9

Mathematics
Quarter 1 - Module 14
Models of Quadratic Function
Week 6
Learning Code - M9AL-If-10

Learning Module for Junior High School Mathematics

Quarter 1 – Module 14 – **New Normal Math for G9**
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Learning Module for Junior High School Mathematics

MODULE 14	# MODELS OF QUADRATIC FUNCTION

In the previous lessons, you have learned about quadratic equations and quadratic inequalities and the ways to find their solutions. You were given opportunities to solve real-life problems using quadratic equations and inequalities. In this module, you will again learn one of the most important topics in algebra because it has many applications that it plays a vital role in our life.

WHAT I NEED TO KNOW

LEARNING COMPETENCY

The learners will be able to:

Model real-life situation using quadratic functions. **M9AL-If-10**

WHAT I KNOW

Find out how much you already know about the module. Write the letter that you think is the best answer to each question on a sheet of paper. 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. It is a function often used in solving for extreme function, values and motion problems such as trajectory and acceleration.
   A) Linear Function
   B) Quadratic Function
   C) Radical Function
   D) Rational Function
2. What is the graph of a quadratic function?
   A) Circle
   B) Line
   C) Parabola
   D) V-Shape
3. Which of the following is the form of quadratic function in the variables x and y.
   A) $y = mx + b$
   B) $y = ax^2 + bx + c$
   C) $y = ax^3 + bx + c$
   D) $y = ax^3 + bx^2 + cx + d$

4. A rental company charges a flat fee of P30 and an additional P0.25 per km to rent a moving van. The equation of this is y=0.25x+30 with the graph shown on the side. What function best describes the situation?

   A) Rational Function
   B) Radical Function
   C) Quadratic Function
   D) Linear Function
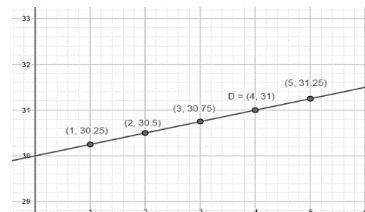
5. A ball is shot from a cannon into the air with an upward velocity of 40 ft/sec. The graph is shown on the side. Which is a possible equation for this situation?
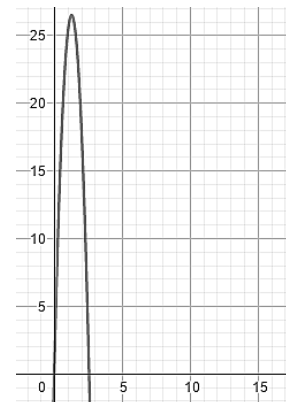   A) $h = -16t^2 + 40t + 1.5$
   B) $h = -16t^3 + 40t^2 + 1.5t$
   C) $h = 40t + 1.5$
   D) $h = 40t$

6. Which of the following situation represents a quadratic function?
   A) An employee is paid $12 for each hour worked.
   B) The maximum area of a rectangular cardboard that can be framed using 140 inches of border materials.
   C) The amount of fuel, in gallons G, in a vehicle's fuel tank after driving m miles is G = 20 - 0.03m.
   D) Jeepney fare J for h kilometers at a flag down rate at P10 and P0.50per kilometer.

7. Which of the following situation does NOT represent a quadratic function?
   A) A rock is thrown off a 75 meter high cliff into some water. The height of the rock relative to the cliff after t seconds is given by $h(t)=-5t^2+20t$.
   B) The area A of a room with width 5m more than the length.
   C) The width of a frame in creating a border using all of the 10sq. feet of fabric for a quilt that is 4 feet by 5 feet.
   D) The total number of credit hours C that remain for a student to earn a degree after s semesters have been completed successfully is given by C = 130 - 9s.

