



ALPHA PLUS

TEACHER'S GUIDE

Math 8



SAMPLE FOR REVIEW

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SUCCESS **OAS**
with

Oklahoma Academic Standards

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Math 8

Ensuring Student Success
with
Oklahoma Academic Standards

Written by Oklahoma Teachers for Oklahoma Teachers

Donna Cook



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SUCCESS *with* OAS

Math 8 by Donna Cook

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FOREWORD

Adopted in 2016 by the State Board of Education, the Oklahoma Academic Standards (OAS) mathematics objectives are measurably more rigorous in content and different in terms of vertical alignment than previous curriculum frameworks.

Immediately, Alpha Plus Educational Systems sought highly qualified teachers to develop a teaching and learning resource specifically aligned to the new standards. CEO Jan Barrick also enlisted my help and that of Dr. Frank Wang, President of the Oklahoma School of Science and Mathematics (OSSM), who is a nationally known, accomplished mathematics educator and an experienced textbook publisher. It has been my pleasure to help ensure the content is of high quality and will provide a solid mathematical foundation.

Written by Oklahoma teachers for Oklahoma teachers, the *Success with OAS: Alpha Plus Mathematics* series provides a robust set of resources relating mathematical skills to the real world of Oklahoma students.

-- Edna McDuffie Manning, *EdD.*, *Mathematics*
Founder and President Emerita, Oklahoma School of Science and Mathematics

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## INTRODUCTION

The *Success with OAS: Alpha Plus Mathematics* framework for instruction, independent student work, and continuous review will prepare students for comprehensive assessments at each grade level. Following is a summary addressing the most effective way to use each element.

### Teacher's Guide

Objective Statement: At the beginning of each lesson, the OAS objective is stated as adopted. This is helpful when writing lesson plans and understanding the focus of the lesson.

Real-World Connections: Students must be engaged and must relate the concept to their daily lives. Connecting to a real-world application taps into students' prior knowledge and shows the practicality behind the concept. It is suggested that the teacher start with a relevant, age-appropriate game, class discussion, website or video, role-play, or other group activity. This will illustrate the need to learn the skill so that students can use it in their daily lives.

Vocabulary: A list of vocabulary words critical to each OAS Objective is provided, particularly those used in the state's *Test and Item Specifications*. A complete vocabulary definition can be found in the student workbook and in the comprehensive Glossary at the end of the book.

Modeling: The Modeling section provides step-by-step instructions for one or more ways to teach the objective and the skills related to the lesson. Teachers may use this to direct students and add more examples or details as needed for the teachers' lesson plans.

Extension Activities: This is a list of possible resources to enhance the objective lesson. Every author provided links to tools they use in class, to online content available at no charge for teacher use, and to other lesson-planning resources.

Answer Key: Every Teacher's Guide includes a complete Answer Key for each assessment item in the student workbook. The Answer Key for the Continuous Review designates what objectives are assessed.

Comprehensive Examination: A Comprehensive Examination was developed to resemble the state assessment and encompasses every objective taught. It can be used as a pre-test and post-test for the school year to better prepare students for state-mandated tests. The Answer Key provides the answers with objective numbers.

### **Student Workbook**

Objective Statement: At the beginning of each student lesson is the objective statement. It clearly defines the focus of the lesson.

Real-World Connections: Written in age-appropriate language, this section reminds students of prior knowledge they have on the topic and how they might use this skill in their daily lives. Relevance is essential to student engagement in the lesson. Teachers can highlight this scenario for the students with a game, role-play, or other group activity.

Vocabulary: Each lesson includes a vocabulary list with definitions for the words the students will encounter on state assessments. Students should also learn to use the Glossary in the back of the book.

Guided Practice: Every objective lesson includes a Guided Practice, which is a set of items available for use in class as part of, or after, instruction. The ten practice problems reflect every skill students will use when they work independently.

Independent Practice: The Independent Practice is a series of twenty questions and activities the student may do independently, either in the classroom or for homework. The Independent Practice can also be used for reinforcement or review as needed.

Continuous Review: At the end of each lesson, there is a Continuous Review with ten questions covering objectives taught previously in the book or aligned to key skills from previous grade level(s). The Answer Key designates the objective each question assesses. The Continuous Review is in sequence after each objective lesson or can be used as a weekly assessment to reinforce past skills.

| Suggested Order | Objective Number | Objective Description                                                                                                                                                                                                                                                                                                                            | Teacher Guide Page Number | Student Book Page Number |
|-----------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|
| 1               | PA.N.1.1         | Develop and apply the properties of integer exponents, including $a^0 = 1$ (with $a \neq 0$ ), to generate equivalent numerical and algebraic expressions.                                                                                                                                                                                       | 1                         | 1                        |
| 2               | PA.N.1.2         | Express and compare approximations of very large and very small numbers using scientific notation.                                                                                                                                                                                                                                               | 13                        | 7                        |
| 3               | PA.N.1.3         | Multiply and divide numbers expressed in scientific notation, express the answer in scientific notation.                                                                                                                                                                                                                                         | 24                        | 13                       |
| 4               | PA.N.1.4         | Classify real numbers as rational or irrational. Explain why the rational number system is closed under addition and multiplication and why the irrational system is not. Explain why the sum of a rational number and an irrational number is irrational; and the product of a non-zero rational number and an irrational number is irrational. | 35                        | 21                       |
| 5               | PA.N.1.5         | Compare real numbers; locate real numbers on a number line. Identify the square root of a perfect square to 400 or, if it is not a perfect square root, locate it as an irrational number between two consecutive positive integers.                                                                                                             | 46                        | 29                       |
| 6               | PA.A.3.1         | Use substitution to simplify and evaluate algebraic expressions.                                                                                                                                                                                                                                                                                 | 56                        | 35                       |

