

Expressions and Patterns: math lesson, Grade 5 – download the PDF

Numbers follow rules, and so do the expressions we write with them. In this chapter you will learn the rules that tell everyone the same answer for a calculation, how to write calculations from words, and how to build two number patterns and see how they are connected on a graph.

1. The order of operations

A **numerical expression** is a group of numbers and operation signs, like $18 - 4 \times 3 + 2$. It has no equals sign. If every person solved it in a different order, we would get different answers, so mathematicians agreed on one order.

D Order of operations (PEMDAS)

1. Work inside **P**arentheses first. 2. Then **E**xponents. 3. Then **M**ultiplication and **D**ivision, from left to right. 4. Last, **A**ddition and **S**ubtraction, from left to right.

① Parentheses () [] { } : inside first

② Exponents (powers)

③ Multiply and divide : left to right

④ Add and subtract : left to right

E**Example 1 : multiplication before subtraction and addition**

Evaluate $18 - 4 \times 3 + 2$.

Multiply first: $4 \times 3 = 12$. The expression becomes $18 - 12 + 2$.

Now go from left to right: $18 - 12 = 6$, then $6 + 2 = 8$.

So $18 - 4 \times 3 + 2 = 8$.

**Careful with “left to right”**

Multiplication does not always come before division. They have the same rank, so you take whichever comes first from the left. For $36 \div 6 \times 2$ you get $6 \times 2 = 12$, not $36 \div 12 = 3$. Addition and subtraction work the same way.

2. Parentheses, brackets and braces

Parentheses (), brackets [] and braces { } are all grouping symbols. They tell you which part of the expression to calculate first. When one group sits inside another, start with the **innermost** group and work outward.

M**Method : expressions with nested groups**

1. Find the innermost group of symbols.
2. Calculate it using the order of operations.
3. Rewrite the whole expression with that result.
4. Repeat until no symbols are left, then finish the calculation.

E Example 2 : three levels of grouping

Evaluate $\{40 - [3 \times (2 + 4)]\} \div 2$.

Innermost: $2 + 4 = 6$, so we get $\{40 - [3 \times 6]\} \div 2$.

Next: $3 \times 6 = 18$, so we get $\{40 - 18\} \div 2$.

Then $40 - 18 = 22$ and $22 \div 2 = 11$.

The value is **11**.

Parentheses can completely change an answer. Compare $14 + 6 \times 2 = 26$ with $(14 + 6) \times 2 = 40$. The numbers and signs are the same, but the grouping is different.

3. Writing numerical expressions

Words such as *sum*, *difference*, *product* and *quotient* tell you the operation. The words *then* and *twice* often tell you when to use parentheses.

In words	Expression	Value
the sum of 5 and 9	$5 + 9$	14
the difference of 20 and 8	$20 - 8$	12
the product of 6 and 7	6×7	42
the quotient of 45 and 9	$45 \div 9$	5

E**Example 3 : from words to symbols**

“Add 8 and 7, then multiply by 3” becomes $(8 + 7) \times 3 = 15 \times 3 = 45$. The parentheses show that the addition happens first.

“Twice the sum of 9 and 4” becomes $2 \times (9 + 4) = 2 \times 13 = 26$.

Word problem: Maya buys 3 notebooks at 4 dollars each and one pen for 2 dollars. She pays $3 \times 4 + 2 = 14$ dollars. No parentheses are needed because multiplication already comes first.

4. Interpreting expressions without evaluating

You can often understand an expression without finding its value. Look at its structure.

- $3 \times (25 + 17)$ is **3 times as large as** the sum $25 + 17$.
- $(62 - 18) \div 2$ is **half of** the difference $62 - 18$.
- 0.5×84 is smaller than 84, because multiplying by a number less than 1 makes a number smaller.

**Zyro's tip**

On my planet we say: read the expression like a sentence before you touch a calculator. “Four times the difference of 82 and 37” already tells you the answer is four times a smaller number.

5. Generating numerical patterns from rules

A **numerical pattern** is a list of numbers, called **terms**, that follows a rule. A rule such as “start at 0 and add 3” gives the terms **0, 3, 6, 9, 12, 15...** Each term is made from the one before it.

D Rule of a pattern

A rule has a **starting number** and an **operation** that is repeated, such as “add 3” or “add 6”. Using the same rule from the same start always gives the same pattern.

6. Comparing two patterns

Start two patterns at 0. Pattern A adds 3 each time, and pattern B adds 6 each time.

Term number	1st	2nd	3rd	4th	5th
Pattern A (add 3)	0	3	6	9	12
Pattern B (add 6)	0	6	12	18	24

Look at each column. Every term of B is **twice** the matching term of A. This is not an accident: adding 6 each step is the same as adding 2×3 , so B always grows twice as fast as A.

E Example 4 : describing the link

Pattern C: start at 1, add 3 gives **1, 4, 7, 10**. Pattern D: start at 2, add 6 gives **2, 8, 14, 20**. Check: $2 \times 1 = 2$, $2 \times 4 = 8$, $2 \times 7 = 14$, $2 \times 10 = 20$. Every term of D is twice the matching term of C.

7. Ordered pairs from patterns

An **ordered pair** is two numbers written in a fixed order inside parentheses, like **(3, 6)**. When you match each term of pattern A with the corresponding term of pattern B, you get ordered pairs: **(0, 0), (3, 6), (6, 12), (9, 18), (12, 24)**.

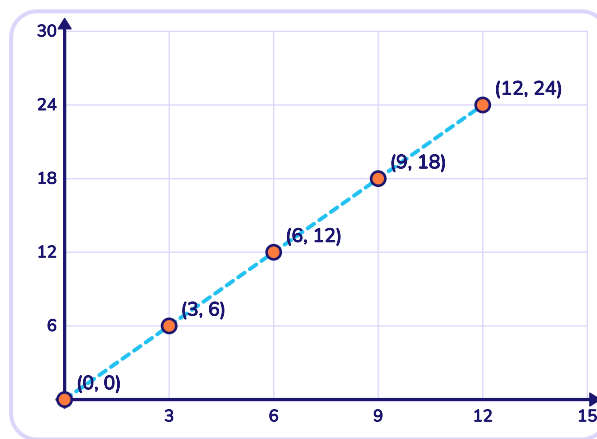


Order matters

$(3, 6)$ and $(6, 3)$ are two different points. The first number is always from the first pattern, the second from the other.

8. Graphing patterns on a coordinate plane

A **coordinate plane** has a horizontal axis (the x-axis) and a vertical axis (the y-axis) that meet at the origin $(0, 0)$. To plot $(3, 6)$, start at the origin, move **3 units right**, then **6 units up**, and draw a point.



The points from our two patterns line up along a straight line that passes through the origin. This shows the relationship: each y-value is 2 times its x-value.



What a graph shows

If one pattern always has terms that are a fixed number of times as large as the other, the ordered pairs form points on a straight line starting at the origin.

Key takeaways

- Order of operations: parentheses, exponents, multiplication and division (left to right), addition and subtraction (left to right).
- With nested groups, start with the innermost one.
- Words like “then”, “sum” and “twice” help you place parentheses when writing an expression.
- You can describe an expression, such as “3 times the sum of 25 and 17”, without evaluating it.
- A pattern comes from a starting number and a rule.
- Corresponding terms of two patterns make ordered pairs (x, y) , which you graph by moving right, then up.



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