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DepED
DEPARTMENT OF EDUCATION

Mathematics

Quarter 1 - Module 18

Graphs of Quadratic Function

Week 7

Learning Code - M9AL-Ih-13.1

ALTERNATIVE DELIVERY MODE
ADM

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MODULE 18

GRAPHS OF QUADRATIC FUNCTION

The previous module, you learned to transform the general form and the standard form of quadratic functions. You were given opportunities to change one in terms of the other and relate the concept in real world. In this module, you will work on graphing quadratic functions. You will find out the steps to consider in graphing quadratic. You will be given opportunities to explore the graphs of quadratic function.

WHAT I NEED TO KNOW

LEARNING COMPETENCY

The learners will be able to:

- graph a quadratic function. **M9AL-Ih-13.1**

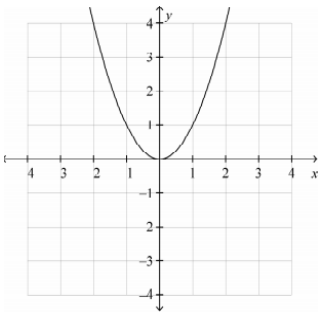
WHAT I KNOW

Find out how much you already know about graphs of quadratic function. Write the letter that you think is the correct answer to each question on your answer sheet. Answer all items. After taking and checking this short test, take note of the items that you were not able to answer correctly and look for the right answer as you go through this module.

1. What is the graph of a quadratic function?

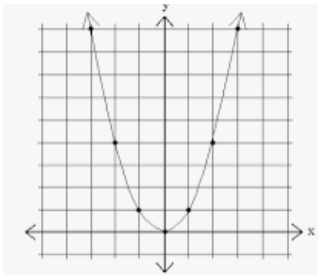
   A) Circle B) Line C) Parabola D) V-Shape

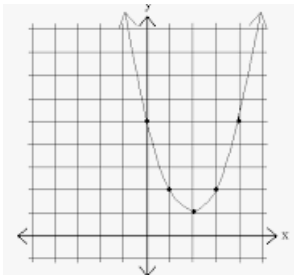
2. Identify the vertex of the graph. Tell whether it is a minimum or maximum.

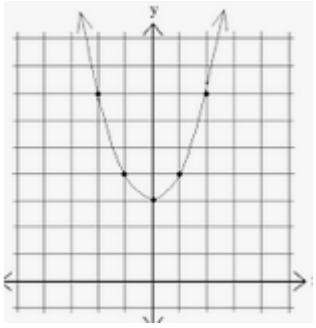


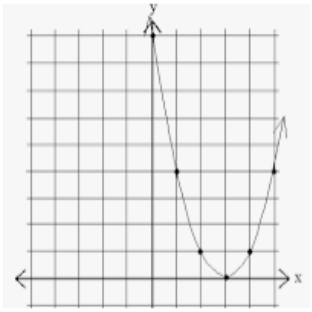
   A) (0,0) ; minimum B) (0,1) ; minimum
   C) (1,0) ; maximum D) (2,0) ; maximum

3. Which of the following is the graph of the equation $y = x^2$

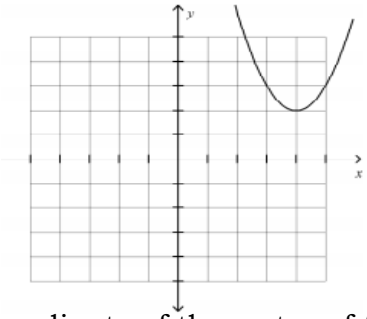
A) 

B) 

C) 

D) 

4. What function models the graph at the right?



A) $y = (x + 2)^2 + 4$ B) $y = (x - 4)^2 + 2$

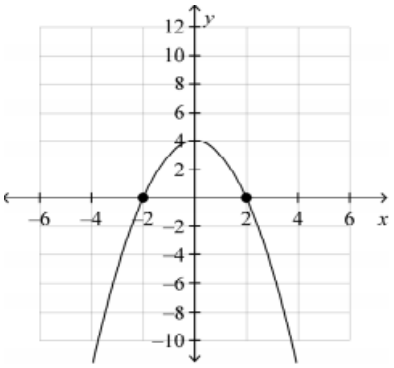
C) $y = (x + 4)^2 + 2$ D) $y = (x - 4)^2 - 2$

5. Find the equation of the axis of symmetry and the coordinate of the vertex of the graph of $y = x^2 - 8x + 7$?

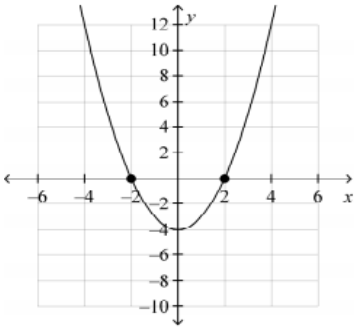
A) $x = 4\,;\, vertex\ (4, -9)$ B) $x = -4\,;\, vertex\ (-4, -9)$

C) $x = -9\,;\, vertex\ (-9,4)$ D) $x = 4\,;\, vertex\ (-4, -9)$

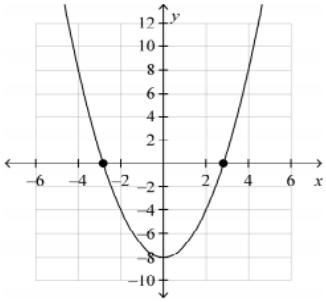
6. Solve $x^2 + 2 = 6$ by graphing the related function.



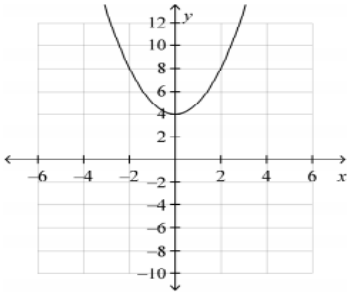
A) There are two solutions: 2 and -2.



