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Mathematics

Quarter 1 - Module 6: Quadratic Function

AIRs - LM

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Alternative Delivery Mode
Quarter 1 - Module 6: Quadratic Function
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Mathematics

Quarter 1 - Module 6: Quadratic Function

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

Target

Are you a PBA fanatic? Have you ever asked yourself why your favorite PBA star players are good in free throws? Are you familiar or even tried playing in your gadget the very famous Angry Bird? How do angry bird expert players shoot their targets? Do you know the strategies in playing this game?

As you go on with this module, you will be able to understand that quadratic functions are used to model real-life situations. Hence, your knowledge on quadratic functions is one of the fundamental tools in solving real-life problems and in making decisions as well.

Learning Competencies

- Model real-life situations using quadratic functions (**M9AL-lg-2)**
- Represent a quadratic function using: (a) table of values; (b) graph; and (c) equation (**M9AL-lg-3)**

Subtasks

1. Differentiate a quadratic function from a linear function using table of values, graph and equation
2. Illustrate a quadratic function using table of values, graph and equation

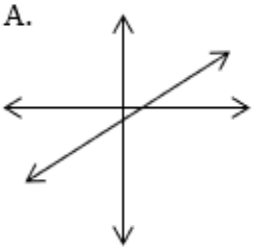
Before we start the lesson, find out how much you already know about this module by answering the pre – assessment.

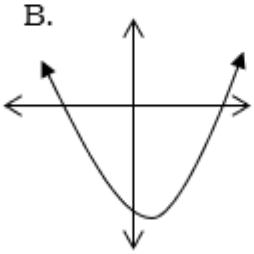
Pre-Assessment

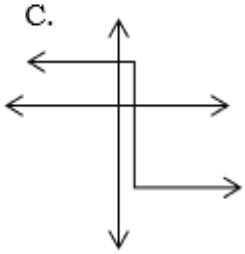
Directions: Choose the letter of the correct answer and write it on a separate sheet of paper.

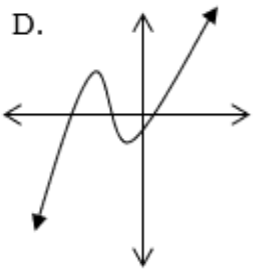
1. What is the general form of a quadratic function?
   A. $y = mx + b$
   B. $y = ax^2 + bx + c$
   C. $y = ax + bx + c$
   D. $y = ax^3 + bx + c$
2. What is the degree of a quadratic function?
   A. 0
   B. 1
   C. 2
   D. 3
3. What is the graph of a quadratic function?
   A. Circle
   B. Line
   C. Parabola
   D. V-shape

4. What type of function is modelled by the following; throwing a ball, shooting a cannon, diving from a platform and hitting a golf ball.?
   A. Linear Function
   B. Polynomial Function
   C. Quadratic Function
   D. Rational Function
5. Quadratic function is a function of the form $y = ax^2 + bx + c$, where a, b, and c are real numbers and _____. Which of the following will complete the sentence?
   A. $a = 0$
   B. $a \neq 0$
   C. $a > 0$
   D. $a \leq 0$
6. An object is fired straight up with a velocity of 64 ft./s and its height ***h*** after ***t*** seconds is given by $h(t) = -16t^2 + 64t$. What function best describes the situation?
   A. Linear Function
   B. Polynomial Function
   C. Rational Function
   D. Quadratic Function
7. Which of the following situations represents a quadratic function?
   A. Precious spend Php75.00 for every piece of chocolate.
   B. The distance covered by Angie in driving her car at the speed of 60 km/hr.
   C. A stone is thrown straight up from 2 m above the ground with a velocity of 10 m/s.
   D. Mang Ador is paid Php375.00 for each day worked as a labor in construction company.
8. Which of the following equations represents a quadratic function?
   A. $y = 7 + 2x^2$
   B. $2y^2 + 7 = x$
   C. $y = 7x - 2^2$
   D. $y = 2^x - 7$
9. Which of the following equations does **NOT** represent a quadratic function?
   A. $y = 9 - 2x^2$
   B. $3x^3 + y - 2x = 0$
   C. $0 = y + (x + 1)(x - 3)$
   D. $y = x^2$
10. Which graph represents a quadratic function?

A. 

B. 

C. 

D. 

11. Which of the following table of values represents a quadratic function?

A.

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

B.

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

C.

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

D.

x	-2	-1	0	1	2
y	-7	0	1	2	9

12. Which of the following tables represents a quadratic function?

A.

x	-3	-2	-1	0	1	2	3
y	-2	0	2	4	6	8	10

B.

x	-3	-2	-1	0	1	2	3
y	-14	-7	-2	1	2	1	-2

C.

