**Lesson Summary**

**EXPONENTIAL NOTATION FOR WHOLE NUMBER EXPONENTS:** Let $m$ be a nonzero whole number. For any number $a$, the expression $a^m$ is the product of $m$ factors of $a$, i.e.,

$$a^m = \underbrace{a \cdot a \cdot \cdots \cdot a}_{m \text{ times}}.$$

The number $a$ is called the *base,* and $m$ is called the *exponent* or *power* of $a$.

When $m$ is 1, "the product of one factor of $a$" just means $a$ (i.e., $a^1 = a$). Raising any nonzero number $a$ to the power of 0 is defined to be 1 (i.e., $a^0 = 1$ for all $a \neq 0$).

## Problem Set

1. Complete the table by filling in the blank cells. Use a calculator when needed.

| Exponential Form | Expanded Form | Standard Form |
|---|---|---|
| $3^5$ | | |
| | $4 \times 4 \times 4$ | |
| $(1.9)^2$ | | |
| $\left(\frac{1}{2}\right)^5$ | | |

2. Why do whole numbers raised to an exponent get greater, while fractions raised to an exponent get smaller?

3. The powers of 2 that are in the range 2 through 1,000 are 2, 4, 8, 16, 32, 64, 128, 256, and 512. Find all the powers of 3 that are in the range 3 through 1,000.

4. Find all the powers of 4 in the range 4 through 1,000.

5. Write an equivalent expression for $n \times a$ using only addition.

6. Write an equivalent expression for $w^b$ using only multiplication.
   a. Explain what $w$ is in this new expression.
   b. Explain what $b$ is in this new expression.

7. What is the advantage of using exponential notation?

8. What is the difference between $4x$ and $x^4$? Evaluate both of these expressions when $x = 2$.



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# Lesson 6: The Order of Operations

## Classwork

### Example 1: Expressions with Only Addition, Subtraction, Multiplication, and Division

What operations are evaluated first?

What operations are always evaluated last?

**Exercises 1–3**

1. $4 + 2 \times 7$

2. $36 \div 3 \times 4$

3. $20 - 5 \times 2$



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**Example 2: Expressions with Four Operations and Exponents**

$$4 + 9^2 \div 3 \times 2 - 2$$

What operation is evaluated first?

What operations are evaluated next?

What operations are always evaluated last?

What is the final answer?

**Exercises 4–5**

4. $90 - 5^2 \times 3$

5. $4^3 + 2 \times 8$



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**Example 3: Expressions with Parentheses**

Consider a family of 4 that goes to a soccer game. Tickets are $5.00 each. The mom also buys a soft drink for $2.00. How would you write this expression?

How much will this outing cost?

Consider a different scenario: The same family goes to the game as before, but each of the family members wants a drink. How would you write this expression?

Why would you add the 5 and 2 first?

How much will this outing cost?

How many groups are there?



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What does each group comprise?

**Exercises 6–7**

6. $2 + (9^2 - 4)$

7. $2 \cdot \big(13 + 5 - 14 \div (3 + 4)\big)$

**Example 4: Expressions with Parentheses and Exponents**

$$2 \times (3 + 4^2)$$

Which value will we evaluate first within the parentheses? Evaluate.

Evaluate the rest of the expression.



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What do you think will happen when the exponent in this expression is outside of the parentheses?

$$2 \times (3 + 4)^2$$

Will the answer be the same?

Which should we evaluate first? Evaluate.

What happens differently here than in our last example?

What should our next step be?

Evaluate to find the final answer.

What do you notice about the two answers?



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What was different between the two expressions?

What conclusions can you draw about evaluating expressions with parentheses and exponents?

**Exercises 8–9**

8. $7 + (12 - 3^2)$

9. $7 + (12 - 3)^2$



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**Lesson Summary**

**NUMERICAL EXPRESSION:** A *numerical expression* is a number, or it is any combination of sums, differences, products, or divisions of numbers that evaluates to a number.

Statements like "3 +" or "3 ÷ 0" are not numerical expressions because neither represents a point on the number line. Note: Raising numbers to whole number powers are considered numerical expressions as well since the operation is just an abbreviated form of multiplication, e.g., $2^3 = 2 \cdot 2 \cdot 2$.

**VALUE OF A NUMERICAL EXPRESSION:** The *value of a numerical expression* is the number found by evaluating the expression.

For example: $\frac{1}{3} \cdot (2 + 4) + 7$ is a numerical expression, and its value is 9.

## Problem Set

Evaluate each expression.

1. $3 \times 5 + 2 \times 8 + 2$

2. $(\$1.75 + 2 \times \$0.25 + 5 \times \$0.05) \times 24$

3. $(2 \times 6) + (8 \times 4) + 1$

4. $\big((8 \times 1.95) + (3 \times 2.95) + 10.95\big) \times 1.06$

5. $\big((12 \div 3)^2 - (18 \div 3^2)\big) \times (4 \div 2)$



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