B) There are two solutions: 2 and -2.

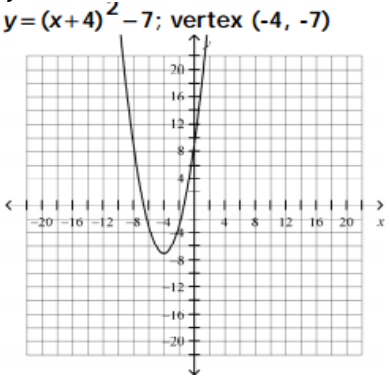


C) There are two solutions: $\pm\sqrt{8}$.

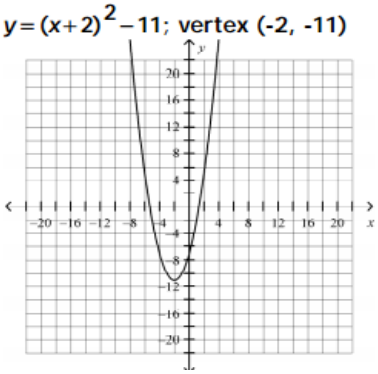


D) There are no real number solutions.

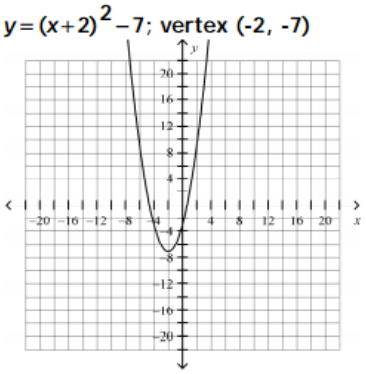
7. Convert $y = x^2 + 4x - 7$ to vertex form, identify the vertex and the graph.



A)



B)



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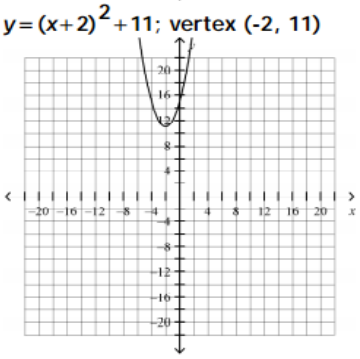
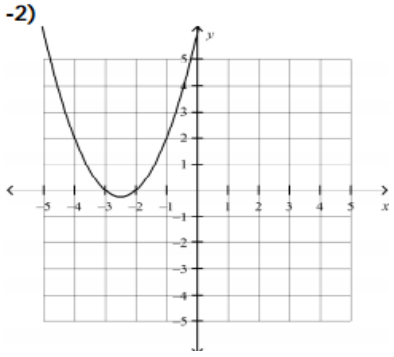


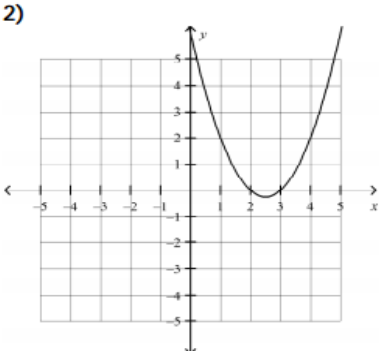
D)

8. Convert $y = x^2 + 5x - 6$ to factored form, identify the x – intercepts and the graph?

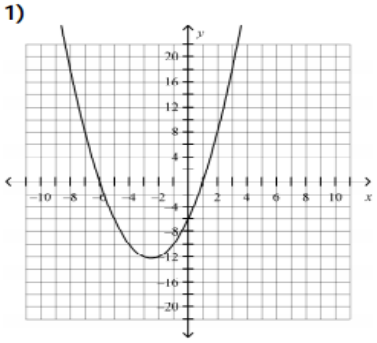
A) y = (x + 3)(x + 2); x-ints (0, -3)(0, -2)



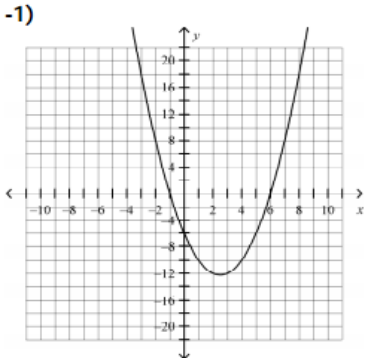
B) y = (x - 3)(x - 2); x-ints (0, 3)(0, 2)



C) y = (x + 6)(x - 1); x-ints (0, -6)(0, 1)



D) y = (x - 6)(x + 1); x-ints (0, 6)(0, -1)



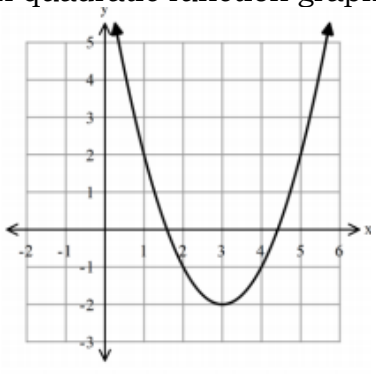
9. Which quadratic function opens upwards and has a vertex of (0,3)

A) $y = -(x-3)^2$ B) $y = -(x-3)^2$

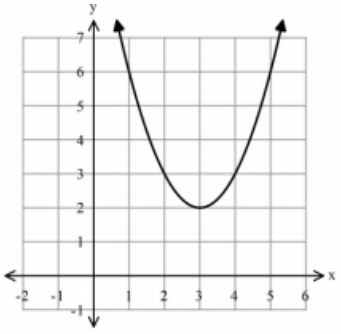
C) $y = x^2 + 3$ D) $y = -x^2 + 3$

10. Which quadratic function graphed below has a vertex of $(3, -2)$?

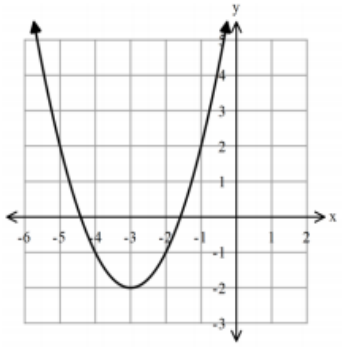
A)



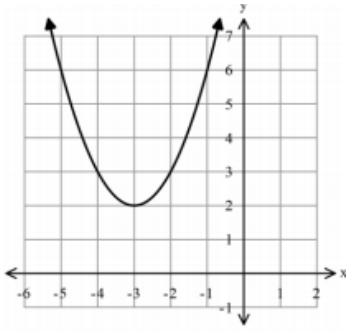
B)



C)



D)



WHAT'S IN

Communication, and Critical Thinking

Let's start the lesson by generating table of values of quadratic functions and plotting the points on the coordinate plane.

