1. Which of the following would be best modeled by a LINEAR, QUADRATIC, or EXPONENTIAL function.

a. A window cleaner is cleaning windows about half way up the Peachtree Plaza Hotel in Downtown Atlanta. The cleaner didn't properly clip one of his squeegee tools and it fell from 400 feet up in the air. The height of the squeegee *t* seconds after it fell is given below. What type of function **(Linear, Quadratic, or Exponential)** would best describe the squeegee's height as a function of time?

Time (seconds)	0	1	2	3	4	5
Squeegee Height (feet)	400	384	336	256	144	0

-16 -48 -80 -112 -144
-32 -32 -32 -32

QUADRATIC

THE SECOND DIFFERENCE IS CONSTANT WHICH SUGGESTS QUADRATIC.

b. Joey's shower fixture began leaking water. So, he called a plumber to help him fix the problem. The plumber said he would charge $100 for making a house call and $60 for every hour he is there working on the problem. What type of function **(Linear, Quadratic, or Exponential)** would best describe the amount the plumber charges the customer? Can you write the function?

LINEAR

Time (hours)	0	1	2	3	4
Cost (dollars)	100	160	220	280	340

60 60 60 60

THE FIRST DIFFERENCE IS CONSTANT (i.e. CONSTANT RATE OF CHANGE) WHICH SUGGESTS A LINEAR MODEL.

$C(t) = 100 + 60t$

c. A pot of tea was brewed such that its temperature was 200°F and then the stove was turned off. The pot of tea slowly cooled back to the room temperature of 80°F over a few hours. The data is shown below in the table. What type of function **(Linear, Quadratic, or Exponential)** would best describe the temperature?

Time (hours)	0	1	2	3	4
Temperature (degrees)	200 °F	140 °F	110 °F	95 °F	87.5 °F

-60 -30 -15 -7.5

EXPONENTIAL

THE FIRST DIFFERENCES ARE GROWING BY THE SAME MULTIPLE WHICH SUGGESTS AN EXPONENTIAL MODEL.

2. Which of the following would be best modeled by a LINEAR, QUADRATIC, or EXPONENTIAL function.

a. A company named 'Fone Faze Foundary' designs the hardware for new smart phones and is offering a new employee an initial salary of $40,000 a year and will get a raise of an additional $6,000 for each year she works for the company. What type of function **(Linear, Quadratic, or Exponential)** would best describe the employee's salary based on the number of years that she works for the company? Can you determine the function?

t = NUMBER OF YEARS WORKED

$S(t) = 40000 + 6000t$

b. A company named 'Phone Program Ring' designs the software for new smartphones is offering a new employee an initial salary of $40,000 a year and will get a raise of an increase of 12% each year he works for the company. What type of function **(Linear, Quadratic, or Exponential)**would best describe the employee's salary based on the number of years that he works for the company? Can you determine the function?

GROWTH FACTOR: 100% + 12% = 112% = 1.12

t = NUMBER OF YEARS WORKED

$M(t) = 40000(1.12)^t$

40000*1.12^8
99038.52705

c. Which company would provide a better salary after 2 years of employment? After 8 years?

AT THE END OF 2 YEARS

$S(2) = 40000 + 6000(2) = 52000$

$M(2) = 40000(1.12)^2 = 50176$

THE FIRST COMPANY HAS A HIGHER SALARY AFTER 2 YEARS.

8 Years

$S(8) = 40000 + 6000(8) = 88000$

$M(8) = 40000(1.12)^8 = 99038.53$

THE SECOND COMPANY WOULD HAVE A HIGHER SALARY AFTER 8 YEARS.

3. Explain what each of the parameter of each model mean.

a. A student was marking the growth of a corn stalk plant and at least for the first several weeks the plant's height in inches could be described by the following model (where *t* is the time in weeks).

$$h(t) = 5(1.40)^t$$

(5: INITIAL VALUE; 1.40: GROWTH FACTOR)

i) What does the 5 represent?

THE PLANT WAS 5 INCHES TALL WHEN THE STUDY BEGAN.

ii) What does the 1.40 represent?

THE GROWTH FACTOR IS 1.40 = 140%. THE PLANT GROWS IN HEIGHT BY 40% EACH WEEK.

b. A person purchased a new car which depreciates in value. The car owner determined the value of the car in dollars could be modeled by the following function (where *t* is in years after the car was purchased).

$$v(t) = 23000(0.93)^t$$

(23000: INITIAL VALUE; 0.93: DECAY FACTOR)

i) What does the 23000 represent?

THE CAR WAS WORTH $23000 WHEN IT WAS FIRST PURCHASED

ii) What does the 0.93 represent?

THE DECAY FACTOR IS 0.93 = 93%. THE CAR IS DEPRECIATING IN VALUE BY 7% EACH YEAR.

c. A physical therapist charges an initial fee and then charges another amount per hour of therapy. The charges could be described by the following function model (where t is in hours of therapy).

$$c(t) = 140 + 40t$$

(140: INITIAL VALUE; 40: RATE)

i) What does the 40 represent?

THE THERAPIST CHARGES $40 PER HOUR

ii) What does the 140 represent?

