Algebra I
7-1: Zero and Negative Exponents

Name ______________________
Date ______________ Class Period ________

Learning Target: Today you will be able to SIMPLIFY EXPRESSIONS INVOLVING ZERO AND NEGATIVE EXPONENTS

Question/Main Ideas:	Notes:
Exploration of Exponents	Complete the following table WITHOUT a calculator and then answer the given questions.

2^x	10^x
$2^4 =$ 16	$10^4 =$ 10000
$2^3 =$ 8	$10^3 =$ 1000
$2^2 =$ 4	$10^2 =$ 100
$2^1 =$ 2	$10^1 =$ 10
$2^0 =$ 1	$10^0 =$ 1
$2^{-1} =$ 1/2	$10^{-1} =$ $\frac{1}{10}$
$2^{-2} =$ 1/4	$10^{-2} =$ $\frac{1}{100}$

a. How does the value of the exponential expression change when you decrease the exponent by 1?

Divide by the base.

b. What do you think the value of 5^{-2} is (written as a fraction)?

$\frac{1}{5^2} = \frac{1}{25}$

Property: Zero Exponents

For every nonzero number a, $a^0 = 1$

$4^0 = 1$ $(-3)^0 = 1$ $(5.14)^0 = 1$

Property: Negative Exponents

For every nonzero number a, $a^{-n} = \frac{1}{a^n}$

$7^{-3} = \frac{1}{7^3} = \frac{1}{343}$ $(-6)^{-2} = \frac{1}{(-6)^2} = \frac{1}{36}$

Example 1: Simplifying Powers

Simplify.

a. $9^{-2} = \frac{1}{9^2} = \frac{1}{81}$

b. $(-3.6)^0 = 1$

Now It's Your Turn	Simplify. a. $4^{-3} = \frac{1}{4^3} = \frac{1}{64}$ b. $(-5)^0 = 1$ c. $3^{-2} = \frac{1}{3^2} = \frac{1}{9}$ d. $6^{-1} = \frac{1}{6^1} = \frac{1}{6}$ e. $(-4)^{-2} = \frac{1}{(-4)^2} = \frac{1}{16}$
Example 2: Simplifying Exponential Expressions	Simplify. a. $5a^3b^{-2} = \frac{5a^3}{b^2}$ only move base w/ negative exponent b. $\frac{1}{x^{-5}} = x^5$ negative exponents become positive when moved up.
Now It's Your Turn	Simplify. a. $x^{-9} = \frac{1}{x^9}$ b. $\frac{1}{n^{-3}} = n^3$ c. $4c^{-3}b = \frac{4b}{c^3}$ d. $\frac{2}{a^{-3}} = 2a^3$ e. $\frac{n^{-5}}{m^2} = \frac{1}{m^2n^5}$

Summary: ______________________________

____

____

Algebra I
7-2: Scientific Notation

Name ______________________________
Date _____________ Class Period _______

Learning Target: Today you will be able to WRITE NUMBERS IN SCIENTIFIC AND STANDARD NOTATION AND COMPARE AND ORDER NUMBERS USING SCIENTIFIC NOTATION

Question/Main Ideas:	Notes:
Concept: Scientific Notation	A number written as a product in the form... $a \times 10^n$ where n is an integer and $1 \leq a < 10$
Example 1: Recognizing Scientific Notation	Is the number written in scientific notation? If not, explain. a. 0.23×10^{-3} = No Not between 1-10 b. 2.3×10^{7} = Yes c. 9.3×100^{9} = No base ≠ 10
Example 2: Writing a Number in Scientific Notation	Write each number in scientific notation. a. 157,090,000 = 1.5709×10^{8} b. 0.061 = 6.1×10^{-2}
Now It's Your Turn	Write each number in scientific notation. a. 678,000 = 6.78×10^{5} b. 0.0000302 = 3.02×10^{-5} c. 51,040,000 = 5.104×10^{7} d. 0.0000007 = 7×10^{-7}
Example 3: Writing a Number in Standard Notation	Write each number in standard notation. a. 2.96×10^{3} = 2,960 b. 1.93×10^{-5} = 0.0000193
Now It's Your Turn	Write each number in standard notation. a. 5.23×10^{7} = 52,300,000 b. 4.6×10^{-5} = 0.000046 c. 2.09×10^{-4} = 0.000209 d. 3.8×10^{12} = 3,800,000,000,000

