Work Space

Unit 4

Multiplication of Whole Numbers

Key Terms

carry
multiplicand
multiplication
multiplier
product

Introduction

Multiplication can be thought of as a fast way to do addition. The process involves the repeated addition of a single number. This may seem odd at first, but look at it this way. If you were to add 3 + 3 + 3 + 3 + 3, the total, of course, would be 15. However, you could think of it as, "3 taken 5 times" or "5 times the number 3." This way of thinking works well for mental calculations of small numbers. It speeds up the process and simplifies the problem. Many people have memorized the multiplication facts for numbers 1 through 12 and these are often seen in chart form as multiplication tables.

Multiplication Table

$2 \times 1 = 2$	$3 \times 1 = 3$	$4 \times 1 = 4$	$5 \times 1 = 5$	$6 \times 1 = 6$	$7 \times 1 = 7$
$2 \times 2 = 4$	$3 \times 2 = 6$	$4 \times 2 = 8$	$5 \times 2 = 10$	$6 \times 2 = 12$	$7 \times 2 = 14$
$2 \times 3 = 6$	$3 \times 3 = 9$	$4 \times 3 = 12$	$5 \times 3 = 15$	$6 \times 3 = 18$	$7 \times 3 = 21$
$2 \times 4 = 8$	$3 \times 4 = 12$	$4 \times 4 = 16$	$5 \times 4 = 20$	$6 \times 4 = 24$	$7 \times 4 = 28$
$2 \times 5 = 10$	$3 \times 5 = 15$	$4 \times 5 = 20$	$5 \times 5 = 25$	$6 \times 5 = 30$	$7 \times 5 = 35$
$2 \times 6 = 12$	$3 \times 6 = 18$	$4 \times 6 = 24$	$5 \times 6 = 30$	$6 \times 6 = 36$	$7 \times 6 = 42$
$2 \times 7 = 14$	$3 \times 7 = 21$	$4 \times 7 = 28$	$5 \times 7 = 35$	$6 \times 7 = 42$	$7 \times 7 = 49$
$2 \times 8 = 16$	$3 \times 8 = 24$	$4 \times 8 = 32$	$5 \times 8 = 40$	$6 \times 8 = 48$	$7 \times 8 = 56$
$2 \times 9 = 18$	$3 \times 9 = 27$	$4 \times 9 = 36$	$5 \times 9 = 45$	$6 \times 9 = 54$	$7 \times 9 = 63$
$2 \times 10 = 20$	$3 \times 10 = 30$	$4 \times 10 = 40$	$5 \times 10 = 50$	$6 \times 10 = 60$	$7 \times 10 = 70$
$2 \times 11 = 22$	$3 \times 11 = 33$	$4 \times 11 = 44$	$5 \times 11 = 55$	$6 \times 11 = 66$	$7 \times 11 = 77$
$2 \times 12 = 24$	$3 \times 12 = 36$	$4 \times 12 = 48$	$5 \times 12 = 60$	$6 \times 12 = 72$	$7 \times 12 = 84$

(Continued)

