Math 2
Unit 3 – Quadratic Functions Continued
Lesson 3 → Completing the Square

Name_____
Date_____ Pd_____

Forms of a quadratic equation:

- Vertex Form: $y = a(x-h)^2 + k$
- Standard Form: $y = ax^2 + bx + c$
  - ✓ If an equation is in standard form we can use the graphing calculator to find the vertex.

❖ Complete the information for each parabola by graphing on the calculator.

$y = -2x^2 - 12x - 16$	$y = 3x^2 + 10x - 2$	$y = 2x^2 + 15x + 29$
1. Vertex:	1. Vertex:	1. Vertex:
2. Maximum or Minimum	2. Maximum or Minimum	2. Maximum or Minimum
3. Axis of Symmetry:	3. Axis of Symmetry:	3. Axis of Symmetry:
4. y – intercept:	4. y – intercept:	4. y – intercept:
5. x – intercepts:	5. x – intercepts:	5. x – intercepts:
6. Domain:	6. Domain:	6. Domain:
7. Range:	7. Range:	7. Range:

- How can we solve a quadratic equation that has **irrational** or **complex** solutions?

❖ **COMPLETING THE SQUARE** will allow us to find all solutions (rational, irrational & imaginary).

1) **REWRITE** as $x^2 + bx + c = 0$ as $x^2 + bx = -c$
2) $x^2 + bx +$ _____ $= -c +$ _____
3) **COMPLETE THE SQUARE** by taking half of b; square it and ADD IT TO BOTH SIDES of the equation in the blanks.
4) **FACTOR** the perfect square trinomial.
5) Take the **SQUARE ROOT** of both sides. Don't forget to include a $\pm$ to create 2 solutions.
6) **SOLVE** both equations. **SIMPLIFY** all irrational and complex solutions.

1. $x^2 - 6x + 8 = 0$

$x^2 - 6x + 9 = -8 + 9$

$\sqrt{(x-3)^2} = \sqrt{1}$

$x - 3 = \pm 1$

$x = 3 \pm 1$ < 4, 2

$(x-4)(x-2)$
$x = 4 \quad x = 2$

2. ~~$x^2 + 16x - 16 = 0$~~

$x^2 = -16x + 16$
$+16x \quad -16$

$x^2 + 16x - 16 = 0$

$\frac{-16 \pm \sqrt{(16)^2 - 4(1)(-16)}}{2} = \frac{-16 \pm \sqrt{320}}{2}$

$\frac{-16 \pm 8\sqrt{5}}{2} = -8 \pm 4\sqrt{5}$

$x = 5 - 8 + 4\sqrt{5}$?

$2\sqrt{320}$
$2\sqrt{160}$
$2\sqrt{80}$
$2\sqrt{40}$
$2\sqrt{20}$
$2\sqrt{10}$
$\sqrt{5}$

3. $x^2 + 12x + 43 = 0$

$\frac{-12 \pm \sqrt{144-4(1)(43)}}{2(1)} = \frac{-12 \pm \sqrt{-28}}{2}$

$\frac{-12 \pm 2i\sqrt{7}}{2} = -6 \pm i\sqrt{7}$

$x = \{-6+i\sqrt{7}, -6-i\sqrt{7}\}$

4. $x^2 - 2x - 15 = 0$

$(x-5)(x+3)=0$

$x=5 \quad x=-3$

$\frac{2 \pm \sqrt{4-4(1)(-15)}}{2} = \frac{2 \pm \sqrt{64}}{2}$

$\frac{2 \pm 8}{2}$ $\quad \frac{10}{2} = 5$ $\quad \frac{-6}{2} = -3$

1) **BEGIN** with $ax^2 + bx + c = 0$ and **MULTIPLY** "a" to "c"
2) **REWRITE** $x^2 + bx = -c \cdot a$
3) $x^2 + bx +$ _____ $= -c \cdot a +$ _____
4) **COMPLETE THE SQUARE** by taking half of b; square it and ADD IT TO BOTH SIDES of the equation in the blanks.
5) **FACTOR** the perfect square trinomial.
6) Take the **SQUARE ROOT** of both sides. Don't forget to include a $\pm$ to create 2 solutions.
7) **SOLVE** both equations. **SIMPLIFY** all irrational and complex solutions.
8) **DIVIDE** by "a" and **REDUCE** all final solutions.