Summary: ____

____

____

Algebra I
7-3: Multiplying Powers with the Same Base

Name ______________________
Date ____________ Class Period ______

Learning Target: Today you will be able to MULTIPLY POWERS WITH THE SAME BASE

Question/Main Ideas: | **Notes:**

Exploration: Complete the Table and Answer the Given Questions

Product of Powers	Expanded Product	Number of Factors	Product as a Power
$7^3 \bullet 7^2$	$(7 \bullet 7 \bullet 7) \bullet (7 \bullet 7)$	5	7^5
$2^4 \bullet 2^4$	$(2\cdot2\cdot2\cdot2)\cdot(2\cdot2\cdot2\cdot2)$	8	2^8
$x^4 \bullet x^5$	$(xxxx)\cdot(xxxxx)$	9	x^9
$m \bullet m^5$	$m\cdot(mmmmm)$	6	m^6
$3^2 \bullet 3^4 \bullet 3^2$	$(3\cdot3)\cdot(3\cdot3\cdot3\cdot3)(3\cdot3)$	8	3^8
$y^5 \bullet y \bullet y^3$	$(yyyyy)\cdot(y)\cdot(yyy)$	9	y^9

a. What do you notice about the base of the original products in the first column and the base of the answer in the last column?

The base stayed the same

b. What do you notice about the exponents of the original products in the first column and the exponent of the answer in the last column?

The final exponent is the sum of the original exponents.

c. Do you see a shortcut that could get you from the original problem to the answer without the two middle columns?

Just add the original exponents.

Property: Multiplying Powers with the Same Base

$$a^m \cdot a^n = a^{m+n}$$

Example 1: Multiplying Powers

Write each expression using each base only once.

a. $12^4 \bullet 12^3$

12^{4+3}

12^7

b. $(-5)^{-2} \bullet (-5)^7$

$(-5)^{-2+7}$

$(-5)^5$

Now It's Your Turn	Write each expression using each base only once. a. $8^3 \bullet 8^6$ 8^{3+6} 8^9 b. $(0.5)^{-3} \bullet (0.5)^{-8}$ $(0.5)^{-3+-8}$ $(0.5)^{-11} = 2^{11}$ c. $9^{-3} \bullet 9^2 \bullet 9^6$ 9^{-3+2+6} 9^5
Example 2: Multiplying Powers in Algebraic Expressions	Simplify. a. $4z^5 \bullet 9z^{-12}$ $(4 \cdot 9)(z^5 \cdot z^{-12})$ $36z^{-7} = \frac{36}{z^7}$ b. $2a \bullet 9b^4 \bullet 3a^2$ $(2 \cdot 9 \cdot 3)(a \cdot a^2)(b^4)$ $54a^3b^4$
Now It's Your Turn	Simplify. a. $5x^4 \bullet x^9 \bullet 3x$ $(5 \cdot 3)(x^4 \cdot x^9 \cdot x)$ $15x^{14}$ b. $-4c^3 \bullet 7d^2 \bullet 2c^{-2}$ $(-4 \cdot 7 \cdot 2)(c^3c^{-2})(d^2)$ $-56cd^2$ c. $j^2 \bullet k^{-2} \bullet 12j$ $12(j^2 \cdot j)k^{-2}$ $12j^3k^{-2}$ $\frac{12j^3}{k^2}$
Example 3: Multiplying Numbers in Scientific Notation	What is the simplified form of $(3 \times 10^5)(5 \times 10^{-12})$? Write your answer in scientific notation. $(3 \cdot 5)(10^5 \cdot 10^{-12})$ 15×10^{-7} 1.5×10^{-6}
Now It's Your Turn	What is the simplified form of $(7 \times 10^8)(4 \times 10^5)$? Write your answer in scientific notation. $(7 \cdot 4)(10^8 \cdot 10^5)$ 28×10^{13} 2.8×10^{14}

Summary: ______________________________

Algebra I
7-4: More Multiplication Properties of Exponents

Name ______________________
Date ____________ Class Period ______

Learning Target: Today you will be able to RAISE A POWER TO A POWER AND RASIE A PRODUCT TO A POWER

Question/Main Ideas:	Notes:
Exploration: Complete the Table and Answer the Given Questions	See table below.

