Section 1: Expressions
Section 1 – Topic 1
Units, Conversions, and Significant Digits

The distance from Starkville, MS to Oxford, MS can be expressed using the following units:

- 95.5 miles
- $168{,}080$ yards
- $504{,}240$ feet
- $6{,}050{,}880$ inches

Which measurement above is the best choice to represent the distance from Starkville to Oxford? Justify your answer.

Miles. The distance is too far to use shorter units.

The table below shows examples of units for different types of measurements.

Length	Mass	Capacity
Feet (ft)	Ounces (oz)	Pints (pt)
Yards (yd)	Pounds (lb)	Quarts (qt)
Inches (in)	Grams (g)	Gallons (gal)
Meters (m)	Kilograms (kg)	Fluid Ounces $(fl\ oz)$
Kilometers (km)	Tons (t)	Liters (l)
Centimeters (cm)	Metric Tons (mt)	Milliliters (ml)

Let's Practice!

1. The staff at the Jackson Swimming Pool are measuring swimming lanes to help swimmers track the distance they swim. Which unit(s) would you use to show the measurement of the lanes? Justify your answer.

Meters or yards. Swimming races are measured in meters or yards. Either answer is acceptable.

Try It!

2. Maria and José, students at Mississippi Valley University, are going to study abroad in Spain. They need to find the weight of their suitcases to make sure they meet airline regulations. What units should they use?

Pounds or kg. Airline regulations in the United States are listed in pounds but in other countries are listed as kg. Either answer is acceptable.

Sometimes, we need to change measurements to units that are more reasonable for a scenario. Some common conversions are shown in the table below.

Length	Mass	Capacity
$1\ yd = 3\ ft$	$1\ t\ =\ 2{,}000\ lb$	$1\ gal\ =\ 4\ qt$
$1\ ft = 12\ in$	$1\ lb\ =\ 16\ oz$	$1\ qt\ =\ 2\ pt$
$1\ km = 1{,}000\ m$	$1\ mt =\ 1{,}000\ kg$	$1\ pt\ =\ 16\ fl\ oz$
$1\ m = 100\ cm$	$1\ kg\ =\ 1{,}000\ g$	$1\ l\ =\ 1{,}000\ ml$

Mrs. Fisher is remodeling her house and needs to buy wallpaper border for her living room. She used her tape measure and found that the wall is 197 inches wide. When she arrived at the store she discovered that the border is only sold in yard long increments. How many yards of border should Mrs. Fisher purchase?

6 yards

How many yards of border does Mrs. Fisher actually need? Round your answer to the nearest thousandth.

5.472 yards

Which of the previous two measurements is more precise? Justify your answer.

5.472 yards is more precise because it is closer to the actual amount needed.

The precision of a number can be expressed by identifying the number of **significant digits** present. The rules to keep in mind when identifying significant digits are:

- Non-zero digits are all significant.
- Zeros that are between other significant digits are significant.
- Zeros to the right of both a decimal point and non-zero significant digits are significant.

Determine the number of significant digits for 0.059810.

5 significant digits

Let's Practice!

3. Engineering students at the University of Southern Mississippi are creating a model of a building for a class project. Sharon is using a tape measure that has markings every centimeter while Darrell is using a tape measure that has markings every millimeter. They are both measuring the width of their group's model and got the values listed below.

   Sharon: 0.51 meters

   Darrell: 0.512 meters

   Compare the number of significant digits from Darrell and Sharon to determine whose measurement is more precise.

Darrell's answer has 3 significant digits and Sharon's answer has 2 significant digits, which means Darrell's answer is more precise.

Try It!

4. The manager at SuperValu is calculating the price per ounce of their sweet tea. The sweet tea only comes in gallon – size containers. Determine the number of ounces in a container of SuperValu sweet tea.

128 ounces

BEAT THE TEST!

1. The Rodgers Family is planning their annual family reunion. Mrs. Rodgers is going to make fruit punch for the event and needs enough for 20 people.

   Part A: Which units should she use to calculate how much fruit punch to make?