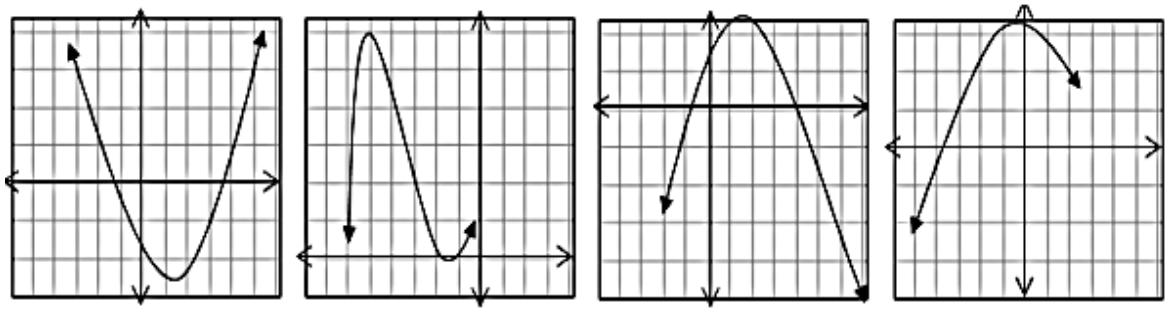
x	-1	0	1	2	3	4	5
y	-7	-5	-3	-1	1	3	5

D.

x	-5	-4	-3	-2	-1	0	1
y	3	5	7	9	11	13	15

13. Which of the following graphs does **NOT** represent a quadratic function?

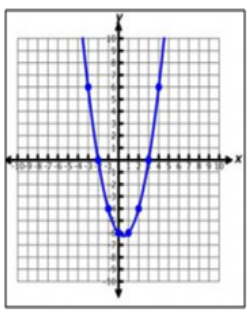
A. B. C. D.



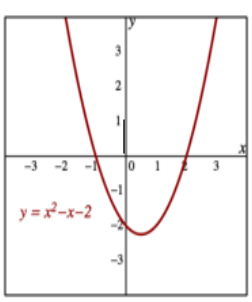
14. Using the table of values, which graph represents the quadratic function?

x	-3	-2	-1	0	1	2	3
y	6	0	-4	-6	-6	-4	0

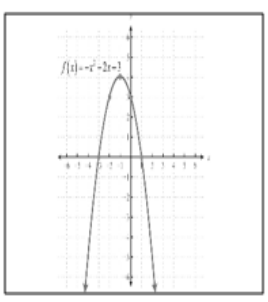
A



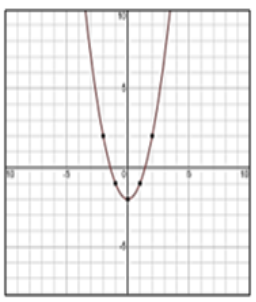
B.



C.



D.



15. Using the graph at the right, which of the following table of values corresponds to it?

A.

x	0	1	2	3	4	5
y	2	1	2	1	0	9

B.

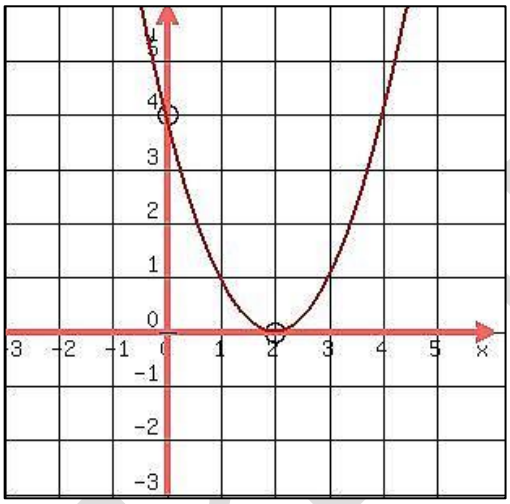
x	-1	0	1	2	3	4
y	9	4	1	0	1	2

C.

x	-1	0	1	2	3	4
y	9	4	1	0	1	4

D.

x	0	1	2	3	4	5
y	9	1	0	1	0	9



Jumpstart

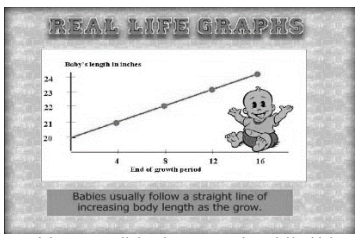
Activity 1*:* Quadratic or Not

Directions: Analyze each of the real figures below. Mark **QF** if the figure models quadratic function, and **NQF** for the figure that does not model quadratic function. Write your answers on a separate sheet of paper.

