are 20,000 owls in the wild. Every year the population decreases 8%. How many owls will there be after 8 years?

GROWTH $b > 1$
collect IF

$$y = 5000(1 + 0.03)^{22}$$

$$y = 5000(1.03)^{22}$$

$$y = \$9580.52$$

DECAY

$$0 < b < 1$$

$$y = 20000(1 - 0.08)^8$$

$$y = 20000(0.92)^8$$

$$y = 10,264 \text{ owls}$$

p. 14-15 answers

CW p.14-15 (1,2,3,8ab,9,13)

P p.14-15 (all) **p.14**

1. For what values of b does $y = a \cdot b^x$ represent exponential growth?

$b > 1$

2. For what values of b does $y = a \cdot b^x$ represent exponential decay?

$0 < b < 1$

3. In the exponential model $y = 1500(1.1)^x$, identify the following:

- a) starting amount: 1500
- b) growth factor: 1.1
- c) percent of increase: 10%

For 4-7, match each equation with a table of values.

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

x	y
0	2
1	0.5
2	0.12
3	0.03

5. $y = 4(0.5)^x$ (C)

x	y
0	4
1	8
2	16
3	32

6. $y = 2(4)^x$ (D)

x	y
0	4
1	2
2	1
3	0.5

7. $y = 2(0.25)^x$ (A)

x	y
0	2
1	8
2	32
3	128

8. Suppose you deposit \$300 into an account that earns 6% annual interest.

a) Write an equation that shows the amount of money in the account after x years. Then, use your equation to find how much money will be in the account after 10 years.

$y = 300(1.06)^x$
 $y = 300(1.06)^{10}$
 $y = \$537.25$

b) About how many years will it take for the amount of money in the account to reach \$2000? Show work.

$300(1.06)^{32} = 1936.02$
 $300(1.06)^{33} = 2052.18$

About 33 years

For 9-16, write an equation in $y = a(b)^x$ to model the situation. Then use your equation to answer the question.

9. The student population of a school with 1200 students is predicted to grow at a rate of 3% each year. How will the student population be after 3 years?

$y = 1200(1.03)^x$
 $y = 1200(1.03)^3$
 $y = 1311$ students growth

10. Dane is training for a marathon. He runs 5 km this weekend. For the next several weeks, he will increase his distance by 10% each weekend. How far will he run after 6 weeks?

$y = 5(1.1)^x$
 $y = 5(1.1)^6$
 $y \approx 8.9$ km growth

11. You drink a beverage with 120 mg of caffeine. Each hour the amount of caffeine in your system decreases by about 12%. How much caffeine is in your system after 8 hours?

$$y = 120(0.88)^x \leftarrow \text{hour}$$

$$y = 120(0.88)^8$$

$$y \approx 43.2 \text{ mg}$$

decay

12. The average cost of gas is about \$3.50 per gallon. The average cost of gas is predicted to increase at a rate of 4% each year. How much will gas cost after 5 years?

$$y = 3.50(1.04)^x \leftarrow \text{year}$$

$$y = 3.50(1.04)^5$$

$$y = \$4.26$$

growth

13. You buy a stereo system for \$780. Each year the value of the stereo system decreases by 5%. What will the value of the stereo system be in 9 years?

$$y = 780(0.95)^x \leftarrow \text{year}$$

$$y = 780(0.95)^9$$

$$y = \$491.59$$

decay

14. A TV station's local news program has 60,000 viewers. The managers of the station plan to increase the viewers by 7% a month. How many viewers will there after one year?

$$y = 60,000(1.07)^x \leftarrow \text{month}$$

$$y = 60,000(1.07)^{12}$$

$$y = 135,131 \text{ viewers}$$

growth

15. An adult takes 400 mg of ibuprofen. Each hour the amount of ibuprofen in the person's system decreases by about 29%. How much ibuprofen is in the person's system after 24 hours?


$$y = 400(0.71)^x \leftarrow \text{hour}$$

$$y = 400(0.71)^{24}$$

$$y \approx 0.11 \text{ mg}$$

decay

16. Write a word problem about a situation that you could use an exponential equation to solve. Give the solution of your problem.