Power of a Power	Partially Expanded Product	Completely Expanded Product	Number of Factors	Product as a Power
$(5^2)^3$	$(5^2)\bullet(5^2)\bullet(5^2)$	$(5\bullet5)\bullet(5\bullet5)\bullet(5\bullet5)$	6	5^6
$[(-3)^2]^2$	$(-3)^2\cdot(-3)^2$	$(-3\cdot-3)(-3\cdot-3)$	4	3^4
$(b^2)^4$	$(b^2)\cdot(b^2)(b^2)(b^2)$	$(bb)(bb)(bb)(bb)$	8	b^8

Do you see a shortcut that could get you from the original problem to the answer without the two middle columns?

Multiply the original exponents

Property: Raising a Power to a Power

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

Example 1: Simplifying a Power Raised to a Power

Write each expression using each base only once.

a. $(n^4)^7 = n^{4\cdot7}$
$= n^{28}$

b. $(x^{-3})^5 = x^{-3\cdot5}$
$= x^{-15}$
$= \frac{1}{x^{15}}$

Example 2: Simplifying an Expression with Powers

Simplify $y^3(y^5)^{-2} = y^3\cdot y^{5\cdot-2}$
$= y^3\cdot y^{-10}$
$= y^{3+-10}$
$= y^{-7}$
$= \frac{1}{y^7}$

Now It's Your Turn

Simplify.

a. $x^2(x^6)^{-4}$

$x^2\cdot x^{-24}$

x^{-22}

$\frac{1}{x^{22}}$

b. $w^{-2}(w^7)^3$

$w^{-2}\cdot w^{21}$

w^{19}

c. $(r^{-5})^{-2}r^3$

$r^{10}\cdot r^3$

r^{13}

Exploration: Complete the Table and Answer the Given Questions

Product to a Power	Expanded Product	Grouped Products	Simplified with Powers	Product as a Power
$(4m)^3$	$(4m)\bullet(4m)\bullet(4m)$	$(4\bullet4\bullet4)\bullet(m\bullet m\bullet m)$	4^3m^3	$64m^3$
$(ab)^4$	$(ab)(ab)(ab)(ab)$	$(aaaa)(bbbb)$	a^4b^4	a^4b^4
$(3xy)^2$	$(3xy)(3xy)$	$(3\cdot3)(xx)(yy)$	$3^2x^2y^2$	$9x^2y^2$

Do you see a shortcut that could get you from the original problem to the answer without the two middle columns?

Just distribute the exponent to each "piece" in the parenthesis

Property: Raising a Power to a Power

$$(ab)^n = a^n b^n$$

Example 3: Simplifying an Expression with Products

Simplify $(n^5)^2(4mn^{-2})^3$ $= n^{10}\cdot4^3\cdot m^3\cdot(n^{-2})^3$

$= n^{10}\cdot64\cdot m^3\cdot n^{-6}$

$= 64m^3n^4$

Now It's Your Turn

Simplify.

a. $(x^{-2})^2(3xy^5)^4$

$x^{-4}\cdot3^4x^4y^{20}$

$81x^0y^{20}$

$81y^{20}$

b. $(6ab)^3(5a^{-3})^2$

$6^3a^3b^3\cdot5^2a^{-6}$

$(216\cdot25)(a^{-3}b^3)$

$\frac{5400b^3}{a^3}$

c. $(3c^5)^4(c^2)^3$

$3^4c^{20}c^6$

$81c^{26}$

Summary: ____

____

____

Algebra I
7-5: Division Properties of Exponents

Name ____________________
Date ______________ Class Period _______

Learning Target: Today you will be able to DIVIDE POWERS WITH THE SAME BASE AND RAISE A QUOTIENT TO A POWER

