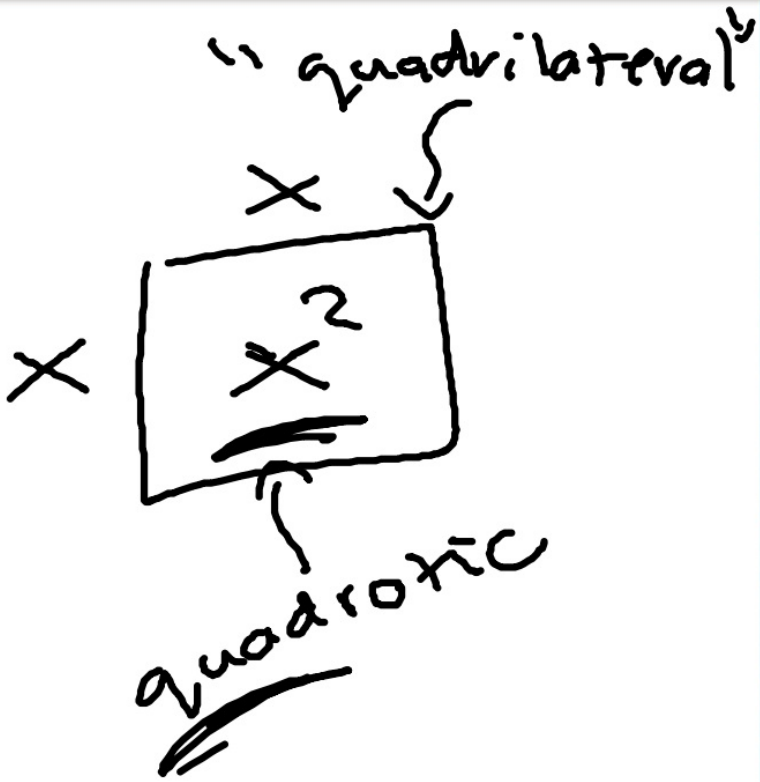
New Vocabulary

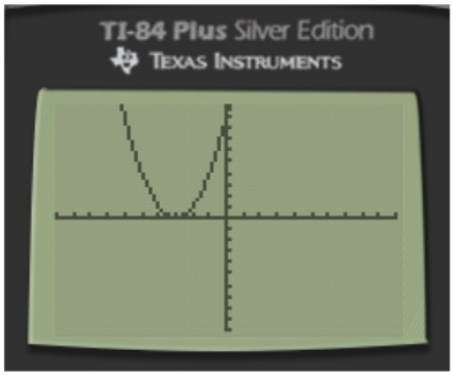
- quadratic function
- standard form
- parabola
- axis of symmetry
- vertex
- minimum
- maximum



What does a quadratic function look like?

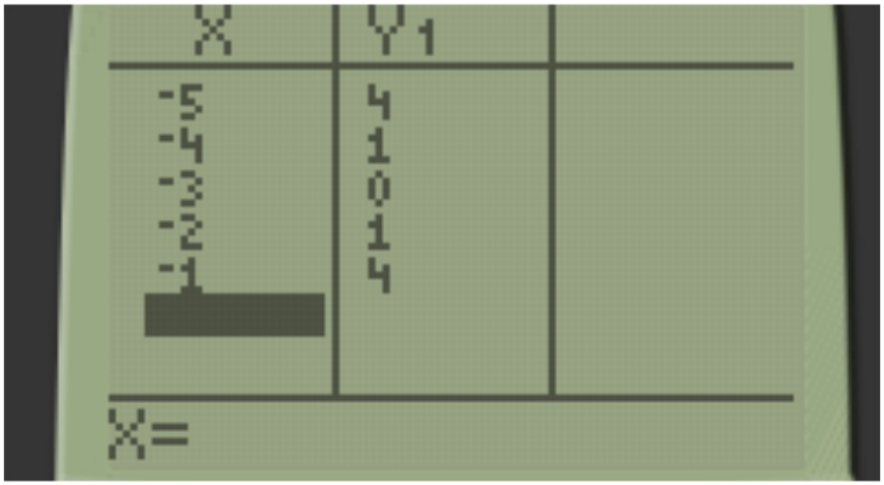
ex. $y = x^2 + 6x + 9$

look at the shape of the graph...