Activity 1: Describe My Paths!

Follow the procedure in doing the activity.

a. Given the quadratic functions $y = x^2 - 8x + 7$ and $y = -x^2 + 4x + 5$, transform them in the form of $y = a(x - h)^2 + k$.

$y = x^2 - 8x + 7$

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

b. Complete the table of values for x and y.

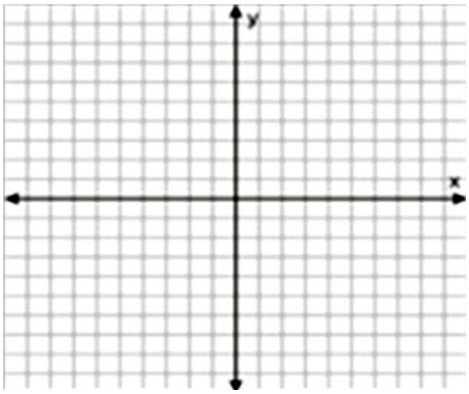
$y = x^2 - 8x + 7$

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

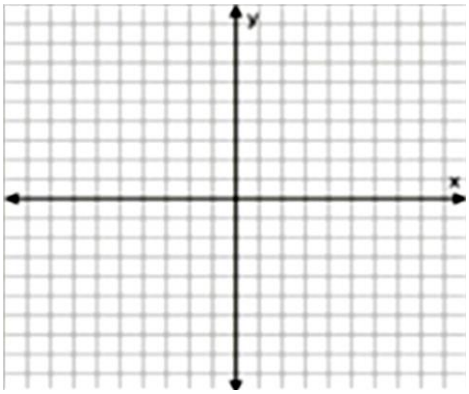
$y = -x^2 + 4x + 5$

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

c. Sketch the graph on the Cartesian plane



$y = x^2 - 8x + 7$



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

✓ **Let's Investigate!**

a. How will you describe the graph formed? What do you call this graphs?
b. What have you observed about the opening of the curves? Do you have any idea where you can relate the opening of the curves?
c. Which of the two quadratic functions has a minimum point? Maximum point? Indicate below.

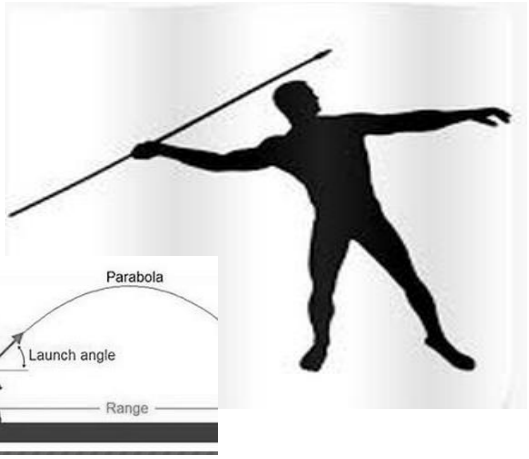
Quadratic Function	**Turning Point**	**Maximum or minimum Point**
$y = x^2 - 8x + 7$		
$y = -x^2 + 4x + 5$		

WHAT'S NEW

Communication, and Collaboration

Quadratics in Athletics

In athletic events that involve throwing objects like the shot put, balls or javelin, quadratic equations become highly useful. For example, you throw a ball into the air and have your friend catch it, but you want to give her the precise time it will take the ball to arrive. Use the velocity equation, which calculates the height of the ball based on a parabolic or quadratic equation.