1

https://www.shutterstock.com/search/shooting+basketball

2

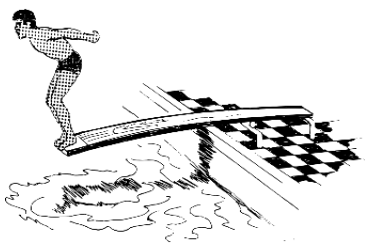


Source:https://www.slideshare.net/mobile/bigpassy/real-world-linear-graphs

3

Source:https://dlpng.com/png/6744324

4



Source: https://webstockreview.net/explore/clipart-platform-diving/

5  *Source: https://www.iconspng.com/ image/18615/banana*	6  *Source: https://www.pinterest.ph/pin/646407352741524528*

Activity 2: Identify Me!

Directions: State whether each of the following equations represents a quadratic function or not. Justify your answer. *(Use separate sheet of paper)*

EQUATIONS	Quadratic Function or Not	Justification
1. $y = x^2 + 21$		
2. $y = 4x - 9$		
3. $y = 16 - 3x^2$		
4. $x^2 = 3 + y$		
5. $y = 4x^2 + x^3 + 4$		
6. $y = 3^2 + 4x + 2$		
7. $3x^2 - 1 = y$		
8. $y = (x - 1)(x + 1)$		
9. $(x - 2)(x + 2) + x^2 - y = 0$		
10. $0 = y + 7x^2 - 7x$		

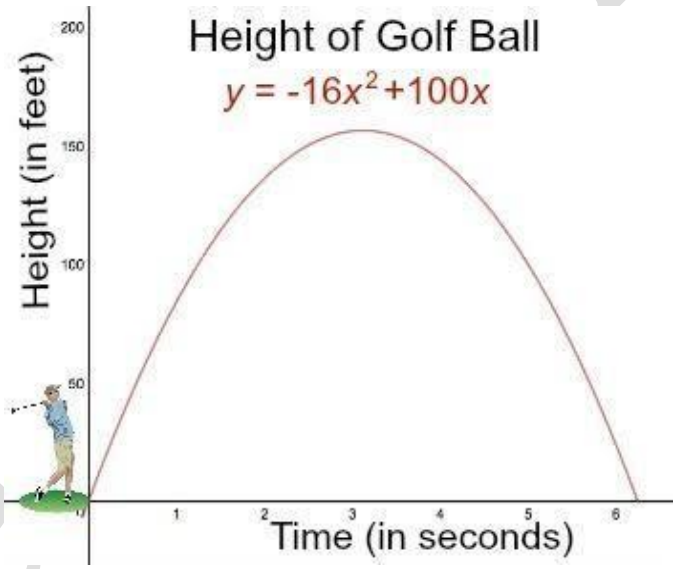
Discover

A **quadratic function** is a function that can be described by the equation of the form $\mathbf{y = ax^2 + bx + c}$ or $\mathbf{f(x) = ax^2 + bx + c}$ where **a**, **b**, and **c** are real numbers and $\mathbf{a \neq 0}$. The highest power of the independent variable x is **2**. Thus, the equation of a quadratic function is of degree 2. The graph of a quadratic function is a smooth curve called **parabola**. But what real-life situations can be modelled by quadratic functions?

Let's have the following examples!

Which of the following real-life situations can be modelled by a quadratic function?

Example 1. An athlete hitting a golf ball at height h for a given time t define by the function $y = -16x^2 + 100x$.



Source:https://courses.lumenlearning.com/ivytech-collegealgebra /chapter/finding-x-intercepts-and-y-intercepts/

Solution:
In the situation, the function is $y = -16x^2 + 100x$ and the degree is 2. The graph also shows a parabola. Thus, hitting a golf ball can be modelled by a quadratic function.

Example 2. The path when a ball is thrown can be modelled by $y = -16x^2 + 64x + 5$, where y (in feet) is the height of the ball x seconds after it is released.

