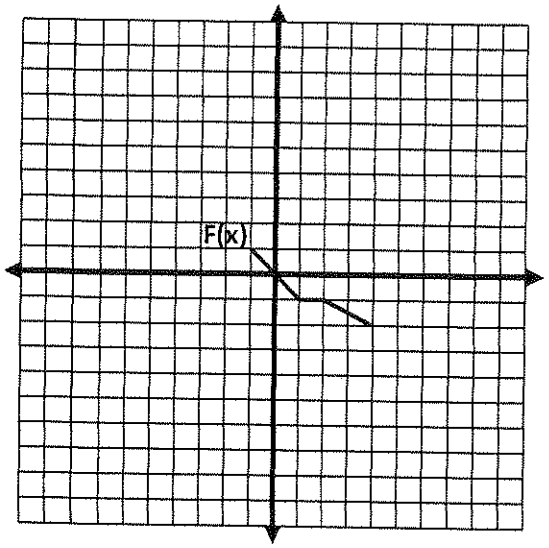
To the right is a graph of a "piece-wise" function. We'll call this function **F(x)**. We can use **F(x)** to explore transformations in the coordinate plane.



1. How do we know that **F(x)** is a function? *(Hint: How do we define a function?)*

   for every x value, there is one y value

2. What is the domain of **F(x)**?

   $\{-1 \le x \le 4\}$

3. What is the range of **F(x)**?

   $\{-2 \le y \le 1\}$

Let's explore the points on F(x).

4. How many points lie on **F(x)**? Can we list them all?

   there is an infinite number of points

5. What are the key points that would help us graph **F(x)**?

   *We are will call these key points **"characteristic" points.** It is important when graphing a function that you are able to identify these characteristic points.*

   - beginning
   - end
   - turn

6. Use the graph of **F(x)** to evaluate the following:

   F(1) = -1 F(-1) = 1 F(5) = undefined (it's not on the line)

Remember that F(x) is another name for the y-values

7. Fill the three tables using the graph of **F(x)**.

x	F(x)
-1	1
1	-1
2	-1
4	-2

x	F(x) + 4
-1	5
1	3
2	3
4	2

x	F(x) - 3
-1	-2
1	-4
2	-4
4	-5

8. Graph **F(x) + 4** and **F(x) – 3** in different colors on the coordinate plane above

   (Use the coordinate plane above)

9. In **y = F(x) + 4**, how did the "+4" affect the graph of **F(x)**? What type of *transformation* maps **F(x)** to **F(x) + 4**? (Be specific)

   it translated up 4

10. In **y = F(x) – 3**, how did the "–3" affect the graph of **F(x)**? What type of *transformation* maps **F(x)** to **F(x) – 3**? (Be specific)

    it translated down 3

11. Fill the three tables using the graph of F(x).

x	F(x)
-1	1
1	-1
2	-1
4	-2

f(x) + n = moves up by n
f(x) - n = moves down by n
f(x + n) = moves left by n
f(x - n) = moves right by n

x	x + 4	y = F(x + 4)
-5	-1	1
-3	1	-1
-2	2	-1
0	4	-2

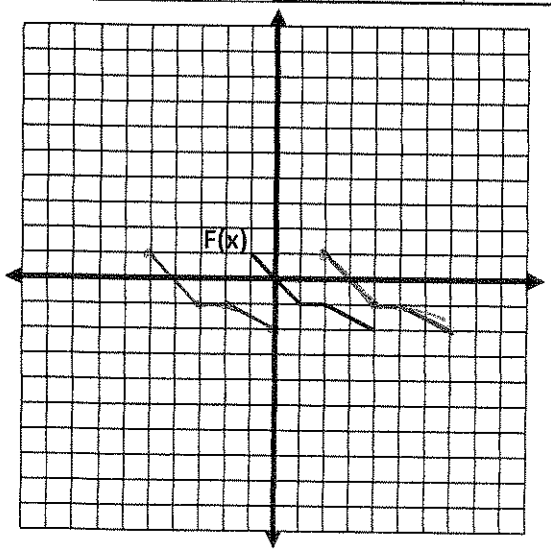
Hint: In the first box we have x + 4 = -1. If we subtract 4 from both sides of the equation, we get x = -5. Use a similar method to find the remaining x values.

x	(x - 3)	y = F(x - 3)
2	-1	1
4	1	-1
5	2	-1
7	4	-2

12. On the coordinate plane to the right:

a. Use one color to graph the 4 ordered pairs (x, y) for **y = F(x + 4)**. The first point is (-5, 1). * red

b. Use a different color to graph the 4 ordered pairs (x, y) for **y = F(x - 3)**. * blue



13. In **y = F(x+4)**, how did the "+4" affect the graph of **F(x)**? What type of *transformation* maps **F(x)** to **F(x + 4)**? (Be specific)

translated to the left by 4

14. In **y = F(x - 3)**, how did the "-3" affect the graph of **F(x)**? What type of *transformation* maps **F(x)** to **F(x - 3)**? (Be specific)

translated to the right by 3

15. Fill the tables using the graph of F(x).

x	F(x)
-1	1
1	-1
2	-1
4	-2

x	-F(x)
-1	-1
1	1
2	1
4	2

x	2F(x)
-1	2
1	-2
2	-2
4	-4

vertical stretch

x	½F(x)
-1	1/2
1	-1/2
2	-1/2
4	-1

vertical shrink

*when you multiply a function by a negative number, it will reflect across the x-axis