Question/Main Ideas:	Notes:

Exploration: Complete the Table and Answer the Given Questions

Division of Powers	Expanded Product	Simplified Product	Number of Factors Left	Quotient as a Power
$\frac{x^7}{x^3}$	$\frac{x \bullet x \bullet x \bullet x \bullet x \bullet x \bullet x}{x \bullet x \bullet x}$	$x \bullet x \bullet x \bullet x$	4	x^4
$\frac{b^5}{b^8}$	$\frac{bbbbb}{bbbbbbbb}$	$\frac{1}{bbb}$	-3	$\frac{1}{b^3}$
$\frac{6a^5}{2a^9}$	$\frac{3 \cdot 2aaaaa}{2aaaaaaaaa}$	$\frac{3}{aaaa}$	-4	$\frac{3}{a^4}$

Do you see a shortcut that could get you from the original problem to the answer without the two middle columns?

Subtract the exponents

Property: Dividing Powers with the Same Base

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

Example 1: Dividing Algebraic Expressions

Simplify

a. $\frac{x^8}{x^3} = x^{8-3} = x^5$

b. $\frac{m^2n^4}{m^5n^3} = m^{2-5}n^{4-3}$
$= m^{-3}n$
$= \frac{n}{m^3}$

Now It's Your Turn

Simplify

a. $\frac{y^5}{y^4} = y^{5-4}$
$= y$

b. $\frac{d^3}{d^9} = d^{3-9}$
$= d^{-6}$
$= \frac{1}{d^6}$

c. $\frac{k^6j^2}{kj^5} = k^{6-1}j^{2-5}$
$= k^5j^{-3}$
$= \frac{k^5}{j^3}$

	d. $\frac{a^{-3}b^7}{a^5b^2} = a^{-3-5}b^{7-2} = a^{-8}b^5 = \frac{b^5}{a^8}$ e. $\frac{x^4y^{-1}z^8}{x^4y^{-5}z} = x^{4-4}y^{-1+5}z^{8-1} = x^0y^4z^7 = y^4z^7$
Property: Raising a Quotient to a Power	$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$
Example 2: Raising a Quotient to a Power	Simplify. a. $\left(\frac{z^4}{5}\right)^3 = \frac{(z^4)^3}{5^3} = \frac{z^{12}}{125}$ b. $\left(\frac{4}{x^3}\right)^{-2} = \frac{4^{-2}}{(x^3)^{-2}} = \frac{4^{-2}}{x^{-6}} = \frac{x^6}{4^2} = \frac{x^6}{16}$
Concept: Raising a Quotient to a Negative Power	$\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$
Example 3: Simplifying an Exponential Expression	Simplify $\left(\frac{2x^6}{y^4}\right)^{-3} = \left(\frac{y^4}{2x^6}\right)^3 = \frac{(y^4)^3}{2^3(x^6)^3} = \frac{y^{12}}{8x^{18}}$
Now It's Your Turn	Simplify $\left(\frac{a}{5b}\right)^{-2} = \left(\frac{5b}{a}\right)^2 = \frac{5^2b^2}{a^2} = \frac{25b^2}{a^2}$

Summary: ____

____

____

Algebra I
7-6: Exponential Functions

Name ______________________________
Date ______________ Class Period ________

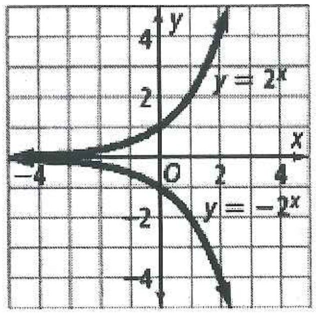
Learning Target: Today you will be able to EVALUATE AND GRAPH EXPONENTIAL FUNCTIONS

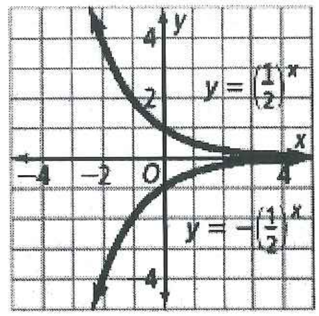
Question/Main Ideas:	Notes:

Concept: Exponential Functions

$y = a \cdot b^x$ where $a \neq 0$ and $b > 0$

Examples of Exponential Functions





Example 1: Identifying an Exponential Function

Does the table represent an exponential function? Explain.

