Whole Numbers

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SECTION 1.1

Place Value and Names for Numbers

Objectives

A   State the place value for numbers in standard notation.

B   Write a whole number in expanded form.

C   Write a number in words.

D   Write a number from words.

A Place Value

Place Value

Our number system is based on the number 10 and is therefore called a "base 10" number system.

We write all numbers in our number system using the *digits* 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

The positions of the digits in a number determine the values of the digits.

For example, the 5 in the number 251 has a different value from the 5 in the number 542.

Place Value

The *place values* in our number system are as follows:

The first digit on the right is in the *ones column*. The next digit to the left of the ones column is in the *tens column*.

The next digit to the left is in the *hundreds column*.

For a number like 542, the digit 5 is in the hundreds column, the 4 is in the tens column, and the 2 is in the ones column.

Place Value

If we keep moving to the left, the columns increase in value.

Table 1 shows the name and value of each of the first seven columns in our number system.

Also, notice how the number 1 is located in the appropriate place value column.

TABLE 1						
Millions Column	Hundred Thousands Column	Ten Thousands Column	Thousands Column	Hundreds Column	Tens Column	Ones Column
1,000,000	100,000	10,000	1,000	100	10	1

Example 1

Give the place value of each digit in the number 305,964.

Solution:

Starting with the digit at the right, we have:

4 in the ones column, 6 in the tens column, 9 in the hundreds column, 5 in the thousands column, 0 in the ten thousands column, and 3 in the hundred thousands column.

Large Numbers

Large Numbers

The photograph shown here was taken by the Hubble telescope.

The object in the photograph is called the *Cone Nebula.* In astronomy, distances to objects like the Cone Nebula are given in light-years, the distance light travels in a year.

If we assume light travels 186,000 miles in one second, then a light-year is 5,865,696,000,000 miles; that is

5 trillion, 865 billion, 696 million miles

Large Numbers

To find the place value of digits in large numbers, we can use Table 2.

TABLE 2														
Trillions			Billions			Millions			Thousands			Ones		
Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones
	5	8	6	5	6	9	6	0	0	0	0	0	0	0

Note how the Ones, Thousands, Millions, Billions, and Trillions categories are each broken into Ones, Tens, and Hundreds. Therefore, if we write the digits for our light-year in the last row of the table, then it would look like the above table.

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Example 2

Give the place value of each digit in the number 73,890,672,540.

Solution:

The following diagram shows the place value of each digit.

Ten Billions	Billions	Hundred Millions	Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones
7	3,	8	9	0,	6	7	2,	5	4	0

B Expanded Form

Expanded Form

We can use the idea of place value to write numbers in *expanded form*. For example, the number 542 can be written in expanded form as

542 = 500 + 40 + 2

because the 5 is in the hundreds column, the 4 is in the tens column, and the 2 is in the ones column.

Example 3

Write 5,478 in expanded form.

Solution:

$$5,478 = 5,000 + 400 + 70 + 8$$

Expanded Form

We can use money to make the results from Example 3 more intuitive.

Suppose you have $5,478 in cash as follows:

$5,000 $400 $70 $8

Expanded Form

Using diagram as a guide, we can write

$$\$5,478 = \$5,000 + \$400 + \$70 + \$8$$

which shows us that our work writing numbers in expanded form is consistent with our intuitive understanding of the different denominations of money.

c Writing Numbers in Words

Writing Numbers in Words

The idea of place value and expanded form can be used to help write the names for numbers.

Naming numbers and writing them in words takes some practice.

Let's begin by looking at the names of some two-digit numbers.

Writing Numbers in Words

Table 3 lists a few.

TABLE 3			
Number	**In English**	**Number**	**In English**
25	Twenty-five	30	Thirty
47	Forty-seven	62	Sixty-two
93	Ninety-three	77	Seventy-seven
88	Eighty-eight	50	Fifty

Notice that the two-digit numbers that do not end in 0 have two parts. These parts are separated by a hyphen.

Example 7

Write each number in words.

a. 452   **b.** 397   **c.** 608

Solution:

a. Four hundred fifty-two

b. Three hundred ninety-seven

c. Six hundred eight

Writing Numbers in Words

Here is a practical reason for being able to write numbers in word form.

D Writing Numbers from Words

Example 10

Write five thousand, six hundred forty-two, using digits instead of words.

Solution:

Five thousand, six hundred forty-two
↓   ↓   ↓
5,   6   42   ⇒ 5,642

Sets and the Number Line

Sets and the Number Line

In mathematics a collection of numbers is called a *set*.

We will be working with the set of *counting numbers* (also called natural numbers) and the set of *whole numbers*, which are defined as follows:

Counting numbers = {1, 2, 3, . . .}

Whole numbers = {0, 1, 2, 3, . . .}

The dots mean "and so on," and the braces { } are used to group the numbers in the set together.

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Sets and the Number Line

Another way to visualize the whole numbers is with a *number line*.

To draw a number line, we simply draw a straight line and mark off equally spaced points along the line, as shown in Figure 1.
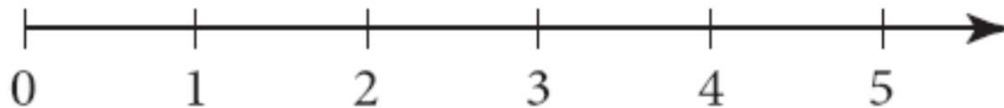

Figure 1

We label the point at the left with 0 and the rest of the points, in order, with the numbers 1, 2, 3, 4, 5, and so on.

The arrow on the right indicates that the number line can continue in that direction forever.