Multiplying Multi-Digit Whole Numbers
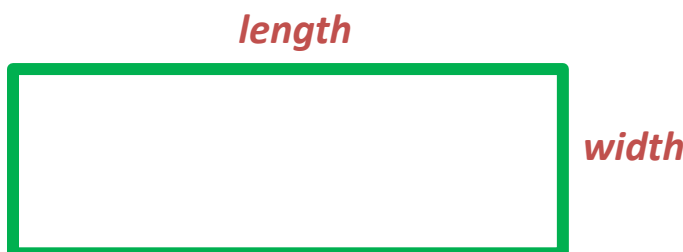
Multiplying Multi-Digit Whole Numbers

Just like **addition** and **subtraction**, **MULTIPLICATION** of multi-digit numbers has many strategies too! Drawing **area models**, **partial products** and using the **standard algorithm** are some of the many strategies used. This lesson will enhance your fluency in multiplying multi-digit numbers using the "**standard algorithm**", but will also deal with the other two mentioned strategies.

Using Area Models to Multiply Multi-Digit Whole Numbers

Area and **decomposing numbers** are the key concepts needed in multiplying multi-digit numbers using **area models**. The process involved may not be as easy and as fast as the standard algorithm, but this method provides a deeper mathematical understanding of the entire multiplication process. **How is it done?**

Remember that each factor of any given multiplication problem is a dimension of a rectangle. These dimensions are the **length** and the **width**!

length

width

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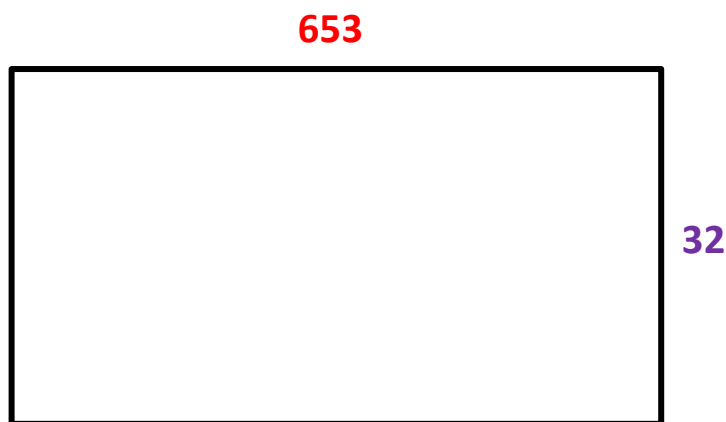
Example:

Multiply 653 and 32 using area models.

Step 1:   Draw a rectangle. The factors of the given multiplication problem will be the dimensions of the rectangle.

Let's say:

<div align="center">

653 is the **Length**

32 is the **Width**

</div>

653

```
┌─────────────────────────────┐
│                             │
│                             │  32
│                             │
└─────────────────────────────┘
```

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Step 2: Decompose the factors of the given multiplication problem using base ten numbers.

$$653 = 600 + 50 + 3$$
$$32 = 30 + 2$$

Step 3: Since **652** is decomposed into three parts. Divide the longer side or the length into three parts. Write **600**, **50** and **3** over the divided parts.

600   **50**   **3**

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Step 4: Since **32** is decomposed into two parts. Divide the width into two parts. Write **30** and **2** over the divided parts. Label the parts.

600		**50**	**2**
30			
2			

Step 5: Find the area of each rectangle. Let's color each rectangle differently and complete the table with its corresponding area.

600		**50**	**3**
30			
2			

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Rectangle	Dimensions		Area of the Rectangle
	Length	Width	
	600	30	18 000
	50	30	150
	3	30	90
	600	2	1 200
	50	2	100
	3	2	6