$8 \times 1 = 8$	$9 \times 1 = 9$	$10 \times 1 = 10$	$11 \times 1 = 11$	$12 \times 1 = 12$
$8 \times 2 = 16$	$9 \times 2 = 18$	$10 \times 2 = 20$	$11 \times 2 = 22$	$12 \times 2 = 24$
$8 \times 3 = 24$	$9 \times 3 = 27$	$10 \times 3 = 30$	$11 \times 3 = 33$	$12 \times 3 = 36$
$8 \times 4 = 32$	$9 \times 4 = 36$	$10 \times 4 = 40$	$11 \times 4 = 44$	$12 \times 4 = 48$
$8 \times 5 = 40$	$9 \times 5 = 45$	$10 \times 5 = 50$	$11 \times 5 = 55$	$12 \times 5 = 60$
$8 \times 6 = 48$	$9 \times 6 = 54$	$10 \times 6 = 60$	$11 \times 6 = 66$	$12 \times 6 = 72$
$8 \times 7 = 56$	$9 \times 7 = 63$	$10 \times 7 = 70$	$11 \times 7 = 77$	$12 \times 7 = 84$
$8 \times 8 = 64$	$9 \times 8 = 72$	$10 \times 8 = 80$	$11 \times 8 = 88$	$12 \times 8 = 96$
$8 \times 9 = 72$	$9 \times 9 = 81$	$10 \times 9 = 90$	$11 \times 9 = 99$	$12 \times 9 = 108$
$8 \times 10 = 80$	$9 \times 10 = 90$	$10 \times 10 = 100$	$11 \times 10 = 110$	$12 \times 10 = 120$
$8 \times 11 = 88$	$9 \times 11 = 99$	$10 \times 11 = 110$	$11 \times 11 = 121$	$12 \times 11 = 132$
$8 \times 12 = 96$	$9 \times 12 = 108$	$10 \times 12 = 120$	$11 \times 12 = 132$	$12 \times 12 = 144$

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

To use this chart, the product of multiplying each number along the top row by each number in the left column is found where the row and column intersect. For example, to find the answer to 8 times 4, locate their intersecting squares. Following column 8 down to row 4 shows the answer to be 32. Likewise, following column 4 down to row 8 also results in 32.

Incidentally, there is no special reason why the multiplication table stopped at 12. It is probably because most people did not want to memorize beyond that point. Even in this age of electronic calculators, you should be very familiar with the multiplication table. You should commit it to memory.

Method Used to Multiply Whole Numbers

Large numbers are calculated by writing them out. To begin, you should know the appropriate terminology.

$$\begin{array}{rl} 132 & \leftarrow \textbf{Multiplicand} \\ \times 23 & \leftarrow \textbf{Multiplier} \\ \hline 3{,}036 & \leftarrow \textbf{Product} \end{array}$$

The upper number in a multiplication equation is the **multiplicand**. This is the number that is being added repeatedly. The number below the multiplicand is the **multiplier**. This number represents how many times the multiplicand will be repeatedly added. The result of a multiplication equation is the **product**. Refer to the multiplication tables if you need to refresh your skills as you study the following examples.

Always line up the figures on the right side in the units column. Multiply every digit in the multiplicand by the number in the units column of the multiplier. Start multiplying the multiplicand at the units column. In this example, it starts with the 3 in the multiplier's units column and the 2 in the multiplicand's units column.

$$\begin{array}{r} 132 \\ \times 23 \\ \hline 396 \end{array}$$

Next, multiply every digit in the multiplicand by the 2 in the multiplier's tens column. Place the results of this multiplication below the first results. However, these second results should be indented so it lines up directly under the 2 in the multiplier. Then, add the results of the two multiplication operations.

$$\begin{array}{r} 132 \\ \times 23 \\ \hline 396 \\ 264 \\ \hline 3{,}036 \end{array}$$

In multiplication problems, you often have to **carry** numbers. This was also done in addition equations when the sum of a single column was 10 or higher. Since only one digit can occupy a column, a number was carried to the next column. See the example below.

$$\begin{array}{r} 298 \\ \times 27 \\ \hline \end{array}$$

In the first operation, $7 \times 8 = 56$. Place the 6 in the answer and write a little 5 directly above the 9.

$$\begin{array}{r} {\scriptstyle 5} \\ 298 \\ \times 27 \\ \hline 6 \end{array}$$

Now, multiply 7×9 to get 63 and add the carried 5 to it, arriving at 68. Place 8 in the answer and a little 6 above the 2.

$$\begin{array}{r} {\scriptstyle 65} \\ 298 \\ \times 27 \\ \hline 86 \end{array}$$

Multiply 7×2 to get 14. Add the carried 6 to the 14 to get 20. Write 20 in the answer. Always check your accuracy.

$$\begin{array}{r} {\scriptstyle 65} \\ 298 \\ \times 27 \\ \hline 2086 \end{array}$$