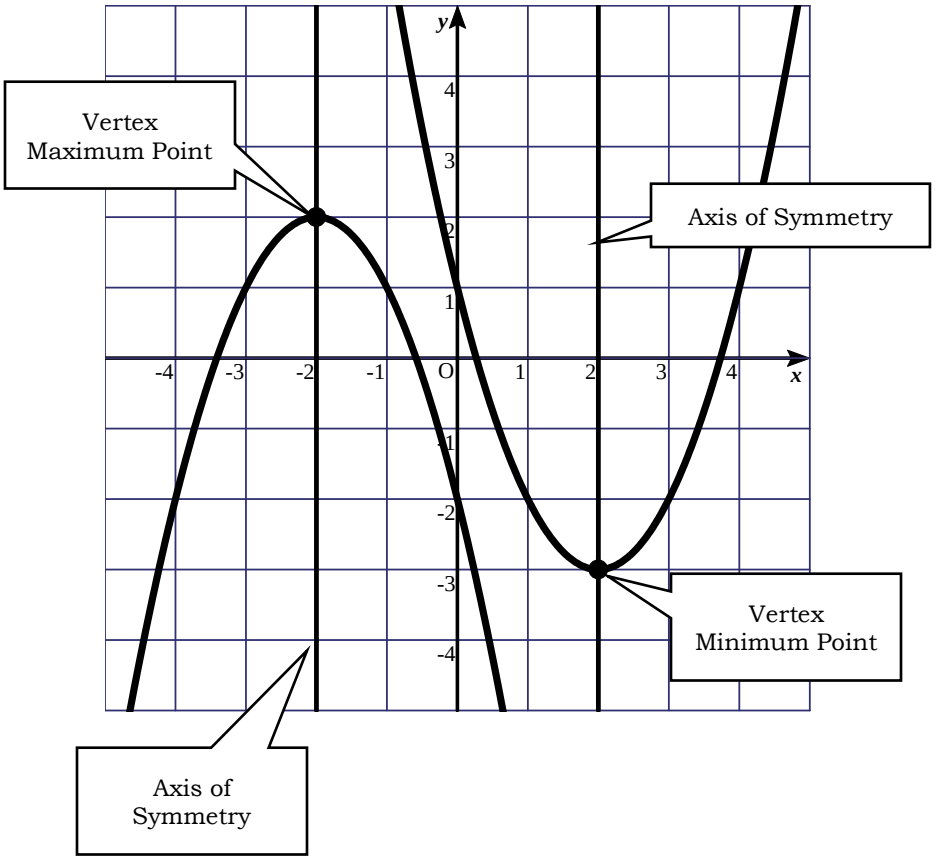


Like the result of activity 1, you produced curves called parabola. Did you enjoy that activity? To better understand the properties of the graph of a quadratic function, study the key concept below.

WHAT IS IT

Communication, Critical Thinking, and Collaboration

The graph of a quadratic function $y = ax^2 + bx + c$ is called **parabola.** You have noticed that the parabola opens upward or downward. It has a turning point called vertex which is either the highest point or the lowest point of the graph. If the value of $a > 0$, the parabola opens upward and has a minimum point. If $a < 0$ the parabola opens downward and has a maximum point. There is a line called the axis of symmetry which divides the graph into two parts such that one half of the graph is a reflection of the other half. If the quadratic function is expressed in the form of $y = a(x-h)^2 + k$ the vertex is the point(h, k) . The line $x = h$ is the axis of symmetry and k is the minimum or maximum value of the function.



Example 1. Draw the graph of the quadratic function $y = x^2 - 4x + 3$.

Solution:

a. Find the vertex and the line of symmetry by expressing the function in the form of $y = a(x - h)^2 + k$.

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

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

$y = (x - 2)^2 - 1$

Thus, the vertex is at (2, -1) and the axis of symmetry is at x = 2

b. On one side of the line of symmetry, choose at least one value of x and compute the value of y.

If x = 3, then $y = (3 - 2)^2 - 1$

$y = 0$

Thus, the point is at (3, 0)

c. Similarly choose at least one value of x on the other side and compute for the value of y.

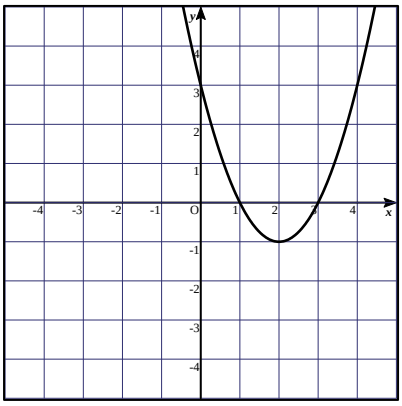
If x = 1, the $y = (1\ -2)^2 - 1$

$y = (-1)^2 - 1$

$y = 0$

Thus, the point is at (1, 0)

d. Plot the points and connect them by smooth curve.



Example 2. Draw the graph of the quadratic function $11 = y - 3x^2 + 12x$

Solution:

a. Find the vertex and the line of symmetry by expressing the function in the form of $y = a(x - h)^2 + k$.

$11 = y - 3x^2 + 12x$

$y = 3x^2 - 12x + 11$

$y = 3(x^2 - 4x) + 11$

$y = 3(x^2 - 4x + 4) + 11 - 12$

$y = 3(x - 2)^2 - 1$

Thus, the vertex is at (2, –1) and the axis of symmetry is at x = 2

b. On one side of the line of symmetry, choose at least one value of x and compute the value of y.

If x = 3, then $y = 3(3 - 2)^2 - 1$

$y = 2$

Thus, the point is at (3, 2)

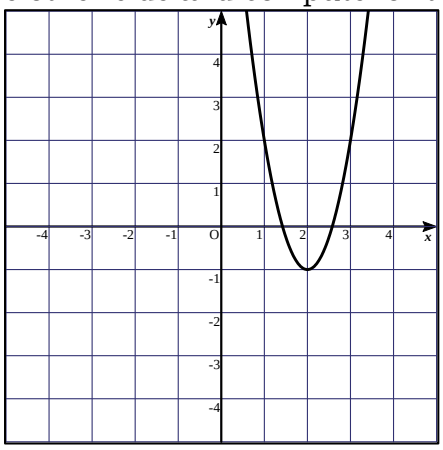
c. Similarly choose at least one value of x on the other side and compute for the value of y.

If x = 1, the $y = 3(1 - 2)^2 - 1$

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

$y = 2$

Thus, the point is at (1, 2)



d. Plot the points and connect them by smooth curve.

Example 3. Draw the graph of the quadratic function $y = -x^2 - 2x + 3$

Solution:

a. Find the vertex and the line of symmetry by expressing the function in the form of $y = -x^2 - 2x + 3$.

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

$y = -(x^2 + 2x) + 3$

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

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

Thus, the vertex is at (-1, 4) and the axis of symmetry is at x = -1

b. On one side of the line of symmetry, choose at least one value of x and compute the value of y.

