Solving quadratic equations by completing the square worksheet with solution

To solve quadratic equations using completing the square method, the given quadratic equation must be in the form of ax2 + bx + c = 0The following steps will be useful to solve a quadratic in the above form using completing the square method. Step 1 :In the given quadratic equation ax2 + bx + c = 0, divide the complete equation by a (coefficient of x2). If the coefficient of x2 is 1 (a = 1), the above process is not required. Step 2 :Move the number term (constant) to the right side of the equation.Step 3 :In the result of step 2, write the "x" term as a multiple of 2. Examples :6x should be written as 2(3)(x).5x should be written as 2(x)(5/2). Step 4 :The result of step 3 will be in the form of x2 + 2(x)y = kStep 4 :Now add y2 to each side to complete the square on the left side of the equation. Then, x2 + 2(x)y + y2 = k + y2Step 5 :In the result of step 4, if we use the algebraic identity(a + b)2 = a2 + 2ab + b2on the left side of the equation, we get (x + y)2 = k + y2Step 6 :Solve (x + y)2 = k + y2 for x by taking square root on both sides. Example 1 :Solve the following quadratic equation by completing the square method.9x2 - 12x + 4 = 0Solution :Step 1 :In the given quadratic equation 9x2 - 12x + 4 = 0, divide the complete equation by 9 (coefficient of x2). x2 - (12/9)x + (4/9) = 0x2 - (4/3)x + (4/9) = 0Step 2 :Subtract 4/9 from each side. x2 - (4/3)x = - 4/9Step 3 :In the result of step 2, write the "x" term as a multiple of 2. Then, x2 - (4/3)x = - 4/9x2 - 2(x)(2/3) = - 4/9Step 4 :Now add (2/3)2 to each side to complete the square on the left side of the equation. Then, x2 - 2(x)(2/3) + (2/3)2 = - 4/9 + (2/3)2(x - 2/3)2 = - 4/9 + 4/9(x - 2/3)2 = 0Take square root on both sides. √(x - 2/3)2 = √0x - 2/3 = 0Add 2/3 to each side. x = 2/3So, the solution is 2/3. Example 2 :Solve the following quadratic equation by completing the square method.(5x + 7)/(x - 1) = 3x + 2Solution :Write the given quadratic equation in the form :ax2 + bx + c = 0Then, (5x + 7)/(x - 1) = 3x + 2Multiply each side by (x - 1). 5x + 7 = (3x + 2)(x - 1)Simplify. 5x + 7 = 3x2 - 3x + 2x - 25x + 7 = 3x2 - x - 20 = 3x2 - 6x - 9or3x2 - 6x - 9 = 0Divide the entire equation by 3.x2 - 2x - 3 = 0Step 1 :In the quadratic equation x2 - 2x - 3 = 0, the coefficient of x2 is 1. So, we have nothing to do in this step. Step 2 :Add 3 to each side of the equation x2 - 2x - 3 = 0.x2 - 2x = 3Step 3 :In the result of step 2, write the "x" term as a multiple of 2. Then, x2 - 2x = 3x2 - 2(x)(1) = 3Step 4 :Now add 12 to each side to complete the square on the left side of the equation. Then, x2 - 2(x)(1) + 12 = 3 + 12(x - 1)2 = 3 + 1(x - 1)2 = 4Take square root on both sides. √(x - 1)2 = √4x - 1 = ±2x - 1 = -2 or x - 1 = 2x = -1 or x = 3So, the solution is {-1, 3}. Apart from the stuff given above, if you need any other stuff in math, please use our google custom search here. Kindly mail your feedback to v4formath@gmail.comWe always appreciate your feedback. Completing The Square How to complete the square of a quadratic equation where the coefficient of x squared is equal to one or greater than one? Step 1: Write the quadratic in the form ax2 + bx + ____ = c + ____ Step 2: If a ≠ 1, divide both sides of the equations by a Step 3: Add (b/2)2 to both sides of the equation Step 4: Factor the left side of the equation. It should be a perfect square trinomial. Write it as a binomial squared. Step 5: Square root both sides of the equation and solve for x. Example: Solve by completing the square 3x2 - 7x - 2 = 0 Show Video Lesson Completing The Square - Algebra Help Students learn to solve quadratic equations by completing the square. Example: m2 + 12m + 30 = 0 Show Video Lesson Completing the Square - Solving Quadratic Equations This video shows a slightly harder example of completing the square to solve a quadratic equation. Example: Solve 2x2 - 6x + 3 = 0 Show Video Lesson Advanced Completing the Square Students learn to solve advanced quadratic equations by completing the square. Note that the quadratic equations in this lesson have a coefficient on the squared term, so the first step is to get rid of the coefficient on the squared term by dividing both sides of the equation by this coefficient. Example: 3n2 - 4n - 1 = 0 Show Video Lesson Completing the Square - Leading Coefficient Not 1 (complex solutions) How to solve a quadratic equation by completing the square when the leading coefficient is not equal to 1 and the solutions are complex? Example: Solve by completing the square 3x2 - 4x - 2 = 0 Show Video Lesson Try the free Mathway calculator and problem solver below to practice various math topics. Try the given examples, or type in your own problem and check your answer with the step-by-step explanations. We welcome your feedback, comments and questions about this site or page. Please submit your feedback or enquiries via our Feedback page. Quadratic Formula. D.Russell Use the Quadratic Formula to Solve the Equations(Answers on 2nd page of PDF. Sample questions are: 1.) 