For larger equations like this one, neatness is important. When multiplying the next set of numbers, write the carried numbers above the previously used carried numbers. Keep careful track of these numbers, so you do not add the wrong numbers. In larger equations, you may want to cross out carried numbers after they have been used in a calculation.

```
  1 1
 ~~6 5~
  298
× 27
 2086
 596
8,046
```

Accurate Alignment

Be sure to line up the numbers accurately in your answer. You may include right-hand zeros or X's to help keep the figures aligned. These zeros and X's occupy the space of indented columns.

```
  154                          154
× 368                        × 368
 1232                         1232
 9240  ← Zeros added to       924X  ← X's added to keep
46200    keep columns aligned. 462XX   columns aligned.
56,672                       56,672
```

Notice the emboldened zeros and Xs in the examples above. Including such characters will help to keep your columns properly aligned. Leaving those spaces open may lead to column confusion and incorrect results.

Checking Multiplication by Reversing Positions

A method of checking your multiplication work is to reverse the positions of the multiplier and multiplicand and repeat the problem. Performing the equation each way should result in the same product. The numbers obtained by multiplying each digit of the multiplier with the multiplicand will be different than the numbers from the first equations. However, these different numbers should still add up to the same final product as the original equation.

Original Equation		Reverse Position Equation
643		972
× 972		× 643
1286	← Different →	2916
45010	← Different →	38880
578700	← Different →	583200
624,996	← Same →	624,996

As shown in the example above, the initial multiplication results may be different, but the final product should match the original answer.

Smaller Multiplier

It does not matter which of the two numbers is positioned as the multiplier or multiplicand. Both will provide the same results. However, it may be easier to place the smaller number as the multiplier. This will result in having fewer rows of numbers to add.

```
  1286                27
× 27                × 1286
 9002                162
25720               2160
34,722              5400
                   27000
        Same       34,722
```

Denominate Numbers

How denominate numbers work in an equation is based on the operation of an equation. For instance, we already know that denominate numbers must have the same units to be added or subtracted. However, in multiplication and division equations, denominate numbers do not need to have the same units. In a multiplication equation, the units of measurements are combined.

When denominate numbers with different units of measurement are multiplied together, they form a new unit of measurement. See the example below.

$$12 \text{ lb} \times 7' = 84 \text{ ft-lb}$$

While the numbers are multiplied, the pound and foot units are combined to form foot-pounds (ft-lb). These compound units can be formed by multiplication and undone by division. When denominate numbers sharing the same unit of measurement are multiplied together, they form a squared unit. See the example below.

$$7'' \times 8'' = 56 \text{ in}^2$$

Multiplying two inch measurements together forms a product measured in inches squared (in^2). More information on denominate numbers in multiplication equations will be covered in later units on measurement.

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Unit 4 Practice

Multiply the following number groupings. Show all your work. Be certain the columns line up. Box your answers.

1. 12 × 34
2. 98 × 75
3. 56 × 70
4. 659 × 423
5. 207 × 845
6. 913 × 600
7. 84,796 × 56
8. 93,253 × 24
9. 53,602 × 35

10. 253 × 6,944 =
11. 804 × 5,022 =
12. 68 × 12,673 =
13. 69,671 × 36 =
14. 12 × 24 × 36 =
15. 18 × 13 × 20 =
16. 109 × 14 × 34 =
17. 263 × 101 × 24 =
18. 468 × 219 × 153 =
19. Lee's Welding produced 193 base frames. Each frame required 98 spot welds. What is the total number of spot welds for the entire job?
20. Ramido's Rapid Delivery Service delivered 4 pallets of rivets to Weld-Can Mfg. Each pallet contained 27 cartons and each carton contained 24 boxes. Each box contained 68 rivets. How many rivets were delivered?

21. Thirty-nine rows of studs will be welded to a metal platform. Each row will be 5″ apart. There will be 27 studs in each row. What is the total number of studs required?

22. A GMAW welder traveling at 17″ per minute was in constant use for 17½ hours each day for 24 days. How many inches of weld were deposited in that time?

