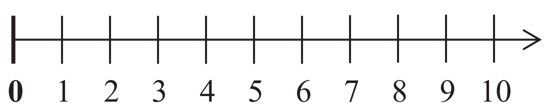
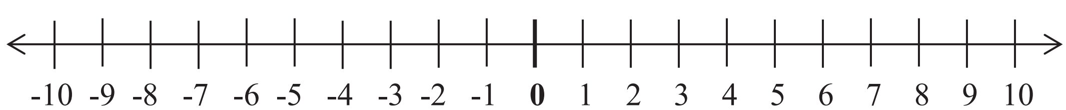
In the first unit we reviewed how our number system was expanded from the whole numbers (0, 1, 2, 3, and so on) to the **integers**. The integers added negative numbers to our number system. You saw that a number line is a good way to picture integers. When you were working only with the whole numbers, you used a number line that started with zero and continued on and on to the right.



The number line we use with integers goes on and on in <u>both</u> directions from zero, to the right for the positive numbers and to the left for the negative numbers.



The <u>integers</u> are called <u>signed numbers</u> because they have both a number and a sign.

PRINCIPLE:
A **signed number** has two elements that must be recognized in order to work with such numbers.
1. The number itself tells the *amount*.
2. The sign tells the *direction* in which the amount is measured or evaluated based on the distance from zero.

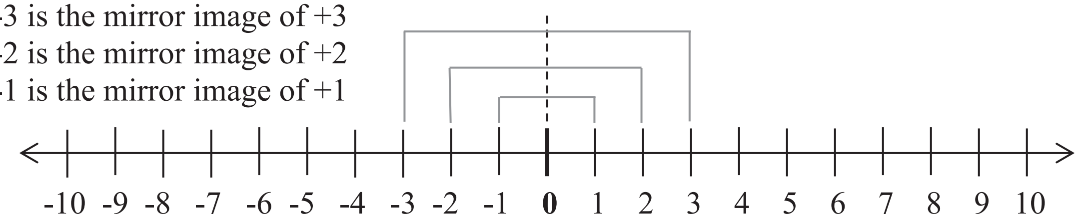
It’s clear that when you are working with integers, just writing “2” will no longer tell someone else which “2” you are describing, the negative two or the positive two. To solve this problem one method is to write a smaller plus sign or smaller minus sign in front of each number toward the upper part of the digit. If the elevated signs are not used in typesetting, then the signs of the numbers are written as usual with the plus and minus signs in front of the number. If necessary the number and its sign are enclosed in parentheses to avoid confusion.

positive 2 is written as (+2) or +2
negative 2 is written as (-2) or -2

➤ Remember, by convention and to make it easier, any number <u>without</u> a sign is positive.

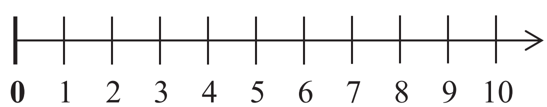
It’s like the negative numbers to the left of zero are the mirror images of the positive numbers to the right of zero, except for the signs. The two numbers mirror each other based on their distance from the zero mark.

-3 is the mirror image of +3
-2 is the mirror image of +2
-1 is the mirror image of +1



Whenever two signed numbers use the same numerals to show the amount, yet have opposite signs, we say they are **opposite numbers**. For example, (+9) and (-9) use the numeral 9 to show the amount, yet one has a positive sign and the other has a negative sign. They are opposites. They are related numbers because they show the same amount (the distance from zero the a number line), yet they are different numbers because they are in opposite directions on the number line. They do NOT have the same value.

When you started working with natural numbers and then whole numbers, you learned to count to ten, then to one hundred. Over the next few years you learned to count with numbers in the thousands, millions, billions, and now the trillions. No matter what number you start with, you can always count on to the next number, which is one unit larger. You can see this on a number line.



No matter how long a number line you draw, each time you move one unit to the right you get to the next greater whole number. No matter which number you choose, let’s say 6, the next unit to the <u>right</u> is 7, which is one more than 6. And the next unit to the <u>left</u> is 5, which is one less than 6. You practiced this feature by telling the numbers that were one greater and one less than a given number.

2,130	**2, 131**	2,132
(one less)		**(one more)**

You also practiced filling in a missing number in a sequence of numbers.