Step 6:   Write the product inside the corresponding rectangles.
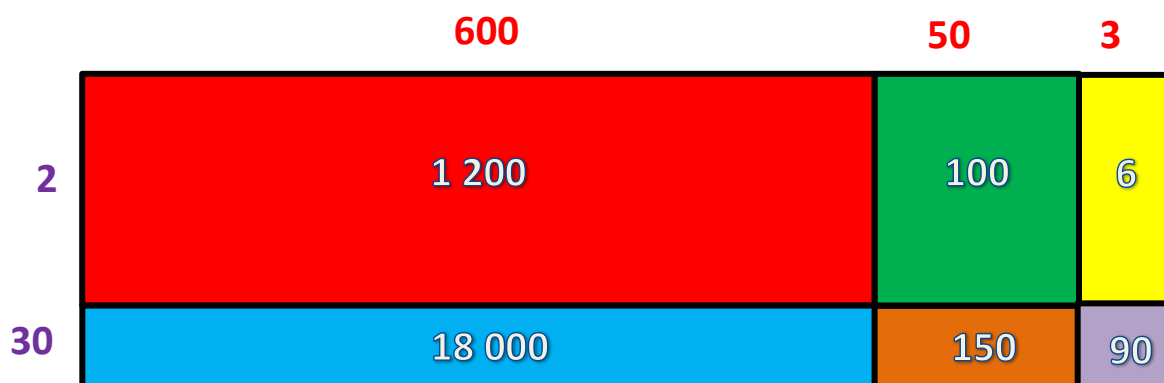
	600	**50**	**3**
2	1 200	100	6
30	18 000	150	90

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Step 7: Add all the area of the smaller rectangles to find the total area of the original rectangle.

Rectangle	Dimensions		Area of the Rectangle
	Length	Width	
	600	30	18 000
	50	30	1 500
	3	30	90
	600	2	1 200
	50	2	100
	3	2	6
Total area of the original rectangle			**20 896**

Therefore, the product of 653 and 32 is **20 896**!!!

Sample Problem 1:

Find the product of 516 and 24 by drawing an area model.

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Solution:

	500	**10**	**6**
4	**2 000**	**40**	**24**
20	**10 000**	**200**	**120**

10 000 + 2 000 + 200 + 120 + 40 + 24 = 12 384

Therefore, 516 x 24 = 12 384

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Multiplying Multi-Digit Numbers Using Partial Products

Here, the concept of **decomposition** is used. Remember that decomposition means to "**break apart**". So we're breaking apart factors to get the product.

How do we multiply multi-digit whole numbers using **partial product**?

Steps in Multiplying Multi-Digit Numbers Using Partial Products

Example: Find the product of 612 and 15.

Step 1:   Decompose each factor.

$$612 = 600 + 10 + 2$$

and

$$15 = 10 + 5$$

So…   612   x   15

| 600 + 10 + 2 | X | 10 + 5 |

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Step 2:   Multiply the 600 to each of the decomposed values of 15.

$$\boxed{600} \enspace + \enspace 10 \enspace + \enspace 2 \qquad \times \qquad \boxed{10 \enspace + \enspace 5}$$

600 x 10 = 6000
600 x 5 = 3000

Step 3:   Multiply the 10 to each of the decomposed values of 15.

$$600 \enspace + \boxed{10} + \enspace 2 \qquad \times \qquad \boxed{10 \enspace + \enspace 5}$$

600 x 10 = 6000
600 x 5 = 3000
10 x 10 = 100
10 x 5 = 50

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Step 4:   Multiply the 2 to each of the decomposed values of 15.

600 + 10 + (2) × (10 + 5)

600 x 10 = 6 000
600 x 5 = 3 000
10 x 10 = 100
10 x 5 = 50
2 x 10 = 20
2 x 5 = 10

6000, 3000, 100, 50, 20, and 10 are the partial products of:

612 x 15

Step 5:   Add all the partial products of 612 x 15.

6 000 + 3 000 + 100 + 50 + 20 + 10 = 9 180

Therefore, 612 x 15 = 9 180.

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Sample Problem 2:

Find the product of 453 and 72 using partial products.

Solution:

400 + 50 + 3 x 70 + 2

400 x 70 = 28 000
400 x 2 = 800
50 x 70 = 3 500
50 x 2 = 100
3 x 70 = 210
3 x 2 = 6

28 000 + 800 + 3 500 + 100 + 210 + 6 = 32 616

Therefore, 453 x 72 = 32 616

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Standard Algorithm

What is "Standard Algorithm"?

When **"standard algorithm"** is defined separately, "standard" refers to something that is usual or common, while "algorithm" is a process or a set of rules to be followed in solving different types of operations.