23. The roof of an arena built for the University of Iowa requires 5,247 plates to secure the roof trusses to the support beams. These plates vary in size and number of bolts required. The plates were flame cut to shape, then subcontracted to a machine shop for drilling the bolt holes. According to the information listed below, what is the total number of bolt holes that need to be drilled?

1,728 plates with 6 holes	2,235 plates with 14 holes
295 plates with 5 holes	15 plates with 23 holes
964 plates with 9 holes	10 plates with 10 holes

Use the information below to answer the questions that follow. The supplies listed below must be transported from the ground floor storage to the top floor. Workers plan to use a freight elevator with a capacity of 8,500 lb to send everything at once.

Steel Rods

Seven bundles of 17 rods each. Each rod is 4′ long and weighs 2 lb per foot.

Plates

Twelve stacks of 13 plates each. Each plate weighs 14 lb. The plates are stacked on 4 wooden pallets that weigh 39 lb each.

Angle Iron

Forty-two pieces. Each piece weighs 18 lb and is 4′ long.

Aluminum Tubing

Six bundles of 16 tubes. Each tube weighs 7 lb.

Four bundles of 12 tubes. Each tube weighs 9 lb.

Seven bundles of 5 tubes each. Each tube is 4′ long and weighs 2 lb per foot.

Four bundles of 5 tubes each. Each tube is 3′ long and weighs 2 lb per foot.

Pipe

Two bundles of 20 pipes each. Each pipe is 3′ long and weighs 2 lb per foot.

Seven bundles of 11 pipes each. Each pipe weighs 11 lb.

Hubs

Four cartons of 19 boxes each. Each box contains 6 hubs. The weight of each box including the 6 hubs is 13 lb. Each carton is on a wooden pallet that weighs 39 lb.

Operator

The elevator operator weighs 165 lb.

24. Will the workers be able to send the whole load in a single trip?

25. What is the total load?

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Use the information below to answer the questions that follow. A power line built for Louisiana Light and Power Co. had 619 towers constructed of various sizes of pipe. Specifications for the job are listed below.

Steel Pipe Requirements

	Tower Legs	Cross Arms	Stiffeners
Material	ASTM A595	ASTM A595	ASTM A595
Size	2′ diameter	1½′ diameter	1′ diameter
Number per Tower	2	1	2
Length	93′ on 175 towers	102′	35′
	108′ on 300 towers		
	122′ on 144 towers		

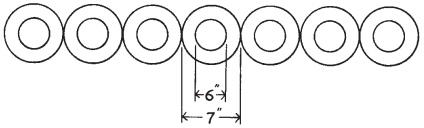
26. Calculate the total length of 2′ diameter pipe.

27. Calculate the total length of 1½′ diameter pipe.

28. Calculate the total length of 1′ diameter pipe.

29. Find the total length of pipe for the entire project.

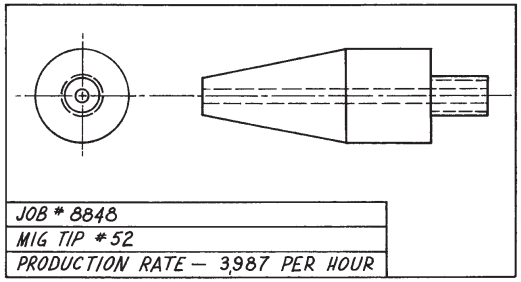
Use the information below to answer the questions that follow. The illustration below depicts equally-sized rings that are welded together.



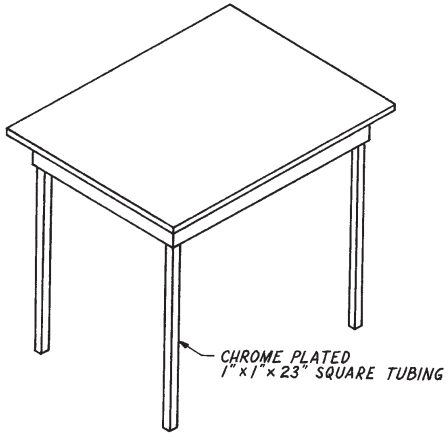
30. What is the total length of the weldment?

