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DepED
DEPARTMENT OF EDUCATION

Mathematics

Quarter 1-Module 2

Solving Quadratic Equations by Extracting Square Roots

Week 1

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MODULE 2

SOLVING QUADRATIC EQUATION BY EXTRACTING SQUARE ROOTS

In the previous module, you have learned how to determine whether a given equation is quadratic or not. Every equation contains variables, the values of which need to be solved. A quadratic equation is a second-degree equation that has at most two solutions. In this module, you will learn how to solve quadratic equations by extracting square roots.

WHAT I NEED TO KNOW

LEARNING COMPETENCY

The learners will be able to:

- solve quadratic equations by extracting square roots. (**M9AL-Ia-2.1)**

WHAT I KNOW

Write the letter of the correct answer on your answer sheet.

1. A _____ produces a specific quantity when multiplied by itself.
   A. square root C. constant
   B. sum D. real number
2. What are the positive and negative square roots of 36?
   A. ± 2 C. ± 6
   B. ± 4 D. ± 1
3. Which of the following denotes a square root expression?
   A. $\sqrt[3]{b}$ C. $\langle b \rangle$
   B. b^3 D. $\sqrt{b}$
4. How many real solutions does the equation $x^2 = c$ where $c < 0$ have?
   A. no real solution C. three
   B. two D. one
5. How do you describe (the signs) of the square root of a positive real number?
   A. positive & positive C. positive & negative
   B. negative & negative D. none of them
6. What are the roots of the quadratic equation $x^2 - 49 = 0$?
   A. ± 49 C. ± 1
   B. ± 4 D. ± 7
7. Applying the method of extracting the square roots, solve for b in $4b^2 - 9 = 71$.
   A. $b = \pm 2\sqrt{5}$ C. $b = \pm 5\sqrt{2}$
   B. $b = \pm 3\sqrt{5}$ D. $b = \pm 5\sqrt{3}$

8. Find the solution set of the equation $2x^2 - 32 = 0$.
   A. $\{2, 4\}$ C. $\{2, -4\}$
   B. $\{-4, 4\}$ D. $\{-1, 3\}$
9. Simplify $\pm\sqrt{\left(\frac{9}{16}\right)}$.
   A. $\pm\frac{3}{4}$ C. $\pm\frac{4}{3}$
   B. $\pm\frac{1}{4}$ D. $\pm\frac{2}{4}$
10. Simplify $\sqrt{50}$.
   A. 25 C. 5
   B. $25\sqrt{2}$ D. $5\sqrt{2}$

***** If you got an honest 10 points (perfect score), you may skip this module**

WHAT'S IN

Communication and collaboration

Knowing how to get the square root of real number is a prerequisite skill in order to understand the lesson in this module. Below is an illustrative example on how to get it.

We often see that:

$$(4)(4) = 4^2 = 16 \rightarrow \sqrt{16} = 4$$

Positive square root of 16

and

$$(-4)(-4) = (-4)^2 = 16 \rightarrow \sqrt{16} = -4$$

Negative square root of 16

The **square root** of a positive real number can be positive or negative. Thus, in order to avoid confusion on what square root is being asked, the ***positive square root*** or ***principal square root*** of a positive real number x is denoted $\sqrt{x}$, while the ***negative square root*** of a positive real number x is denoted by $-\sqrt{x}$.

If ***both square roots*** are required, the notation becomes $\pm\sqrt{x}$.

For instance,

$$\pm\sqrt{16} = \pm 4$$

Positive and negative square root of 16

The expression ± 4 is read as '*positive and negative 4*'

Examples:

1. $\sqrt{25} = \mathbf{5}$
2. $-\sqrt{64} = \mathbf{-8}$
3. $\pm\sqrt{\frac{4}{9}} = \pm\frac{\mathbf{2}}{\mathbf{3}}$
4. $\sqrt{-4} = \boldsymbol{not\ a\ real\ number}$