   Gallons or ounces

   Part B: Mrs. Rodgers' recipe makes 250 ounces of punch. How many gallons does her recipe make? (round to the nearest ten – thousandth of a gallon)

   1.9531 gallons

   Part C: How many significant digits does your answer to *Part B* have?

   5 significant digits

Section 1 – Topic 2
Using Expressions to Represent Real World Situations

Jenny tweets 33 times a day. Antonio posts five tweets every day. Let d represent the given number of days.

Use an algebraic expression to describe Jenny's total posts after any given number of days.

$\mathbf{33d}$

Create an algebraic expression to describe Antonio's total posts after any given number of days.

$\mathbf{5d}$

Write an algebraic expression to describe the combined total posts for Jenny and Antonio after any given number of days.

$\mathbf{33d + 5d}$

After five days, how many tweets have Antonio and Jenny posted altogether?

$\mathbf{33(5) + 5(5) = 165 + 25 = 190}$ **total posts**

Let's Practice!

1. Mario and Luigi plan to buy a Wii U™ for $\$299.00$. Wii U™ games cost \$59.99 each. They plan to purchase one console.

   a. Use an algebraic expression to describe how much they will spend before sales tax based on purchasing the console and the number of games.

      Let g represent the number of games.

      $$\mathbf{299.00 + 59.99}g$$

   b. If they purchase one console and three games, how much do they spend before sales tax?

      $$\mathbf{299.00 + 59.99(3) = 478.97}$$

   c. Mario and Luigi want to purchase some extra controllers for their friends. Each controller costs $\$29.99$. Use an algebraic expression to describe how much they spend in total, before sales tax (based on purchasing the console), the number of games, and the number of extra controllers.

      Let c represent the number of controllers

      $$\mathbf{299.00 + 59.99}g\mathbf{ + 29.99}c$$

   d. What is the total cost, before sales tax, if Mario and Luigi purchase one console, three games, and two extra controllers?

      $$\mathbf{299.00 + 59.99(3) + 29.99(2) = 538.95}$$

STUDY EDGE TIP

When defining variables, choose variables that make sense to you, such as h for hours and d for days.

Try It!

2. Micah and Crystal purchase two movie tickets. Tickets cost $\$8.50$ each, drinks cost $\$3.50$ each, and boxes of candy cost $\$3.00$ each. Use an algebraic expression to describe how much they spend based on the number of drinks and boxes of candy they buy. Identify the parts of the expression by underlining the coefficient(s), circling the constant(s), and drawing a box around the variable(s).

Let d represent number of drinks and c represent boxes of candy.

$$8.5(2) + 3.5d + 3c$$

3. Ramiro brought home ten pounds of rice to add to the 24 ounces of rice he had in the pantry. Let x represent the amount of rice Ramiro uses over the next few days.

   a. Write an algebraic expression to describe the amount of rice remaining in Ramiro's pantry.

   Let x represent number of pounds of rice:

   $$(1.5 + 10) - x = 11.5 - x$$

   b. Determine if there are any constraints on x.

   x will be greater than or equal to zero but less than or equal 11.5 (amount of rice available to use)

BEAT THE TEST!

1. José is going to have the exterior of his home painted. He will choose between Krystal Klean Painting and Elegance Home Painting. Krystal Klean Painting charges $\$175.00$ to come out and evaluate the house plus $\$14.00$ per hour. Elegance Home Painting charges $\$23.00$ per hour. Let h represent the number of hours for which José hires a painter. Which of the following statements are true? Select all that apply.

- ☐ The expression $14h$ represents the total charge for Krystal Klean Painting.
- ☒ The expression $23h$ represents the total charge for Elegance Home Painting.
- ☐ The expression $175 + 14h + 23h$ represents the total amount José will spend for the painters to paint the exterior of his home.
- ☒ If José hires the painters for 10 hours, Elegance Home Painting would be cheaper.
- ☒ If José hires the painters for 20 hours Krystal Klean Painting will be cheaper.

2. During harvesting season at Florida Blue Farms, hand pickers collect about 200 pounds of blueberries per day with a 95% pack-out rate. The blueberry harvester machine collects about $22{,}000$ pounds of blueberries per day with a 90% pack-out rate. The pack-out rate is the percentage of collected blueberries that can be packaged to be sold, based on Florida Blue Farms' quality standards.