| Suggested Order | Objective Number | Objective Description                                                                                                                                                                                                                    | Teacher Guide Page Number | Student Book Page Number |
|-----------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|
| 7               | PA.A.3.2         | Justify steps in generating equivalent expressions by identifying the properties used, including the properties of operations (associative, commutative, and distributive laws) and the order of operations, including grouping symbols. | 70                        | 45                       |
| 8               | PA.A.4.1         | Illustrate, write and solve mathematical and real-world problems using linear equations with one variable with one solution, infinitely many solutions, or no solutions. Interpret solutions in the original context.                    | 83                        | 55                       |
| 9               | PA.A.4.2         | Represent, write, solve, and graph problems leading to linear inequalities with one variable in the form $px + q > r$ and $px + q < r$ , where $p$ , $q$ , and $r$ are rational numbers.                                                 | 96                        | 65                       |
| 10              | PA.A.4.3         | Represent real-world situations using equations and inequalities involving one variable.                                                                                                                                                 | 112                       | 75                       |
| 11              | PA.A.1.1         | Recognize that a function is a relationship between an independent variable and a dependent variable in which the value of the independent variable determines the value of the dependent variable.                                      | 134                       | 89                       |
| 12              | PA.A.1.2         | Use linear functions to represent and explain real-world and mathematical situations.                                                                                                                                                    | 147                       | 99                       |

| Suggested Order | Objective Number | Objective Description                                                                                                                                                                                                       | Teacher Guide Page Number | Student Book Page Number |
|-----------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|
| 13              | PA.A.1.3         | Identify a function as linear if it can be expressed in the form $y=mx + b$ or if its graph is a straight line.                                                                                                             | 162                       | 111                      |
| 14              | PA.A.2.1         | Represent linear functions with tables, verbal descriptions, symbols, and graphs; translate from one representation to another.                                                                                             | 176                       | 121                      |
| 15              | PA.A.2.2         | Identify, describe, and analyze linear relationships between two variables.                                                                                                                                                 | 193                       | 133                      |
| 16              | PA.A.2.3         | Identify graphical properties of linear functions including slope and intercepts. Know that the slope equals the rate of change, and that the y-intercept is zero when the function represents a proportional relationship. | 211                       | 147                      |
| 17              | PA.A.2.4         | Predict the effect on the graph of a linear function when the slope or y-intercept changes. Use appropriate tools to examine these effects.                                                                                 | 231                       | 161                      |
| 18              | PA.A.2.5         | Solve problems involving linear functions and interpret results in the original context.                                                                                                                                    | 246                       | 173                      |
| 19              | PA.D.1.1         | Describe the impact that inserting or deleting a data point has on the mean and the median of a data set. Know how to create data displays using a spreadsheet and use a calculator to examine this impact.                 | 260                       | 185                      |



**OAS Mathematics**
**Table of Contents**
**8th grade**

| Suggested Order | Objective Number | Objective Description                                                                                                                                                                                                                                                                             | Teacher Guide Page Number | Student Book Page Number |
|-----------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|
| 20              | PA.D.1.2         | Explain how outliers affect measures of central tendency.                                                                                                                                                                                                                                         | 272                       | 195                      |
| 21              | PA.D.1.3         | Collect, display, and interpret data using scatterplots. Use the shape of the scatterplot to informally estimate a line of best fit, make statements about the average rate of change, and make predictions about values not in the original data set. Use appropriate titles, labels, and units. | 286                       | 205                      |
| 22              | PA.D.2.1         | Calculate experimental probabilities and represent them as percents, fractions, and decimals between 0 and 1 inclusive. Use experimental probabilities to make predictions when actual probabilities are unknown.                                                                                 | 301                       | 219                      |
| 23              | PA.D.2.2         | Determine how samples are chosen (random, limited, biased) to draw and support conclusions about generalizing a sample to a population.                                                                                                                                                           | 315                       | 229                      |
| 24              | PA.D.2.3         | Compare and contrast dependent and independent events.                                                                                                                                                                                                                                            | 329                       | 241                      |
| 25              | PA.GM.1.1        | Informally justify the Pythagorean Theorem using measurements, diagrams, or dynamic software and use the Pythagorean Theorem to solve problems in two and three dimensions involving right triangles.                                                                                             | 341                       | 251                      |

