

ORDER OF OPERATIONS

For problems like $3 + 4 \cdot 2$, some students think the answer is 14 and some think the answer is 11. There needs to be a method to simplify an expression which involves more than one operation so that everyone can agree on the answer.

There is a set of rules to follow that provides a consistent way for everyone to evaluate expressions. These rules, called the **order of operations**, must be followed in order to arrive at a correct solution. As the name says, these rules tell the order in which the mathematical operations are done.

For additional information, see Year 1, Chapter 3, problems PR-38 through 43 and PR-45 on pages 78-81 or Year 2, Chapter 4, problems GC-2, 3, 5, and 6 on pages 129-31.

The first step is to organize the expression into parts called **TERMS**. Terms are separated by addition (+) or subtraction (-) symbols unless the addition (+) or subtraction (-) happens inside parentheses.

Examples of numerical terms are: 4, $3(6)$, $6(9 - 4)$, $2 \cdot 3^2$, $3(5 + 2^3)$, and $\frac{16 - 4}{6}$.

For the problem above, $3 + 4 \cdot 2$, the terms are circled at right.

$$\textcircled{3} + \textcircled{4 \cdot 2}$$

Each term is simplified separately, giving $3 + 8$. Then the terms are added: $3 + 8 = 11$. Thus, $3 + 4 \cdot 2 = 11$.

Example 1

- Circle the terms.
- Simplify each term until it is one number.
 - The operations inside the parentheses are done first.
 - Exponents are a form of multiplication.
 - Multiplication and division are done from left to right.
- Finally, add or subtract the terms going from left to right.

$$2 \cdot 3^2 + 3(6 - 3) + 10$$

$$\textcircled{2 \cdot 3^2} + \textcircled{3(6 - 3)} + 10$$

$$\textcircled{2 \cdot 3^2} + \textcircled{3(3)} + 10$$

$$\textcircled{2 \cdot 9} + \textcircled{3(3)} + 10$$

$$\textcircled{18} + \textcircled{9} + 10$$

$$27 + 10$$

$$37$$

Example 2

- Circle the terms.
- Simplify inside the parentheses.
- Simplify the exponents.
- Multiply and divide from left to right.
- Finally, add and subtract from left to right

$$\begin{aligned} & 5 - 8 + 2^2 + 6(5 + 4) - 5^2 \\ \textcircled{5} - \textcircled{8 + 2^2} + \textcircled{6(5 + 4)} - \textcircled{5^2} \\ \textcircled{5} - \textcircled{8 + 2^2} + \textcircled{6(9)} - \textcircled{5^2} \\ \textcircled{5} - \textcircled{8 + 4} + \textcircled{6(9)} - 25 \\ \textcircled{5} - \textcircled{2} + \textcircled{54} - \textcircled{25} \\ & 3 + 54 - 25 \\ & 57 - 25 \\ & 32 \end{aligned}$$

Example 3

- Circle the terms.
- Multiply and divide left to right, including exponents.
(Note: calculation details are shown for the second term.)
- Add or subtract from left to right.

$$\begin{aligned} & 20 + \frac{5+7}{3} - 4^2 + 12 \div 4 \\ \textcircled{20} + \textcircled{\frac{5+7}{3}} - \textcircled{4^2} + \textcircled{12 \div 4} \\ \textcircled{20} + \textcircled{\frac{5+7}{3} = \frac{12}{3} = 4} - \textcircled{16} + \textcircled{3} \\ & 24 - 16 + 3 \\ & 8 + 3 \\ & 11 \end{aligned}$$

Problems

Circle the terms, then simplify the expression.

- $5 \cdot 3 + 4$
- $10 \div 5 + 3$
- $2(9 - 4) \cdot 7$
- $6(7 + 3) + 8 \div 2$
- $15 \div 3 + 7(8 + 1) - 6$
- $\frac{9}{3} + 5 \cdot 3^2 - 2(14 - 5)$
- $\frac{20}{6+4} + 7 \cdot 2 \div 2$
- $\frac{5+30}{7} + 6^2 - 18 \div 9$
- $2^3 + 8 - 16 \div 8 \cdot 2$
- $25 - 5^2 + 9 - 3^2$
- $5(17 - 7) + 4 \cdot 3 - 8$
- $(5 - 2)^2 + (9 + 1)^2$
- $4^2 + 9(2) \div 6 + (6 - 1)^2$
- $\frac{18}{3^2} + \frac{5 \cdot 3}{5}$
- $3(7 - 2)^2 + 8 \div 4 - 6 \cdot 5$
- $14 + 2 + 6 \cdot 8 \div 2 - (9 - 3)^2$
- $\frac{27}{3} + 18 - 9 \div 3 - (3 + 4)^2$
- $26 \cdot 2 \div 4 - (6 + 4)^2 + 3(5 - 2)^3$
- $\left(\frac{42+3}{5}\right)^2 + 3^2 - (5 \cdot 2)^2$