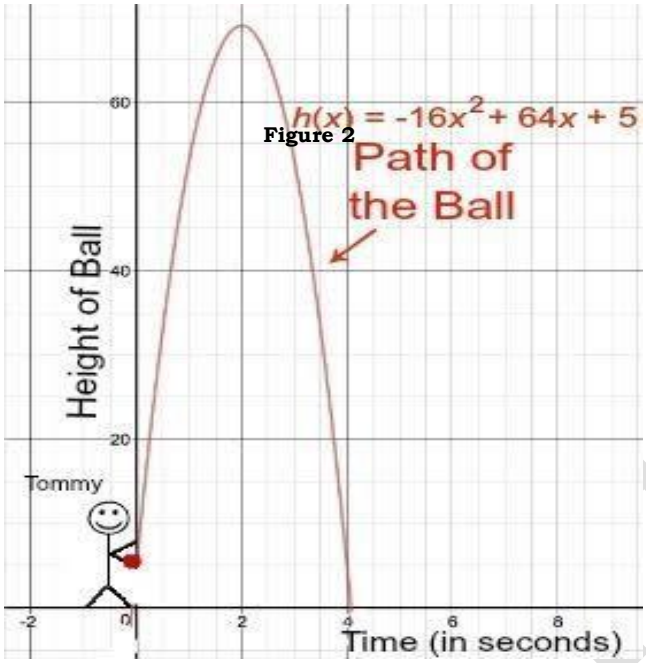


Figure 2

Source: *https://study.com/academy/lesson/modeling-the -real-world-with-families-of-functions.html*

Solution:
In the situation, the function is $y = -16x^2 + 64x + 5$ and the degree is 2. The graph also shows a parabola. Thus, throwing a ball can be modelled by a quadratic function.

Example 3. The area A of a rectangular garden whose width is 5m longer than its length.

If we let A = area of the rectangular garden
l = length
w = width

then,

$A = lw$	Area of a rectangle
$w = l + 5$	width is 5 m longer than its length
$A = l(l + 5)$	Express the area in terms of the length
$A(l) = l(l + 5)$	Express the area as a function of length

In this function, ***l*** is the independent variable and ***A(l)*** read as *"A of l"* is the dependent variable. Hence, if we complete the table of values below,

a. If $l = 1$, substituting the value of l in the rule $A(l) = l(l + 5)$, we have

$$A(l) = l(l + 5)$$
$$A(1) = 1(1 + 5)$$
$$A(1) = 1(6)$$
$$A(1) = 6$$

Using the same procedure to complete the table of values below, the result is:

A(l)	6	14	24	36	50
l	1	2	3	4	5

which means that the area of the rectangular garden when the length l is 1m is 6m^2, 14 m^2 if the length is 2m and so on. So, what is the area A of the rectangular garden if the length l is 7m? 9m? 10m?

In the given situation, the rule of the correspondence is $l(l+5) = l^2 + 5l$ applying distributive property of multiplication. Hence, the function can be written as $A(l) = l^2 + 5l$. Basically, the rule of the correspondence is a polynomial of degree 2 and it is a quadratic function.

A quadratic function just like any other function can be represented using table of values, graphs, and equations. But, how do we know if the given table of values, graphs and equations represent quadratic functions? To answer this, let's have the following examples.

A. TABLE OF VALUES

The table of values below has columns for x and its corresponding values of y. **To solve for the values of "y", substitute the value of x.**

1. f(x) = 2x + 1

1 1 1 1 1 1 ⇨ *equal differences in variable "x"*

x	-3	-2	-1	0	1	2	3
y	**-5**	**-3**	**-1**	**1**	**3**	**5**	**7**

⇨ **NOTE**: *To determine the differences in variable x and y, subtract it from right to left.*

2 2 2 2 2 2 ⇨ *equal 1st differences in "y".*

Solution: To determine the value of "y", substitute the value of "x" in the equation *f(x) = 2x + 1 resulting to:*

If x = 3, then
y = 2x + 1
y = 2(3) + 1
y = 6 + 1
y = 7

If x = 2, then
y = 2x + 1
y = 2(2) + 1
y = 4 + 1
y = 5

If x = 1, then
y = 2x + 1
y = 2(1) + 1
y = 2 + 1
y = 3

If x = 0, then
y = 2x + 1
y = 2(0) + 1
y = 0 + 1
y = 1

If x = -1, then
y = 2x + 1
y = 2(-1) + 1
y = -2 + 1
y = -1

If x = -2, then
y = 2x + 1
y = 2(-2) + 1
y = -4 + 1
y = -3

If x = –3, then
y = 2x + 1
y = 2(-3) + 1
y = -6 + 1
y = -5

2. g(x) = $x^2 - 4$

1 1 1 1 1 1 ⇨ *equal differences in variable "x"*

X	-3	-2	-1	0	1	2	3
Y	5	0	-3	-4	-3	0	5

NOTE: *To determine the differences in variable x and y, subtract it from right to left.*