If x = 0, then

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

$y = -(0)^2 - 2(0) + 3$

$y = 3$

Thus, the point is at (0, 3)

c. Similarly choose at least one value of x on the other side and compute for the value of y

If x = -2, then

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

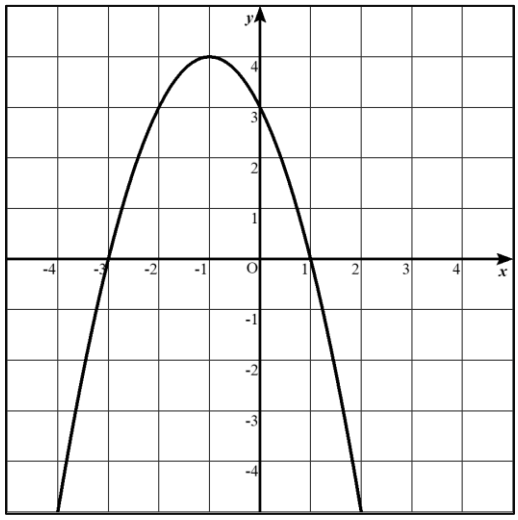
$y = -(-2)^2 - 2(-2) + 3$

$y = -4 + 4 + 3$

$y = 3$

Thus, the point is at (-2, 3)

d. Plot the points and connect them by smooth curve.



Are you ready to work on your own? Try to graph the next set of quadratic functions.

WHAT'S MORE

Critical Thinking, Communication and Collaboration

Graph the following quadratic functions following the steps used in the examples.

1. $y = -(x^2 - 2x) + 3$
2. $2x^2 + 8x = 4 - y$
3. $4x^2 - y = 12x - 7$
4. $11 = y - 3x^2 + 12x$
5. $3 = (x - 4)^2 - y$

How did you find the activity? Were you able to graph all the quadratic functions? If not, in which part did you find challenging? How did you cope up with it?

WHAT I HAVE LEARNED

Steps in graphing quadratic equation.

1. Find the axis of symmetry
2. Find the vertex
3. Draw your coordinate and dash in your axis of symmetry. Plot the point for the vertex.
4. Plot the y – intercept and the point symmetrical to it. The y-intercept is "*c*".
5. Find at least one point on the parabola then draw the curve.

WHAT I CAN DO

Critical Thinking

Graph the following quadratic functions.

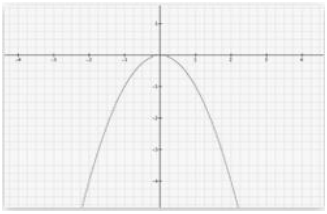
1. $y = (x + 2)^2 - 3$
2. $y = -(x - 3)^2 + 2$
3. $y = 2x^2 - 8x + 3$
4. $y = -x^2 + 2x + 1$
5. $y + 3x^2 = 6x - 1$
6. $y = -3x^2 - 6x + 4$
7. $y = 2x^2 - 12x + 9$
8. $2x^2 - 16x = y - 33$
9. $y - 3x^2 + 6x = 5$
10. $y - 4 = 3x^2 + 12x$

ASSESSMENT

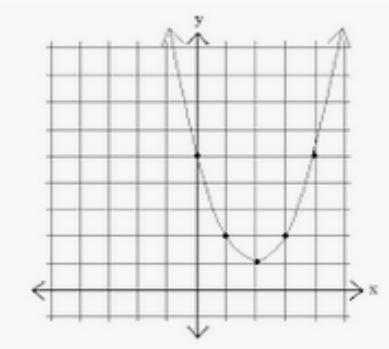
Read each item carefully. Identify the choice that correctly completes the statement or answers the question.

1. What is the graph of a quadratic function?
   A) Circle B) Line C) Parabola D) V-Shape

2. Identify the vertex of the graph. Tell whether it is a minimum or maximum.
   A) (0,0) ; minimum B) (0,1) ; minimum
   C) (1,0) ; maximum D) (0,0) ; maximum



3. Which set of data is correct for this graph?



	Axis of symmetry	vertex
A)	$x = 2$	(2,1)
B)	$x = 2$	$(-2,1)$
C)	$x = 1$	(1,2)
D)	$x = 1$	$(-1,2)$

4. Which set of data is correct for the quadratic function $= (x - 20)^2 + 20$?

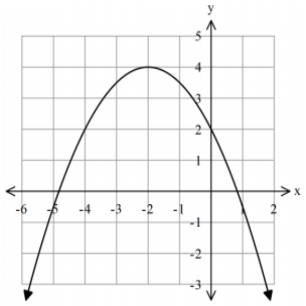
	Directions parabola opens	Vertex	Axis of symmetry
A)	Upward	$(20, -20)$	$x = 20$
B)	Upward	(20,20)	$x = 20$
C)	Downward	(20,20)	$x = 20$
D)	Downward	$(-20, -20)$	$x = 20$

5. Which quadratic function has an axis of symmetry of $x = 2$ and a maximum value of 4?

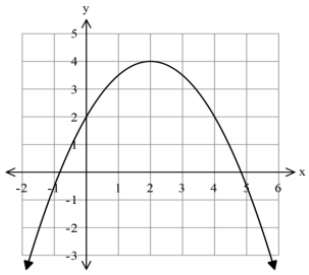
A) $y = 3(x + 2)^2 - 4$
B) $y = -3(x + 2)^2 + 4$
C) $y = 3(x - 2)^2 - 4$
D) $y = -3(x - 2)^2 + 4$

6. Which graph represents the function $y = -\frac{1}{2}(x + 2)^2 + 4$?

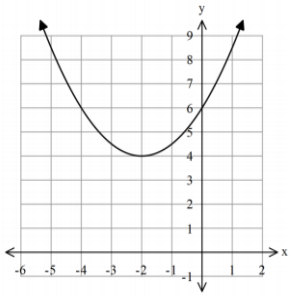
A)



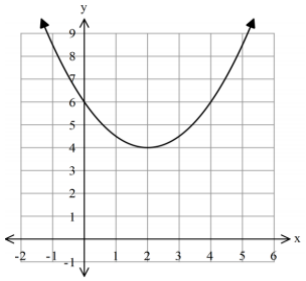
B)