8. Which of the following is a quadratic function?
   A) $2x + y = 6$ C) $2x^2 - y = 6$
   B) $2x^2 - 3x + 1 = 0$ D) $2x - y^2 = 6$

For item 9, use the given below.
   I. $y = 4x + 3$
   II. $y = 3x^2 - 2$
   III. $y = (x - 5)(x + 8)$
   IV. $(3x - 4)(x + 1) = 3(x + 1) + y$

9. Which of the following equation/s represents a quadratic function?
   A) I only   C) II, III, and IV
   B) I and II only   D) I, II, III, and IV

10. What is true about the equation $y + 2x^2 = 2x(x + 1)$?
    A) The equation represents quadratic function because the highest degree of the variable is 2
    B) If you will simplify and rearrange the function, it will be in the form of y = mx +b. Therefore, it is not quadratic function, but a linear function.
    C) The highest degree of the variable is 3. Thus, it is not quadratic function.
    D) If the function is expanded it will be $y = 2x^2 + 2x + 1$. Thus, the equation represents quadratic function.

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WHAT'S IN

Let us recall the concept of linear function. This will help you understand the next lesson better.

The graph of a function f is the set of points which satisfy the equation y=f(x). A linear function is of the form y = mx + b or f(x)=mx+b.

Let us graph the linear function y = 2x – 1 following the given steps:
Step 1: Complete the table

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

Solution: Since **y = f(x),** to get the values of y and complete the table we need to do this:

if x = -2,
$y = 2x - 1$
$f(x) = 2x - 1$
$f(-2) = 2(-2) - 1$
$f(-2) = -4 - 1$
$f(-2) = -5$
then y = -5

if x = -1,
$y = 2x - 1$
$f(x) = 2x - 1$
$f(-1) = 2(-1) - 1$
$f(-1) = -2 - 1$
$f(-2) = -3$
then y = -3

if x = 0, then y = -1
$y = 2x - 1$
$f(x) = 2x - 1$
$f(0) = 2(0) - 1$
$f(0) = 0 - 1$
$f(0) = -1$

if x = 1, then y = 1
$y = 2x - 1$
$f(x) = 2x - 1$
$f(1) = 2(1) - 1$
$f(1) = 2 - 1$
$f(1) = 1$

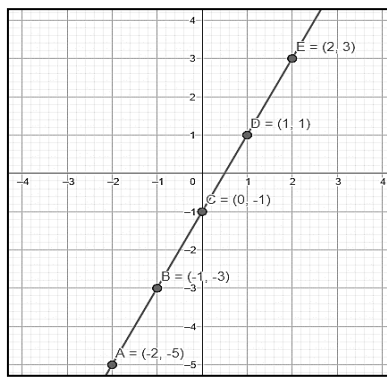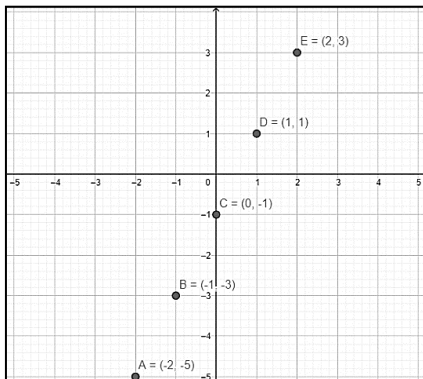if x = 2, then y = 3
$y = 2x - 1$
$f(x) = 2 - 1$
$f(2) = 2(2) - 1$
$f(2) = 4 - 1$
$f(2) = 3$
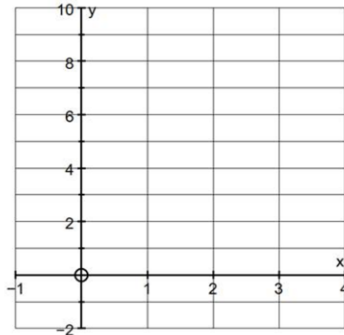
Step 2: Plot the coordinates   Step 3: Connect the points
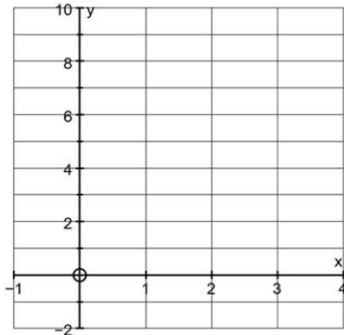
Try This!

Graph the following linear functions.