-5 -3 -1 1 3 5 ⇨ *1st differences in "y"*

2 2 2 2 2 ⇨ *equal 2nd differences in "y".*

Solution: To determine the value of "y", substitute the value of "x" in the equation *$g(x) = x^2 - 4$ resulting to:*

If x = 3, then
$y = x^2 - 4$
$y = (3)^2 - 4$
$y = 9 - 4$
y = 5

If x = 2, then
$y = x^2 - 4$
$y = (2)^2 - 4$
$y = 4 - 4$
y = 0

If x = 1, then
$y = x^2 - 4$
$y = (1)^2 - 4$
$y = 1 - 4$
y = -3

If x = 0, then
$y = x^2 - 4$
$y = (0)^2 - 4$
$y = 0 - 4$
y = -4

If x = -1, then
$y = x^2 - 4$
$y = (-1)^2 - 4$
$y = 1 - 4$
y = -3

If x = -2, then
$y = x^2 - 4$
$y = (-2)^2 - 4$
$y = 4 - 4$
y = 0

If x = 3, then
$y = x^2 - 4$
$y = (-3)^2 - 4$
$y = 9 - 4$
y = 5

Remember:

You have seen that in a linear function, *equal differences in variable "x" produce equal differences in "y".*

However, in a quadratic function, *equal differences in variable "x" produce equal second differences in "y".*

B. GRAPH

Using the respective table of values, we have determined the values of "y" in terms of the values of "x".

- From the given function, **y = 2x + 1**, the table yields the *ordered pairs: {(–3, –5), (–2, –3), (–1, –1), (0, 1), (1, 3), (2, 5), (3, 7)}*

x	-3	-2	-1	0	1	2	3
y	-5	-3	-1	1	3	5	7

- From the function, **y = x² – 4**, the *ordered pairs are {(–3, 5), (–2, 0), (–1, –3), (0, –4), (1, –3), (2, 0), (3, 5)}*

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

Now, we can plot the ordered pairs (x, y) using a Cartesian plane and connect the points on the graph.

y = 2x + 1

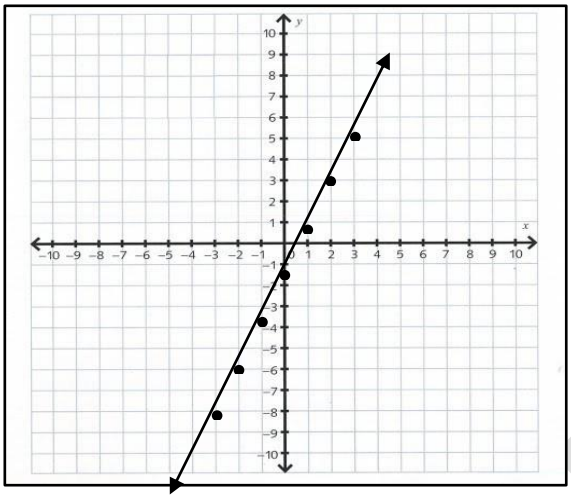


Figure 1:
Linear Function

y = x² – 4

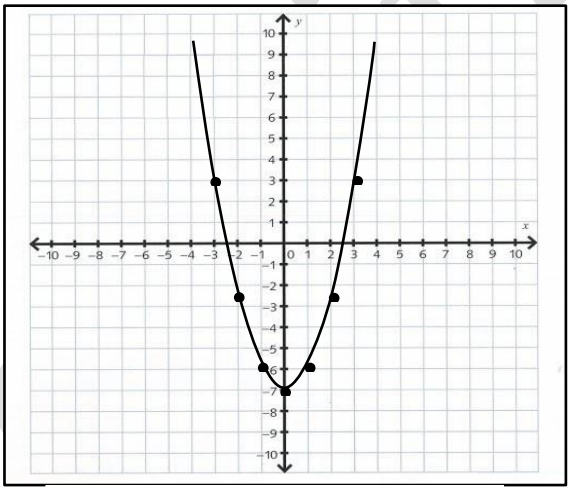


Figure 2:
Quadratic Function

Remember:
The graph of a linear function is a **straight line** while the graph of a quadratic function is a smooth curve called **parabola.**

C. EQUATIONS

Apart from knowing the definition of quadratic function, prior knowledge of products of binomials is also imperative to broaden your knowledge in representing quadratic function by equations.