Combined, **standard algorithm** means the usual or common way of solving problems, such as multiplication, following a set of rules or steps. Here, you will fluently learn how to multiply multi-digit numbers using the standard algorithm.

Standard Algorithm for Multiplication

Just like **Addition** and **Subtraction**, the "**Standard Algorithm**" is also used in **Multiplication**. So long as you follow each step properly, rest assured that correct answers are obtained.

Imagine you're trying to bake the yummiest chocolate cake ever! You are actually doing the same steps over and over again, very much the same in using standard algorithm for addition and subtraction (including all other operations).

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Multiplying Multi-Digit Whole Numbers

The Place Value and the Standard Algorithm

The concept of "**place value**" is very important in multiplying multi-digit numbers using the standard algorithm. Being very accurate when it comes to place values gives absolutely correct answers!

Steps in Multiplying Multi-Digit Numbers the Standard Algorithm

Example 1: Find the product of 376 x 47.

Step 1: Align the factors vertically according to their place values.

$$
\begin{array}{r}
376 \\
\times\ 47 \\
\hline
\end{array}
$$

Step 2: Multiply 7 to each digit of 375 starting with the ones digit. Don't forget to carry over the tens digit every time you multiply 7 to each digit of 375.

$$
\begin{array}{r}
54 \\
376 \\
\times\ 47 \\
\hline
2632 \\
\end{array}
$$

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Step 3: Multiply 40 to each digit of 376 starting with the ones digit.

Why 40? Remember that in **47**, "**4**" is in the tens place… thus it has a value of "**40**".

```
        3 2
        3 7 6
    ×     4 7
      2 6 2 5
    1 5 0 4 0
```

Adding "**zero**" means that we are multiplying by tens.

If you are multiplying a value in the hundreds place, then 2 "**zeros**" are added, because we are multiplying by hundreds.

Multiplying Multi-Digit Whole Numbers

Step 4:   Add the partial products to get the final product.

```
          3 7 6
        ×   4 7
        2 6 3 2
      + 1 5 0 4 0
        1 7 6 7 2
```

> **Therefore, 376 × 47 = 17 672.**

Example 2: Find the product of 4 316 × 252.

```
          4 3 1 6
        ×   2 5 2
          8 6 3 2
        2 1 5 8 0 0   ⟶  tens
    +   8 6 3 2 0 0   ⟶  hundreds
      1 0 8 7 6 3 2
```

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Instead of "**zeros**" you can leave the zeros "**blank**" as well.

```
      4 3 1 6
   ×    2 5 2
      8 6 3 2
    2 1 5 8 0 0  ──→  tens
 +  8 6 3 2 0 0  ──→  hundreds
  1 0 8 7 6 3 2
```

```
      4 3 1 6
   ×    2 5 2
      8 6 3 2
    2 1 5 8 0    ──→  tens
 +  8 6 3 2      ──→  hundreds
  1 0 8 7 6 3 2
```

Sample Problem 3:

Find the product of 7 189 and 53 using the standard algorithm.

Solution:

```
      7 1 8 9
   ×      5 3
    2 1 5 6 7
 +  3 5 9 4 5
    3 8 1 0 1 7
```

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Multiplying Multi-Digit Whole Numbers

Multiplication of Multi-Digit Whole Numbers Word Problems

It is a known fact that Mathematics is a part of our daily lives. Whether we like it or not, we add, subtract, multiply and divide EVERYDAY… and we are quite not conscious that we actually do it!

Now that you know how to multiply multi-digit whole numbers using the standard algorithm… it's high time that you apply what you learned in solving word problems.

Example:

Sam bought 105 bikes for his rent-a-bike shop at $637 each. How much did Sam spend for his bikes?

Solution:

```
      1 0 5
  x   6 3 7
      7 3 5
    3 1 5 0
+ 6 3 0 0 0
  6 6 8 8 5  bikes
```

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Sample Problem 4:

A concert will be held at a stadium with a capacity of 1584 people. If each ticket costs $45, how much will the organizers earn if all tickets are sold?

Solution:

$$
\begin{array}{r}
1584 \\
\times\ \ \ 45 \\
\hline
7920 \\
+\ 63360 \\
\hline
\$71280 \\
\end{array}
$$