2x2 = 98 2.) 4x2 + 2x = 42 3.) x2 = 90 - 2x 4.) x2+2x = 63 5.) 5n2 - 15 = 10n 6.) 2x2 = 44 + 3x 7.) 4x2 - 10x = 84 8.) x2 - 16 = -6x 9.) x2 = 36 10.) x2 -4x = 96 Each worksheet is in PDF for quick printing. Note that the answers are found on the second page of the PDF. Although there are other methods to solve quadratic equations (factoring, graphing, completing the square) it is important to use efficiency, hence you are asked to use the quadratic formula to solve these questions. However, there are other worksheets that require you to complete the square, factor and graphing. It's important to be able to use the various methods so that you will eventually be able to use the most efficient method. After all, algorithms in math were developed to increase efficiency. Long ago, a teacher reminded me in a jokingly way that mathematicians are lazy, hence let's find all the shortcuts possible. We previously learned how to solve quadratic equations by factoring. In many cases, we must utilize a different method. When this occurs, we can turn to a method known as completing the square. This method creates a perfect square trinomial on one side and sets it equal to a constant on the other. We can then solve using the square root property. Test Objectives Demonstrate the ability to use the square root propertyDemonstrate the ability to solve a quadratic equation by completing the squareDemonstrate the ability to solve a quadratic equation with a complex solution Solving quadratics via completing the square can be tricky, first we need to write the quadratic in the form (x+\textcolor{red}{d})^2 + \textcolor{blue}{e} then we can solve it. Since a=1, this can be done in 4 easy steps. Example: By completing the square, solve the following quadratic x^2+6x +3=1 Step 1: Rearrange the equation so it is =0 \begin{aligned}(-1)\,\,\,\,\,\,\,\,\,x^2+6x+3 &=1 \\ x^2 +6x +2&=0\end{aligned} Step 2: Half the coefficient of x, so in this case \textcolor{red}{d}=6\div 2=\textcolor{red}{3}, and add it in the place of \textcolor{red}{d} (x+\textcolor{red}{3})^2 + \textcolor{blue}{e} Step 3: Next we need to find \textcolor{blue}{e} which equals the constant at the end of the quadratic, +2, minus \textcolor{red}{d^2}, then replace \textcolor{blue}{e} in the equation (\textcolor{blue}{e} \textcolor{black}{=c-}\textcolor{red}{d}\textcolor{black}{^2} as \textcolor{black}{a=1}). \begin{aligned}\textcolor{blue}{e} &= 2 -\textcolor{maroon}{9} \\ \textcolor{blue}{e} &= -7\end{aligned} (x+\textcolor{red}{3})^2 \textcolor{blue}{-7} = 0 Step 4: Now we have the equation in this form we can solve the equation. \begin{aligned}(+7)\,\,\,\,\,\,\,\,\,(x+3)^2 -7 &= 0 \\ (\sqrt{})\,\,\,\,\,\,\,\,\,\,\,\,\,\,\,\,\,\,(x+3)^2 &= 7 \\ (-3)\, x+3 &= \pm \sqrt{7} \\ x &= \pm \sqrt{7}- 3\end{aligned} This gives the solutions to be \sqrt{7} - 3 and -\sqrt{7} - 3 Remember: A square root can have both a positive and negative solution Level 8-9 If you are already familiar with the steps involved in completing the square, you may skip the introductory discussion and review the seven (7) worked examples right away. The key step in this method is to find the constant “k” that will allow us to express the given trinomial as the square of a binomial. For instance, The value of “k” is determined by squaring one-half of the coefficient of x. In this case, the coefficient of the linear term x is - \,6. Therefore, half of - \,6 is - \,3, and its square {\left({ - \,3} \right)^2} = 9. The value of k must be 9! If I substitute k by 9, the trinomial is factored into two equal binomials. This is great because I can now rewrite it in a more compact form, that is, the square of a single binomial. The following are the general steps involved in solving quadratic equations using completing the square method. Key Steps in Solving Quadratic Equation by Completing the Square 1) Keep all the x-terms (both the squared and linear) on the left side, while moving the constant to the right side. In symbol, rewrite the general form a{x^2} + bx + c as: a{x^2} + bx = - \,c 2) Now, identify what type of problem you have by looking at the coefficient of the leading term, a. Examples: “Difficult Type” when a e 1 3) If you have the “Easy type”, proceed immediately to Step 4. If you have the “Difficult Type”, you must divide the entire equation first by the value of a before moving to step 4. 4) Take the coefficient of x-term, divide it by 2 then square its result. Add this value to both sides of the equation. 5) Express the left side as a square of binomial. 