| Suggested Order | Objective Number | Objective Description                                                                                                                                                                                                                                                                                  | Teacher Guide Page Number | Student Book Page Number |
|-----------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------|
| 26              | PA.GM.1.2        | Use the Pythagorean Theorem to find the distance between any two points in a coordinate plane.                                                                                                                                                                                                         | 353                       | 261                      |
| 27              | PA.GM.2.1        | Calculate the surface area of a rectangular prism using decomposition or nets. Use appropriate measurements such as $cm^2$ .                                                                                                                                                                           | 366                       | 271                      |
| 28              | PA.GM.2.3        | Develop and use the formulas $V=lwh$ and $V=Bh$ to determine the volume of rectangular prisms. Justify why base area (B) and height (h) are multiplied to find the volume of a rectangular prism. Use appropriate measurements such as $cm^3$ .                                                        | 378                       | 281                      |
| 29              | PA.GM.2.2        | Calculate the surface area of a cylinder, in terms of $\pi$ and using approximations for $\pi$ , using decomposition or nets. Use appropriate measurements such as $cm^2$ .                                                                                                                            | 394                       | 293                      |
| 30              | PA.GM.2.4        | Develop and use the formulas $V=\pi r^2 h$ and $V=Bh$ to determine the volume of right cylinders, in terms of $\pi$ and using approximations for $\pi$ . Justify why base area (B) and height (h) are multiplied to find the volume of a right cylinder. Use appropriate measurements such as $cm^3$ . | 409                       | 305                      |

## Teacher's Guide

**PA.N.1.1 Develop and apply the properties of integer exponents, including  $a^0 = 1$  (with  $a \neq 0$ ), to generate equivalent numerical and algebraic expressions.**

### Real-World Connections

Students will understand how a number changes exponentially, such as using a text tree to contact lots of people quickly. Students must apply properties of exponents to create equivalent expressions, know the zero power rule, and understand how to raise a power to a larger power. These skills are necessary in order to understand terminology within the computer world. You often hear about megabytes, gigabytes, and terabytes. "Mega" means  $10^6$  or one million, "giga" means  $10^9$ , and "tera" means  $10^{12}$ . The prefixes mega- and giga- are used in other fields as well; one example is megahertz, which means  $10^6$  or one million hertz. Students will also use these skills later to calculate exponential growth and decay in higher level mathematics and science classes.

### Vocabulary

integer exponents, power, base, expressions, equivalent numerical expressions, equivalent algebraic expressions

### Modeling

**Step 1:** Discuss rules of exponents with like bases.

Suppose you are working with a long repeated multiplication problem, such as:

$$3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$$

This does not look like the way a mathematician would write numbers. There must be a short cut. So, group them into  $(3 \cdot 3 \cdot 3 \cdot 3 \cdot 3) \cdot (3 \cdot 3 \cdot 3 \cdot 3 \cdot 3)$ . Now, change each group into exponential form which would be  $3^5 \cdot 3^6$ .

However, instead of doing all that rewriting, you count how many 3s are in that list. There are 11. So, to write in exponential form use 3 with an exponent of 11. Therefore,

$$3^{11} = 3^5 \cdot 3^6$$

## Teacher's Guide PA.N.1.1

Could this be a rule for multiplying exponents with the same base? Think about this. Suppose the same factor is multiplied many times, and to make it easier to count, these factors are divided into two groups and put into exponential form. To get the exponent for the first group, the factors were counted; and to get the exponents for the second group, the factors were counted. Since both groups were counted separately but are the same factor, why not add the exponents to give a total count? Will this always work?

$$7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 = 7^5$$

or

$$(7 \cdot 7 \cdot 7) \cdot (7 \cdot 7) = 7^3 \cdot 7^2 = 7^5$$

- The rule for multiplying numbers in exponential form is: if the **bases** multiplied together are the **same**, then add the exponents.

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

**Step 2:** Discuss rules of exponents with unlike bases.

What would be the exponential form of  $3 \cdot 3 \cdot 3 \cdot 5 \cdot 5$ ? Count the common (same) factors and put each group in exponential form.

$$3 \cdot 3 \cdot 3 \cdot 5 \cdot 5 = (3 \cdot 3 \cdot 3) \cdot (5 \cdot 5) = 3^3 \cdot 5^2$$

To write  $5^4 \cdot 4^3 \cdot 7^2 \cdot 4^6 \cdot 5^7$  in a shorter form, collect together the common (same) bases and with those common bases add the exponents.

$$(5^4 \cdot 5^7)(4^3 \cdot 4^6)(7^2) = (5^{4+7})(4^{3+6})(7^2) = 5^{11}4^97^2$$

When **multiplying common bases** with exponents, the shorter way of writing the same number is **adding their exponents**.

**Step 3:** Discuss rules of dividing common bases.

What happens when dividing common bases?

$$\frac{\overset{1}{5} \times \overset{1}{5} \times \overset{1}{5} \times 5 \times 5}{\underset{1}{5} \times \underset{1}{5} \times \underset{1}{5}} = \frac{25}{1} = 25$$

Now put in exponential form.

$$\frac{5^5}{5^3} = 5^2 = 25$$

## Teacher's Guide PA.N.1.1

Notice the exponents were subtracted. Be careful and notice which exponents were subtracted. You must subtract the denominator's exponent from the numerator's exponent ( $5 - 3$ ).