Products of Binomials

1. Multiplying monomial to a binomial
Examples:

STEPS

a. $3(x^2 + 7) = \mathbf{3x^2 + 21}$ -----> (Use Distributive Property of Equality)

1. multiply 3 and 1st term of the binomial

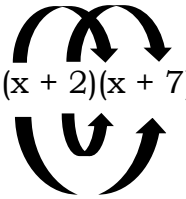
2. multiply 3 and 2nd term of the binomial

b. $x(x - 4) = \mathbf{x^2 - 4x}$ ------> (Use Distributive Property of Equality)

1. multiply x and 1st term of the binomial
2. multiply 3 and 2nd term of the binomial

2. Multiplying binomial to a binomial

Examples:



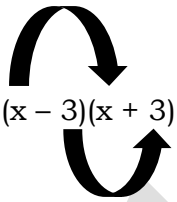
a. $(x + 2)(x + 7) = x^2 + 7x + 2x + 14$ ------> (Use FACE or FOIL Method)

$= \mathbf{x^2 + 9x + 14}$

1. multiply the first terms
2. multiply the outer terms
3. multiply the inner terms
4. multiply the last terms

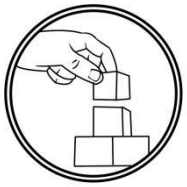
b. $(x + 7)^2 = \mathbf{x^2 + 14x + 49}$ -------> (Use Square of a Binomial)

1. square the 1st term
2. twice the product of the 1st and 2nd term
3. square the 2nd term



c. $(x - 3)(x + 3) = \mathbf{x^2 - 9}$ -------> (Use Sum & Difference of a Binomial)

1. multiply the two 1st terms
2. multiply the two 2nd terms



Explore

Activity 3:

Find My Difference!

Direction: Show and tell whether the given table of values below represent a quadratic function or linear function. *(Write your answers in a separate sheet of paper).*

1.

x	-1	0	1	2	3	4
y	9	4	1	0	1	4

2.

x	-5	-4	-3	-2	-1	0	1
y	3	5	7	9	11	13	15

3.

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

4.

x	-5	-4	-3	-2	-1	0	1
y	27	18	11	6	3	2	3

The previous activity familiarized you with recognizing whether a given table of values demonstrates quadratic function or not. I'm sure in the next activity, you are now ready to represent table of values using graph. Let's do it!

Activity 4: What Do I Model?

Directions: Identify which of the given real-life situations represents a linear function or a quadratic function. Write **QF** if the situation represents a quadratic function and **LF** if the situation represents a linear function.

1. Throwing a ball
2. Distance travelled when jogging
3. Shooting a cannon
4. Diving from a platform
5. Renting a van
6. Richard predicted that the number of mango trees, $\boldsymbol{x}$, planted in a farm could yield $y = -20x^2 + 2800$ mangoes per year.
7. The cost C of milkfish per number of kilogram n at Php 170.00 represented by the function $C(x) = 170n$.
8. A store sells lecture notes, and the monthly revenue R of this store can be modelled by the function $R(x) = 3000 + 500x - 100x^2$, where x is the peso increase over Php 4.00.
9. The maximum height that can be reached by the projectile if the height in meters of a projectile after t seconds is given by $h(t) = 160t - 80t^2$.
10. If 100 m of fencing wire is to be used to enclosed a rectangular lot, then the area of the fenced lot is represented by $A(w) = w(50 - w)$.

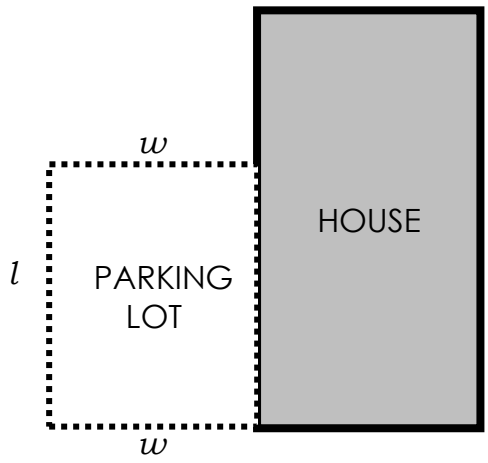
Deepen

Activity 5

Directions: Read and analyze the problem below and do what is asked.

Parking Lot Problem

Mr. Santos wants to enclose the rectangular parking lot beside his house by putting a wire fence on the three sides as shown in figure 1. If the total length of the wire is 80 m, find the dimension of the parking lot that will enclose a maximum area.



Process Questions:

1. If we let w be the width and l be the length, what is the equation for the sum of the measures of the three sides of the parking lot?
2. What is the length of the rectangle in terms of the width?
3. Write the quadratic function that models the area of the parking lot.

