**Warm-up:**

**Solve each quadratic equation by completing the square and then graph the function.**

**1) $x^2 - 10x + 7 = 0$**

$$(x^2 - 10x \quad ) + 7 = 0$$

$$(x^2 - 10x \quad \quad ) \quad + 7 = 0$$

$$(5)^2 = 25$$

$$(x^2 - 10x + 25 - 25) + 7 = 0$$

$$(x-5)^2 - 18 = 0$$

$$\sqrt{(x-5)^2} = \sqrt{18}$$

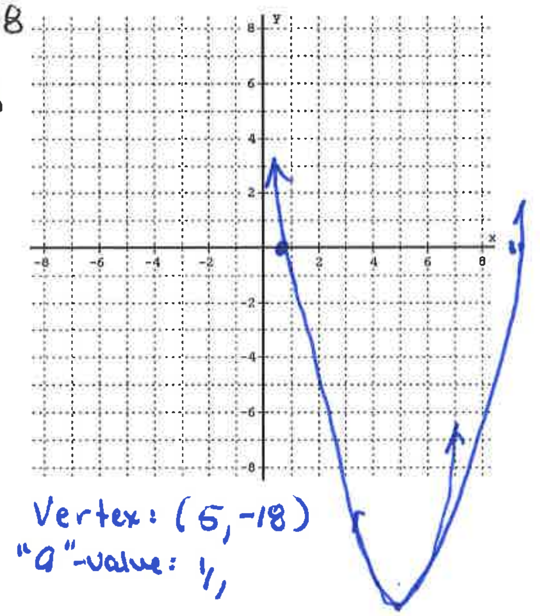
$$x - 5 = \pm\sqrt{18}$$

$$x = 5 \pm \sqrt{18}$$

or

$$x = .76$$

$$x = 9.24$$



Vertex: (5, −18)

"a"-value: 1

**The quadratic formula was "discovered" by a mathematician who used completing the square on a generic quadratic in standard form: $ax^2 + bx + c = 0$**

**2) With your elbow partner try to "discover" the quadratic formula by completing the square.**

$$ax^2 + bx \quad + c = 0$$

$$a\left(x^2 + \frac{b}{a}x + \frac{b^2}{4a^2} - \frac{b^2}{4a^2}\right) + c = 0$$

$$\left(\frac{b}{2a}\right)^2 = \frac{b^2}{4a^2}$$

$$a\left(x + \frac{b}{2a}\right)^2 - \frac{b^2}{4a} + c = 0$$

$$a\left(x + \frac{b}{2a}\right)^2 = \frac{b^2}{4a} - \frac{c}{1}$$

or

$$\frac{a\left(x + \frac{b}{2a}\right)^2}{a} = \frac{\frac{b^2 - 4ac}{4a}}{a}$$

$$\sqrt{\left(x + \frac{b}{2a}\right)^2} = \sqrt{\frac{b^2 - 4ac}{4a^2}}$$

$$x + \frac{b}{2a} = \frac{\pm\sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-b}{2a} \pm \frac{\sqrt{b^2 - 4ac}}{2a}$$

Agenda:

1) **Warm-up**
2) **Homework questions**
3) **New Lesson---3.4 The Quadratic Formula**
4) **Homework/in-class activity**

## Algebra 2: 3.4 The Quadratic Formula:

**Learning Targets for Today:**

1) Solve quadratic equations using the Quadratic Formula.
2) Solve real life problems.

### (A) Solving a Quadratic Equation using the Quadratic Formula

We have been solving quadratics for a while…

1) Graphing (x-int are solutions)
2) Factor Method
3) Square-root Method
4) Completing the Square

Well…today is the most powerful way of solving quadratics

**Quadratic Formula:**

*Used for find x-intercepts to quadratics: $ax^2+bx+c = 0$

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

**Step 1**: Set your equation equal to zero

**Step 2**: list a= b= c=

**Step 3:** Plug a, b, c into the formula

**Step 4**: Simplify

*This finds x-intercepts or solutions to quadratic equations!

**Example:**

$$2x^2 + x = 5$$

$-5 \quad -5$

$\boxed{\text{Step1}}$ $2x^2 + x - 5 = 0$

$\boxed{\text{Step2}}$ $a = 2 \quad b = 1 \quad c = -5$

$\boxed{\text{Step 3:}}$ $\dfrac{-1 \pm \sqrt{1 - 4(2)(-5)}}{2(2)}$

$\boxed{\text{Step4}}$ $\dfrac{-1 \pm \sqrt{1 + 40}}{4}$ → $\boxed{\dfrac{-1 \pm \sqrt{41}}{4}}$