What would happen if the denominator's exponent was larger? ( $3 - 5 = ?$ )

$$\frac{\cancel{3}^1 \times \cancel{3}^1 \times \cancel{3}^1}{\cancel{3} \times \cancel{3} \times \cancel{3} \times 3 \times 3} = \frac{1}{3 \times 3} = \frac{1}{9} \qquad \frac{3^3}{3^5} = 3^{-2} = \frac{1}{3 \times 3} = \frac{1}{9}$$

Look at the exponential form. If you subtract the common base exponents  $3 - 5 = -2$ , the negative exponent means a fraction and the answer is a fraction.

It does not matter which is the larger exponent, the numerator or the denominator. When **dividing** common bases with exponents, **subtract the exponent of the denominator from the exponent of the numerator**.

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

To write in simplified form  $\frac{5^3 \cdot 4^5 \cdot 7^2}{5^4 \cdot 4^3 \cdot 7^5}$ , notice this is both multiplication and division.

The numerator's common bases are both simplified as are the denominators. To proceed, subtract exponents of common bases.

$$(5^{3-4})(4^{5-3})(7^{2-5}) = 5^{-1}4^27^{-3} = \frac{4^2}{5^1 \cdot 7^3}$$

The positive exponents belong in the numerator, and the negative exponents belong in the denominator. (+ exponents up/ - exponents down) The answer would be:

$$\frac{4^2}{5 \cdot 7^3} = \frac{16}{5 \cdot 343} = \frac{16}{1715}$$

**Step 4:** Discuss the special rule for when the exponent is 0.

What is the value of each of these fractions  $\frac{5}{5}$ ,  $\frac{2 \cdot 3}{6}$ , and  $\frac{m}{m}$ ? They each have a value of 1, because you are essentially dividing a number by itself. Now look at the following problem and apply the rule for dividing exponential numbers with a common base.

$$\frac{3^2}{3^2}$$

When written to one power, you get  $3^0$ . Notice in the problem above the numerator and denominator are exactly the same; therefore, you are dividing a number by itself, which has a value of one. From these two concepts you can write a rule for  $a^0$ , when  $a \neq 0$ . Any number other than **zero** raised to the **zero** power is equal to one.

**Step 5:** Discuss raising a power to a power.

What would  $(2^3)^2$  be if it were written as a repeated multiplication problem? Since the base is  $2^3$ , you use that as your factor, and the exponent of 2 tells you that you have two factors. Therefore, it would be  $2^3 \cdot 2^3$ . Notice you now have a multiplication problem with like bases, so you follow those rules and get  $2^6$ . How can you get a 6 from a 3 and 2? You multiply 3 and 2 to get six. Could this be a rule for raising a power to a power? Think about it, since you have a base with an exponent, you multiply that exponential number by itself the number of times the outside exponent is, and therefore you can make the rule: When raising a **power** to a **power**, you keep the base and **multiply the two powers**.

**Step 6:** Summarize the lesson with the students. Students need to understand:

- How to write a repeated multiplication problem in exponential form.
- When to add and when to subtract exponents.
- When subtracting in a division of exponential forms, what order do you subtract?
- How to change a number with an exponent into a standard number.
- Negative exponents will appear as fractions, and can be rewritten by changing the exponent to a positive as a denominator with 1 as the numerator.

$$4^{-3} = \frac{1}{4^3} = \frac{1}{4 \times 4 \times 4} = \frac{1}{64}$$

- The zero power of any number except 0 equals 1.

Example:  $3^0 = 1$

- How to raise a power to a power.

## Teacher’s Guide PA.N.1.1

### Extension Activities

Have students roll a double die or pair of dice in two colors. Students may decide which die they want to represent the base and the exponent. Students should complete the table using their information.

| Exponential Form | Base | Exponent | Numerical/Algebraic Expression | Value |
|------------------|------|----------|--------------------------------|-------|
|                  |      |          |                                |       |

Consider sharing video “Pre-algebra – Exponents, radicals, and scientific notation: Exponentiation warmup” from Khan Academy®

<https://www.khanacademy.org/math/pre-algebra/pre-algebra-exponents-radicals/pre-algebra-exponents/v/exponents-warmup>

Oklahoma State Department of Education objective analysis of PA.N.1.1

<http://okmathframework.pbworks.com/w/page/112827562/PA-N-1-1>

## Answer Key PA.N.1.1

### Guided Practice

|    | Exponential Form | Base | Exponent | Numerical/Algebraic Expression                   | Value |
|----|------------------|------|----------|--------------------------------------------------|-------|
| 1. | $4^5$            | 4    | 5        | $4 \times 4 \times 4 \times 4 \times 4$          | 1024  |
| 2. | $3^6$            | 3    | 6        | $3 \times 3 \times 3 \times 3 \times 3 \times 3$ | 729   |

3.  $5^{10} = 9,765,625$

4.  $2^9 \cdot 3^7 = 1,119,744$

5.  $5^4 = 625$

6.  $2^3 \cdot 3^2 = 72$

7.  $\frac{4^2}{3^1} = \frac{16}{3}$

8.  $2^0 = 1$

9.  $2^8 \cdot 3^4 = 20,736$

10. 128

### Independent Practice

1.  $3^5$

2.  $m^6$

3.  $6 \times 6 \times 6 \times 6$

4.  $b \times b \times b \times b \times b \times b$

5. base = 2 exponent = 3

6. base = 5 exponent = 7

7. 81

8. 125

9.  $2^{11} = 2,048$

10.  $3^9 = 19,683$

11.  $2^9 \cdot 4^6 = 2,097,152$

12.  $3^9 \cdot m^9 = 19,683 \cdot m^9$

13.  $4^4 = 256$

14.  $6^2 = 36$

15.  $3^3 \cdot 4^2 = 432$

16.  $2^3 \cdot 4^2 = 128$

17.  $\frac{3^3}{2^2} = \frac{27}{4}$

18.  $4^0 = 1$

19.  $4^6 \cdot n^9 = 4,096 \cdot n^9$

20.  $1(\text{Nicki}) + (3^1) + (3^2) + (3^3) + (3^4) = 1 + 3 + 9 + 27 + 81 = 121$