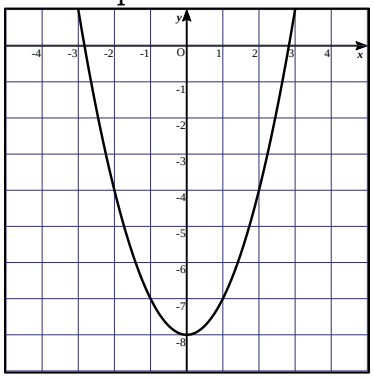
C)



D)

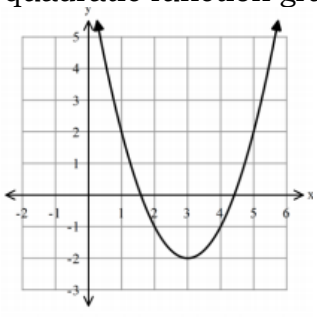


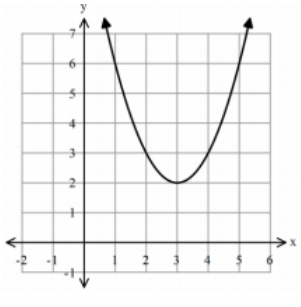
7. Which statement is correct for the quadratic function graphed below?

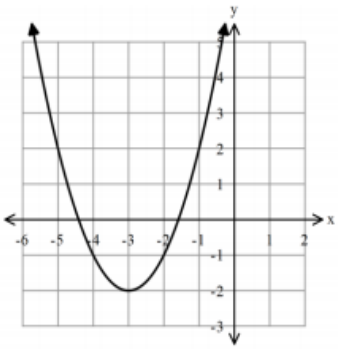


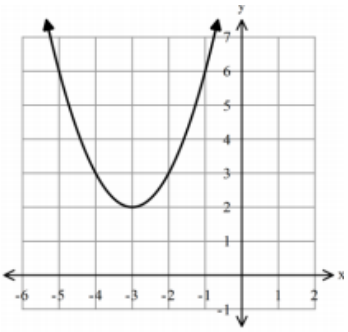
A) The graph of the function is $y = x^2 + 8$ with a maximum value of -8
B) The graph of the function is $y = -x^2 + 8$ with a maximum value of -8
C) The graph of the function is $y = x^2 - 8$ with a minimum value of -8
D) The graph of the function is $y = -x^2 - 8$ with a minimum value of -8

8. Which quadratic function graphed below has a vertex of $(-3,2)$?

A) 

B) 

C) 

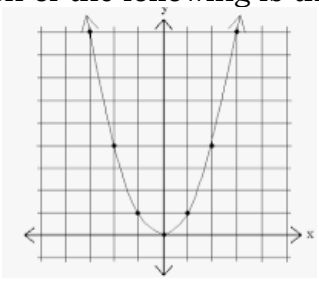
D) 

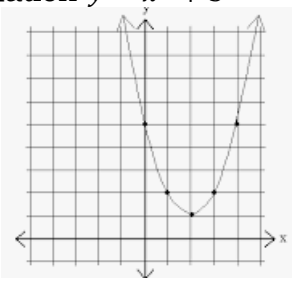
9. Which quadratic function opens downward and has a vertex of $(0,3)$

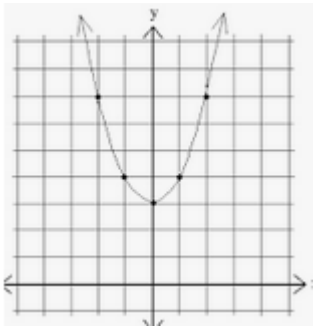
A) $y = -(x-3)^2$ B) $y = -(x-3)^2$

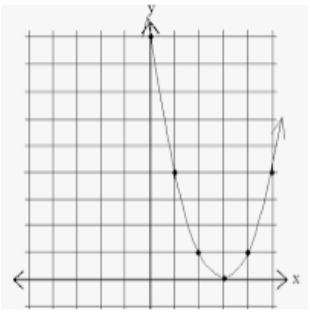
C) $y = x^2 + 3$ D) $y = -x^2 + 3$

10. Which of the following is the graph of the equation $y = x^2 + 3$

A) 

B) 

C) 

D) 

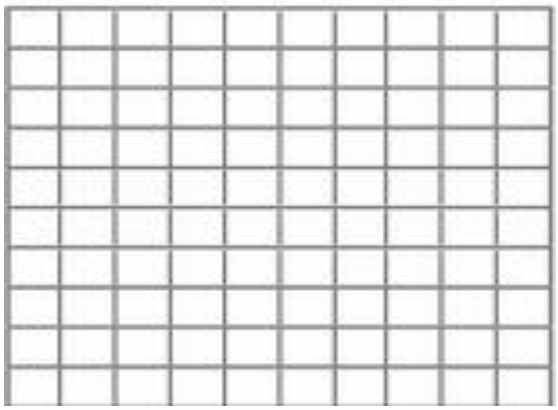
ADDITIONAL ACTIVITIES

Communication, Critical Thinking, Creativity and Character Building

Activity 1: Hit the Ball!

Mara hit the ball at 3 ft. above the ground with an initial velocity of 32 ft/sec. The path of the ball is given by the function $S(t) = -16t^2 + 32t + 3$, where S is the height of the ball at t seconds. What is the maximum height reach by the ball?

a. What kind of function is used to model the path of the volleyball?
b. Draw the path of the volleyball and observe the curve.



c. What is the maximum point reached by the ball?
d. What is represented by the maximum point of the graph?

Activity 2: Reflection

Like graphs of quadratic function, your life is full of ups and downs. Without the "downs" your "ups" would mean nothing.

Have you encountered any situation that you fill so down? How did you manage to stand and move up?