5. $3x^2 + 10x - 8 = 0$

$x^2 + 10x - 24$

$(x+12)(x-2)$

$x=-4 \quad x=2/3$

$\frac{-10 \pm \sqrt{100-4(3)(-8)}}{6} = \frac{-10 \pm \sqrt{196}}{6}$

$\frac{-10 \pm 14}{6}$

$\frac{-10+14}{6} = 2/3$

$\frac{-10-14}{6} = -4$

6. $4x^2 - 8x + 3 = 0$

$\frac{8 \pm \sqrt{64-4(4)(3)}}{8} = \frac{8 \pm \sqrt{16}}{8}$

$\frac{8 \pm 4}{8} = \frac{12}{8} = 3/2, \quad \frac{4}{8} = 1/2$

7. $4x^2 - 16x + 71 = 0$

$\frac{16 \pm \sqrt{256-4(4)(71)}}{8}$

$\frac{16 \pm \sqrt{-880}}{8}$

$\frac{16 \pm 4i\sqrt{55}}{8} = \frac{4 \pm i\sqrt{55}}{2}$

$2|880$
$2|440$
$2|220$
$2|110$
$5|55$
11

$x = \{\frac{4+i\sqrt{55}}{2}, \frac{4-i\sqrt{55}}{2}\}$

8. $2x^2 + 5x - 4 = 0$

$\frac{-5 \pm \sqrt{25-4(2)(-4)}}{4}$

$= \frac{-5 \pm \sqrt{57}}{4}$

$2|64$
$2|32$
$2|16$
$2|8$
$2|4$
2

$3|57$
19

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❖ **SOLVE BY COMPLETING THE SQUARE:**

1. $x^2 + 14x - 51 = 0$

$\frac{-14 \pm \sqrt{196-4(1)(-51)}}{2}$

$\frac{-14 \pm \sqrt{400}}{2} = \frac{-14 \pm 20}{2}$ → 3, -17

$x = \{-17, 3\}$

2. $x^2 - 12x + 23 = 0$

$\frac{12 \pm \sqrt{144-4(1)(23)}}{2}$

$2|52$
$2|26$
13

$\frac{12 \pm \sqrt{52}}{2}$ $\frac{12 \pm 2\sqrt{13}}{2}$ $x = \{6+\sqrt{13}, 6-\sqrt{13}\}$

$6 \pm \sqrt{13}$

3. $x^2 - 4x + 6 = 0$

$\frac{4 \pm \sqrt{16-4(1)(6)}}{2} = \frac{4 \pm \sqrt{-8}}{2}$

$2|8$
$2|4$
2

$\frac{4 \pm 2i\sqrt{2}}{2} = 2 \pm i\sqrt{2}$

$x = \{2+i\sqrt{2}, 2-i\sqrt{2}\}$

4. $x^2 - 10x + 18 = 0$

$\frac{10 \pm \sqrt{100-4(1)(18)}}{2}$

$2|28$
$2|14$
7

$\frac{10 \pm \sqrt{28}}{2}$ $\frac{10 \pm 2\sqrt{7}}{2} = 5 \pm \sqrt{7}$

$x = \{5+\sqrt{7}, 5-\sqrt{7}\}$

5. $x^2 + 18x - 40 = 0$

$(x+20)(x-2) = 0$

$x = -20$ $x = 2$

6. $x^2 + x + 9 = 0$

$\frac{-1 \pm \sqrt{1-4(1)(9)}}{2}$

$\frac{-1 \pm \sqrt{-35}}{2} = \frac{-1 \pm i\sqrt{35}}{2}$

7. $x^2 + 2x + 20 = 0$

8. $x^2 + 4x + 7 = 0$

❖ Remember the DRS method:

9. $3x^2 - 8x + 4 = 0$

$$\frac{-b \pm \sqrt{(b)^2 - 4ac}}{2a}$$

10. $3x^2 - 2x - 5 = 0$

11. $2x^2 + 3x = 5$

$-5 \quad -5$

$2x^2 + 3x - 5 = 0$

$$\frac{-3 \pm \sqrt{(3)^2 - 4(2)(-5)}}{2(2)} = \frac{-3 \pm \sqrt{49}}{4}$$

$$\frac{-3 \pm 7}{4} \begin{cases} \frac{4}{4} = 1 \\ \frac{-10}{4} = -\frac{5}{2} \end{cases}$$

$x = \{1, -5/2\}$

12. $10x^2 + 4x + 68 = 0$