Unit 11: Non-Linear Functions					Name: _____	Hr: _____
pg. #	Learning Targets	CW <small>(teacher sign)</small>	Homework	Practice <small>(teacher sign)</small>	Understanding? 	
1-6	Review Linear Functions (Table, Graph, Equation, POI)	woo	4-6	hoo		
7-8	Intro Non-Linear Functions (One Grain of Rice Story)	woo	7-8	hoo		
9-11	1a) I can model exponential change using a table, graph, equation.	woo	10-11	hoo		
12-15	1b) I can write and use the exponential equation $y = a(b)^x$ to model exponential change.	yee	14-15	haa		
16-21	1c) I can compare linear vs. exponential changes.		18-21			
	1d) I can write and use an exponential equation given 2 points. (Quiz Review)					
	Exponential Review					
	2a) I can predict the graph of a quadratic equation.					
	2b) I can multiply binomials, using algebra tiles, to create a quadratic equation.					
	2c) I can factor quadratic equations using algebra tiles.					
	Tangent Ratio (Valley Fair)					
	Review					

Which Bank?

The Situation: You have \$1,000 saved. Now, you need to figure out which bank you want to invest your money in. You can choose from the following two banks.



TCF Bank
\$100 end
of each year



Wells Fargo Bank
Account earns 6%
annual interest



TCF Bank

\$100 end
of each year

Wells Fargo Bank

Account earns 6%
annual interest

p.16

1. Write an equation that represents the total amount of savings at each bank.

Let y = total savings

Let x = number of years



TCF: $y = 100x + 1000$ $y = mx + b$



Wells Fargo: $y = 1000(1.06)^x$ $y = a \cdot b^x$

Use your data to complete the following table. Round to the nearest cent.

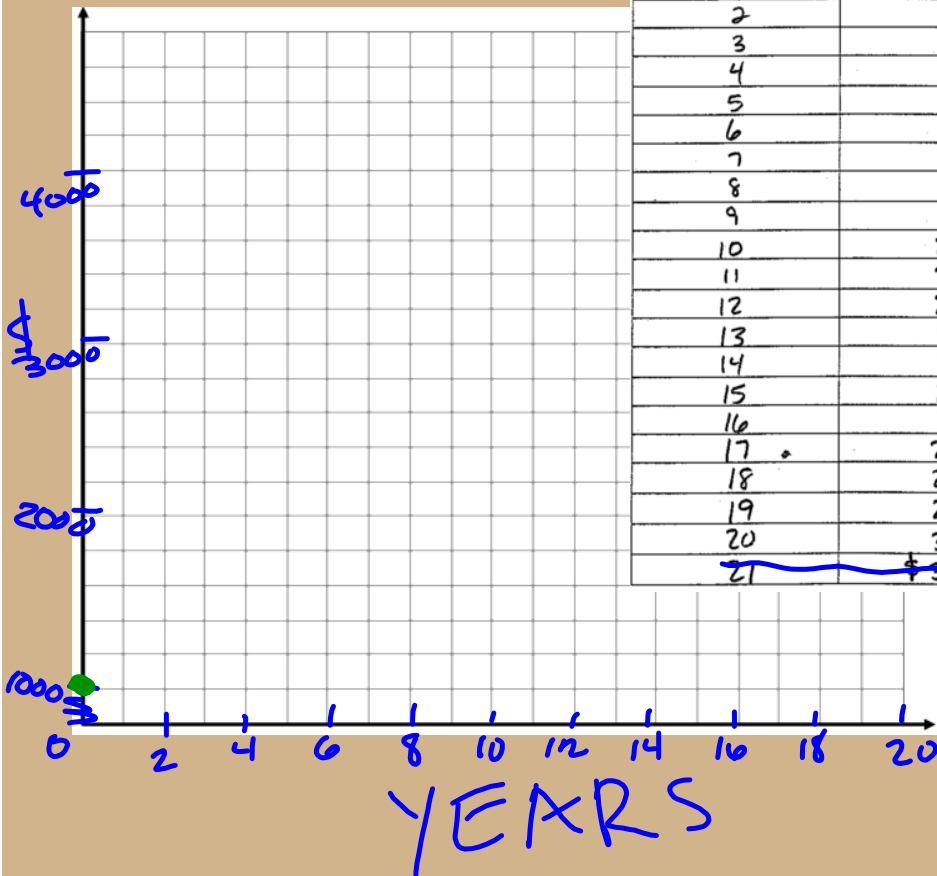
Number of years X	Total Savings at TCF y_1	Total Savings at Wells Fargo y_2
0	1000	1000
1		1060
2		1123.60
3		1191.02
4		
5		
6		
7		
8	$y = 100x + 1000$	
9		
10		1790.85
11		
12		
13		
14		
15		2396.56
16		
17		
18		
19		
20	3000	3207.14