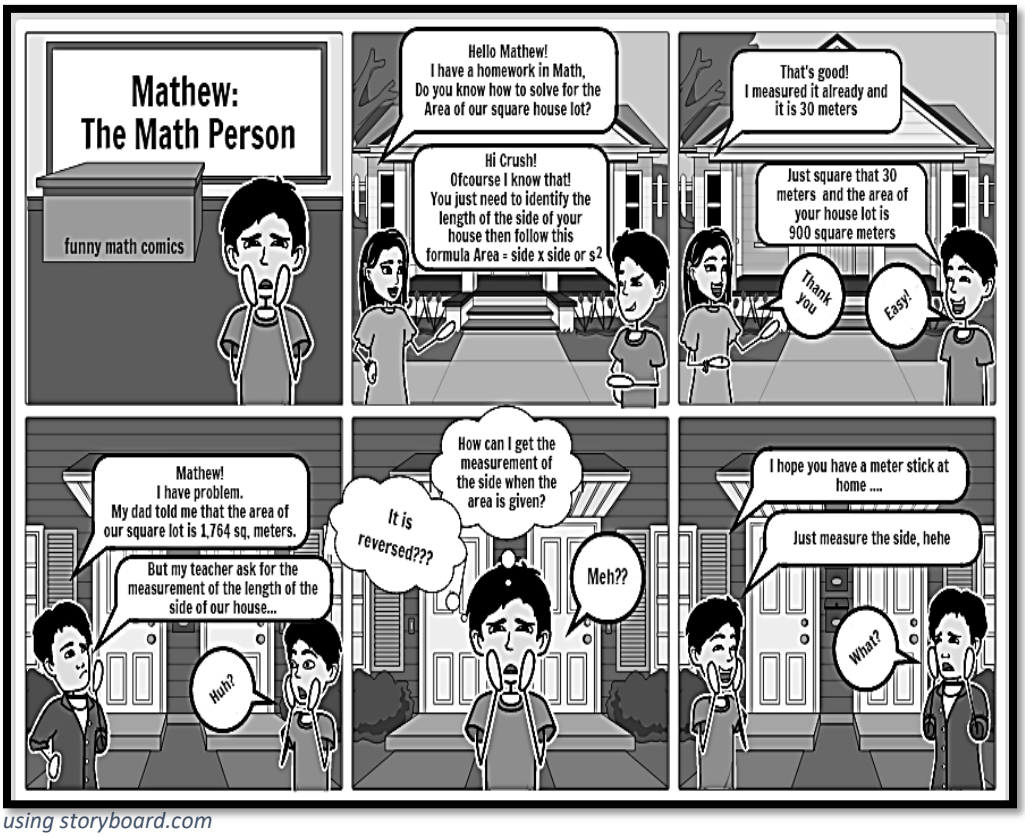
You Try!

1. $-\sqrt{49}$ = _____ 2. $\sqrt{225}$ = _____ 3. $\pm\sqrt{144}$ = _____ **4.** $-\sqrt{\frac{36}{49}}$ = _____

WHAT'S NEW

Let's Investigate!

Communication, Collaboration and Critical Thinking



1Comic generated using storyboard.com

How can we solve for the value of the side?
What is the value of the side?

If the floor area of a house is 1,764 sq. meters, and the formula for finding the area of a square is $Area = s^2$, where s is a side, then, $s^2 = 1{,}764$ sq. units.

WHAT IS IT

One way to help us answer the problem above is by extracting the square roots. How? Let us take a look at the properties and examples.

Square-Root Property

This is one method that can be used to solve quadratic equations. It states that if $x^2 = c$, then $x = \sqrt{c}$ or $x = -\sqrt{c}$, where c is a real number.

WORDS	NUMBERS	ALGEBRA
To solve for $\boldsymbol{x}$ in the quadratic equation of the form $\boldsymbol{x^2 = c}$, take the square root of both sides of the equation.	$x^2 = 17$ $\sqrt{x^2} = \sqrt{17}$ $x = \pm\sqrt{17}$	If $\boldsymbol{x^2 = c}$ and **c** is a positive real number, then $\boldsymbol{x = \pm\sqrt{c}}$

Example 1: USING SQUARE ROOTS TO SOLVE $x^2 = c$

Solve by extracting the square roots.

a. $x^2 = 64$

Solution: $x^2 = 64$

$\sqrt{x^2} = \sqrt{64}$

$x = \pm 8$

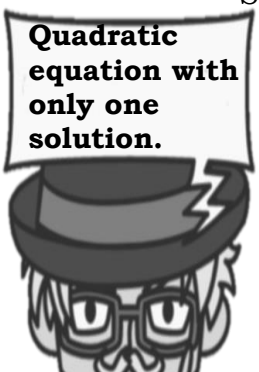
The solutions are 8 and -8

Example 2: USING SQUARE ROOTS TO SOLVE QUADRATIC EQUATIONS

Solution:

Solve by extracting the square roots.

a. $x^2 + 6 = 6$



Solution:

$x^2 + 6 = 6$

$x^2 + 6 - 6 = 6 - 6$ Subtract 6 from both sides

$x^2 = 0$

$\sqrt{x^2} = \pm\sqrt{0}$ Take the square root of both sides

$x = 0$

The solution is 0.

b. $9x^2 + 16 = 0$

Solution:

$9x^2 + 16 = 0$

$9x^2 + 16 - 16 = -16$ *Subtract 16 from both sides*

$\frac{9x^2}{9} = \frac{-16}{9}$ *Divide both sides by 9.*

$x^2 = -\frac{16}{9}$

$\sqrt{x^2} = \pm\sqrt{-\frac{16}{9}}$ *Take the square root of both sides.*

$x = \pm\sqrt{-\frac{16}{9}}$ *The answer will not be a real number*

There is no real solution.

(Since the square root of a negative radicand is an imaginary number)

c. $2(x + 4)^2 = 18$

Solution:

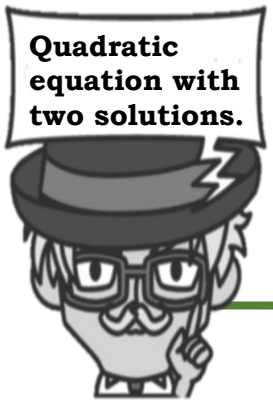
$\frac{2(x+4)^2 = 18}{2 \quad 2}$ Divide both sides by 2.

$(x + 4)^2 = 9$

$\sqrt{(x+4)^2} = \pm\sqrt{9}$ Take the square root of both sides.

$x + 4 = \pm 3$

$x + 4 = 3$ or $x + 4 = -3$



Write two equations using both the positive and negative square roots and solve each equation.

$x + 4 - 4 = 3 - 4$ $\qquad$ $x + 4 - 4 = -3 - 4$

$\boldsymbol{x = -1}$ $\qquad$ ***or*** $\qquad$ $\boldsymbol{x = -7}$

The solutions are $\boldsymbol{-1}$ ***and*** $\boldsymbol{-7}$

WHAT'S MORE

Solve the following quadratic equations. Check the solutions.

1. $x^2 - 49 = 0$
2. $9x^2 - 25 = 0$
3. $4x^2 + 1 = 5$
4. $5(x + 7)^2 = 1\,125$
5. $x^2 = 43$

WHAT I HAVE LEARNED

Solving quadratic equations by extracting roots is applicable if the equation is in the form $ax^2 + c = 0$ where a and c are real numbers and $a \neq 0$. Below are the steps in solving this type of quadratic equation.

1. Write the equation in the form: $x^2 = \frac{c}{a}$
2. Extract the square roots of both side of the equation. Put a $\pm$ sign before the square root of the number. Use the $\pm$ roots to solve for the resulting equation.
3. Check your answer by substitution to see whether the equation is true.

WHAT I CAN DO

Solve the following quadratic equations by extracting square roots. **ENCIRCLE** your final answer.

1) $\boldsymbol{x^2 = 16}$	**6)** $\boldsymbol{4x^2 - 225 = 0}$
2) $\boldsymbol{t^2 = 81}$	**7)** $\boldsymbol{3h^2 - 147 = 0}$

3) $r^2 - 100 = 0$	**8)** $(x-4)^2 = 169$
4) $x^2 - 144 = 0$	**9)** $(2s-1)^2 - 225 = 0$
5) $2s^2 = 50$	**10)** $k^2 + 12 = 3$

ASSESSMENT

Write the letter of the correct answer on your answer sheet.

