

Multi-Digit Multiplication: math lesson, Grade 5 – download the PDF

How many seats are in a stadium with 42 sections of 135 seats? How many wing beats does a hummingbird make in a day? To answer questions like these you need to multiply big numbers quickly and correctly. In this chapter you will build the skills one step at a time, from powers of 10 all the way to the standard algorithm for multiplying a 3-digit number by a 2-digit number.

1. Powers of 10 and exponents

When you multiply 10 by itself, the result grows fast: 10, 100, 1,000, 10,000... Mathematicians use a short way to write this called an **exponent**.

D Definition: power of 10

An exponent tells how many times the base 10 is used as a factor.

$10^3 = 10 \times 10 \times 10 = 1,000$. The small raised number is the **exponent**, and 10 is the **base**.

Power	Factors	Value	Zeros
10^1	10	10	1
10^2	10×10	100	2
10^3	$10 \times 10 \times 10$	1,000	3
10^4	$10 \times 10 \times 10 \times 10$	10,000	4
10^5	$10 \times 10 \times 10 \times 10 \times 10$	100,000	5

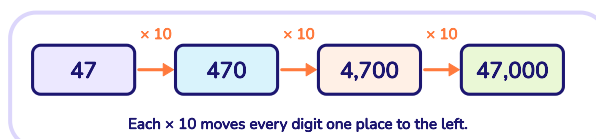


Common mistake

10^3 does **not** mean $10 \times 3 = 30$. It means three factors of 10, so $10^3 = 1,000$. The exponent counts the zeros.

2. Multiplying by multiples of 10

Our number system is based on ten. Every time you multiply by 10, each digit moves one place to the left and a zero fills the empty ones place.



Property

Multiplying by 10^n shifts each digit n places to the left. So $47 \times 10^2 = 4,700$ and $47 \times 10^3 = 47,000$.

M**Method: multiples of 10 (such as 30, 600 or 5,000)**

1. Cover the zeros at the end of each factor.
2. Multiply the remaining digits using a basic fact.
3. Write all the covered zeros after the result.

E**Example 1**

Compute 60×500 . The basic fact is $6 \times 5 = 30$. There are $1 + 2 = 3$ zeros to add, so $60 \times 500 = 30,000$.

Careful: **30** already ends in a zero, so the answer has **four** zeros in total, and 30,000 is correct.

3. Estimating products

An **estimate** is a quick answer that is close to the exact one. To estimate a product, round each factor to its greatest place, then multiply the rounded numbers using what you know about multiples of 10.

E**Example 2**

Estimate 58×41 . Round 58 to 60 and 41 to 40. Then $60 \times 40 = 2,400$. The exact product should be close to 2,400.



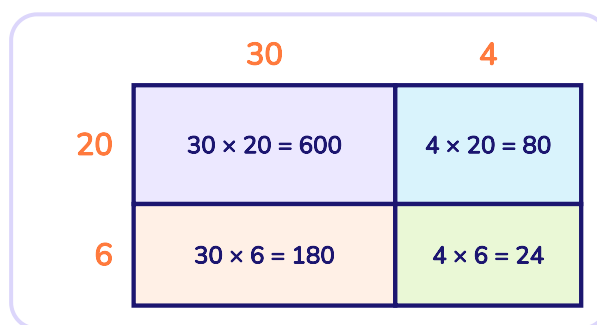
Zyro's tip

On my home planet we always estimate first. If the exact answer is far from the estimate, I know I made a slip somewhere, so I go back and check my steps!

4. The area model for multiplication

The area of a rectangle is its length times its width. You can split a big rectangle into smaller rectangles by breaking each factor into place-value parts. This picture is called an **area model**.

To compute 34×26 , write $34 = 30 + 4$ and $26 = 20 + 6$. Draw a rectangle with four parts. The figure is not drawn to scale.



Add the four parts: $600 + 180 + 80 + 24 = 884$. So $34 \times 26 = 884$.

5. Partial products



Definition: partial product

A **partial product** is the product of one part of a factor and the other factor. Adding all the partial products gives the full product.

Instead of drawing a rectangle, you can multiply the whole number by the ones digit, then by the tens digit, and add the results. For 23×14 :

- $23 \times 4 = 92$ (ones)
- $23 \times 10 = 230$ (tens)
- $92 + 230 = 322$

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Example 3

Compute 52×37 with partial products. $52 \times 7 = 364$ and $52 \times 30 = 1,560$. Then $364 + 1,560 = 1,924$.

6. The standard algorithm: 2-digit by 2-digit

The **standard algorithm** is a compact way to write partial products in a column. Here is 47×38 .

$$\begin{array}{r}
 47 \\
 \times 38 \\
 \hline
 376 \quad \leftarrow 47 \times 8 \text{ (ones)} \\
 1410 \quad \leftarrow 47 \times 30 \text{ (tens)} \\
 \hline
 1786 \quad \leftarrow \text{total}
 \end{array}$$

M

Method: standard algorithm

1. Multiply the top number by the **ones** digit of the bottom number ($47 \times 8 = 376$). Regroup when a product is 10 or more.
2. Put a **0** in the ones place of the next row. This is the placeholder: you are now multiplying by tens.
3. Multiply the top number by the **tens** digit ($47 \times 3 = 141$, which is 1,410 with the placeholder).
4. Add the rows: $376 + 1,410 = 1,786$.



Do not forget the placeholder zero

If you skip the zero in the second row, you multiply by 3 instead of by 30, and your answer will be about ten times too small. Your estimate ($50 \times 40 = 2,000$) catches this error right away.

7. The standard algorithm: 3-digit by 2-digit

The steps are exactly the same. You just have one more digit in the top number, so you regroup more often.



Example 4

Compute 256×43 .

- Estimate: $300 \times 40 = 12,000$.
- Ones row: $256 \times 3 = 768$.
- Tens row: $256 \times 40 = 10,240$.
- Add: $768 + 10,240 = 11,008$, which is close to the estimate.

When a digit is 0, as in 805×47 , the product 0×47 still needs a place: write the zero in that column and carry on carefully.

8. Multiplication word problems

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Method: solving a word problem

1. Read the problem and find the question.
2. Decide whether you have equal groups. If yes, multiply.
3. Estimate the answer.
4. Calculate with the algorithm and compare to your estimate.
5. Write a full sentence with the unit.

For example, a farm packs 24 eggs in each carton. In 38 cartons there are $24 \times 38 = 912$ eggs.
Estimate: $20 \times 40 = 800$, so 912 makes sense.

Key takeaways

- 10^n means n factors of 10, so it has n zeros: $10^4 = 10,000$.
- Multiplying by 10, 100 or 1,000 shifts digits left by 1, 2 or 3 places.
- To multiply multiples of 10, use a basic fact and add all the zeros.
- Estimate by rounding both factors, and compare your exact answer to the estimate.
- The area model and partial products split a hard problem into easy ones.
- In the standard algorithm, write a placeholder zero in the second row, then add the rows.
- In word problems, write a final sentence with the unit.



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