   Let h represent the number of days the hand pickers work and m represent the number of days the harvester machine is used. Which of the following algebraic expressions can be used to estimate the amount of collected blueberries that are packed at the Florida Blue Farms for fresh consumption this season?

   A $(0.95h + 200)(0.90m + 22000)$

   B $0.95(200h) + 0.90(22000m)$

   C $200.95h + 22000.90m$

   D $(200h + 0.95)(22000m + 0.90)$

Answer is B.

Want to learn more about how Florida Blue Farms uses algebra to harvest blueberries? Visit the Student Area in Algebra Nation to see how people use algebra in the real world! You can find the video in the "Math in the Real World: Algebra at Work" folder.

Section 1 – Topic 3
Understanding Polynomial Expressions

A ***term*** is a constant, variable, or multiplicative combination of the two.

Consider $3x^2 + 2y - 4z + 5$.

How many terms do you see?

4

List each term.

$3x^2$
$2y$
$-4z$
5

This is an example of a ***polynomial expression***. A polynomial can be one term or the sum of several terms. There are many different types of ***polynomials***.

A monarchy has one leader. How many terms do you think a monomial has?

1

A bicycle has two wheels. How many terms do you think a binomial has?

2

A triceratops has three horns. How many terms do you think a trinomial has?

3

Let's recap:

Type of Polynomial	Number of Terms	Example
Monomial	1	$2x^5$
Binomial	2	$3x + 5$
Trinomial	3	$4a^2 + 2b + 3c$
Polynomial	1 or more	$2m + 3n + \frac{1}{2}p + 7$

Some important facts:

- The ***degree of a monomial*** is the sum of the **exponents** of the variables.
- The ***degree of a polynomial*** is the degree of the monomial term with the **highest** degree.

Sometimes, you will be asked to write polynomials in standard form.

- Write the monomial terms in **descending** **degree** order.
- The ***leading term*** of a polynomial is the term with the **highest** **degree**.
- The ***leading coefficient*** is the coefficient of the **leading** **degree**.

Let's Practice!

1. Are the following expressions polynomials? If so, name the type of polynomial and state the degree. If not, justify your reasoning.

a. $8x^2y^3$

Yes, monomial, degree 5

b. $\frac{2a^2}{3b}$

No, it is the quotient of variables

c. $\frac{3}{2}x^4 - 5x^3 + 9x^7$

Yes, trinomial, degree 7

d. $10a^6b^2 + 17ab^3c - 5a^7$

Yes, trinomial, degree 8

e. $2m + 3n^{-1} + 8m^2n$

No, it has the quotient of a constant and variable.

Try It!

2. Are the following expressions polynomials?

a. $\frac{1}{2}a + 2b^2$

- ● polynomial
- ○ not a polynomial

b. 34

- ● polynomial
- ○ not a polynomial

c. $\frac{xy}{y^2}$

- ○ polynomial
- ● not a polynomial

d. $2rs + s^4$

- ● polynomial
- ○ not a polynomial

e. $xy^2 + 3x - 4y^{-1}$

- ○ polynomial
- ● not a polynomial

3. Consider the polynomial $3x^4 - 5x^3 + 9x^7$.

a. Write the polynomial in standard form.

$\mathbf{9x^7 + 3x^4 - 5x^3}$

b. What is the degree of the polynomial?

7

c. How many terms are in the polynomial?

3

d. What is the leading term?

$\mathbf{9x^7}$

e. What is the leading coefficient?

9

BEAT THE TEST!

1. Match the polynomial in the left column with its descriptive feature in the right column.

A.	$x^3 + 4x^2 - 5x + 9$	**V**	I.	Fifth degree polynomial
B.	$5a^2b^3$	**I**	II.	Constant term of -2
C.	$3x^4 - 9x^3 + 4x^9$	**VII**	III.	Seventh degree polynomial
D.	$7a^6b^2 + 18ab^3c - 9a^7$	**VI**	IV.	Leading coefficient of 3
E.	$x^5 - 9x^3 + 2x^7$	**III**	V.	Four terms
F.	$3x^3 + 7x^2 - 11$	**IV**	VI.	Eighth degree polynomial
G.	$x^2 - 2$	**II**	VII.	Equivalent to $4x^9 + 3x^4 - 9x^3$

Section 1 – Topic 4
Algebraic Expressions Using the Distributive Property

Recall the ***distributive property***.