Equation of line	$y = 2x + 3$

Table of values

x	0	1	2	3
y				

Graph

Equation of line	$y = -3x + 1$

Table of values

x	0	1	2	3
y				

Graph

How did you find the activity? Do you think the concept of linear function helped you in solving real-life problems? Can you give situations that represents a linear function?

WHAT'S NEW

Communication

There are situations that represent other function that is equally important as a linear function. Perform the activity below to find out.

THE BOTTLE BATTLE

In a carnival, a popular game Bottle Toss have bottles arranged as shown. You are asked to choose your level to toss. However, bottles in levels 4 and 5 are not yet arranged.

Help me find out how many bottles should I need for level 4 and level 5?

WHAT IS IT

Communication, Critical Thinking, and Collaboration

Let's analyze.

A. Observe the pattern and draw level 4 and level 5

B. Use the table to represent the number of bottles

Level (x)	1	2	3	4	5
Number of bottles (y)	1	4	9	___	___

C. What equation describes the pattern?

_____

D. Graph the relation using the Cartesian plane on the right .

How will you describe the graph obtained in the activity? Consider using a table of values to graph the function y = x²

What you have seen is not a linear function, but an example of a **Quadratic Function.**
Quadratic function is any function of the form:

$$y = ax^2 + bx + c \quad \text{or} \quad f(x) = ax^2 + bx + c$$

where a, b and c are real numbers and a is not equal to 0.
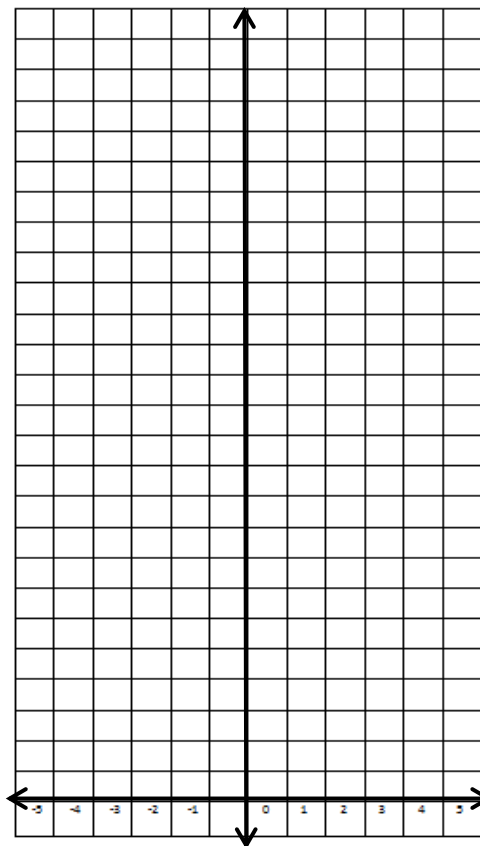
Now plot the other points on the same Cartesian plane above. How will you describe the graph?

x	-5	-4	-3	-2	-1	0	1	2	3	4	5
y	25	16	9	4	1	0	1	4	9	16	25

The graph of a quadratic function is a smooth curve called a **parabola**.

Example 1: Which of the following real-life models represents a quadratic function or linear function?
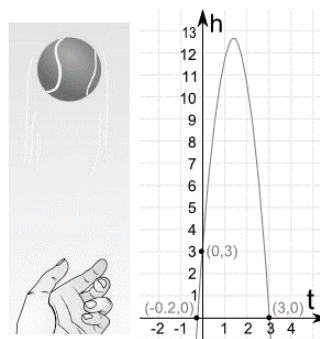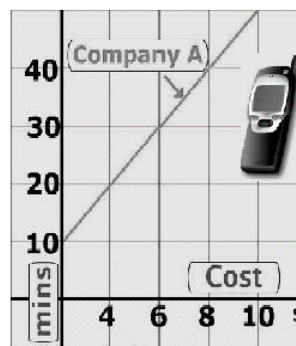
a. The graph of throwing a ball at height h for a given time t define by the function
   h = 3 + 14t − 5t²

b. The graph of duration of phone calls per minute *m* at a given cost *c* represented by the function
   m = c + 10

c. The graph of Bike Company's profit P gained at a given cost c represented by the function
   P = −200c² + 92,000c − 8,400,000

