

Worksheet 1

Order of Operations

A *mathematical sentence* is any sentence regarding mathematical objects (numbers, symbols, operations) that contains a subject, a verb, and an object. $3 \times 2 = 6$ is a sentence. “ 3×2 ” is the subject, “= (equals)” is the verb, and 6 is the direct object.

A *mathematical expression* is a noun phrase that involves numbers (or symbols that stand for numbers). “ 3×2 ” is an expression. It is a number described by the phrase “three times two”. “ $5x + 2$ ” is a mathematical expression because it stands for the number gotten by multiplying three and some number and then adding two.

Mathematical expressions are evaluated according the following rules. These rules are called *conventions*, which means that there could be different rules, but these are the ones that, over time, people have come to agree to use.

1. If there are parentheses, do what is inside them. To do what is inside parentheses, apply the rules listed here, including this one. After you have done what is inside parentheses, cross out that part of the expression and replace it with its result.
2. Perform every exponentiation in the order they occur as you read from left to right. Cross out that part of the expression and replace it with its result.
3. Perform every negation in the order they occur left to right. Cross out that part of the expression and replace it with its result.
4. Perform every multiplication or division in the order they occur as you read from left to right. Cross out that part of the expression and replace it with its result.
5. Perform every addition or subtraction in the order they occur as you read from left to right. Cross out that part of the expression and replace it with its result.

Practice

Evaluate each expression according to the rules listed above. Then check your answer with other students.

Example:

$$2 * (12 - 3) + 32 / 8$$

$$2 * \overset{9}{\cancel{(12 - 3)}} + 32 / 8 \quad \text{Do what is in parentheses first}$$

$$\overset{18}{\cancel{2 * (12 - 3)}} + 32 / 8 \quad \text{Do multiplication and division, reading from left to right.}$$

$$\overset{18}{\cancel{2 * (12 - 3)}} + \overset{4}{\cancel{32 / 8}} \quad \text{Do multiplication and division, reading from left to right}$$

$$\overset{18}{\cancel{2 * (12 - 3)}} + \overset{22}{\cancel{32 / 8}} \quad \text{Do addition and subtraction, reading from left to right.}$$

Part I

Evaluate each of the expressions given below. Notice that the exercises are given in pairs. Each expression on the right involves the same numbers and operations as the expression on its left, but the grouping is different from the conventional grouping.

- | | |
|-----------------------------------|---|
| 1. $16 - 9 + 2$ | 2. $16 - (9 + 2)$ |
| 3. $20 - 12 / 2$ | 4. $(20 - 12) / 2$ |
| 5. $3 * 8 - 7$ | 6. $3 * (8 - 7)$ |
| 7. $2 * 6 + 2 * 4$ | 8. $2 * (6 + 2) * 4$ |
| 9. $8 + 3 * 6 / 9$ | 10. $(8 + 3) * 6 / 9$ |
| 11. $6 + 2 * 8 - 2 * 3 / 4$ | 12. $(6 + 2) * (8 - 2) * (3 / 4)$ |
| 13. $2 * 12 + 2 * 7 + 2 * 8 + 10$ | 14. $2 * (12 + 2 * (7 + 2 * (8 + 10)))$ |
| 15. $-2^4 * 4 - 10 / 5$ | 16. $(-2)^4 * (4 - 10) / 5$ |

Part II

Put parentheses in the expressions given below so that the explicit groupings match the implicit groupings that are determined by the conventions for order of operations. Check your answers by putting them into a calculator. You will need to use a TI-82 (or higher).

Example: $11+4*2$ -----> $11+(4*2)$

Do $4*2$ first
No more parentheses needed

Example: $9-2*7/3+4$ -----> $9 - (2*7)/3+4$

Do $2*7$ first

-----> $9 - ((2*7)/3)+4$

Do $(2*7)/3$ second

-----> $(9-((2*7)/3))+4$

Do $9 - ((2*7)/3)$ third

No more parentheses needed

Without ParenthesesWith Parentheses

(Draw them in yourself)

1. $1 + 2 + 3 + 4$

$1 + 2 + 3 + 4$

2. $4 - 2 + 5 / 3$

$4 - 2 + 5 / 3$

3. $3 * 18 - 6 / 3 + 10$

$3 * 18 - 6 / 3 + 10$

4. $5 + 4 * 2 / 8 - 6$

$5 + 4 * 2 / 8 - 6$

5. $2 / 3 + 7 - 5 * 8 / 4$

$2 / 3 + 7 - 5 * 8 / 4$

6. $8 - 4 + 7 - 6 + 2$

$8 - 4 + 7 - 6 + 2$

7. $7 * 6 - 5 / 4 + 3 / 2$

$7 * 6 - 5 / 4 + 3 / 2$

Name _____

Part III

Place parentheses within each expression so that, when evaluated, it gives the indicated result. Check your answer by evaluating the expression after you have inserted parentheses.

Example: $2 * 3 + 4 * 5 = 50$ (put parentheses where necessary to get 50)

$(2 * 3 + 4) * 5 = 50$ (your answer)

1. $10 - 2 + 4 / 2 = 6$
2. $10 - 2 + 4 / 2 = 7$
3. $9 + 6 / 3 - 1 = 12$
4. $9 + 6 / 3 - 1 = 4$
5. $10 / 2 - 1 * 3 + 4 = 16$
6. $10 / 2 - 1 * 3 + 4 = 28$
7. $8 / 2 + 6 - 4 / 2 = -1$
8. $8 / 2 + 6 - 4 / 2 = 1$
9. $8 * 6 - 3 + 1 * 4 = 41$
10. $8 * 6 - 3 + 1 * 4 = 64$
11. $-2^4 - 2 + 1 = 13$
12. $-2^4 - 2 + 1 = -3$