- If $\boldsymbol{a}$ and $\boldsymbol{b}$ are real numbers, then $\boldsymbol{a(b + c) = a \cdot \underline{\quad b \quad} + a \cdot \underline{\quad c \quad}}$.

One way to visualize the distributive property is to use models.

Consider $(a + 3)(a + 2)$.

	$\boldsymbol{a}$	$\boldsymbol{2}$
$\boldsymbol{a}$	$\boldsymbol{a^2}$	$\boldsymbol{2a}$
$\boldsymbol{3}$	$\boldsymbol{3a}$	$\boldsymbol{6}$

$\boldsymbol{a^2 + 5a + 6}$

Now, use the distributive property to write an equivalent expression for $(a + 3)(a + 2)$.

$\boldsymbol{a \cdot a + a \cdot 2 + 3 \cdot a + 3 \cdot 2 =}$
$\boldsymbol{a^2 + 2a + 3a + 6 =}$
$\boldsymbol{a^2 + 5a + 6}$

Let's Practice!

1. Write an equivalent expression for $3(x + 2y - 7z)$ by modeling and then by using the distributive property.

	x	$2y$	$-7z$
3	$3x$	$6y$	$-21z$

$3(x + 2y - 7z) =$
$3 \cdot x + 3 \cdot 2y - 3 \cdot 7z =$
$3x + 6y - 21z$

2. Write an equivalent expression for $(x - 3)(x - 2)$ by modeling and then by using the distributive property.

	x	-2
x	x^2	$-2x$
-3	$-3x$	6

$x^2 - 5x + 6$

$(x - 3)(x - 2) =$
$x \cdot x - x \cdot 2 - 3 \cdot x - 3 \cdot (-2) =$
$x^2 - 5x + 6$

Try It!

3. Use the distributive property or modeling to write an equivalent expression for $(m + 5)(m - 3)$.

	m	-3
m	m^2	$-3m$
5	$5m$	-15

$$m^2 + 2m - 15$$

$$(m + 5)(m - 3) =$$
$$m \cdot m + m \cdot (-3) + 5 \cdot m + 5 \cdot (-3) =$$
$$m^2 + 2m - 15$$

BEAT THE TEST!

1. Students were asked to use the distributive property to write an equivalent expression for the expression $(x-5)(x-2)$. Their work is shown below. Identify the student with the correct work. For the answers that are incorrect, explain where the students made mistakes.

Student 1

$$(x-5)(x-2)$$
$$= x \cdot x - 5(-2)$$
$$= x^2 + 10$$

Incorrect. Student did not correctly distribute.

Student 2

$$(x-5)(x-2)$$
$$= xx - 2x - 5x - 5(-2)$$
$$= x^2 - 2x - 5x + 10$$
$$= x^2 - 7x + 10$$

Correct.

Student 3

$$(x-5)(x-2)$$
$$= x \cdot x + x(-2) - 5 \cdot x - 5(-2)$$
$$= x^2 - 2x - 5x - 10$$
$$= x^2 - 7x - 10$$

Incorrect. $(-5)(-2) = 10$, not -10.

Section 1 – Topic 5
Algebraic Expressions Using the Commutative and Associative Properties

What is $5 + 2$?

7

What is $2 + 5$?

7

Does it matter which number comes first?

No

What is $9 \cdot 2$?

18

What is $2 \cdot 9$?

18

Does it matter which number comes first?

No

This is the ***commutative property***.

- The order of the numbers can be **changed** without affecting the **sum** or **product**.
- If a and b are real numbers, then $a + b =$ **$b + a$** and $a \cdot b =$ **$b \cdot a$**.

Does the commutative property hold true for division or subtraction? If so, give an example. If not, give a counterexample.

