

7.1 Order of Operations

Learning Objectives

- I can decide which operations should be given precedence when evaluating an expression.

Introduction

What if your teacher asked you to evaluate the expression $3 + 2 \times 6 \div (3 - 1)$? Which should you do first, the addition, subtraction, multiplication, or division? What should you do second, third, and fourth? Also, should the parentheses affect your decisions? After completing this Concept, you'll be able to answer these questions and correctly evaluate the expression to your teacher's delight!

Guided Learning

The Mystery of Math Verbs

Some math verbs are “stronger” than others and must be done first. This method is known as the **order of operations**.

A mnemonic (a saying that helps you remember something difficult) for the **order of operations** is PEMDAS - Please Excuse My Dear Aunt Sally.

The order of operations:

Whatever is found inside **PARENTHESES** must be done first. **EXPONENTS** are to be simplified next. **MULTIPLICATION** and **DIVISION** are equally important and must be performed moving left to right. **ADDITION** and **SUBTRACTION** are also equally important and must be performed moving left to right.

Example A

Use the order of operations to simplify $(7 - 2) \times 4 \div 2 - 3$.

Solution: First, we check for parentheses. Yes, there they are and must be done first.

$$(7 - 2) \times 4 \div 2 - 3 = (5) \times 4 \div 2 - 3$$

Next we look for exponents (little numbers written a little above the others). No, there are no exponents so we skip to the next math verb.

Multiplication and division are equally important and must be done from left to right.

$$5 \times 4 \div 2 - 3 = 20 \div 2 - 3$$

$$20 \div 2 - 3 = 10 - 3$$

Finally, addition and subtraction are equally important and must be done from left to right.

$$10 - 3 = 7$$

This is our answer.

Example B

Use the order of operations to simplify the following expressions.

a) $3 \times 5 - 4 \div 2$

b) $3 \times (5 - 4) \div 2$

c) $(3 \times 5) - (4 \div 2)$

Solutions:

a) There are no parentheses and no exponents. Go directly to multiplication and division from left to right:

$$3 \times 5 - 4 \div 2 = 15 - 4 \div 2 = 15 - 2$$

Now subtract: $15 - 2 = 13$

b) Parentheses must be done first: $3 \times (1) \div 2$

There are no exponents, so multiplication and division come next and are done left to right:

$$3 \times (1) \div 2 = 3 \div 2 = \frac{3}{2} = 1\frac{1}{2}$$

c) Parentheses must be done first: $(3 \times 5) - (4 \div 2) = 15 - 2$

There are no exponents, multiplication, division, or addition, so simplify:

$$15 - 2 = 13$$

Parentheses are used two ways. The first is to alter the order of operations in a given expression, such as example (b). The second way is to clarify an expression, making it easier to understand.

Some expressions contain no parentheses, while others contain several sets of parentheses. Some expressions even have parentheses inside parentheses! When faced with **nested parentheses**, start at the innermost parentheses and work outward.

Example C

A **variable** is a letter used to represent an unknown quantity. You can often solve problems with variables by substituting the value for the variable.

Use the order of operations to evaluate the following expression when $x = 2$.

$$(2x - 3) + x^2 - 3$$

Solution:

First, we will substitute in 2 for x .

$$(2(2) - 3) + (2)^2 - 3$$

Now we will use the order of operations to evaluate the expression, starting inside the parentheses and then with the exponent.

$$(2(2) - 3) + (2)^2 - 3 = (1) + 4 - 3 = 2$$

We finish evaluating with addition and subtraction.

Guided Practice

1. Use the order of operations to simplify

$$8 - [19 - (2 + 5) - 7].$$

2. Use the order of operations to evaluate the following expression when $x = 3$ and $y = 5$.

$$3 \cdot y^2 - 2(7 - x)$$



Check your answers with a partner.

Solutions:

1. Begin with the innermost parentheses:

$$8 - [19 - (2 + 5) - 7] = 8 - [19 - 7 - 7]$$

Simplify according to the order of operations:

$$8 - [19 - 7 - 7] = 8 - [5] = 3$$

2. First, we will substitute in 3 for x and 5 for y .

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

Now we will use the order of operations to evaluate the expression, doing parentheses and exponents first, then multiplication, and finally subtraction.

$$3 \cdot 5^2 - 2(7 - 3) = 3 \cdot 25 - 2(4) = 75 - 8 = 67.$$

Note that there was no division or addition, so we skipped those steps.

Review

Order of operations ~ PEMDAS, work all problems from left to right

- P - Parenthesis
- E - Exponents
- MD - Multiplication and/or Division
- AS - Addition and/or Subtraction

Order of operations

The order of operations is a set of rules that tells you the order in which to perform operations.

Nested parentheses

Nested parentheses are a set of parentheses inside another set of parentheses.

Variable

A variable is a letter used to identify an unknown quantity.

Additional Resources

[Order of Operations Video](#)