or

$\dfrac{-1 \pm 6.4}{4}$

$\boxed{x = 1.35 \text{ \& } -1.85}$

**Try/ Slowly**

$$3x^2 + 8x = 35$$

step1 $3x^2 + 8x - 35 = 0$

step2 $a = 3 \quad b = 8 \quad c = -35$

step3 $\dfrac{-8 \pm \sqrt{64 - 4(3)(-35)}}{2(3)}$

$\dfrac{-8 \pm \sqrt{64 + 420}}{6}$

$\dfrac{-8 \pm \sqrt{484}}{6}$ → $\dfrac{-8 \pm 22}{6}$

$\dfrac{-8 + 22}{6} = 2.33$

$\dfrac{-8 - 22}{6} = -5$

**Try:**

$$x^2 - x = 5x - 9$$
$-5x \quad -5x$

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

$a = 1$
$b = -6$
$c = 9$

$$\frac{6 \pm \sqrt{36 - 4(1)(9)}}{2(1)}$$

$$\frac{6 \pm \sqrt{36 - 36}}{2}$$

$$\frac{6 \pm \sqrt{0}}{2} \rightarrow \frac{6}{2} = 3$$

Could have factored!

$9 \cdot 1$
$\underline{3 \cdot 3}$

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

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

$x - 3 = 0$

$\underline{\underline{x = 3}}$

**Try:**

**1)** $12x - 5 = 2x^2 + 13$
$-12x + 5 \quad -12x + 5$

$2x^2 - 12x + 18 = 0$

$a = 2$
$b = -12$
$c = 18$

$$\frac{12 \pm \sqrt{144 - 4(2)(18)}}{2(2)}$$

$$\frac{12 \pm \sqrt{144 - 144}}{4} \rightarrow \frac{12}{4} = \boxed{3}$$

**Example/ Together:**

$-x^2 + 2x = 2$

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

$a=-1$

$b=2$

$c=-2$

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

$$\frac{-2 \pm \sqrt{4-8}}{-2}$$

$$\frac{-2 \pm \sqrt{-4}}{-2}$$

imaginary solutions

$$\frac{-2 \pm \sqrt{4}\cdot\sqrt{-1}}{-2}$$

$$\frac{-2 \pm 2i}{-2}$$

Lets reduce

$$\frac{-2}{-2} \pm \frac{2i}{-2}$$

$$\boxed{1 \pm i}$$

**Try:**

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

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

$a=2$

$b=-2$

$C=3$

$$\frac{2 \pm \sqrt{4-4(2)(3)}}{2(2)}$$

$$\frac{2 \pm \sqrt{4-24}}{4}$$

$$\frac{2 \pm \sqrt{-20}}{4}$$

$$\frac{2 \pm \sqrt{20}\,i}{4}$$

$\sqrt{4}\cdot\sqrt{5}$

$$\frac{2 \pm 2\sqrt{5}i}{4}$$

$$\frac{2}{4} \pm \frac{2\sqrt{5}i}{4}$$

$$\boxed{\frac{1}{2} \pm \frac{\sqrt{5}i}{2}}$$

## (B) Solving Real-Life Problems

The function $h = -16t^2 + h^0$ (this is the initial height or starting height) is used to model the height of a dropped object. For an object that is launched or thrown, an extra term ( $vt$ ) must be added to the model to account for the object's initial vertical velocity.

**Core Concept:**

- $H = -16t^2 + h^0$ (use when an object is dropped)
- $H = -16t^2 + vt + h^0$ (use when an object is launched or thrown)
- $h^0$ is starting height
- $v$ is the object's initial velocity

As shown below, the value of $v$ can be positive, negative, or zero depending on whether the object is launched upward, downward, or parallel to the ground.

$v_0 > 0$

$v_0 < 0$

$v_0 = 0$

**Example/Try:**

$h^0$ starting height

A juggler tosses a ball into the air. The ball leaves the juggler's hand 4 feet above the ground and has an initial vertical velocity of 30 feet per second. The juggler catches the ball when it falls back to a height of 3 feet. How long is the ball in the air?

finishing height

find the $t$ = time

$t$ = time after the toss

$H = -16t^2 + vt + h^0$

finishing height — initial velocity — starting height

$3 = -16t^2 + 30t + 4$

set equal to 0

$-16t^2 + 30t + 1 = 0$

Solve for $t$

$a = -16 \quad b = 30 \quad c = 1$

$$\frac{-30 \pm \sqrt{900 - 4(-16)(1)}}{2(-16)}$$

$$\frac{-30 \pm \sqrt{900 + 64}}{-32} \Rightarrow \frac{-30 \pm \sqrt{964}}{-32}$$

$$\rightarrow \frac{-30 \pm 31.05}{-32} \rightarrow t = 1.91 \text{ sec} \;\;\&\;\; t = -.03$$

reject the − answer.. time can't be negative

**Homework: pg. 127 ( 5-13, 63)**