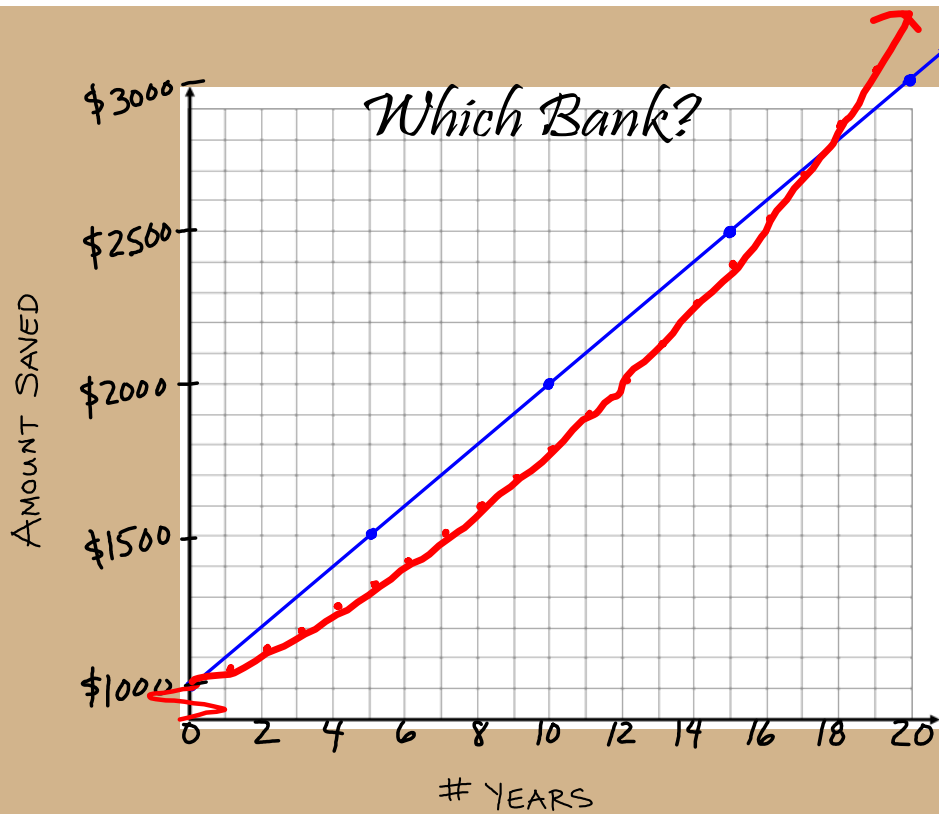
$(1.06)^x$



Which Bank

Number of years X	Total Savings at TCF y1	Total Savings at Wells y2
0	\$ 1000	\$ 1000
1	1100	1060
2	1200	1123.60
3	1300	1191.02
4	1400	1262.48
5	1500	1338.23
6	1600	1418.52
7	1700	1503.63
8	1800	1593.85
9	1900	1689.48
10	2000	1790.85
11	2100	1898.30
12	2200	2012.20
13	2300	2132.93
14	2400	2260.90
15	2500	2396.56
16	2600	2540.35
17	2700	2692.77
18	2800	2854.34
19	2900	3025.60
20	3000	3207.14
21	3100	3399.56





1. Describe the relationship for the TCF graph.

a.

b.

2. Describe the relationship for the WELLS FARGO graph.

a.

b.