No, $3 - 6 \neq 6 - 3$ and $\frac{10}{2} \neq \frac{2}{10}$

Let's look at some other operations and how they affect numbers.

Consider $2 + 4 + 6$. What happens if you put parentheses around any two adjacent numbers? How does it change the sum?

$(2 + 4) + 6$
$2 + (4 + 6)$
It does not change the sum.

Consider $3 \cdot 6 \cdot 4$. What happens if you put parentheses around any two adjacent numbers? How does it change the product?

$(3 \cdot 6) \cdot 4$
$3 \cdot (6 \cdot 4)$
It does not change the product.

This is the ***associative property***.

- The **order** of the numbers does not change.
- The grouping of the numbers can change and does not affect the **sum** or **product**.
- If a, b, and c are real numbers, then $(a + b) + c =$ $a + (b + c)$ and $(ab)c =$ $a(bc)$.

Does the associative property hold true for division or subtraction? If not, give a counterexample.

No, $10 - (5 - 4) \neq (10 - 5) - 4$ and $20 \div (4 \div 2) \neq (20 \div 4) \div 2$.

Let's Practice!

1. Name the property (or properties) used to write the equivalent expression.

   a. $[5 + (-3)] + 2 = 5 + [(-3) + 2]$

   Associative property of addition

   b. $(8 \cdot 4) \cdot 6 = 6 \cdot (8 \cdot 4)$

   Commutative property of multiplication

   c. $p + (u + t) = (t + u) + p$

   Commutative property of addition

STUDY EDGE TIP

When identifying properties, look closely at each piece of the problem. The changes can be very subtle.

Try It!

2. Identify the property (or properties) used to find the equivalent expression.

   a. $(11 + 4) + 5 = (5 + 11) + 4$
   Commutative property of addition
   Associative property of addition

   b. $v \cdot (y \cdot b) = (v \cdot y) \cdot b$
   Associative property of multiplication

   c. $(8 + 1) + 6 = 8 + (1 + 6)$
   Associative property of addition

   d. $(9 \times 13) \times 14 = (13 \times 9) \times 14$
   Commutative property of multiplication

3. The following proof shows $(3x)(2y)$ is equivalent to $6xy$. Fill in each blank with either "commutative property" or "associative property" to indicate the property being used.

$(3x)(2y) = 3(x \cdot 2)y$ — **Associative Prop. Of Multiplication**

$= 3(2 \cdot x)y$ — **Commutative Prop. Of Multiplication**

$= (3 \cdot 2)(x \cdot y)$ — **Associative Prop. Of Multiplication**

$= 6xy$

BEAT THE TEST!

1. Fordson High School hosted a math competition. A student completed the following proof and the question was marked incorrect. Identify and correct the student's mistake(s).

1.	$(2x-5)+3x=(-5+2x)+3x$	Commutative Property of addition
2.	$(-5+2x)+3x=-5+(2x+3x)$	Associative Property of addition
3.	$-5+(2x+3x)=-5+x(2+3)$	Distributive Property
4.	$-5+x(2+3)=x(2+3)-5$	Associative Property of addition
5.	$x(2+3)-5=x(5)-5$	Wrote an equivalent expression

Step 4 is incorrect. In Associative Property of Addition, the order of the numbers does not change. In step 4, the student changed the order of the terms in the sum. The correct answer is Commutative Property of Addition.

Section 1 – Topic 6
Properties of Exponents

Let's review the properties of exponents.

$2^4 = \mathbf{2 \cdot 2 \cdot 2 \cdot 2 = 16}$
$2^3 = \mathbf{2 \cdot 2 \cdot 2 = 8}$
$2^2 = \mathbf{2 \cdot 2 = 4}$
$2^1 = \mathbf{2}$

What pattern do you notice?

We are dividing by 2 each time.

Continuing the pattern, what does the following term equal?

$2^0 = \mathbf{2^1 \div 2 = 2 \div 2 = 1}$

- This is the ***zero exponent property***: $a^0 =$ ___**1**___.

Continuing the pattern, what do the following terms equal?

