Solving Quadratics without Factoring - General Example

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Example: Find the solution(s) to:

$$a(x - \frac{-b}{2a})^2 + \frac{4ac-b^2}{4a} = ax^2 + bx + c = 0$$

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Square it

Multiply by a

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

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

Divide by a

Take the Square Root

Add $\frac{-b}{2a}$

Subtracting $\frac{4ac-b^2}{4a}$ from both sides gives us:

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

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$$\sqrt{(x-\tfrac{-b}{2a})^2}=\sqrt{\tfrac{b^2-4ac}{4a^2}}$$

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Now, we can Take the Square Root of both sides to get:

▸ why?

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

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Now, we can Take the Square Root of both sides to get:

▸ why? $\left|x-\tfrac{-b}{2a}\right|=\sqrt{(x-\tfrac{-b}{2a})^2}=\sqrt{\tfrac{b^2-4ac}{4a^2}}=\tfrac{\sqrt{b^2-4ac}}{\sqrt{4a^2}}=\tfrac{\sqrt{b^2-4ac}}{2a}$

Since $\left|x-\tfrac{-b}{2a}\right|=\tfrac{\sqrt{b^2-4ac}}{2a}$, we know that $x-\tfrac{-b}{2a}=\pm\tfrac{\sqrt{b^2-4ac}}{2a}$

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Take the Square Root
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Subtracting $\tfrac{4ac-b^2}{4a}$ from both sides gives us:

$$a(x-\tfrac{-b}{2a})^2=a(x-\tfrac{-b}{2a})^2+\tfrac{4ac-b^2}{4a}-\tfrac{4ac-b^2}{4a}=0-\tfrac{4ac-b^2}{4a}=\tfrac{b^2-4ac}{4a}$$

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Since $\left|x-\tfrac{-b}{2a}\right|=\tfrac{\sqrt{b^2-4ac}}{2a}$, we know that $x-\tfrac{-b}{2a}=\pm\tfrac{\sqrt{b^2-4ac}}{2a}$

Adding $\tfrac{-b}{2a}$ to both sides gives: $x=\tfrac{-b}{2a}\pm\tfrac{\sqrt{b^2-4ac}}{2a}$

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$$a(x-\tfrac{-b}{2a})^2+\tfrac{4ac-b^2}{4a}=ax^2+bx+c=0$$

As before, we need to write this in the form: $a(x-h)^2+k$ ▸ Here's how

To solve for x in: $a(x-\tfrac{-b}{2a})^2+\tfrac{4ac-b^2}{4a}=0$ we have to undo 4 operations:

Subtract $\tfrac{-b}{2a}$
Square it
Multiply by a
Add $\tfrac{4ac-b^2}{4a}$

Subtract $\tfrac{4ac-b^2}{4a}$
Divide by a
Take the Square Root
Add $\tfrac{-b}{2a}$

Subtracting $\tfrac{4ac-b^2}{4a}$ from both sides gives us:

$$a(x-\tfrac{-b}{2a})^2=a(x-\tfrac{-b}{2a})^2+\tfrac{4ac-b^2}{4a}-\tfrac{4ac-b^2}{4a}=0-\tfrac{4ac-b^2}{4a}=\tfrac{b^2-4ac}{4a}$$

Now, we need to Divide by a to get:

$$(x-\tfrac{-b}{2a})^2=\frac{a(x-\frac{-b}{2a})^2}{a}=\tfrac{1}{a}\cdot\tfrac{b^2-4ac}{4a}=\tfrac{b^2-4ac}{4a^2}$$

Now, we can Take the Square Root of both sides to get:

▸ why? $$\left|x-\tfrac{-b}{2a}\right|=\sqrt{(x-\tfrac{-b}{2a})^2}=\sqrt{\tfrac{b^2-4ac}{4a^2}}=\tfrac{\sqrt{b^2-4ac}}{\sqrt{4a^2}}=\tfrac{\sqrt{b^2-4ac}}{2a}$$

Since $\left|x-\tfrac{-b}{2a}\right|=\tfrac{\sqrt{b^2-4ac}}{2a}$, we know that $x-\tfrac{-b}{2a}=\pm\tfrac{\sqrt{b^2-4ac}}{2a}$

Adding $\tfrac{-b}{2a}$ to both sides gives: $x=\tfrac{-b}{2a}\pm\tfrac{\sqrt{b^2-4ac}}{2a}=\tfrac{-b\pm\sqrt{b^2-4ac}}{2a}$

Solving Quadratics without Factoring - General Example

Example: Find the solution(s) to:

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

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Using this, we can now compute solutions to quadratic equations very quickly!