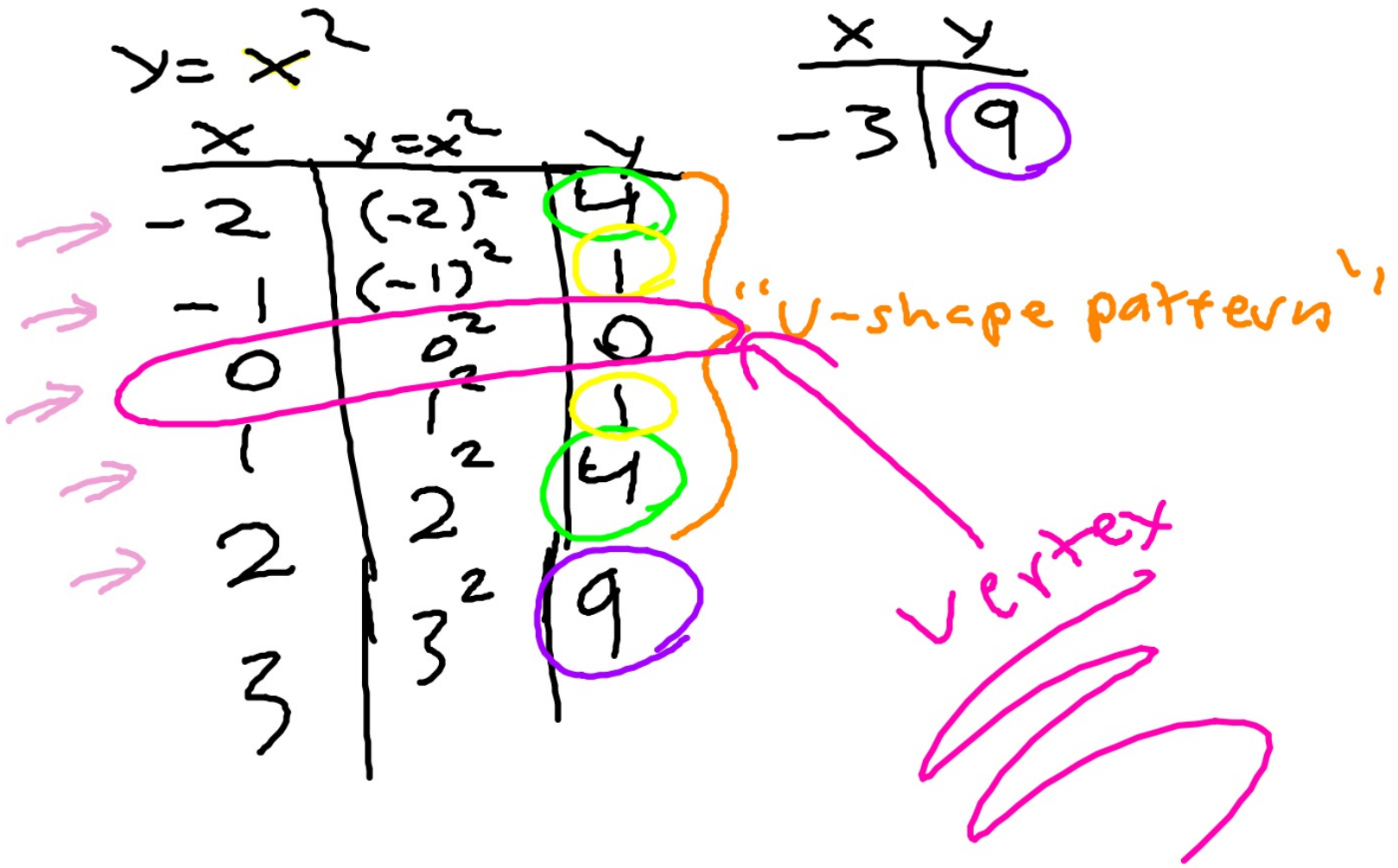


look at where the vertex is at...

also, look at the patterns of the values on the table...