6) Get the square root of both sides of the equation. Don’t forget to attach the \pm symbol on the right side! 7) Finish it off by solving the linear equation(s) that arise from it. Examples of How to Solve Quadratic Equations by Completing the Square Example 1: Solve the quadratic equation below by completing the square method. This is an “Easy Type” since a = 1. I will keep the “x-terms” (both the squared and linear terms) on the left side but move the constant to the right side. I can do that by adding 15 on both sides of the equation. Now, take the coefficient of the linear term (which is the x-term with power 1) and perform TWO operations on it: Squaring (raising to the 2nd power) The output here, which is +1, will be added to both sides of the quadratic equation. This step forces the left side to generate a perfect-square-trinomial which can be expressed as a square of a binomial. Great! At this point, it is very easy to solve for x. To get rid of the exponent 2 in the binomial, I will apply square root operation on both sides of the equation. Next, solve the pair of linear equations that arise as a result of squaring both sides. Break x = \pm \,4 + 1 into two cases, then solve. That is it! Our answers are {x_1} = 5 and {x_2} = - \,3. Make it a habit to check your solved values of x back into the original equation to verify if indeed they are “true” answers. I will leave it to you as an exercise. Example 2: Solve the quadratic equation below by completing the square method. Obviously, I can’t proceed with the steps required in completing the square. I must isolate the x-terms to the left, and the constant to the right. Do that by subtracting both sides by 1. This time I am ready to perform the completing the square steps to solve this quadratic equation. Start by taking the coefficient of the linear x-term then divide it by 2 followed by squaring it. This is the MOST important step of this whole process. Whatever number that comes out will be added to both sides of the equation. The left side becomes a perfect square trinomial which can be rewritten as the square of binomial. Eliminate the power 2 of the binomial by taking the square root of both sides. I hope that you’ll be able to follow the rest of the solution. I got the following as the answers which are {x_1} = 7 and {x_2} = 3. Go ahead and check the solutions yourself as an exercise. Example 3: Solve the quadratic equation below by completing the square method. Solution: The answers are {x_1} = 2 and {x_2} = - 10 Example 4: Solve the quadratic equation below by completing the square method. The first thing to do is to move the constant to the right side by subtracting each side by 8. This is actually the “Difficult Type” since a e 1. Thus, I need to make the coefficient of the squared x-term equal to 1. This can be done by dividing through the entire equation by a which equals 8! By dividing through by 8, I have converted this problem into the “easy” case because the coefficient of the squared x-term becomes +1. Finish this off by doing the same process as seen in examples 1 and 2. The only difference is that I will deal with fractions. Consider the coefficient of the linear x-term, divide by 2 and square it. Take the output of the step above, and add to both sides of the quadratic equation. Then proceed with the rest of the steps to complete the square. The answers should be {x_1} = 2 and {x_2} = {1 \over 2}. Example 5 (Practice Problem): Solve the quadratic equation below by completing the square method. Try solving this problem on your own first. Then click below to view the solution. Answer NOTE: The solution to this problem may look messy but as long as you apply the correct procedures for completing the square, you will soon realize that the answers to this problem come out nicely. Hint: The solution set includes a rational number and a negative integer. Example 6: Solve the quadratic equation below by completing the square method. I will move the constant to the right side while keeping all x-terms on the left. Then I must divide the entire equation by - \,3 since a e 1. Subtract both sides by 42 Divide entire equation by - \,3 Now, I will take the coefficient of the linear term, divide it by 2 and square it. Add this output 4 to both sides of the equation. This makes the left side a perfect-square-trinomial which can be rewritten as the square of a binomial. That was easy, right? Again, the more you see how these problems are being solved correctly, the better you become! Example 7 (Practice Problem): Solve the quadratic equation below using the completing the square method. Try solving this problem on your own first. Then click below to view the solution. Answer You might also be interested in: Solving Quadratic Equations by Square Root Method Solving Quadratic Equations by Factoring Method Solving Quadratic Equations by the Quadratic Formula

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