328 329 330 **<u>331</u>** 332 333 334

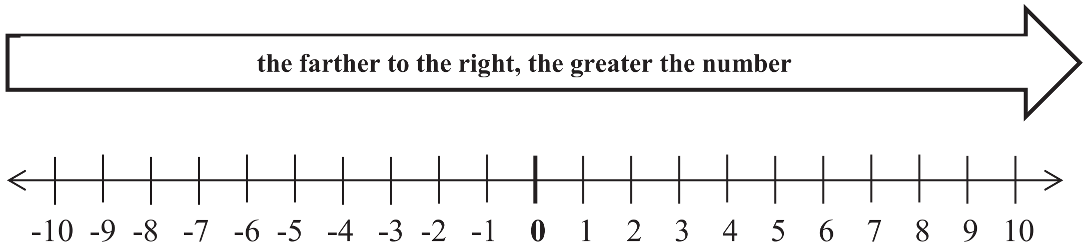
You may be wondering why we are reminding you of such a simple feature of our number system. There are two reasons:

1. We are expanding the set of whole numbers to the set of **integers**.

2. Each expansion of our number system keeps *all* the features of the previous set, as well as giving us more features or advantages.

Therefore, it is very important for you to see that for *every integer*, the number that is one unit to the right is one more or one greater, and the number that is one unit to the left is one less.

Let's take another look at the number line showing integers. R**eading from left to right, each number is one more than the one before it.**



This means that (-4) is one more than (-5)! At first this doesn't make sense. Many people think that (-5) should be greater than (-4) because 5 > 4. But it does make sense when we remember that the numbers must be written on the number line in this way in order to keep the mirror images of the numbers. If we go three spaces to the right (+3) and then go three spaces to the left (-3), we must end up at zero. The numbers have to be mirror images around zero, but no matter where we are on the number line, **each unit to the right is one greater.** We can also say that if you pick any two integers and compare their value, the number farthest to the right on the number line is the greater.

It's easy to see that the whole numbers (the positive integers) get larger as we go to the right on the number line, but you MUST remember that *all* the integers, including the negative numbers also get larger as we go to the *right.*

Let's make sure you understand how this feature of our number system applies to all the integers

Example #1: Given this sequence of numbers, fill in the missing number. -8 ____ -6 -5
The negative signs before these numbers tell us we are dealing with negative numbers to the left of zero. Because of the mirror image of the numbers around zero, we know the missing number has to be -7.

Example #2: Given the number (-3), what number is one unit more and what number is one unit less?
Remember, the unit that is one more is on the right and the unit that is one less is on the left. The sign of the number tells us we are working on the left side of number line. We know that the negative numbers are mirror images of the positive numbers around zero. So the number to the right of (-3) has to be (-2) and the number to the left of (-3) has to be (-4).

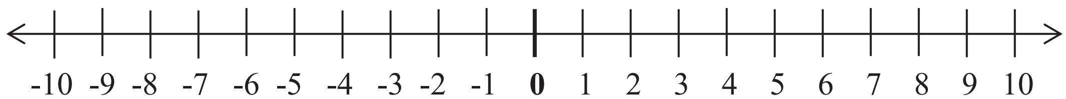
-4	**-3**	-2
(one less)		**(one more)**

Example #3: Given the number (-3), what number is two units more and what number is two units less?
We know the sequencing of the numbers stays the same. And the mirror image of the numbers must hold true. So we can extend the same sequence as we did in example 2.

5	-4	-3	-2	-1
(two less)				**(two more)**

You have not had much practice working with integers. When sequencing integers as in Examples 1-3 it is best to locate the given number on a number line, and count the necessary unit spaces to the right and to the left to find the correct answers.

Practice



Write the integer that is one less than and one greater than the given number. You can use the integer number line to help you think through the answer.

(1) ______ 6 ______   (2) ______ 1 ______   (3) ______ -2 ______

(4) ______ -4 ______   (5) ______ 0 ______   (6) ______ -7 ______

Use the number line to write the number that is TWO less than and TWO greater than the given number.

(7) ______ 5 ______   (8) ______ -2 ______   (9) ______ 0 ______

(10) ______ 1 ______   (11) ______ -6 ______   (12) ______ -1 ______

Use the number line to write the number that is FOUR less than and FOUR greater than the given number.

(13) ______ 7 ______   (14) ______ 0 ______   (15) ______ 1 ______

(16) ______ -4 ______   (17) ______ -3 ______   (18) ______ -6 ______