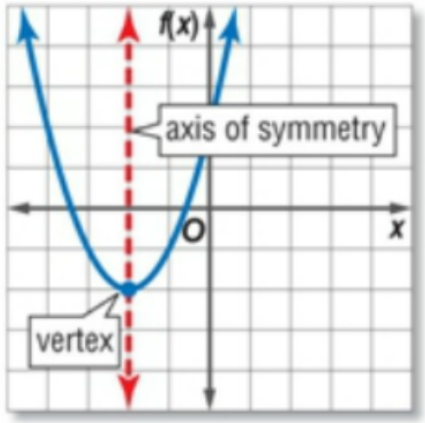
Center the table around the axis of symmetry!


$y = x^2$
x | $y = x^2$ | y
-2 | $(-2)^2$ | 4
-1 | $(-1)^2$ | 1
0 | 0^2 | 0
1 | 1^2 | 1
2 | 2^2 | 4
3 | 3^2 | 9
x y
-3 9
"U-shape pattern"
vertex

LESSON 9–1 Graphing Quadratic Functions

KeyConcept Quadratic Functions

Parent Function:	$f(x) = x^2$
Standard Form:	$f(x) = ax^2 + bx + c$
Type of Graph:	parabola
Axis of Symmetry:	$x = -\frac{b}{2a}$
y-intercept:	c



First step for all of these problems;

We will use the axis of symmetry to find the "center."

Check Your Understanding

= Step-by-Step Solutions begin on page R13.

Example 1 Use a table of values to graph each equation. State the domain and range.

1–4. See Ch. 9 Answer Appendix.

1. $y = 2x^2 + 4x - 6$
2. $y = x^2 + 2x - 1$
3. $y = x^2 - 6x - 3$
4. $y = 3x^2 - 6x - 5$

Step 1: find the axis of symmetry

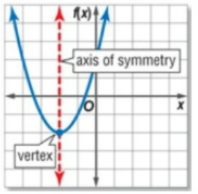
Standard Form:	$f(x) = ax^2 + bx + c$
Type of Graph:	parabola
Axis of Symmetry:	$x = -\frac{b}{2a}$
y-intercept:	c

(1) $x = \frac{-b}{2a}$ $a=2$ $b=4$

$y = 2x^2+4x-6$

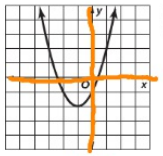
$y = ax^2+bx+c$

$x = \frac{-(4)}{2(2)} = \frac{-4}{4} = -1$



2.

x	−3	−2	−1	0	1
y	2	−1	−2	−1	2



D = {all real numbers};
R = {y | y ≥ −2}

x	y
−3	0
−2	−6
−1	−8
0	−6
1	

Just use five points for the table...

$y = 2x^2+4x-6$
$= 2(-3)^2+4(-3)-6$
$= 2(9)-12-6$
$= 18-12-6 = 0$

$y = 2x^2+4x-6$
$= 2(-2)^2+4(-2)-6$
$= 2(4)-8-6$
$= 8-8-6$
$= -6$

$y = 2x^2+4x-6$
$= 2(-1)^2+4(-1)-6$
$= 2(1)-4-6$
$= 2-10 = -8$

$y = 2(0)^2+4(0)-6$
$y = -6$

$y = 2(1)^2+4(1)-6$
$= 2+4-6 = 0$

Check Your Understanding

= Step-by-Step Solutions begin on page R13.

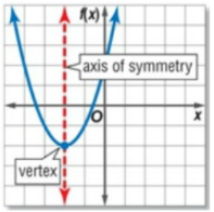
Example 1 Use a table of values to graph each equation. State the domain and range.

1. $y = 2x^2 + 4x - 6$
2. $y = x^2 + 2x - 1$
3. $y = x^2 - 6x - 3$
4. $y = 3x^2 - 6x - 5$

1–4. See Ch. 9 Answer Appendix.