1. The _____ states that if x and c are real number and if $x^2 = c$, then $x = \sqrt{c}$ or $x = -\sqrt{c}$.
   A. Square Root Property
   B. Multiplication Property
   C. Addition Property
   D. Zero Product Property
2. What are the positive and negative square root of 81?
   A. ± 8
   B. ± 16
   C. ± 9
   D. ± 7
3. What is the practical way to solve $x^2 - 25 = 0$?
   A. factoring
   B. extracting the square root
   C. completing the square
   D. quadratic formula
4. How many real number solutions does the equation $x^2 = c$, where $c > 0$ have?
   A. no real solution
   B. two
   C. three
   D. one
5. What are the roots of $x^2 - 144 = 0$?
   A. ± 24
   B. ± 11
   C. ± 12
   D. ± 13
6. Solve: $4x^2 - 80 = 0$ by extracting the square root.
   A. ± 5
   B. ± 2
   C. $\pm 5\sqrt{2}$
   D. $\pm 2\sqrt{5}$
7. Simplify $\pm\sqrt{\frac{144}{169}}$.
   A. $\pm\frac{11}{12}$
   B. $\pm\frac{12}{13}$
   C. $\pm\frac{13}{14}$
   D. $\pm\frac{14}{15}$
8. What is the solution set of the equation $x^2 + 16 = 0$?
   A. $\{2, 4\}$
   B. $\{-4, 4\}$
   C. $\{2, -4\}$
   D. *no real roots*

9. Simplify $-\sqrt{\frac{256}{16}}$.

   A. -16
   B. -4
   C. 4
   D. $\frac{18}{4}$

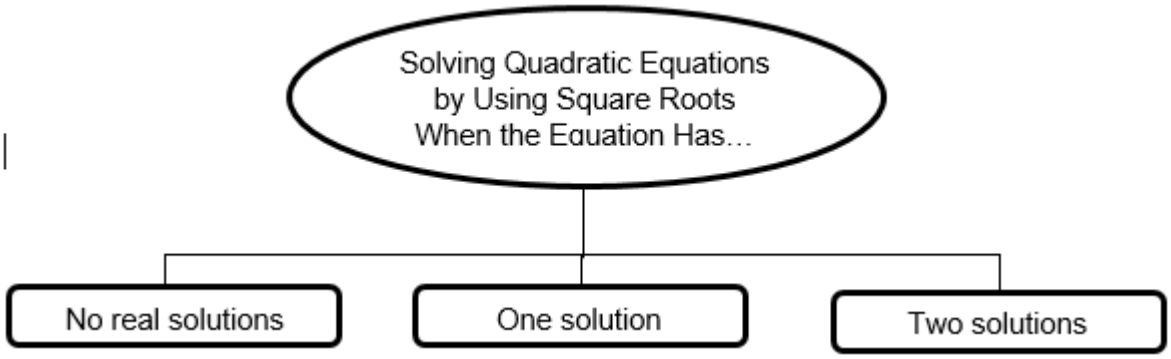
10. Baby Brown has a piece of wood whose area is 25 square centimeters. What is the length of the side of the largest square that can be formed using the wood?

   A. 5 cm.
   B. 10 cm.
   C. 4 cm
   D. $5\sqrt{2}$ cm

ADDITIONAL ACTIVITIES

Critical Thinking, Creativity and Collaboration

A. Copy and complete the graphic organizer. In each box, write at least 3 quadratic equation, not on this module, with the given number of solutions. Solve each equation.



B. You already know that in solving quadratic equations of the form $x^2 = c$, it is possible to have a positive and a negative root of the variable x.
Can you think of a problem in your life that after solving it resulted to a positive and a negative consequence?

E-Search

You may also check the following links for your reference and further learnings on solving quadratic equations by extracting roots:

Solving Quadratic Equations:

- https://www.youtube.com/watch?v=NnjVQRwAaMg&t=272s
- https://www.youtube.com/watch?v=ZFFDSHoZBVo

REFERENCES

Refer to the following links to further understand the lesson.

https://www.mathsisfun.com/square-root.html
https://www.coursehero.com/file/37800346/math-9-lm-draft-3242014pdf/
https://www.stcs.org/view/11836.pdf
https://www.storyboardthat.com/storyboard-creator
https://charat.me/en/face/create/
https://www.google.com/search?q=handkerchiefs+collections&tbm=isch&ved=2ahUKEwi5ze-AlLDpAhXRA6YKHUG_BrgQ2-cCegQIABAA&oq=handkerchiefs+collections&gs_lcp=CgNpbWcQAzoCCAA6BggAEAUQHjoGCAAQCBAeOgYIABAKEBhQgMcDWPnjA2D15gNoAHAAeACAAXuIAdQIkgEDNS42mAEAoAEBqgELZ3dzLXdpei1pbWc&sclient=img&ei=NIy7XrnjHdGHmAXB_prACw&bih=663&biw=1366#imgrc=HSkKooIAFxGDmM
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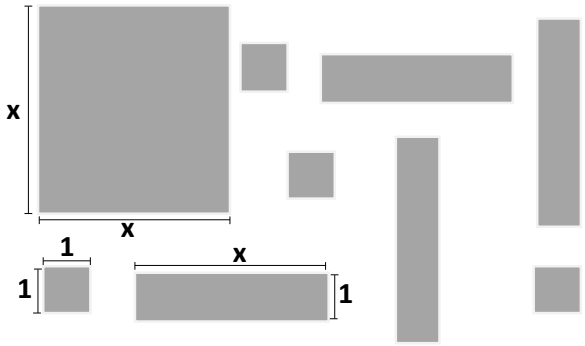
https://www.freepik.com/free-vector/kids-having-online-lessons_7560046.htm