Solution:
a. The highest degree of the variable is 2 and the equation can be formed into:
   h = − 5t² + 14t + 3. The graph also shows a parabola. Thus, throwing a ball represents quadratic function.
b. The highest degree of the variable is 1 and the graph is in the form of y = mx + b. The graph also shows a straight line. Thus, it is a linear function.
c. The highest degree of the variable is 2. The graph also shows a parabola. Thus, the situation represents quadratic function.

Example 2: Which of the following equations represents a quadratic function?

a. $y = 2x^2 - 7x$
b. $x = y - 34$
c. $y = 5x^3 - 7 + 3x$
d. $f(x) = (x + 3)(x + 4)$

Solution:

a. The highest degree of the variable is 2 and, also in the form of $y = ax^2 + bx + c$. Thus, the equation represents quadratic function.
b. If you will rearrange the function, it will be in the form of y = mx +b. Therefore, it is not quadratic function, but a linear function.
c. The highest degree of the variable is 3. Thus, it is not quadratic function.
d. If the function is expanded it will be $f(x) = x^2 + 7x + 12$. Thus, the equation represents quadratic function.

WHAT'S MORE

Communication and Critical Thinking

Let's see if you can do this.

A. Which of the following situations represents a quadratic function?
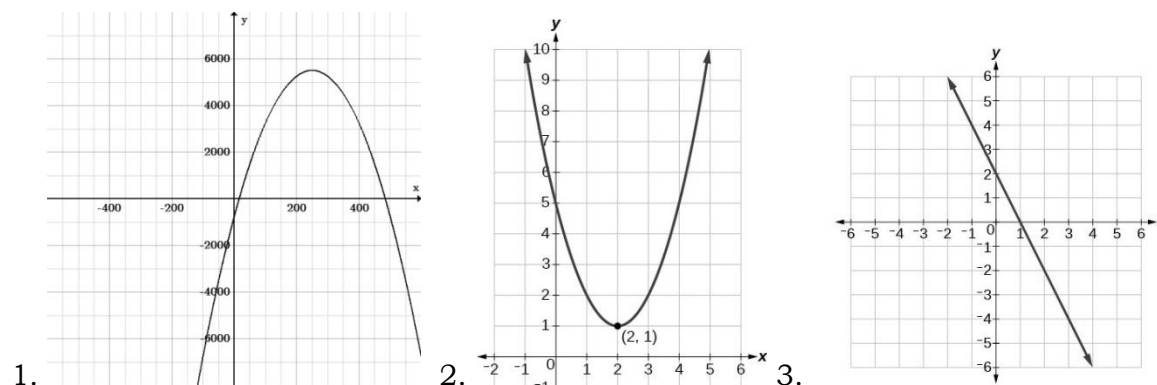1. Taxi fare F for d kilometers at flag down rate at P40.00 and P13.50 per kilometer.
2. The maximum area of a rectangular garden that can be fenced using 100m of fencing materials. Note that:
$$A = w\left(\frac{100 - 2w}{2}\right)$$
3. The equation P = -0.1x² + 50 x -750 models a profit function that a company earns as a function of x number of products of a given type that are sold.

B. Identify if the graph represents quadratic function.

1.   2. (2, 1)   3.

C. Which of the following equations is quadratic functions?

      1. $y = 2x^2 + 7x - 15$ 2. $y = (x + 1)(x - 3)$
      3. $y = 3x + 5$ 4. $(x + 5)(2x - 3) = 2(x + 1) + y$

WHAT I HAVE LEARNED

> Quadratic functions are present in our lives, like the projectile motion of a thrown object, calculating speed, or determining profit of a given business.
>
> Quadratic equations show a polynomial equation with degree 2; standard form of equation is $y = ax^2 + bx + c$ where a, b, and c are real numbers and a cannot be zero; and, the graph is called parabola.