Step 1: find the axis of symmetry

Standard Form:	$f(x) = ax^2 + bx + c$
Type of Graph:	parabola
Axis of Symmetry:	$x = -\frac{b}{2a}$
y-intercept:	c



① $y = 2x^2 + 4x - 6$

$x = \frac{-b}{2a} = \frac{-(4)}{2(2)}$

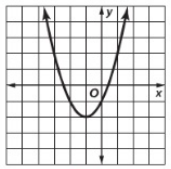
$x = -1$

x	y
−3	0
−2	−6
−1	−8
0	−6
1	0

← vertex

2.

x	−3	−2	−1	0	1	2
y	2	−1	−2	−1	2	7



D = {all real numbers};
R = {y | y ≥ −2}

$y = 2(-1)^2 + 4(-1) - 6$

$2 - 4 - 6$

-6

Just use five points for the table...

$y = 2(-3)^2 + 4(-3) - 6$

$18 - 12 - 6 = 0$

$y = 2(1)^2 + 4(1) - 6$

$y = 2 + 4 - 6 = 0$

$y = 2(-2)^2 + 4(-2) - 6$

$y = 8 - 8 - 6$

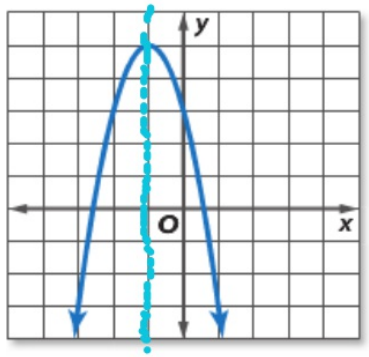
$y = -6$

$y = 0 + 0 - 6$

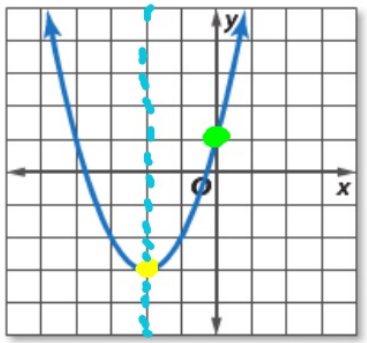
$= -6$

Example 2 Find the vertex, the equation of the axis of symmetry, and the y-intercept of each graph.

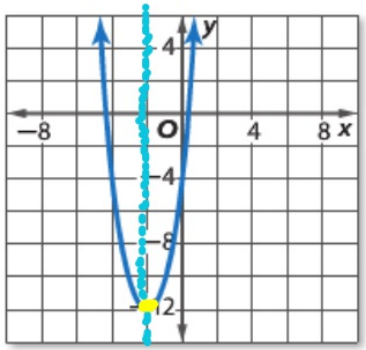
5.



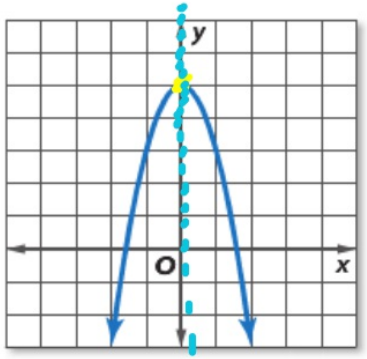
6.



7.

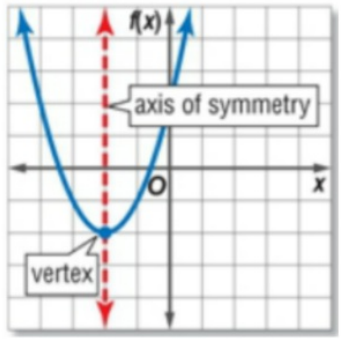


8.



5. vertex (−1, 5), axis of symmetry $x = -1$, y-intercept 3
6. vertex (−2, −3), axis of symmetry $x = -2$, y-intercept 1
7. vertex (−2, −12), axis of symmetry $x = -2$, y-intercept −4
8. vertex (0, 5), axis of symmetry $x = 0$, y-intercept 5

$x = \frac{-b}{2a}$



Check Your Understanding

= Step-by-Step Solutions begin on page R13.

Example 1 Use a table of values to graph each equation. State the domain and range.