3. For how many years is it better to invest their money at...

TCF? _____

Wells Fargo? _____

Number of years X	Total Savings at TCF y1	Total Savings at Wells Fargo y2
0	\$ 1000	\$ 1000
1	1100	1060
2	1200	1123.60
3	1300	1191.02
4	1400	1262.48
5	1500	1338.23
6	1600	1418.52
7	1700	1503.63
8	1800	1593.85
9	1900	1689.48
10	2000	1790.85
11	2100	1898.30
12	2200	2012.20
13	2300	2132.93
14	2400	2260.90
15	2500	2396.56
16	2600	2540.35
17	2700	2692.77
18	2800	2854.34
19	2900	3025.60
20	3000	3207.14
21	\$ 3100	\$ 3399.56

4. Express each of your answers in #3 as an inequality.
Let x = number of years.

TCF _____

Wells Fargo _____

p.19

For 7-12, decide whether the table represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

7.

x	0	1	2	3	4	5	6	7
y	12	8	4	0	-4	-8	-12	-16

-4 -4 -4 -4 -4

Linear or exponential?

$$f(x) = 12 - 4x$$

$$-4x + 12$$

8.

x	0	1	2	3	4	5	6	7
y	10	5	2.5	1.25	0.625	0.3125	0.15625	0.078125

0.5 0.5 0.5

Linear or exponential?

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

$a \cdot b^x$

CW p.18-21 (1,2,6,7,12,15abcde)

P p.18-21 (all)

SHOW WORK!



1,2,6,7,12

1. Linear; $f(x) = 3x$
2. Exponential; $f(x) = 3^x$
6. Exponential; $f(x) = 3^{2x}$
7. Linear; $f(x) = -4x + 1$
12. Exponential; $f(x) = 3^{x+1}$



15abcde

CW p.18-21 (1,2,6,7,12,15abcde)**P** p.18-21 (all)**p.18**

Linear Function	Exponential Function
$f(x) = mx + b$	$f(x) = a \cdot b^x$
b is the <i>starting value</i> , m is the <i>rate</i> or the <i>slope</i> . m is positive for growth, negative for decay.	a is the <i>starting value</i> , b is the <i>growth rate</i> . $b > 1$ for growth, $0 < b < 1$ for decay.
If the growth or decay involves increasing or decreasing by a fixed number (constant difference), use a linear function	If the growth or decay is expressed using multiplication (including words like "doubling" or "halving") use an exponential function.

For 1-6, decide whether the word problem represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

1. A gym's customers must pay \$50 for a membership, plus \$3 for each time they use the gym.

Linear or exponential?

$$f(x) = 3x + 50$$

2. There are 20,000 owls in the wild. Every decade, the number of owls is halved.

Linear or exponential?

$$f(x) = 20,000(0.5)^x$$

3. A library has 8000 books, and is adding 500 more books each year.

Linear or exponential?

$$f(x) = 500x + 8000$$

4. At the start of a carnival, you have 50 ride tickets. Each time you ride the roller coaster, you have to pay 6 tickets.

Linear or exponential?

$$f(x) = 50 - 6x$$

5. A bank account starts with \$10. Every month, the amount of money in the account is tripled.

Linear or exponential?

$$f(x) = 10(3)^x$$

6. As a reward, you ask for a penny the first day and to double the amount each day for 30 days.

Linear or exponential?

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

For 7-12, decide whether the table represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

p.19

7.

x	0	1	2	3	4	5	6	7
y	12	8	4	0	-4	-8	-12	-16

Linear or exponential?
 $f(x) = -4x + 12$

8.

x	0	1	2	3	4	5	6	7
y	10	5	2.5	1.25	0.625	0.3125	0.15625	0.078125

Linear or exponential?
 $f(x) = 10(0.5)^x$

9.

x	0	1	2	3	4	5	6	7
y	2	5	8	11	14	17	20	23

Linear or exponential?
 $f(x) = 3x + 2$

10.

x	0	1	2	3	4	5	6	7
y	0.4	0.6	0.9	1.35	2.025	3.0375	4.55625	6.834375

Linear or exponential?
 $f(x) = 0.4(1.5)^x$

11.

x	0	1	2	3	4	5	6	7
y	3	6	12	24	48	96	192	384

Linear or exponential?
 $f(x) = 3(2)^x$

12.

x	0	1	2	3	4	5	6	7
y	50	35	24.5	17.15	12.005	8.4035	5.88245	4.117715

Linear or exponential?
 $f(x) = 50(0.7)^x$

For 13-14, WITHOUT A CALCULATOR make a table for the linear or exponential function.

