NOTES 4/24

Linear Function	Exponential Function
$f(x) = mx + b$ or $f(x) = m(x - x_1) + y_1$	$f(x) = a \cdot b^x$
b is the *starting value,* m is the *rate* or the *slope.* m is positive for growth, negative for decay.	a is the *starting value,* b is the *base* or the *multiplier.* $b > 1$ for growth, $0 < b < 1$ for decay. See below for ways to find the base b.

Choosing linear vs. exponential

In growth and decay problems (that is, problems involving a quantity increasing or decreasing), here's how to decide whether to choose a linear function or an exponential function.

- If the growth or decay involves increasing or decreasing by a fixed number, use a **linear** function. The equation will look like:

$$y = mx + b$$

$$f(x) = (\text{rate})\, x + (\text{starting amount}).$$

- If the growth or decay is expressed using multiplication (including words like "doubling" or "halving") use an **exponential** function. The equation will look like:

$$f(x) = (\text{starting amount}) \cdot (\text{base})^x.$$

$$y = ab^x$$

Exercise 1:

Decide whether the word problem represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

a. "A library has 8000 books, and is <u>adding 500</u> more books each year."

(Linear) or exponential? $y = \underline{500x + 8000}$

b. "A gym's customers must pay \$50 for a membership, <u>plus \$3 for each</u> time they use the gym."

(Linear) or exponential? $y = \underline{3x + 50}$.
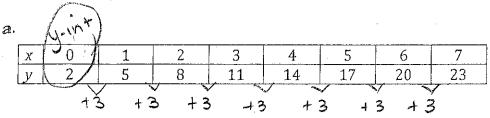
c. "A bank account starts with \$10. Every month, the amount of money in the account <u>is tripled.</u>"

Linear or (exponential) $y = \underline{10(3)^x}$.

d. "At the start of a carnival, you have 50 ride tickets. <u>Each time</u> you ride the roller coaster, you have to <u>pay 6 tickets.</u>"

(Linear) or exponential? $y = \underline{50 - 6x}$.

Exercise 2:

y-intercept: when $x = 0$

Decide whether the table represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

a.

y-int

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

+3 +3 +3 +3 +3 +3 +3

(Linear) or exponential? $y = \underline{3x + 2}$.

b.

y-int

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

×2 ×2 ×2 ×2 ×2 ×2 ×2

Linear or (exponential) $y = \underline{3(2)^x}$.

c.

y-int

x	0	1	2	3	4	5	6	7
y	10	5	2.5	1.25	.625	.3125	.15625	.078125

×.5 ×.5 ×.5 ×.5 ×.5 ×.5 ×.5

Linear or exponential? $y = \underline{10(.5)^x}$.

d.

y-int

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

-4 -4 -4 -4 -4 -4 -4

Linear or exponential? $y = \underline{-4x + 12}$

linear $y = mx + b$

exponential $y = ab^x$

Exercise 3:

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 $f(x)$ a linear function or an exponential function? Explain how you know.

linear because each minute costs the same amount of money ($0.15)

b. Find a function formula equation $f(x) =$ $40 - .15x$

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

$f(x) = 40 - .15x$
$f(0) = 40 - .15(0)$
$f(0) = 40$

When she talks for zero minutes, she has $40 remaining.

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

$f(x) = 40 - .15x$
$f(100) = 40 - .15(100)$
$f(100) = 25$

When she talks for 100 mins, she has $25 remaining.

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

$f(x) = 40 - .15x$
$10 = 40 - .15x$
$-40 \quad -40$
$-30 = -.15x$
$\overline{-.15} = \overline{-.15}$
$x = 200$

If she talks for 200 mins, her balance is $10.

Exercise 4:

Rachel and Marc were given the information shown below about the bacteria growing in a Petri dish in the biology class.

Number of hours (x)	3	4	5	6	7	8
Number of Bacteria, B(x)	350	440	550	690	860	1070

Rachel wants to model this information with a linear function. Marc wants to use an exponential function. Which model is the better choice? Explain why you chose this model.

exponential because the # of bacteria is changing by a different amount each time.