1. $y = 2x^2 + 4x - 6$
2. $y = x^2 + 2x - 1$
3. $y = x^2 - 6x - 3$
4. $y = 3x^2 - 6x - 5$

1–4. See Ch. 9 Answer Appendix.

$y = ax^2 + bx + c$

$y = 3x^2 - 6x - 5$
$= 3 - 6 - 5$
$= -3 - 5$

Step 1: find the axis of symmetry

(4) $x = \frac{-b}{2a} = \frac{-(-6)}{2(3)} = \frac{6}{6} = 1$

$a = 3$
$b = -6$

$y = 3x^2 - 6x - 5$
$= 3(-1)^2 - 6(-1) - 5$
$= 3 + 6 - 5$

$y = 3x^2 - 6x - 5$
$= 3(2)^2 - 6(2) - 5$
$= 12 - 12 - 5$

$y = 3x^2 - 6x - 5$
$= 3(3)^2 - 6(3) - 5$
$= 27 - 18 - 5$
$27 - 23 = 4$

x	y
-1	4
0	-5
1	-8
2	-5
3	4

Example 3 Find the vertex, the equation of the axis of symmetry, and the y-intercept of the graph of each function.

9. $y = -3x^2 + 6x - 1$

10. $y = -x^2 + 2x + 1$

11. $y = x^2 - 4x + 5$

12. $y = 4x^2 - 8x + 9$ **vertex (1, 5), axis of symmetry $x = 1$, y-intercept 9**

Step 1: find the axis of symmetry

(9) $y = -3x^2 + 6x - 1$

$x = \frac{-b}{2a} = \frac{-(6)}{2(-3)} = \frac{-6}{-6}$

$x = 1$

$F(x) = ax^2 + bx + c$

$y = -3(1)^2 + 6(1) - 1$

$= -3 + 6 - 1$

$= -4 + 6 = 2$

$y = 2$

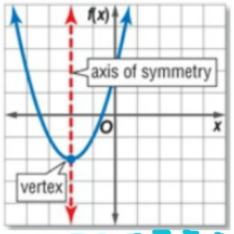
axis of symmetry

$x = 1$

vertex

$(1, 2)$

10. vertex (1, 2), axis of symmetry $x = 1$, y-intercept 1



Standard Form:	$f(x) = ax^2 + bx + c$
Type of Graph:	parabola
Axis of Symmetry:	$x = -\frac{b}{2a}$
y-intercept:	c

$x = 1,$

Example 4 Consider each function. **13–16. See margin.**

a. Determine whether the function has *maximum* or *minimum* value.

b. State the maximum or minimum value.

c. What are the domain and range of the function?

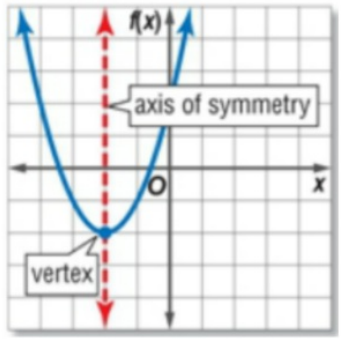
13 $y = -x^2 + 4x - 3$

14. $y = -x^2 - 2x + 2$

15. $y = -3x^2 + 6x + 3$

16. $y = -2x^2 + 8x - 6$

Step 1: find the axis of symmetry



Standard Form:	$f(x) = ax^2 + bx + c$
Type of Graph:	parabola
Axis of Symmetry:	$x = -\frac{b}{2a}$
y-intercept:	c