$2^{-1} = \mathbf{2^0 \div 2 = 1 \div 2 = \frac{1}{2} = \frac{1}{2^1}}$
$2^{-2} = \mathbf{2^{-1} \div 2 = \frac{1}{2} \div 2 = \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{2^2}}$

- This is the ***negative exponent property***: $a^{-n} =$ ___$\mathbf{\frac{1}{a^n}}$___ and $\frac{1}{a^{-n}} =$ ___$\mathbf{a^n}$___.

Let's explore multiplying terms with exponents and the same base.

$2^3 \cdot 2^4 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 2^7$

$2^5 \cdot 2^{-3} = \cancel{2 \cdot 2 \cdot 2} \cdot 2 \cdot 2 \cdot \frac{1}{\cancel{2 \cdot 2 \cdot 2}} = 2 \cdot 2 = 2^2$

$x^3 \cdot x^2 = x \cdot x \cdot x \cdot x \cdot x = x^5$

- This is the ***product property***: $a^m \cdot a^n =$ a^{m+n}.

Let's explore dividing terms with exponents and the same base.

$\frac{4^5}{4^3} = \frac{\cancel{4 \cdot 4 \cdot 4} \cdot 4 \cdot 4}{\cancel{4 \cdot 4 \cdot 4}} = 4^2$

$\frac{x^7}{x^8} = \frac{\cancel{x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x}}{\cancel{x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x} \cdot x} = \frac{1}{x} = x^{-1}$

- This is the ***quotient property***: $\frac{a^m}{a^n} =$ a^{m-n}.

Let's explore raising powers to an exponent.

$(5^3)^2 = 5^3 \cdot 5^3 = 5^{(3+3)} = 5^6$

$(y^4)^3 = y^4 \cdot y^4 \cdot y^4 = y^{(4+4+4)} = y^{12}$

- This is the ***power of a power property***: $(a^m)^n =$ a^{mn}.

Let's explore raising a product to an exponent.

$(2 \cdot 3)^2 = \mathbf{(2 \cdot 3) \cdot (2 \cdot 3) = (2 \cdot 2) \cdot (3 \cdot 3) = 2^2 \cdot 3^2}$

$(4 \cdot x)^3 = \mathbf{(4 \cdot x) \cdot (4 \cdot x) \cdot (4 \cdot x) = (4 \cdot 4 \cdot 4) \cdot (x \cdot x \cdot x) = 4^3 \cdot x^3}$

- This is the ***power of a product property***: $(ab)^n =$ $\mathbf{a^n b^n}$.

Let's explore a quotient raised to an exponent.

$\left(\frac{20}{3}\right)^2 = \mathbf{\frac{20}{3} \cdot \frac{20}{3} = \frac{20 \cdot 20}{3 \cdot 3} = \frac{20^2}{3^2}}$

$\left(\frac{6}{y}\right)^3 = \mathbf{\frac{6}{y} \cdot \frac{6}{y} \cdot \frac{6}{y} = \frac{6^3}{y^3}}$

- This is the ***power of a quotient property***: $\left(\frac{a}{b}\right)^n =$ $\mathbf{\frac{a^n}{b^n}}$.

Let's Practice!

1. Determine if the following equations are true or false. Justify your answers.

a. $3^3 \cdot 3^4 = \frac{(3^9)}{(3^2)}$

True

$\mathbf{3^3 \cdot 3^4 = 3^{(3+4)} = 3^7}$ **and** $\mathbf{\frac{(3^9)}{(3^2)} = 3^{(9-2)} = 3^7}$

b. $(5 \cdot 4^2)^3 = 5^4 \cdot 5^0 \cdot \left(\frac{4^6}{5^{-1}}\right)^{-1}$

False

$$\mathbf{(5 \cdot 4^2)^3 = 5^3 \cdot (4^2)^3 = 5^3 \cdot 4^6}$$

$$\mathbf{5^4 \cdot 5^0 \cdot \left(\frac{4^6}{5^{-1}}\right)^{-1} = 5^4 \cdot 1 \cdot \frac{4^{-6}}{5^1} = \frac{5^{4-1}}{4^6} = \frac{5^3}{4^6}}$$

Try It!