WHAT I CAN DO

Critical Thinking

A. Which of the following situations represents a quadratic function?
1. The area A of a room with length 3m more than the width.
2. The price P of a meat per number of kilograms n at P220.00 per kilo.
3. The maximum area of a garden that can be fenced using 300m of fencing materials.
4. A shot-put throw can be modeled using the equation $y = -0.0241x^2 + x + 5.5$, where x is the distance traveled and y is the height.
5. Maximum height H a ball can reach when launched upward from a flat form of height h modeled by the equation $H = -16t^2 + vt + h$

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B.   Identify if the graph represents quadratic function.

1.   2.   3.

4.   5.
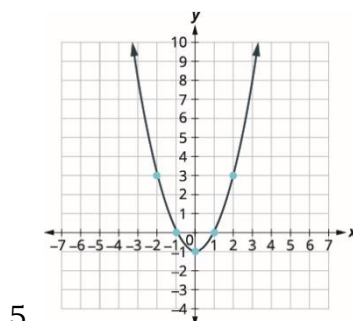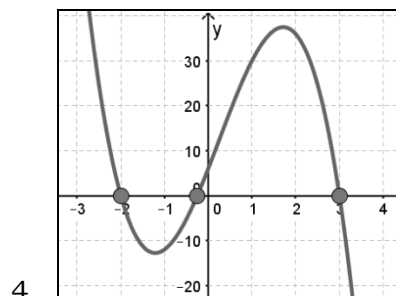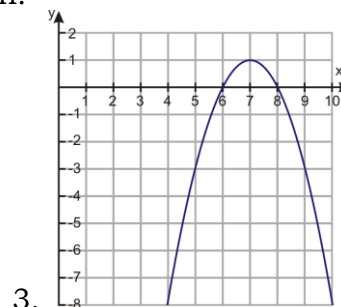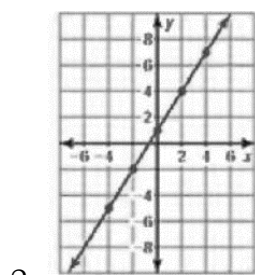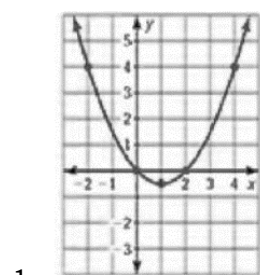
C. Put the letter of the given equation in the diagram below where you think it belongs.

a. y = 3x² - 2
b. x = y
c. y = 3x² - 5x -2
d. 3x – 1 = y
e. y = (x +3) (x - 4)
f. y = x²
g. 4² + x = y
h. y = 4ˣ + 2x + 3
i. x + x² = 3y
j. x (x + 3) – y = 0

Linear Function

Quadratic Function

Not Quadratic nor Linear Function

ASSESSMENT

   Read each item carefully. Identify the choice that best completes the statement or answers the question.
   1. Throwing a ball, shooting a cannon, diving from a platform and hitting a golf ball are all examples of situations that can be modeled by _____.
      A)   Rational Function   C)   Quadratic Function
      B)   Radical Function   D)   Linear Function
   2. The graph of a quadratic function is a smooth curve called
      A)   Line   C)   V-Shape
      B)   Circle   D)   Parabola
   3. Quadratic function is any function of the form: $y = ax^2 + bx + c$, where a, b and c are real numbers and _____.
      A) $a \neq 0$ C) $a = 0$
      B) $a < 0$ D) $a \geq 0$

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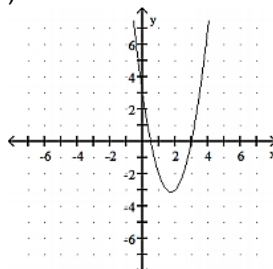
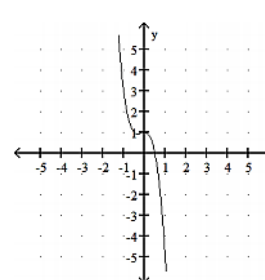4. Which of the following is an example of a graph of a quadratic function?
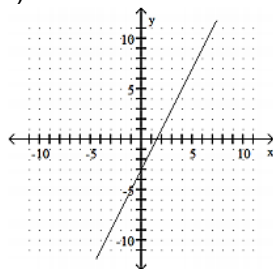
A)   B)   C)