+1 +1 +1

x	0	1	2	3
y	-1	-3	-9	-27

·3 ·3 ·3

Yes because the y-values change by a common factor

Now It's Your Turn

Does the table represent an exponential function? Explain.

a.

x	0	1	2	3	4	5
y	2	2.6	3.38	4.394	5.7122	7.42586

·1.3 ·1.3

Yes multiplied by 1.3

b.

x	0	1	2	3	4	5
y	500	550	605	665.5	732.05	805.255

Yes multiplied by 1.1

c.

x	0	1	2	3	4	5
y	2.3	3.8	5.3	6.8	8.3	9.8

No, goes up by a constant (Linear)

d.

x	1	2	3	4	5
y	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{6}$	$\frac{1}{8}$	$\frac{1}{10}$

No, not multiplied each time

Example 2: Identifying an Exponential Function

Does the rule represent an exponential function? Explain.

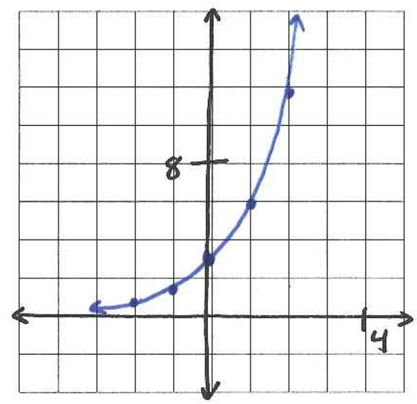
a. $y = 3x^2$ – No because the exponent is not a variable.

b. $y = 3 \cdot 6^x$ – Yes the exponent is a variable

Example 3: Graphing an Exponential Function

Graph $y = 3 \cdot 2^x$

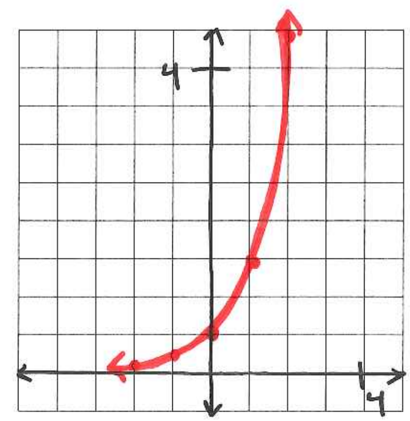
x	$3 \cdot 2^x$	y
-2	$3 \cdot 2^{-2}$	0.75
-1	$3 \cdot 2^{-1}$	1.5
0	$3 \cdot 2^0$	3
1	$3 \cdot 2^1$	6
2	$3 \cdot 2^2$	12



Now It's Your Turn

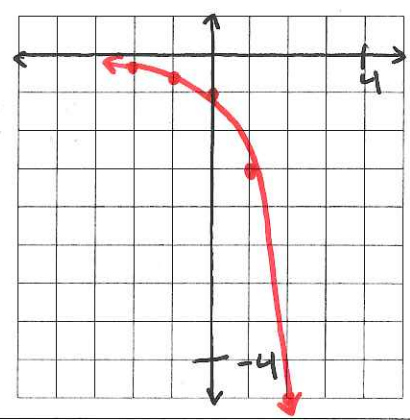
a. Graph $y = 0.5 \cdot 3^x$

x	$0.5 \cdot 3^x$	y
-2	$0.5 \cdot 3^{-2}$	0.06
-1	$0.5 \cdot 3^{-1}$	0.17
0	$0.5 \cdot 3^0$	0.5
1	$0.5 \cdot 3^1$	1.5
2	$0.5 \cdot 3^2$	4.5



b. Graph $y = -0.5 \cdot 3^x$

x	$-0.5 \cdot 3^x$	y
-2	$-0.5 \cdot 3^{-2}$	-0.06
-1	$-0.5 \cdot 3^{-1}$	-0.17
0	$-0.5 \cdot 3^0$	-0.5
1	$-0.5 \cdot 3^1$	-1.5
2	$-0.5 \cdot 3^2$	-4.5