PROBLEM – BASED WORKSHEET

Frame for Sale

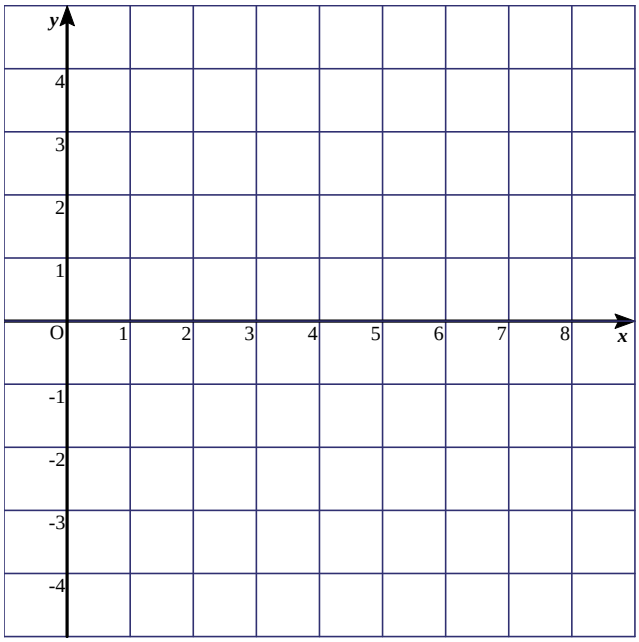
A frame company offers a line of square frames. If the side length of the frame is s, then the area of the opening in the frame is given by the function $A = s^2 - 12s + 32$. Graph the function.

Let's Analyze!

1. Complete the table of values for the function $A = s^2 - 12s + 32$.

x	1	2	3	4	5	6	7	8	9
y									

2. Graph the function.



3. Based on the graph which length of sides of the square frame should be avoided? Why?

4. What are the possible sides of the square frame? Why?

E-Search

You may also check the following link for your reference and further learnings on graphs of quadratic function.

- https://www.youtube.com/watch?v=Cn1aFaxRyeU
- http://jwilson.coe.uga.edu/EMT668/EMAT6680.Folders/Barron/unit/Lesson%206/6.html
- https://saylordotorg.github.io/text_intermediate-algebra/s09-04-quadratic-functions-and-their-.html
- https://www.ohschools.k12.oh.us/userfiles/223/Classes/197/6_March15.pdf

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https://www.slideshare.net/paolodagaojes/9-math-lm-u1m2v10
https://www.slideshare.net/dionesioable/module-2-quadratic-functions
https://sciencing.com/everyday-examples-situations-apply-quadratic-equations-10200.html

Illustrations:
https://www.freepik.com/free-vector/woman-with-long-hair-teaching-online_7707557.htm
https://www.freepik.com/free-vector/kids-having-online-lessons_7560046.htm
https://www.freepik.com/free-vector/illustration-with-kids-taking-lessons-online-design_7574030.htm

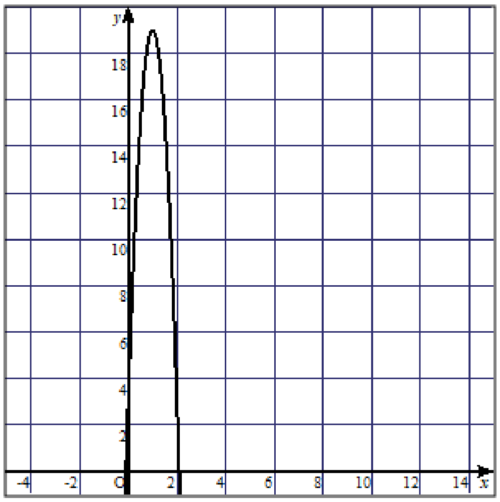
ASSESSMENT

1. C
2. D
3. A
4. B
5. D
6. A
7. C
8. D
9. D
10. C

ADDITIONAL ACTIVITIES

a. Quadratic Function

b.



c. (-1,19)

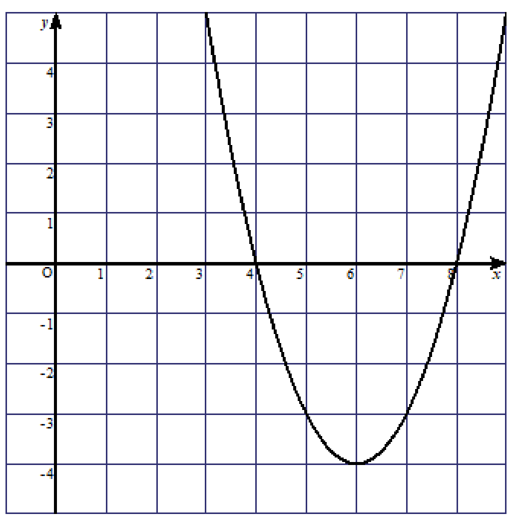
d. vertex

PROBLEM – BASED WORKSHEET

1.

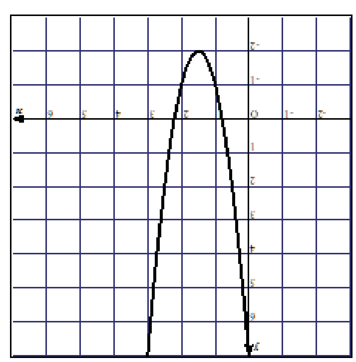
x	1	2	3	4	5	6	7	8	9
y	21	12	5	0	-3	-4	-3	0	5

2.



3. The frames should not have a side of 4 units to 8 units because it will result to either zero area or a negative area at all.

4. The side of the square frame can be 0< s < 4 and s > 8 because this values produce positive area.

3.