https://www.freepik.com/free-vector/illustration-with-kids-taking-lessons-online-design_7574030.htm

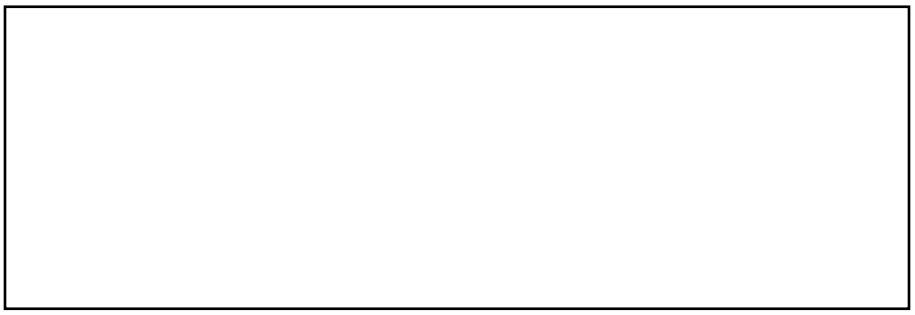
PISA – BASED WORKSHEET

The Algebra Tiles

Suppose you can build a rectangle with algebra tiles. The expression for the length and the width of the rectangle are the factors of the trinomial.



1. Model $x^2 + 4x + 4$ using the algebra tiles and arrange the tile to form a rectangle. Make a sketch of your arrangement.



2. What special kind of rectangle is it? _____

3. Use the dimension of your rectangle to complete the statement:

$$x^2 + 4x + 4 = (\_\_\_\_\_)(\_\_\_\_\_) = (\_\_\_\_\_)^2$$

4. If the area of the figure formed is $225cm^2$, what is the value of x? _____

Answer Key

WHAT'S IN

1. -7
2. 15
3. ± 12
4. $-\frac{6}{7}$

WHAT I CAN DO

1. 4 and -4
2. 9 and -9
3. 10 and -10
4. 12 and - 12
5. 5 and -5
6. $\frac{15}{2}$ and $-\frac{15}{2}$
7. 7 and -7
8. 17 and -9
9. 8 and -7
10. No real solution

WHAT'S MORE

1. ± 7
2. $\pm \frac{5}{3}$
3. ± 1
4. $8, -22$
5. $\pm\sqrt{43}$

WHAT I KNOW

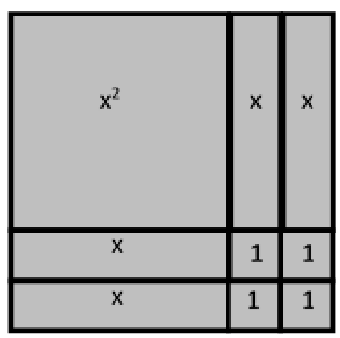
1. A
2. C
3. D
4. A
5. C
6. D
7. A
8. B
9. A
10. D

ASSESSMENT

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

PISA-BASED WORKSHEET

1. Arrange the tiles as shown:



2. The figure formed is a square.
3. $x^2 + 4x + 4 = (x + 2)(x + 2) = (x + 2)^2$
4. If the area of the square is 225cm², then:

$$(x + 2)^2 = 225$$

By extracting the square root,

$$x + 2 = \pm 15$$

Thus, we have

$$x + 2 = 15 \quad \text{and} \quad x + 2 = -15$$

$$x = 13 \qquad\qquad x = -17$$

But a negative value of x does not fit the conditions of the problem, thus the value of x is 13.