## Answer Key PA.N.1.1

### Continuous Review

1.-2. (PA.N.1.1)

|    | Exponential Form | Base | Exponent | Numerical/Algebraic Expression | Value |
|----|------------------|------|----------|--------------------------------|-------|
| 1. | $6^3$            | 6    | 3        | $6 \times 6 \times 6$          | 216   |
| 2. | $3^4$            | 3    | 4        | $3 \times 3 \times 3 \times 3$ | 81    |

3. (PA.N.1.1)  $3^2 \cdot 4^3 = 576$
4. (PA.N.1.1)  $\frac{3^4}{2^2} = \frac{81}{4}$
5. (PA.N.1.1)  $4^6 = 4,096$
6. (7.N.2.1) 20
7. (7.N.2.1) -15
8. (7.N.2.1) -5
9. (7.N.2.1) -3
10. (6.N.2.3) \$10

**PA.N.1.1 Develop and apply the properties of integer exponents, including  $a^0 = 1$  (with  $a \neq 0$ ), to generate equivalent numerical and algebraic expressions.**

**Real-World Connections**

In the real world, why would you need to know exponents? Often times, a coach may need to notify his players that a game is being cancelled, postponed, or moved, but if the team was large that could be very time consuming for one person. The coach instead could send a text to the three team captains. This means, after one round of texts  $3^1$ , three players have been notified. These three captains each text three more players. Therefore, during the second round of texts  $3^2$ , nine more players are texted for a total of 12. This would continue with each player texting three players. To determine how many were texted in one round, you would use 3 as the base number and the round of texts as the exponent. To get the total texted, you add the value from each round.

**Vocabulary**

|                                         |                                                                                                                                                                                                            |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>exponent</b>                         | the number or variable that indicates how many times the base is used as a factor, e.g., in $4^3 = 4 \times 4 \times 4 = 64$ , the exponent 3 shows that 4 is repeated as a factor three times             |
| <b>base</b>                             | the number or variable representing the factor being multiplied                                                                                                                                            |
| <b>expression</b>                       | a mathematical phrase that combines operations, numbers, and/or variables                                                                                                                                  |
| <b>equivalent numerical expressions</b> | two numerical expressions are equivalent if one can be obtained from the other using the properties of operations, as well as by representing numbers in the expressions in different but equivalent forms |
| <b>equivalent algebraic expressions</b> | two algebraic expressions are equivalent if one can be obtained from the other using the properties of operations, as well as by representing numbers in the expressions in different but equivalent forms |

**Guided Practice (PA.N.1.1)**

Name \_\_\_\_\_

Given a number in exponential form, a base and exponent, a numerical or algebraic expression, or a base and total value, calculate the missing parts.

|    | Exponential Form | Base | Exponent | Numerical/Algebraic Expression | Value |
|----|------------------|------|----------|--------------------------------|-------|
| 1. | $4^5$            |      |          |                                |       |
| 2. |                  | 3    | 6        |                                |       |

Write the multiplication or division problem to one power and solve.

3.  $5^3 \cdot 5^5 \cdot 5^2 =$  \_\_\_\_\_

4.  $3^2 \cdot 2^4 \cdot 3^3 \cdot 2^3 \cdot 3^2 \cdot 2^2 =$  \_\_\_\_\_

5.  $\frac{5^6}{5^2} =$  \_\_\_\_\_

6.  $\frac{2^5 \cdot 3^6}{3^4 \cdot 2^2} =$  \_\_\_\_\_

7.  $\frac{4^2 \cdot 3^3 \cdot 4^3 \cdot 3^2}{3^2 \cdot 4^2 \cdot 4 \cdot 3^4} =$  \_\_\_\_\_

8.  $\frac{2^3 \cdot 2^5}{2^6 \cdot 2^2} =$  \_\_\_\_\_

9.  $(2^4 3^2)^2 =$  \_\_\_\_\_

Solve.

10. If Richard bought two boxes of batteries at Sam's and each box had 4 packages continuing 4 rows of 4 batteries each, how many batteries did Richard buy?