4. Write the quadratic function to its equivalent quadratic equation then find the values of *a, b,* and *c.*
5. Use the formula $x = \frac{-b}{2a}$ to solve for the width then solve for the length using the obtained value of x.

Activity 6: Show Me My Graph!

Directions: Do what is asked. Use separate sheet of paper for your answer.

A. Illustrate whether the following table of values below represent a quadratic function or not.

1.

x	-3	-2	-1	0	1	2
y	2	0	0	2	6	12

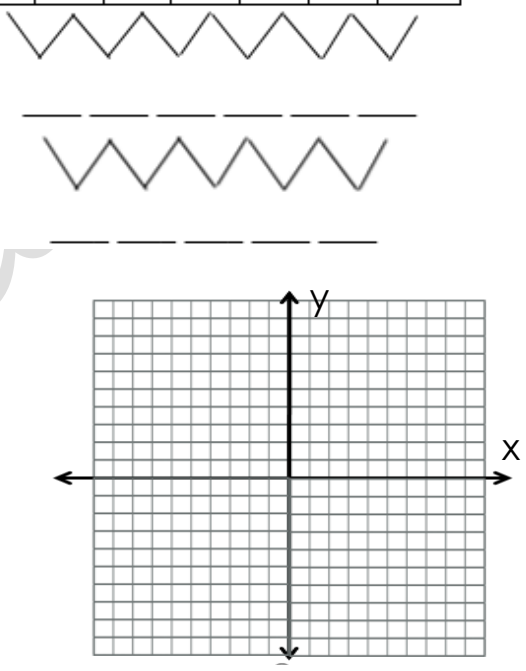
2.

x	-1	0	1	2	3	4	5
y	-7	-5	-3	-1	1	3	5

B. Given the equation $y = -x^2$, find the differences in variable "y" to complete the table of values then plot the points on the Cartesian plane to show it represents a quadratic function.

3.

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



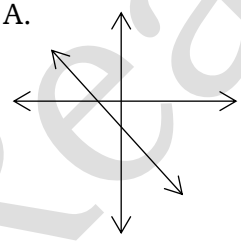
Since you already know the important notes about representing quadratic function, let us go deeper.

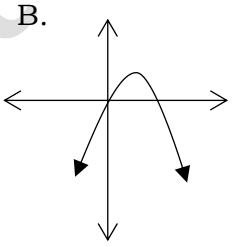
Gauge

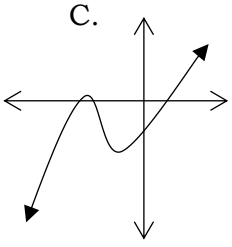
Post-Assessment

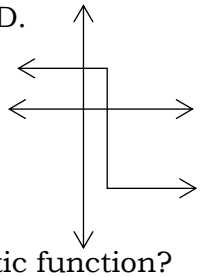
***Directions*:** Choose the letter of the best answer from the given choices. Write your answers in a separate sheet of paper.

1. Which of the following equations represents a quadratic function?
   - A. $x = 1 + 2y^2$
   - B. $2x^2 + 5 = y$
   - C. $y = 9x - 2^2$
   - D. $y - 2^x = 7$
2. Which of the following equations does **NOT** represent a quadratic function?
   - A. $y = -2x^2$
   - B. $3^2 - 2x = y$
   - C. $y = (x + 3)(x - 3)$
   - D. $y = 3 + x^2$
3. Which equation represents a quadratic function?
   - A. $y = 3x^2 + 1$
   - B. $y - x = 3^2$
   - C. $y = 3x^3 + 1$
   - D. $x - y^2 = 2$
4. Which of the following equations represents a quadratic function?
   - A. $y = x - 6 + x + 1$
   - B. $2^2 + 9x = y$
   - C. $-x(x + 5) + y = 0$
   - D. $y = 7^2 + 2^x$
5. Which of the following equations does **NOT** represent a quadratic function?
   - A. $y = -(x + 11)^2$
   - B. $y = 9x^2 - 2^3$
   - C. $y = (x)(x + 3)(x - 4)$
   - D. $0 = y - (x + 3)(x - 7)$
6. Which graph represents a quadratic function?

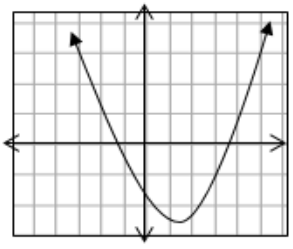
A. 

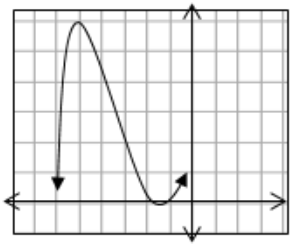
B. 