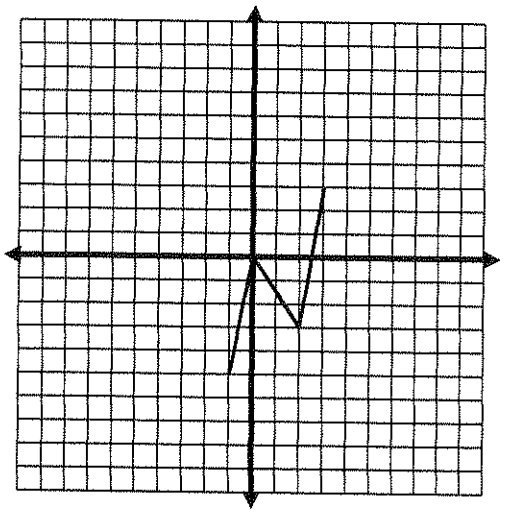
16. How did each of the following affect the graph of F(x):	*Hint: Use one of the coordinate planes above if needed.*
a) the "-" sign	a) reflect over the x-axis
b) the "2"	b) vertical stretch
c) the "½"	c) vertical shrink

Summary: Describe the effect to F(x) for the following functions.

Equation	Effect on the graph of F(x)
Example: y=F(x + 18)	Translate F(x) to the left 18 units
1. y = F(x) - 100	down 100
2. y = F(x - 48)	right 48
3. y = F(x) + 32	up 32
4. y = -F(x)	reflect over x-axis
5. y = F(x - 10)	right 10
6. y = F(x) + 7	up 7
7. y = ¼F(-x)	vertical shrink by ¼, reflect over y-axis
8. y = F(x) - 521	down 521
9. y = F(x) + 73	up 73
10. y = -5F(x)	vertical stretch by 5, reflect over x-axis
11. y = F(x) - 22	down 22
12. y = 2F(x - 13)	vertical stretch by 2, right 13
13. y = F(x + 30) + 18	left 30, up 18
14. y = -¼F($\frac{1}{3}$x) -27	vertical shrink ¼, reflect over the x-axis, horizantal stretch of 3, down 27

take the reciprocal

To the right is a graph of a "piece-wise" function that we'll call **H(x)**.



Use **H(x)** to demonstrate what you have learned so far about the transformations of functions.

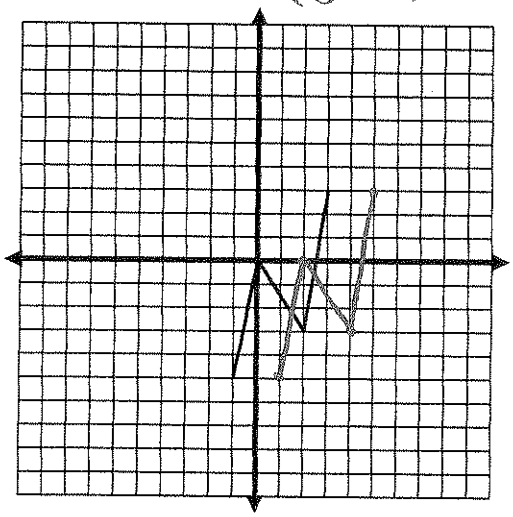
1. What are the characteristic points of **H(x)**?

(-1, -5) (0, 0) (2, -3) (3, 3)

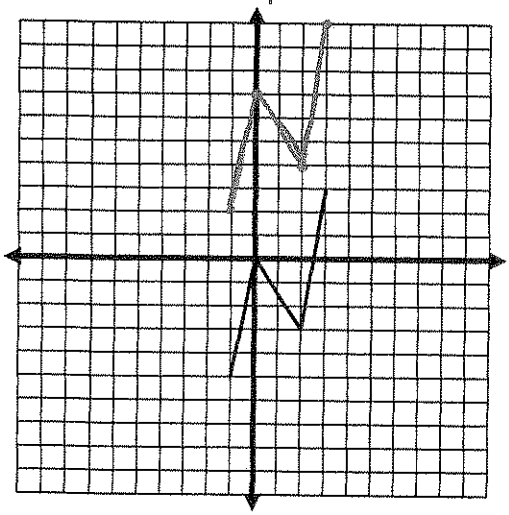
2. Describe the effect on the graph of H(x) for each of the following:
   a. H(x - 2) right 2
   b. H(x) + 7 up 7
   c. H(x+2) - 3 left 2, down 3
   d. -2H(x) vertical stretch 2, reflect over x-axis

3. Use your answers to questions 1 and 2 to help you sketch each graph *without using a table*.

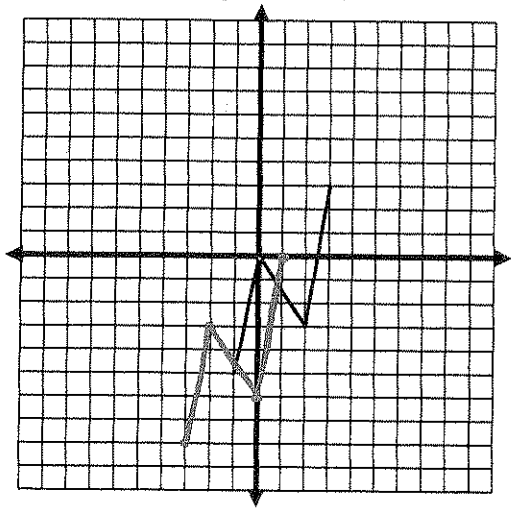
a. y = H(x - 2) (right 2)



b. y = H(x) + 7 (up 7)



c. y = H(x+2) - 3 (left 2, down 3)



d. y = -2H(x) (vertical stretch by 2, reflect over x-axis)