13.

x	$f(x) = \frac{1}{2}x + 8$
0	8
1	8.5
2	9
3	9.5
4	10
5	10.5
6	11

14. answer in fractions

x	$f(x) = 8 \cdot (\frac{1}{2})^x$
0	8
1	$8(\frac{1}{2})^1 = 4$
2	$8(\frac{1}{2})^2 = 8 \cdot \frac{1}{4} = 2$
3	$8(\frac{1}{2})^3 = 8 \cdot \frac{1}{8} = 1$
4	$8(\frac{1}{2})^4 = 8 \cdot \frac{1}{16} = 0.5 = \frac{1}{2}$
5	$8(\frac{1}{2})^5 = 8 \cdot \frac{1}{32} = 0.25 = \frac{1}{4}$
6	$8(\frac{1}{2})^6 = 8 \cdot \frac{1}{64} = 0.125 = \frac{1}{8}$

15. A science experiment involves periodically measuring the number of mold cells present on a piece of bread. At the start of the experiment, there are 50 mold cells. Each time a periodic observation is made, the number of mold cells triples. For example, at observation #1, there are 150 mold cells.

p.20

- a) Is this a linear or exponential function? Explain how you know.

Exponential, because the cells are tripling.
(multiply 3)

- b) Write an equation for the number of mold cells present, where x stands for the observation number.

mold cells $\rightarrow y = 50(3)^x$ ← observation

- c) Fill in the missing outputs for the table.

$x =$ observation number	0	1	2	3	4	5
$y =$ mold cell count	50	150	450	1,350	4,050	12,150

- d) Suppose that the mold begins to be visible as green coloration when the mold cell count exceeds 100,000. On which observation will this happen?

$$50(3)^6 = 36,450$$

$$50(3)^7 = 109,350$$

Mold begins to be visible at observation 7.

- e) What will be the mold cell count on the 20th observation? When you find the answer on your calculator, it will be so large that it displays in scientific notation. Rewrite the answer in decimal notation.

$$50(3)^{20} \approx 1.74 \times 10^{11}$$

$\approx 174,009,000,000$ mold cells

16. Julie gets a pre-paid cell phone. Initially she has a \$40.00 balance on the phone. Each minute of talking costs \$0.15. Let x stand for the amount of time in minutes that Julie has talked on the phone, and let $f(x)$ stand for the remaining dollar value of the phone.

p.21

- a) Is this a linear or exponential function? Explain how you know.

Linear, because you subtract \$0.15 each minute.

- b) Write an equation that represents Julie's situation.

$$f(x) = 40 - 0.15x$$

- c) Find the value of $f(0)$ and explain its meaning in terms of the cell phone.

$$\begin{aligned} f(0) &= 40 - 0.15(0) \\ f(0) &= 40 \end{aligned}$$

0 minutes of talking, there's a \$40 balance.

- d) Find the value of $f(100)$ and explain its meaning in terms of the cell phone.

$$\begin{aligned} f(100) &= 40 - 0.15(100) \\ f(100) &= 40 - 15 \\ f(100) &= 25 \end{aligned}$$

After 100 minutes of talking, there's \$25 left.

- e) Find the value of x that makes $f(x) = 10$, and explain its meaning in terms of the cell phone.

$$\begin{array}{r} 10 = 40 - 0.15x \\ -40 = -40 \\ \hline -30 = -0.15x \\ -0.15 \quad | \quad -0.15 \end{array}$$

$$\begin{aligned} x &= 200 \\ f(200) &= 10 \end{aligned}$$

200 mins of talking, \$10 remain

- f) Find the value of x that makes $f(x) = 0$, and explain its meaning in terms of the cell phone.

$$\begin{array}{r} 0 = 40 - 0.15x \\ -40 = -40 \\ \hline -40 = -0.15x \\ -0.15 \quad | \quad -0.15 \\ 266.7 = x \end{array}$$

$$f(266.7) = 0$$

You have about 267 mins before your balance runs out \$0.