\_\_\_\_\_

**PA.N.1.1 Develop and apply the properties of integer exponents, including  $a^0 = 1$  (with  $a \neq 0$ ), to generate equivalent numerical and algebraic expressions.**

*Write the numerical or algebraic expression as an exponential number.*

**Example:**  $5 \times 5 \times 5 \times 5 = 5^4$

1.  $3 \times 3 \times 3 \times 3 \times 3 =$  \_\_\_\_\_

2.  $m \times m \times m \times m \times m \times m =$  \_\_\_\_\_

*Write each exponential number as a numerical or algebraic expression.*

**Example:**  $d^3 = d \times d \times d$

3.  $6^4 =$  \_\_\_\_\_

4.  $b^6 =$  \_\_\_\_\_

*Identify the base and exponent of the exponential number.*

**Example:**  $3^4$ ; base = **3** exponent = **4**

5.  $2^3$ ; base = \_\_\_\_\_ exponent = \_\_\_\_\_

6.  $5^7$ ; base = \_\_\_\_\_ exponent = \_\_\_\_\_

*Calculate the value of the exponential number.*

**Example:**  $2^4 = 16$

7.  $3^4 =$  \_\_\_\_\_

8.  $5^3 =$  \_\_\_\_\_

**Independent Practice (PA.N.1.1)**

Name \_\_\_\_\_

*Write the multiplication or division problem to one power and solve.***Example:**  $3^5 \cdot 3^2 = 3^7 = \underline{2,187}$ 

9.  $2^5 \cdot 2^4 \cdot 2^2 =$  \_\_\_\_\_

10.  $3^3 \cdot 3^4 \cdot 3^2 =$  \_\_\_\_\_

11.  $4^2 \cdot 2^4 \cdot 4 \cdot 2^3 \cdot 4^3 \cdot 2^2 =$  \_\_\_\_\_

12.  $m^5 \cdot 3^2 \cdot m \cdot 3^4 \cdot m^3 \cdot 3^3 =$  \_\_\_\_\_

13.  $\frac{4^6}{4^2} =$  \_\_\_\_\_

14.  $\frac{6^7}{6^5} =$  \_\_\_\_\_

15.  $\frac{3^6 \cdot 4^6}{4^4 \cdot 3^3} =$  \_\_\_\_\_

16.  $\frac{4^5 \cdot 2^7}{2^4 \cdot 4^3} =$  \_\_\_\_\_

17.  $\frac{3^4 \cdot 2^3 \cdot 3^7 \cdot 2^2}{2^2 \cdot 3^2 \cdot 2^5 \cdot 3^6} =$  \_\_\_\_\_

18.  $\frac{4^5 \cdot 4^2}{4^4 \cdot 4^3} =$  \_\_\_\_\_

19.  $(4^2 n^3)^3 =$  \_\_\_\_\_

*Solve.*

20. Nicki shows a magic trick to three of her friends. Each of these friends show it to three more friends. If this pattern is repeated two more times, how many people now know the trick?

\_\_\_\_\_

Complete the table below.

|    | Exponential Form | Base | Exponent | Numerical/Algebraic Expression | Value |
|----|------------------|------|----------|--------------------------------|-------|
| 1. | $6^3$            |      |          |                                |       |
| 2. |                  | 3    | 4        |                                |       |

Write the multiplication or division problem to one power and solve.

3.  $\frac{3^2 \cdot 4^6 \cdot 3^5 \cdot 4^3}{4^2 \cdot 3^3 \cdot 4^4 \cdot 3^2} = \underline{\hspace{2cm}}$       4.  $\frac{3^5 \cdot 2^2 \cdot 3^7 \cdot 2^3}{2^4 \cdot 3^4 \cdot 2^3 \cdot 3^4} = \underline{\hspace{2cm}}$       5.  $(4^2)^3 = \underline{\hspace{2cm}}$

6.  $5(4) = \underline{\hspace{2cm}}$       7.  $-3(5) = \underline{\hspace{2cm}}$       8.  $15 \div (-3) = \underline{\hspace{2cm}}$

9.  $-27 \div 9 = \underline{\hspace{2cm}}$

10. Charley had \$100 on the first of the month. He made three deposits of \$135, \$340, and \$175. He had five debits in the amounts of \$310, \$135, \$115, \$130, and \$50. What was his new balance at the end of the month?

\_\_\_\_\_

**8<sup>TH</sup> GRADE**

**COMPREHENSIVE  
ASSESSMENT**

1. What is the value of the expression below?

$$\frac{3^2}{3^5}$$

- A  $\frac{1}{27}$
- B -27
- C  $\frac{1}{-27}$
- D 27

2. If the value of  $m^2 \cdot m^3$  is 32, what is the value of  $m$ ?

- A 4
- B -4
- C 2
- D -2

3. Sound travels at 340.29 meters per second (m/s). Which is **closest** in value to the speed of sound?

- A  $3.0 \times 10^2$  m/s
- B  $3.0 \times 10^4$  m/s
- C  $3.4 \times 10^2$  m/s
- D  $3.4 \times 10^4$  m/s

4. If the United States' national debt is  $2.4 \times 10^{14}$  and the population was 400,000,000 people, what would each person's fair share be? Express the answer in correct scientific notation.

- A  $0.6 \times 10^6$
- B  $6 \times 10^5$
- C  $0.6 \times 10^5$
- D  $6 \times 10^6$



5. If the average worker around the world earns \$35,000 per year and there are approximately  $5.5 \times 10^9$  people working, about how much money would be made annually worldwide?