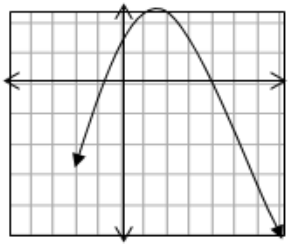
C. 

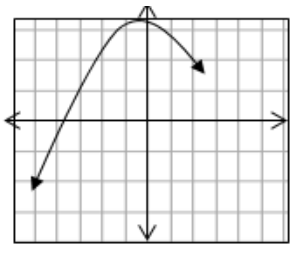
D. 

7. Which of the following graphs does **NOT** represent a quadratic function?

A. 

B. 

C. 

D. 

8. Using the graph at the right, which of the following table of values do you think it belongs?

A.

x	0	1	2	3	4	5
y	2	1	2	1	0	9

B.

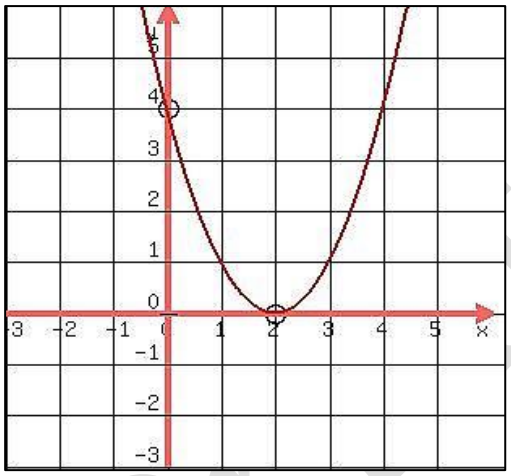
x	-1	0	1	2	3	4
y	9	4	1	0	1	2

C.

x	-1	0	1	2	3	4
y	9	4	1	0	1	4

D.

x	0	1	2	3	4	5
y	9	1	0	1	0	9



9. Which of the following table of values below represent quadratic function?

I.

x	-2	-1	0	1	2
y	0	0	2	6	12

II.

x	-3	-2	-1	0	1	2
y	13	9	5	1	-3	-7

III.

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

A. I and II
B. I and III
C. II and III
D. I, II and III

10. Which ordered pairs represent a quadratic function?
A. (-4,9), (-3,8), (-2,7), (-1,6), (0,5)
B. (-4,-11), (-3,-4), (-2,1), (-1,4), (0,5)
C. (-4,-9), (-3,-8), (-2,-7), (-1,-6), (0,-5)
D. (-4, 69), (-3, 32),(-2, 13), (-1,6), (0,5)

11. JC often rides a taxi in going to work. The standard fare in riding a taxi is ₱40.00 as a flag-down rate plus Php 5.50 for every 100 meters or a fraction of it. Which of the following statements is **TRUE** about the situation?
A. The situation models a linear function defined by $y = 5.50x + 40$.
B. JC is always on time in going to work because there is no traffic.
C. JC is the Manager of the company so she needs to arrive on time.
D. The situation models a quadratic function because the graph is a parabola.

12. An object is fired straight up with a velocity of 64 ft/s. Its height h after t seconds is given by $h(t) = -16t^2 + 64t$. What function best describes the situation?
A. Linear Function
B. Polynomial Function
C. Quadratic Function
D. Rational Function

13. Which of the following situations does **NOT** represent a quadratic function?
    A. The dimensions of the largest rectangular field that can be enclosed with 100 m of wire.
    B. Rental cost paid by Michael in borrowing a car with a rental charge of Php 1000.00 per day plus Php 100.00 per mile travelled.
    C. The maximum number of mangoes produce per year is represented by the equation $y = -20x^2 + 2800x$ where x is the number of mango trees planted in a farm.
    D. A ball is thrown vertically upward with a velocity of 96 m/sec is given by the function $S(t) = 96t - 5t^2$ where $S\ (t)$ is the distance above the ground after t seconds.
14. A rental company charges a flat fee of Php 50.00 and an additional of Php 0.25 per kilometer of travel defined by the function $y = 0.25x + 30$. What function best describes the situation?
    A. Linear Function
    B. Polynomial Function
    C. Quadratic Function
    D. Rational Function
15. A ball is shot from a cannon into the air with an upward velocity of 50 ft/sec represented by the function $h = -16t^2 + 50t + 1.5$. What function best describes the situation?
    A. Linear Function
    B. Polynomial Function
    C. Quadratic Function
    D. Rational Function

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