2. Use the properties of exponents to match each of the following expressions with its equivalent expression.

A) $\left(\frac{7}{2}\right)^4$	**II**	I.	$7^3 \cdot 2^6$
B) $(7 \cdot 2^2)^3$	**I**	II.	$\frac{7^4}{2^4}$
C) $(7^2)(7^2)$	**IV**	III.	$\frac{2^4}{7^4}$
D) $(7^2)(7)^0$	**V**	IV.	7^4
E) $\left(\frac{7}{2}\right)^{-4}$	**III**	V.	7^2
F) $\frac{(7^6)}{(7^3)}$	**VI**	VI.	7^3

BEAT THE TEST!

1. Crosby and Adam are working with exponents.

Part A: Crosby claims that $3^3 \cdot 3^2 = 3^5$. Adam argues that $3^3 \cdot 3^2 = 3^6$. Which one of them is correct? Use the properties of exponents to justify your answer.

Crosby is correct. $3^3 \cdot 3^2 = 3^{3+2} = 3^5$. Adam multiplied the exponents instead of adding using the product property.

Part B: Crosby claims that $\frac{3^8}{3^2} = 3^4$. Adam argues that $\frac{3^8}{3^2} = 3^6$. Which one of them is correct? Use the properties of exponents to justify your answer.

Adam is correct. $\frac{3^8}{3^2} = 3^{8-2} = 3^6$. Crosby divided the exponents instead of subtracting using the quotient property.

Section 1 – Topic 7
Operations with Rational and Irrational Numbers

Let's review rational and irrational numbers.

- Numbers that can be represented as $\frac{a}{b}$,where a and b are integers and $b \neq 0$, are called rational numbers.

- Numbers that cannot be represented in this form are called irrational numbers.

  - Radicals that cannot be rewritten as integers are examples of such numbers.

Determine whether the following numbers are rational or irrational.

	Rational	Irrational
$\sqrt{9}$	●	○
$\sqrt{8}$	○	●
π	○	●
$\frac{22}{7}$	●	○
$9.\overline{48}$	●	○
$\frac{33}{2}$	●	○
$2.23606\ldots$	○	●
-25	●	○

Given two rational numbers, a and b, prove that the sum of a and b is rational.

The sum is always rational.

Examples: $3 + 5 = 8$, $\frac{1}{3} + \frac{1}{2} = \frac{5}{6}$

Given two rational numbers, a and b, what can be said about the product of a and b?

The product is always rational.

Examples: $3 \cdot -5 = 15$, $0.3 \cdot 1.7 = 0.51$

Given a rational number, a, and an irrational number, b, prove that the sum of a and b is irrational.

The sum is always irrational.

Examples: $4 + \sqrt{12} = 4 + 2\sqrt{3}$, $2 + 3\pi = 2 + 3\pi$

Given a non-zero rational number, a, and an irrational number, b, what can be said about the product of a and b?

The product is always irrational.

Examples: $2 \cdot \sqrt{5}$, 4π

Let's Practice!

1. Consider the following expression.

$$2 + \sqrt{3}$$

The above expression represents the

- ● sum
- o product

of a(n)

- ● rational number
- o irrational number

and a(n)

- o rational number
- ● irrational number

and is equivalent to a(n)

- o rational number
- ● irrational number

Try It!

2. María and her 6 best friends are applying to colleges. They find that Bard College accepts $\frac{1}{3}$ of its applicants. María and her friends write the expression below to represent how many of them would likely be accepted.

$$7 \cdot \frac{1}{3}$$

The above expression represents the

- o sum
- ● product

of a(n)

- ● rational number
- o irrational number

and a(n)

- ● rational number
- o irrational number

and is equivalent to a(n)

- ● rational number.
- o irrational number.

BEAT THE TEST!

1. Let a and b be non-zero rational numbers and c be an irrational number. Consider the operations below and determine whether the result will be rational or irrational.

	Rational	Irrational
$a + b$	☒	☐
$a - c$	☐	☒
$a \cdot b$	☒	☐
$\frac{a}{b}$	☒	☐
$a \cdot b \cdot c$	☐	☒

2. Consider $x \cdot y = z$. If z is an irrational number, what can be said about x and y?

At least one of the variables MUST BE irrational.