Summary: ______________________________

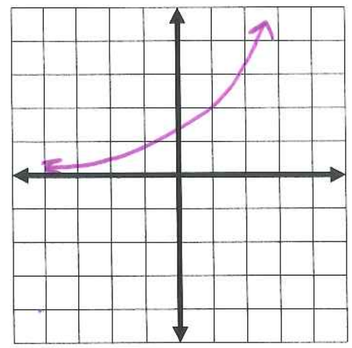
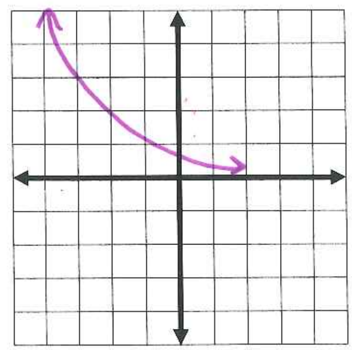
____

____

Algebra I
7-7 Day 1: Exponential Growth and Decay

Name ______________________________
Date ______________ Class Period _______

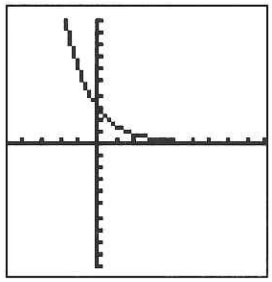
Learning Target: Today you will be able to IDENTIFY WHETHER A GIVEN RELATIONSHIP IS EXPONENTIAL GROWTH OR EXPONENTIAL DECAY AND CALCULATE THE GROWTH FACTOR.

Question/Main Ideas:	Notes:
Concept: Exponential Growth	$y = a \cdot b^x$ a - initial amount b - growth factor $b > 1$ 
Concept: Exponential Decay	$y = a \cdot b^x$ a - initial amount b - decay factor $0 < b < 1$ 
Example 1: Growth versus Decay from an Equation	State whether the equation represent exponential growth, exponential decay, or neither. If it is exponential, identify the growth/decay factor. a. $y = -3\left(\frac{5}{2}\right)^x$ Growth $b = \frac{5}{2}$ b. $y = 4 \cdot x^2$ Neither - exponent is not a variable
Now It's Your Turn	State whether the equation represent exponential growth, exponential decay, or neither. If it is exponential, identify the growth/decay factor. a. $y = 5 \bullet \frac{1}{2}^x$ Decay $b = \frac{1}{2}$ b. $y = -2 \cdot x^3$ Neither c. $y = 5.1^x$ Growth $b = 5.1$ d. $y = 2 \cdot 0.123^x$ Decay $b = 0.123$

Example 2: Growth versus Decay from a Graph

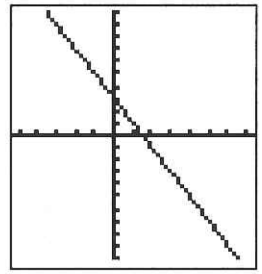
State whether the graph represent exponential growth, exponential decay, or neither.

a.



Exponential Decay

b.

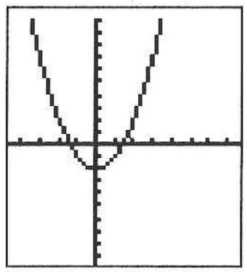


Neither

Now It's Your Turn

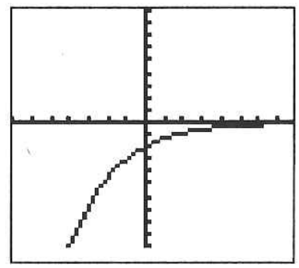
State whether the graph represent exponential growth, exponential decay, or neither.

a.



