

## 1-2-3-4 Puzzle

You can change the meaning of an arithmetic **expression** by inserting or removing parentheses. Another way to change the meaning of an expression is to rearrange its terms.

In this activity, you will use the digits 1, 2, 3, and 4, in any order, to create arithmetic expressions with different numeric values.

For this problem, a “1-2-3-4 expression” is any expression that uses each of these digits *exactly once*, according to these rules.



- You may use any of the four basic arithmetic operations—addition, subtraction, multiplication, and division. For example,  $2 + 1 \cdot 3 - 4$  is a 1-2-3-4 expression for the number 1.
- You may use **exponents**. For example,  $2^3 - 4 - 1$  is a 1-2-3-4 expression for the number 3.
- You may juxtapose two or more digits—that is, put them next to each other—to form a number such as 12. For instance,  $43 - 12$  is a 1-2-3-4 expression for the number 31.
- You may use **square roots**. For example,  $\sqrt{4 \cdot 2 + 1}$  is equal to 3, so  $3 + \sqrt{4 \cdot 2 + 1}$  is a 1-2-3-4 expression for the number 6.
- You may use **factorials**. For example,  $4!$  means  $4 \cdot 3 \cdot 2 \cdot 1$ , so  $3 + 4! + 1 - 2$  is a 1-2-3-4 expression for the number 26.
- You may use parentheses and brackets. For example,  $1 + 4 \cdot 3^2$  is a 1-2-3-4 expression for the number 37. You can add parentheses and brackets to get  $[(1 + 4) \cdot 3]^2$ , which is a 1-2-3-4 expression for the number 225.

Your task is to create a 1-2-3-4 expression for each of the numbers from 1 through 25. *Remember:* Every expression must use each of the digits 1, 2, 3, and 4 *exactly once*.