- A  $2 \times 10^{14}$
- B  $2.9 \times 10^{13}$
- C  $1 \times 10^{14}$
- D  $1.9 \times 10^{13}$

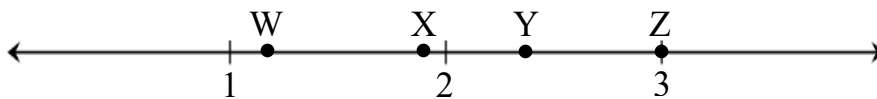
6. Identify the irrational number.

- A  $\frac{12}{4}$
- B  $\frac{\sqrt{12}}{4}$
- C  $\frac{36}{6}$
- D  $\frac{\sqrt{36}}{6}$

7. Identify the rational number.

- A  $\sqrt{5} \cdot \sqrt{5}$
- B  $\sqrt{5} \cdot \sqrt{3}$
- C  $\sqrt{5}$
- D  $\sqrt{3}$

8. Which point represents the value of  $\sqrt{6}$ ?



- A Z
- B W
- C X
- D Y

9. Identify the list that places the following numbers in the correct order from greatest to least.

$$\sqrt{11}, 2^2, 2.8, 5$$

- A  $\sqrt{11}, 5, 2.8, 2^2$   
B  $2.8, \sqrt{11}, 2^2, 5$   
C  $2^2, 2.8, 5, \sqrt{11}$   
D  $5, 2^2, \sqrt{11}, 2.8$

10. Which of the following tables represents a linear function?

A

| $x$ | $y$ |
|-----|-----|
| 0   | 5   |
| 2   | 8   |
| 4   | 12  |
| 6   | 10  |

B

| $x$ | $y$ |
|-----|-----|
| -2  | 4   |
| -1  | 8   |
| 0   | 6   |
| 1   | 2   |

C

| $x$ | $y$ |
|-----|-----|
| 0   | 2   |
| 3   | 5   |
| 5   | 8   |
| 8   | 10  |

D

| $x$ | $y$ |
|-----|-----|
| 0   | 1   |
| 2   | 3   |
| 6   | 7   |
| 9   | 10  |

50. Jackson has a sack of multicolored jelly beans. Each jellybean is blue, red, or orange.

Jackson takes a jellybean from the sack without looking, record the color, and then returns the jellybean to the sack. He repeats this process until he has recorded the color of jellybeans 20 times. His results are shown.

- Blue: 5
- Red: 7
- Orange: 8

Jackson will take another jellybean from the sack without looking. Based on Jackson's data, what is the experimental probability he will take a blue jellybean from the sack?

- A  $\frac{1}{3}$
- B  $\frac{1}{5}$
- C  $\frac{1}{4}$
- D  $\frac{1}{15}$

### A

**acute angle:** an angle with a measure greater than  $0^\circ$  but less than  $90^\circ$

**addends:** are the digits in an addition problem that are being added

**absolute value:** the absolute value of a real number is its (non-negative) distance from 0 on a number line; this is also known as magnitude

**addition:** to join two or more numbers or quantities to get one number called a sum or total

**additive comparison problems:** the underlying question is what amount would be added to one quantity to result in the other

**algebraic expression:** a mathematical phrase combining numbers and/or variables; an expression does not contain equality or inequality signs but may include other operators and grouping symbols; both sides of an equation are expressions

**algebraic equation:** includes mathematical signs, symbols, and numbers connected with an equal sign (=); an algebraic equation contains an equal sign

**algorithm:** a step-by-step process for solving a problem

**angle:** a figure formed by two rays with a common endpoint called the vertex and it is measured in degrees ( $^\circ$ )

**angle ruler:** similar to a protractor and is used to measure and draw angles

**analog clock:** a clock with hour, minute, and, sometimes, second hands

**approximation:** the estimate a number, amount or total, often rounding it off to the nearest 10 or 100

**area:** the space occupied by a flat shape (closed two-dimensional shape) or the surface of an object; the number of unit squares that cover the surface of a closed figure; measured in square units such as square centimeters, square feet, square inches, etc.

**area models:** a model using area to show multiplication or division

**area of a circle:** the area of the interior of the circle, which can be found with  $A = \pi r^2$  where  $r$  is the radius and  $\pi$  the irrational number “pi”

**area of a parallelogram:** the area of the interior of the parallelogram; is measured in square units; can be found by using the formula  $A = bh$

**area of similar triangles:** if two similar triangles have sides in the ratio  $x:y$ , then their areas are in the ratio  $x^2:y^2$

**area of a square or rectangle:** the area of the interior of the square or rectangle; is measured in square units; can be found by using the formula  $A = l \times w$  or  $A = lw$ ; area of a square can also be found using the formula  $A = s^2$

**area of a trapezoid:** the sum of its bases multiplied by the height of the trapezoid then divided by 2; the area is measured in square units and can be found using the formula  $A = \frac{1}{2}(b_1 + b_2)h$

## OAS Mathematics Glossary

**area of triangles:** amount of surface a triangle covers and measured in square units; can be found using the formula  $A = \frac{1}{2}bh$

**arrays:** an orderly arrangement of objects arranged in rows or columns

**ascending:** increasing in size

**ascending order:** numbers arranged from smallest to largest

**associative property of addition:** states that the sum remains the same regardless of how they are grouped,  $(a + b) + c = a + (b + c)$

**associative property of multiplication:** states that the product remains the same regardless of how they are grouped,  $(a \times b) \times c = a \times (b \times c)$