Neither

b.



Exponential Decay

Example 3: Growth versus Decay from a Table

State whether the graph represent exponential growth, exponential decay, or neither. If it is exponential, identify the growth/decay factor.

a.

x	0	1	2	3
y	1	3	9	27

Growth $b = 3$

b.

x	0	1	2	3
y	3	6	9	12

Neither

Now It's Your Turn

State whether the graph represent exponential growth, exponential decay, or neither. If it is exponential, identify the growth/decay factor.

a.

x	0	1	2	3
y	200	100	50	25

Decay $b = \frac{1}{2}$

b.

x	0	1	2	3
y	1	2	8	48

Neither

Summary: ____

____

____

Algebra I
7-7 Day 2: Compound Interest

Name ______________________
Date ____________ Class Period ______

Learning Target: Today you will be able to CALCULATE COMPOUND INTEREST

Question/Main Ideas:	Notes:

Exploring Exponential Functions with Percents

You are going to invest $500 into an account that earns 5% interest each year. Complete the table which represents the amount of money in the account at the end of each year.

Years	0	1	2	3	4
Amount in Account	500	525	551.25	578.81	607.75

a. The above table represents an exponential function. Identify it as growth or decay and find the growth/decay factor.

growth $b = 1.05$

c. How does the growth/decay factor relate to the 5% from the problem?

$1 + 5\% = 1.05$

d. Write an exponential equation that represents the data in the table?

$y = 500 \cdot 1.05^x$

You buy a car for $25,000. Cars depreciate (meaning they lose value) at a rate of 5% per year. Complete the following table which represents the amount the car is worth after each year.

Years	0	1	2	3	4
Cars Worth ($)	25000	23750	22562	21434	20362

a. The above table represents an exponential function. Identify it as growth or decay and find the growth/decay factor.

Decay $b = 0.95$

c. How does the growth/decay factor relate to the 5% from the problem?

$1 - 5\% = 0.95$

d. Write an exponential equation that represents the data in the table?

$y = 25000 \cdot 0.95^x$

Concept: Exponential Functions with Percents

<u>Exponential Growth</u>

$A = P(1+r)^t$ ← time

Amount, starting amount, rate (decimal)

<u>Exponential Decay</u>

$A = P(1-r)^t$ ← time

Amount, starting amount, rate (decimal)

Example 1: Modeling Exponential Growth/Decay	Since 2005, the amount of money spent at restaurants in the United States has increased about 7% each year. In 2005, about $360 billion was spent at restaurants. If the trend continues, about how much will be spent at restaurants in 2015? Write an exponential equation to model the situation. $A = 360(1+0.07)^t$ $A = 360(1.07)^t$ $A = 360(1.07)^{10}$ $A = \$708$ billion
Now It's Your Turn	The kilopascal is a unit of measure for atmospheric pressure. The atmospheric pressure at sea level is about 101 kilopascals. For every 1000-m increase in altitude, the pressure decreases about 11.5%. What is the approximate pressure at an altitude of 3000 m? Write an exponential equation to model the situation. $A = 101(1-0.115)^t$ $A = 101(0.885)^t$ $A = 101(0.885)^3$ $A = 70$ kilopascals
Formula: Compound Interest	$A = P\left(1+\frac{r}{n}\right)^{nt}$ A = Amount P = principal r = rate (decimal) t = time n = times compounded per year
Example 2: Compound Interest	Suppose that when your friend was born, your friend's parents deposited $2000 in an account paying 4.5% interest compounded quarterly. What will the account balance be after 18 years? $A = 2000\left(1+\frac{0.045}{4}\right)^{4\cdot 18}$ $A = \$4,475.53$
Now It's Your Turn	Suppose the account above pays 3.8% interest compounded monthly. What will the account be after 18 years? $A = 2000\left(1+\frac{0.038}{12}\right)^{12\cdot 18}$ $A = \$3959.30$

Summary: ______________________________

____

____