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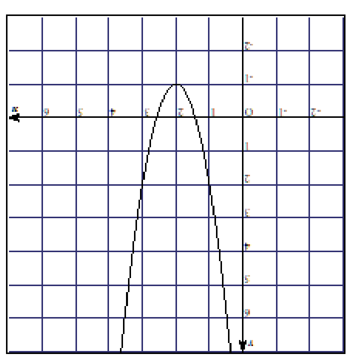

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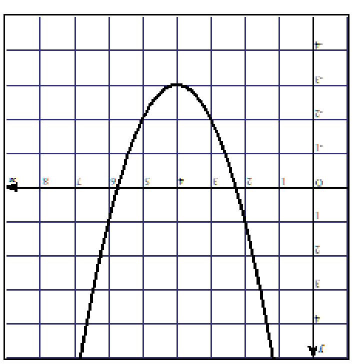

WHAT I CAN DO

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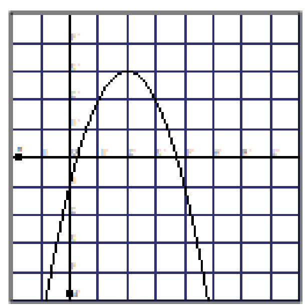

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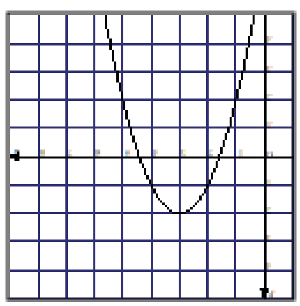

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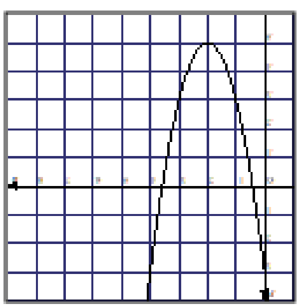

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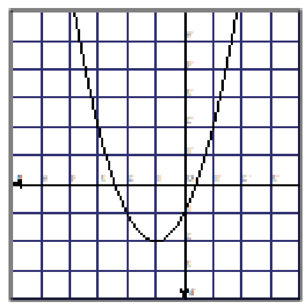

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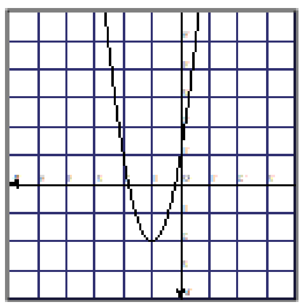

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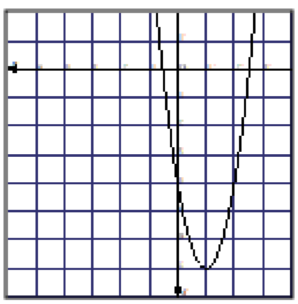

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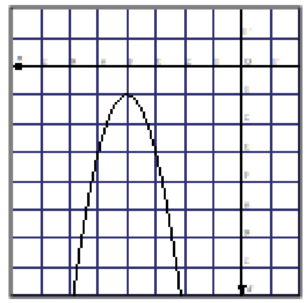

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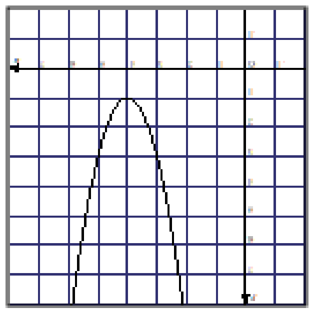

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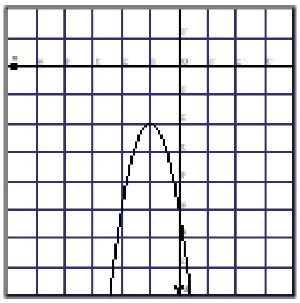

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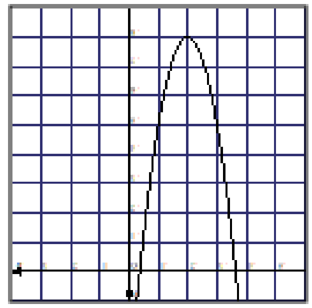


ANSWER KEY

WHAT I KNOW

1. C	3. A	5. A	7. B	9. C
2. A	4. B	6. B	8. C	10. A

WHAT'S IN

a. $y = (x-4)^2 - 9$
$y = -(x-2)^2 + 9$

b. Complete the table of values for x and y.

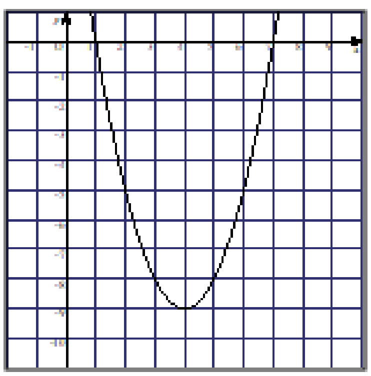
$y = x^2 - 8x + 7$

x	-3	-2	-1	0	1	2	3	4	5
y	40	27	16	7	0	-5	-8	-9	-8

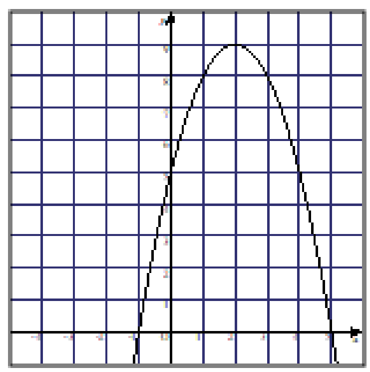
$y = -x^2 + 4x + 5$

x	-3	-2	-1	0	1	2	3	4	5
y	-16	-7	0	5	8	9	8	5	0

c. Sketch the graph on the Cartesian plane



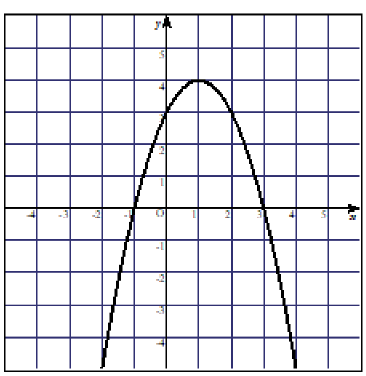
$y = x^2 - 8x + 7$



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

WHAT'S MORE

1.



2.