Example 5 Graph each function. **17–20. See margin.**

17. $f(x) = -3x^2 + 6x + 3$

18. $f(x) = -2x^2 + 4x + 1$

19. $f(x) = 2x^2 - 8x - 4$

20. $f(x) = 3x^2 - 6x - 1$

Step 1: find the axis of symmetry

(20) $x = \frac{-b}{2a} = \frac{(-6)}{2(3)}$

$= \frac{6}{6} = 1$

$x = 1$

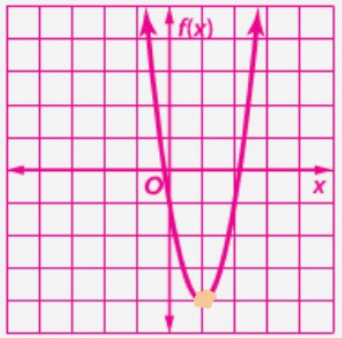
$y = 3x^2 - 6x - 1$

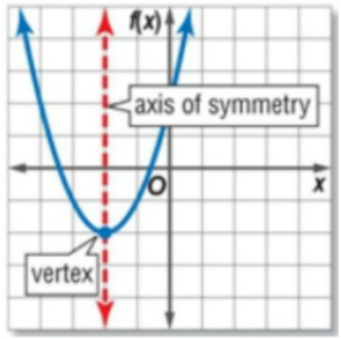
$y = 3(1) - 6(1) - 1$

$y = 3 - 6 - 1$

$y = -4$

20.





Standard Form:	$f(x) = ax^2 + bx + c$
Type of Graph:	parabola
Axis of Symmetry:	$x = -\frac{b}{2a}$
y-intercept:	c

Example 6

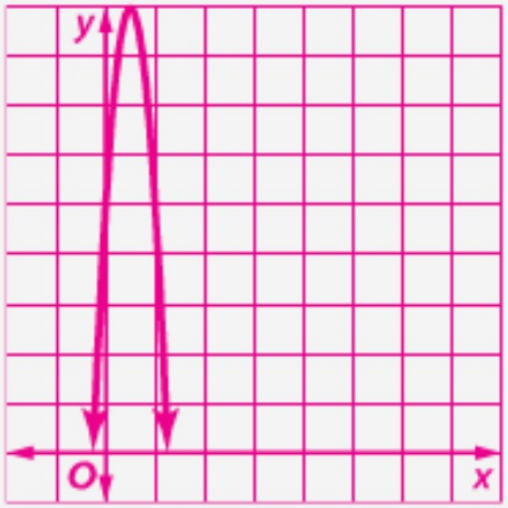
21. CCSS **REASONING** A juggler is tossing a ball into the air. The height of the ball in feet can be modeled by the equation $y = -16x^2 + 16x + 5$, where y represents the height of the ball at x seconds.

a. Graph this equation. **See margin.**

b. At what height is the ball thrown? **5 ft**

c. What is the maximum height of the ball? **9 ft**

21a.

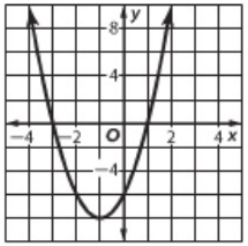


Standard Form:	$f(x) = ax^2 + bx + c$
Type of Graph:	parabola
Axis of Symmetry:	$x = -\frac{b}{2a}$
y-intercept:	c

Lesson 9-1

1.

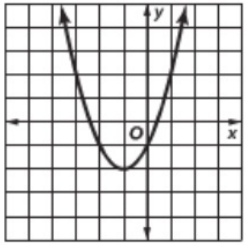
x	−3	−2	−1	0	1	2
y	0	−6	−8	−6	0	10



D = {all real numbers};
R = {$y \mid y \geq -8$}

2.

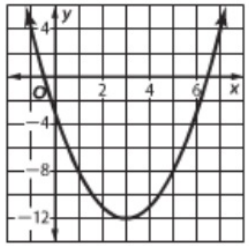
x	−3	−2	−1	0	1	2
y	2	−1	−2	−1	2	7



D = {all real numbers};
R = {$y \mid y \geq -2$}

3.

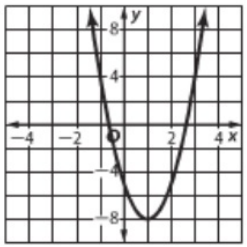
x	y
−1	4
0	−3
1	−8
2	−11
3	−12
4	−11
5	−8
6	−3
7	4



D = {all real numbers};
R = {$y \mid y \geq -12$}

4.

x	−2	−1	0	1	2	3
y	19	4	−5	−8	−5	4



D = {all real numbers};
R = {$y \mid y \geq -8$}