31. What is the total weight of the weldment if each ring weighs 6 lb?

32. How many of the following GMAW welding tips can be produced in 67 working days at 9 hours per day?



33. How many inches of chrome plated tubing will be required to manufacture 289 tables?



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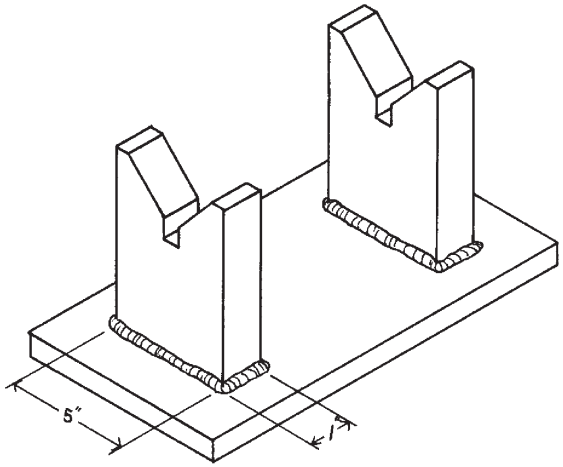
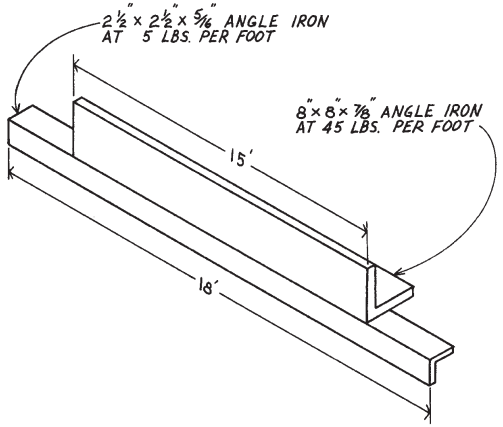
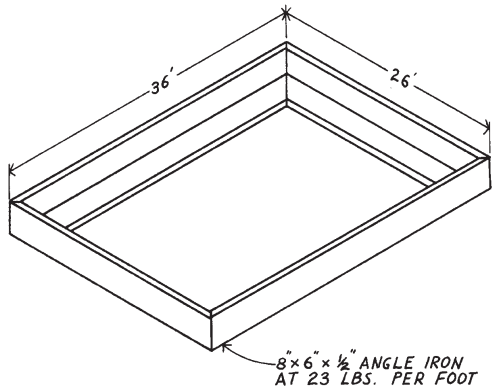
34. Each of the posts in this shaft support is welded all around. How many inches of weld will be applied to make 12,983 shaft supports?



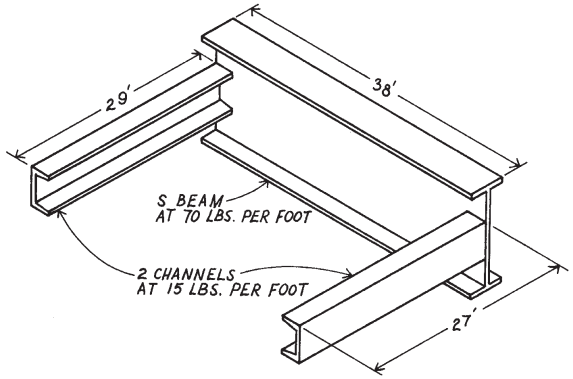
35. Review the diagram below. Calculate the weight of the weldment. Assume there is no filler added to the welds.



36. Review the diagram below. Calculate the weight of the weldment. Assume there is no filler added to the welds.



37. Review the diagram below. Calculate the weight of the weldment. Assume there is no filler added to the welds.



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38. The diagram below shows the measurements for a frame. Eighty-five frames are to be fabricated. What is the total number of inches of tubing required?