

Topics: Operations with Whole Numbers, Order of Operations

Materials List

- ✓ 6-sided die
- ✓ Sand timer (1 minute)
- ✓ Pens or pencils
- ✓ Scratch paper

This activity can be used to teach:

Common Core Math Standards:

- Addition, Subtraction, Multiplication, and Division of Whole numbers (Grade 4, Number and Operations in Base Ten, 4, 5, & 6)
- Order of Operations (Grade 5, Operations and Algebraic Thinking, 1)
- Problem Solving and Reasoning (Mathematical Practices Grades 4-7)

Algebraic H-O-R-S-E

A game of algebraic dexterity



Reinforce the correct order of mathematical operations by playing this fast-paced game of algebraic H-O-R-S-E. Figure out the leader's chosen mathematical expression of operations and numbers.

Playing the Game (for 2-4 players)

1. All players roll one die and the person with the highest value starts the game.
2. Each player draws 3 boxes on a piece of scratch paper.
3. Player 1 leads by rolling a die 3 times to obtain 3 values, which are written in the boxes in order. For example if 5, 4, and 2 are rolled:

5	4	2
---	---	---

4. Player 1 secretly creates a number sentence deciding on which operations out of the possible 4 to use (+, -, * or /), and whether or not to use parentheses. There are many possible combinations (see list on page 2). Player 1 then calculates the answer. If “(5+4) / 2” is selected the answer is 4½. Player 1 tells the other players the answer, but does not reveal the order of operation at this point in time!

5	4	2	=	4 ½
---	---	---	---	-----

5. Start the timer. The other players have 1 minute to use the information provided to create an arithmetically correct number sentence equating to the answer given by Player 1, in this case 4½.
6. When the time is up the number sentences are compared to player 1's. Players who did not identify the correct sequence of the operations before the allotted time are penalized with one letter from H-O-R-S-E. (Note: there may be more than 1 correct number sentence with the same answer – any arithmetically correct number sentence with a matching answer is acceptable).
7. Repeat steps 2 to 6 with each player taking turns being the “leader” while others try to follow.
8. If H-O-R-S-E is completely spelled out, then that player is eliminated. Continue play until one winner emerges.

The Math Behind the Activity

When an arithmetic expression has more than one operation, it is necessary to know the following rules to correctly evaluate the expression:

The order of operations in mathematical expressions follows agreed upon rules:

- 1) In case there are parentheses, do the operation(s) within the parenthesis first.
- 2) Exponents if they exist, are performed next from left to right
- 3) Multiply or divide (work from left to right)
- 4) Add or subtract (work from left to right)

The following *mnemonic* may be helpful in remembering the order of operations:

PEMDAS : *Please Excuse My Dear Aunt Sally* _ Parentheses Exponent Multiply Divide Add Subtract

The following examples show the paramount importance of the location of parentheses, if any, and the order of operations. The mathematical expressions using the same operations and the same numbers will produce quite different answers depending on the operations chosen and the order in which they are used.

Possible “order of operations” combinations between numbers 5, 4, and 2:

Options	1 st box	Operation	2 nd box	Operation	3 rd box	Operation	Answer
1	5	+	4	+	2	=	11
2	5	+	4	-	2	=	7
3	5	+	4	*	2	=	13
4	5	+	4	/	2	=	7
5	(5	+	4)	*	2	=	18
6	(5	+	4)	/	2	=	4½
7	5	-	4	+	2	=	1
8	5	-	4	-	2	=	-1
9	5	-	4	*	2	=	-3
10	5	-	4	/	2	=	3
11	(5	-	4)	*	2	=	2
12	(5	-	4)	/	2	=	½
13	5	*	4	+	2	=	22
14	5	*	4	-	2	=	18
15	5	*	4	*	2	=	40
16	5	*	4	/	2	=	10
17	5	*	(4	+	2)	=	30
18	5	*	(4	-	2)	=	10
19	5	/	4	+	2	=	3¼
20	5	/	4	-	2	=	¾
21	5	/	4	*	2	=	2½
22	5	/	4	/	2	=	5/8
23	5	/	(4	+	2)	=	5/6
24	5	/	(4	-	2)	=	2½
25	5	/	(4	*	2)	=	5/8
26	5	/	(4	/	2)	=	2½

By playing Algebraic Horse, students develop proficiency with the order of operations which will help as they learn to use variables, moving from number sentences to algebraic expressions.

Taking it Further

- The 3 numbers can be used in any order to create the number sentence.
- Players take turns and create Order of Operations puzzles and challenge others to find the solution.
For example, use the numbers 2, 3, and 8 to solve the following puzzle:

$$\underline{\quad} + \underline{\quad} * \underline{\quad} = 14 \quad (\text{solution: } 8 + 2 * 3)$$
- Increase complexity of the puzzles, by increasing the number of operations to 3 or 4.

Web Resources (Visit www.raft.net/raft-idea?isid=607 for more resources!)

- Order of Operations information - <http://www.mathforum.org/dr.math/faq/faq.order.operations.html>
- Order of Operations game - <http://www.homeschoolmath.net/operation-game.php>
- Basics of Algebra - <http://www.algebrahelp.com/lessons/equationbasics/>
- Teacher designed math courses from the New Jersey Center for Teaching & Learning – <https://njctl.org/courses/math>