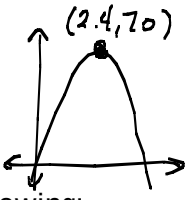
THE INITIAL FEE WAS $140.

d. A baseball is struck by a bat. The height in feet of the ball can described by the following function (where *t* is in seconds after the ball was struck).

$$h(t) = -16(t - 2.4)^2 + 70$$

i) What does the 2.4 represent?

IT TOOK 2.4 SECONDS AFTER THE BALL WAS STRUCK TO REACH A MAXIMUM HEIGHT.



ii) What does the 70 represent?

THE BALL REACHED A MAXIMUM HEIGHT OF 70 FEET.

4. Create a function model for each of the following:

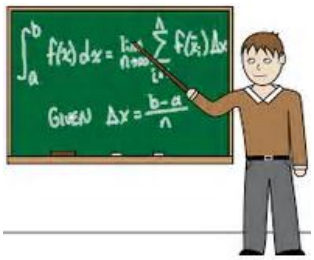
a. Some kids are selling lemonade for $1.50 per cup at a high school baseball game. They spent $14 on all of the items needed for the lemonade stand (cups, lemonade, table cloth, sign, etc.). Create a function that would represent their profit based on the number of cups of lemonade they sold.

C = # OF CUPS

$$P(C) = 1.50C - 14$$

(1.50: RATE; 14: SET UP COSTS)

b. A first year teacher is paid $38,000. Each year he is paid an additional 5% over the previous year. Create function that would represent the teacher's salary based on the number of years that the teacher worked.



t = # OF YEARS

$$S(t) = 38000(1.05)^t$$

(38000: INITIAL VALUE; 1.05: GROWTH FACTOR)

GROWTH FACTOR:

100% + 5% = 105% = 1.05

5. Comparing function types

a. A top level professional sports organization offers its athletes two different bonus retirement plans.

Option #1: They will start an account and add $20,000 years for each year the player plays successfully for the organization.

$R(t) = 20000 + 20000t$

t = # OF YEARS

Years Played	0	1	2	....
Retirement Account	$20,000	$40,000	$60,000	....

Option #2: They will start an account with $20,000 the add 50% to the value of the account for each year the athlete successfully plays for the team.

t = # OF YEARS

GROWTH FACTOR: 100% + 50% = 150% = 1.50

Years Played	0	1	2	....
Retirement Account	$20,000	$30,000	$45,000	....

$S(t) = 20000(1.50)^t$

Which option would be better for the athlete if he played for the team for 3 years? How much of difference is there between the two plans? $R(3) = 20000 + 20000(3) = 80000$

$S(3) = 20000(1.50)^3 = 67500$

OPTION #1 IS BETTER BY $12500

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20000(1.50)^3
        67500
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Which option would be better for the athlete if he played for the team for 10 years? How much of difference is there between the two plans? $R(10) = 20000 + 20000(10) = 220000$

$S(10) = 20000(1.50)^{10} = 1153300.78$

OPTION #2 IS BETTER BY $933,300.78

```
20000+20000(10)
        220000
20000(1.50)^10
     1153300.781
1153300.78-220000
        933300.78
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b. Two different computer programmers are trying to hack in to a computer file that has been protected by an encryption key using a brute force method in which a computer begins trying all possible passwords. A company is going to higher the programmer that successfully retrieves the file first.

The first computer programmer, Bill, wrote a brute force program that will try 50 thousands passwords each minute. t = # OF MINUTES $P(t) = 50t$

Minutes Passed	1	2	3	4	5	.....
Passwords Attempted in a minute (in thousands)	50	50	50	50	50	.....
Total Passwords Attempted (in thousands)	50	100	150	200	250	.....

The second computer programmer, Marcy, wrote an adaptive program that leveraged the hardware more efficiently that will try 5 thousand passwords the first minute, 10 thousand the next minute, 20 thousand the next minute, and continue doubling the attempts each minute.

t = # OF MINUTES $C(t) = -5 + 5 \cdot 2^t$ ← ALGEBRA 2 → GEOMETRIC SERIES $S_n = \frac{a_1(1-r^n)}{(1-r)}$

Minutes Passed	1	2	3	4	5	.....
Passwords Attempted in a minute (in thousands)	5	10	20	40	80	.....
Total Passwords Attempted (in thousands)	5	15	35	75	155	.....

GROWTH FACTOR = 100% + 100% = 200% = 2

10 20 40 80 160

USING JUST THE PATTERN WE COULD DETERMINE 10 MINUTES.

Which programmer will have tried the most passwords to break the code at the end of 5 minutes? How much difference is there between the two programmers? $P(5) = 50(5) = 250$ THOUSAND PASSWORDS

$C(5) = -5 + 5 \cdot 2^5 = 155$ THOUSAND PASSWORDS

THE FIRST PROGRAMMER BY 95000 PASSWORDS

Which programmer will have tried the most passwords to break the code at the end of 10 minutes? How much difference is there between the two programmers? $P(10) = 50(10) = 500$ THOUSAND PASSWORDS

$C(10) = -5 + 5 \cdot 2^{10} = 5115$ THOUSAND PASSWORDS

THE SECOND PROGRAMMER WOULD HAVE TRIED 4615 THOUSAND PASSWORDS MORE (WHICH IS 4.615 MILLION) BY THE END OF 10 MINUTES