5. The height of the ball from the ground at time t is h, which is given by, he = -16t² + 64t + 80. What function best describe the situation?
   A) Linear Function
   B) Quadratic Function
   C) Radical Function
   D) Rational Function

6. Which of the following situation represents a quadratic function?
   A) A train travels 45 miles every hour after departing the station.
   B) h(t)=−4.9t²+8t+5 represents Jeremiah's height (h) in meters above the water t seconds after he leaves the diving board.
   C) The amount of money in a bank account increases by 1 percent each year.
   D) The cost C of sending m text messages C = ₱1m.

7. Which of the following situation does NOT represent a quadratic function?
   A) A toy rocket is fired into the air from the top of a barn. Its height (h) above the ground in yards after t seconds is given by the function h(t)=−5t²+10t+20.
   B) The maximum area of a house lot that can be fenced using 150m of fencing materials.
   C) Your height in meters relative to the height of the ski jump after t seconds is given by h(t)=−5t²+12t.
   D) The cost C, in peso, of parking a car in a busy downtown area for h hours is C = ₱10 + ₱3h.

8. Which of the following is a quadratic function?
   A) $y - 4x = 2x^2 + 5$
   B) $2x^2 - 4x + 5 = 0$
   C) $2x + y = 5$
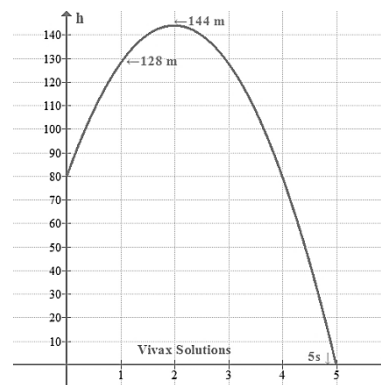   D) $y^2 = 4x + 5$

For item 9, use the given below.
   I. $y = (x - 5)^2$
   II. $y - 3x^2 = 3x(x + 5) - 2$
   III. $2x (x - 3) - y = 0$
   IV. $x = 3^y + 7x + 23$

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9. Which of the following equations is/are quadratic function/s?
    A)   I only
    B)   I and II only
    C)   I and III only
    D)   I, II, and III
10. What is true about the equation y - 5x = (x + 1)(x+3)?
    A)   The highest degree of the variable is 1. Thus, it is not quadratic function.
    B)   If you will simplify and rearrange the function, it will be in the form of y = mx +b. Therefore, it is not quadratic function, but a linear function.
    C)   The equation represents function with the highest degree of the variable is 3
   D)   If the function is rearranged it represents quadratic function

ADDITIONAL ACTIVITIES

Communication, Critical Thinking, Creativity and Character Building

A.   Based on an article from Rappler.com, this graph shows ways to reduce the spread of corona virus (Covid19) in the Philippines.

The graph shows different parabolas. By observing the behavior of the graphs, which of the actions would you choose to reduce the spread of the virus? Why?
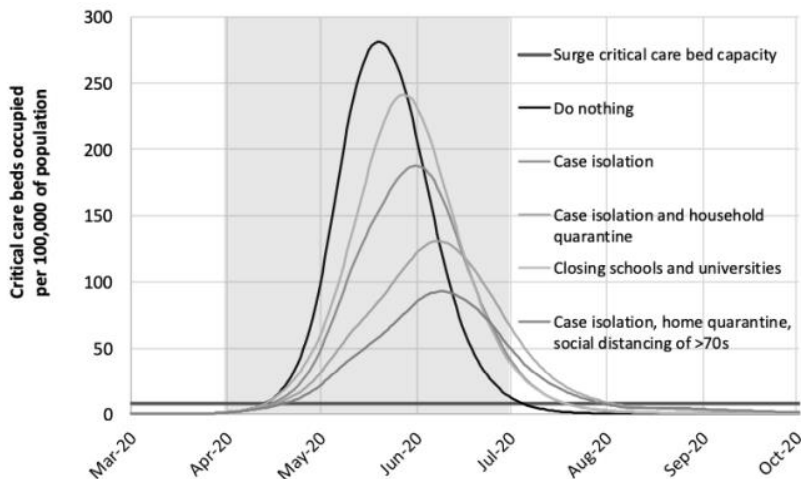
B. Now think of the following:

1. Based on your own understanding, how would you differentiate quadratic and linear function?

2. Copy and complete the graphic organizer below. In each box, describe ways in identifying quadratic functions.

Identifying Quadratic Functions — Forms a parabola
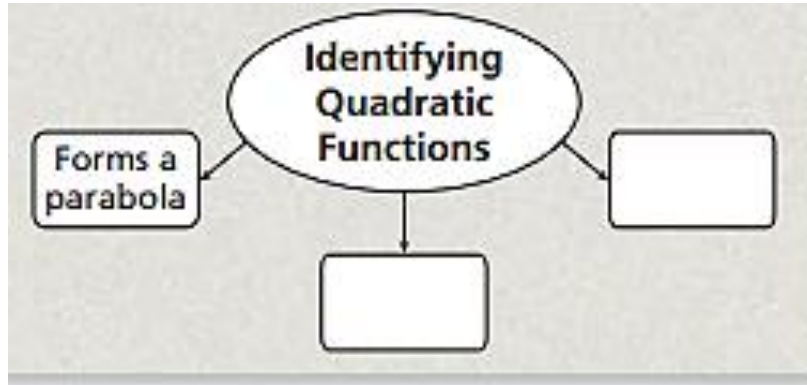
PROBLEM – BASED WORKSHEET

The Parking Lot

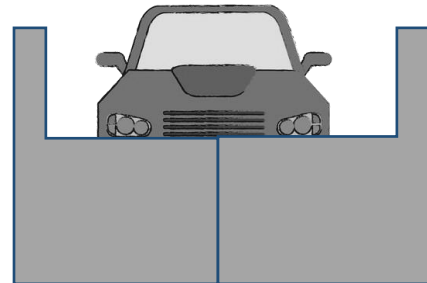Mr. Santos wants to enclose the rectangular parking lot beside his house by putting a wire fence on the three sides.

If the total length of the wire is 80 meters, find the dimension of the parking lot that will enclose a maximum area.

1. If you represent one of the sides as x, how will you represent the other side adjacent to it?

2. Write the quadratic function that models the area of the parking lot.

3. Write the equivalent quadratic equation of the function and identify the values of a, b, and c.

4. To get the desired dimension use the formula $x = -\dfrac{b}{2a}$, then solve for y using the obtained value of x

E-Search

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

https://www.mathsisfun.com/algebra/quadratic-equation-real-world.html
https://learnzillion.com/lesson_plans/656-model-real-world-problems-by-choosing-a-scenario-appropriate-quadratic-function/?card=14484

REFERENCES

https://cdn.clipart.email/bb0a33e7291d7ae5f8948c2db254cfaf_plastic-bottle-drawing-free-download-on-clipartmag_400-151.png
https://image.freepik.com/free-vector/carnival-game-milk-bottle-toss_90508-91.jpg
https://charat.me/en/face/create/
https://www.geogebra.org/graphing?lang=en
https://www.shsu.edu/~kws006/Precalculus/1.2_Function_Graphs_files/S%26Z%201.6.pdf
https://d1e4pidl3fu268.cloudfront.net/6fc34955-f852-4cff-82ae-6fad0cf06787/cover.jpg
https://www.mathsisfun.com/algebra/quadratic-equation-real-world.html
https://www.mathwarehouse.com/algebra/linear_equation/equation-from-graph.php
https://study.com/academy/lesson/comparing-graphs-of-quadratic-linear-functions.html
https://www.coursehero.com/file/37800346/math-9-lm-draft-3242014pdf/

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

What I Can Do

A.
1. Quadratic Function
2. Not Quadratic Function
3. Quadratic Function
4. Quadratic Function
5. Quadratic Function

B.
1. Quadratic Function
2. Not Quadratic Function
3. Quadratic Function
4. Not Quadratic Function
5. Quadratic Function

C.