**attributes:** characteristics

**average:** a number expressing the central or typical value in a set of data, in particular- the mode, median, or most commonly the mean, which is found by dividing the sum of the values in the set by the number of values in the set

**axis:** a real or imaginary reference line

### B

**bar graph:** a graph that compares data from several situations using vertical or horizontal bars

**bar notation:** a horizontal bar over decimals to indicate that they repeat

**base:** the number or variable representing the factor being multiplied

**base area:** the area of the base denoted with  $B$

**base 10 blocks:** blocks which show base-10 number values

**base of a figure:** a face on which the 3D figure sits

**benchmark:** something by which other things can be measured or compared

**benchmark fractions:** fractions that are easy to visualize or represent, such as,  $\frac{1}{4}$ ,  $\frac{1}{3}$ ,  $\frac{1}{2}$ ,  $\frac{2}{3}$ , and  $\frac{3}{4}$

**biased:** sample in which individuals, items, or data were not equally likely to have been chosen

**box and whisker plot:** a diagram or graph using a number line to show the distribution of a set of data which displays the median, upper and lower quartiles, and the maximum and minimum values of the data

### C

**calculate:** to work something out, a mathematical operation

**calculator:** electronic device used for making mathematical calculations

**capacity:** the maximum amount or number that can be contained or accommodated

**cent:** equals one hundredth of a dollar (100 cents equal one dollar)

**centimeter:** a length of measurement that is equal to 1/100 (0.01) of a meter; it is part of the metric system of measurement, which is used around the world

## OAS Mathematics Glossary

**central tendency:** typical value for the probability distribution, the most common measures of central tendency are mean (average), median (middle data point), and mode (data point that occurs most often)

**change:** the money that you get back when you've paid for something with more money than it actually costs

**circle:** the set of all points that are equidistant from a given point; a 2-dimensional shape made by drawing a curve that is always the same distance from a center

**circumference of a circle:** the length of the circle if cut and opened up to make a straight line segment, which can be found with  $C = 2\pi r$  where  $r$  is the radius and  $\pi$  is the irrational number "pi" (approximately 3.14 or  $\frac{22}{7}$ ) or  $C = \pi d$  where  $d$  is the diameter

**classify:** arrange in categories by characteristics

**cm<sup>2</sup> (squared):** a cm raised to the second power which is indicated by a small 2 to its upper-right; read as cm squared; a square with dimensions of 1cm × 1cm

**cm<sup>3</sup> (cubed):** a cm raised to the third power which is indicated by a small 3 to its upper-right; read as centimeter cubed; a cube with dimensions of 1cm × 1cm × 1cm

**coefficient:** number the variable is multiplied by

**collect:** bring or gather together

**common factor:** a factor that is divisible in the numerator and denominator greater than 1

**commutative property of addition:** numbers may be added together in any order;  $a + b = b + a$

**commutative property of multiplication:** numbers may be multiplied together in any order;  $a \times b = b \times a$

**compare:** tells how two or more things are alike or different

**compatible numbers:** numbers close in value to the actual numbers in a problem but easier to estimate or calculate

**complementary angles:** two angles whose measures have a sum of 90 degrees

**composite figure:** a shape composed of a combination of other shapes; composite figures are often split into their component shapes to calculate area

**composite number:** a number greater than 1 that has more than two factors

**concrete model:** another way to show how to represent an equation using physical objects

**conclusion:** the end or finish of an event or process

**congruent:** the same shape and size

**congruent angles:** have the same angle in degrees

**consecutive positive numbers:** positive numbers that follow one another, without gaps, from least to greatest

**constant:** number that does not change

**contrast:** show how two or more items are different

### W

**weight:** how heavy an object is, such as ounce (oz), pound (lb), and ton (T)

**whole number:** positive numbers, including zero, without any decimal or fractional parts. (ex: 0, 1,2,3,4,5, ....)

**whole number exponents:** the numbers 0, 1, 2, 3...that indicate how many times the base is used as a factor, e.g., in  $4^3 = 4 \times 4 \times 4 = 64$ , the exponent 3, indicating that 4 is repeated as a factor three times

**wide division:** a strategy to use to solve division problems, instead of long division

**width:** breadth/distance across from side to side

**withdrawal:** money taken out of a bank or money removed from a saving account or a checking account

**word form:** a number written out in words to represent the value of the digits

**word problem:** a math problem presented as a scenario in text form with a variety of number sentences

### X

**x-axis:** the horizontal number line of a coordinate plane used to show horizontal distance

**x-coordinate:** the first number in an ordered pair, it shows the distance a point is along the horizontal axis

**x-intercept:** where the line crosses the  $x$ -axis,  $y = 0$ , when in standard form it is  $C/A$

### Y

**y-axis:** the vertical number line of a coordinate plane used to show vertical distance

**y-coordinate:** the second number in an ordered pair, it shows the distance a point is along the vertical axis

**y-intercept:** where the line crosses the  $y$ -axis,  $x = 0$ , when in standard form it is  $C/B$ , when in slope-intercept form it is  $b$

**yard:** 1 yard is equivalent to 3 feet or 36 inches

### Z

**zero:** the numeral 0, used as a place holder (nothing, none, nil, naught)



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