Quadratic Function	Linear Function	Not Quadratic nor Linear Function
a, c, e, f, I, j	b, d, g	h

Assessment

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

PROBLEM-BASED WORKSHEET

1. We let x be the length of the one of the two equal sides, the other side (opposite to the house) is $80 - 2x$, since 80 meters stands for the perimeter to be used for fencing materials. Let $P(x)$ be the area of the lot.
2. The area of the can be modelled by the quadratic function by the aid of the formula;

$$P(x) = (x)(80 - 2x)$$

3. Writing it in standard form, $P(x) = -2x^2 + 80x$; we obtained the values:

$$a = -2, \quad b = 80, \quad \text{and} \quad c = 0$$

4. To get one of the dimension, we use the formula,

$$x = -\frac{b}{2a} = -\frac{80}{2(-2)} = \textbf{20}$$

To other dimension is $80 - 2(20) = \textbf{40}$.

Therefore, the **dimensions** that will enclose the parking lot with a maximum area are

20 meters by 40 meters. (*The maximum area = **800** square meters*).

What's More

A.
1. Not Quadratic Function - Taxi fare F for d kilometers at flag down rate at P40.00 and P13.50 per kilometer, denoted by the equation F = 40 +13.5d which is a linear function.
2. Quadratic Function - $A = w\left(\frac{100-2w}{2}\right)$
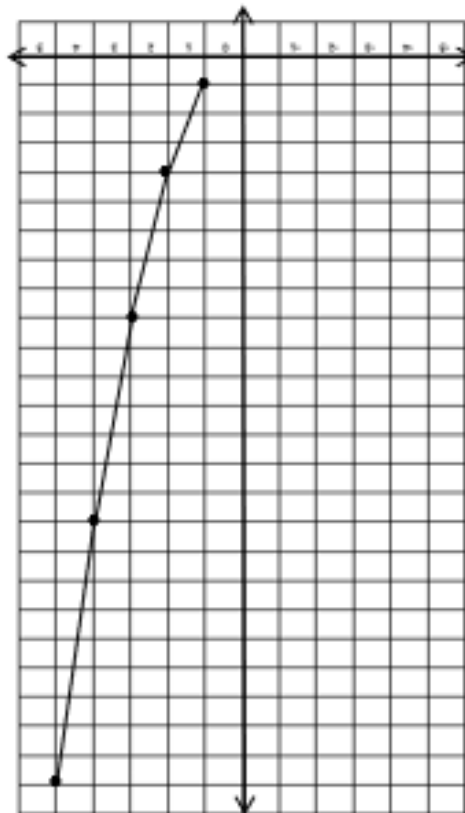 $A = w(50 - w)$
   $A = 50w - w^2$
3. Quadratic Function

B.
1. Quadratic Function
2. Quadratic Function
3. Not Quadratic Function

C.
1. Quadratic Function
2. Quadratic Function
3. Not Quadratic Function
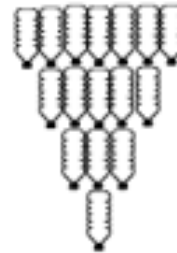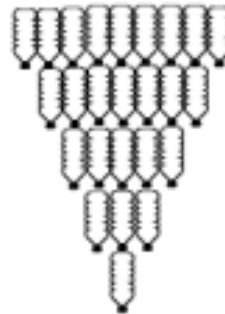4. Quadratic Function

D.

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ANSWER KEY

What I Know

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

What's In

Equation of line	$y = 2x + 3$

Table of values

x	0	1	2	3
y	3	5	7	9

Graph

Equation of line	$y = -3x + 1$

Table of values

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

Graph

What Is It

A.

B.

Level (x)	1	2	3	4	5
Number of bottles (y)	1	4	9	16	25

Level 4   Level 5

C. $y = x^2$