Continue

In order to continue enjoying our site, we ask that you confirm your identity as a human. Thank you very much for your cooperation. A vertex form is an alternative form of writing the quadratic equation, usually written in the standard form as ax2 + bx + c = 0. Graphing a quadratic function gives a parabola, which helps find the two roots of the equation. However, if we need to find the vertex of a parabola, the standard form of the equation is less useful. In such cases, we need to convert the equation into an alternative vertex form, which is written as: y = a(x – h)2 + k, here a ≠ 0 and (h, k) is the vertex of the parabola'a' is the leading constant (constant) that tells us whether the parabola is facing upwards or downwards. If 'a' is positive, the parabola is facing upwards, and if 'a' is negative, the parabola is facing downwards'h' represents horizontal translation (shift left or right from x = 0)'k' represents vertical translation (shift up or down from y = 0) Vertex Form of a Quadratic Equation For example, in the equation y = 4(x – 1)2 + 3 (1, 3) is the vertex of the parabola'a' is 4, and thus the parabola is facing upwardsThe horizontal translation is 1 unit to the right of x = 0The vertical translation is 3 units up from x = 0 Find the vertex of the parabola with equation 3(x + 4)2 – 6Solution:Comparing the given equation with the vertex form of the quadratic equation y = a(x – h)2 + k, the vertex is at:h = -4, k = -6Thus, the vertex of the parabola with equation 3(x + 4)2 – 6 is (-4, -6) Let us consider the quadratic equation y = x2 + 12x + 32, to show how a quadratic equation in standard form is converted to its vertex form. Step 1: Isolating the x2 and x terms to one side of the equation y = x2 + 12x + 32 => y – 32 = x2 + 12x Step 2: Add ${\left(\dfrac{b}{2}\right) ^{2}}$ to both sides of the equation Here, b = ${\left(\dfrac{12}{2}\right) ^{2}}$ = 36 Thus, y – 32 + 36 = x2 + 12x + 36 => y + 4 = x2 + 12x + 36 Step 3: Factor the right side of the equation into a perfect square => y + 4 = (x + 6)2 Step 4: Rewriting the equation in terms of y => y = (x + 6)2 – 4 Thus the vertex form of the equation y = x2 + 12x + 32 is y = (x + 6)2 – 4 Write the vertex form of the quadratic equation y = x2 + 8x + 16. Also, find the vertex of the parabola so formed.Solution:Isolating the x2 and x terms to one side of the equationy = x2 + 8x + 16=> y -16 = x2 + 8xAdding ${\left(\dfrac{b}{2}\right) ^{2}}$ to both sides of the equationHere, b = ${\left(\dfrac{8}{2}\right) ^{2}}$ = 16Thus,=> y -16 + 16 = x2 + 8x + 16 Step 3: Factoring the right side of the equation into a perfect square => y = (x + 4)2 Thus the vertex form of the equation y = x2 + 8x + 16is y = (x + 4)2, and the vertex of the parabola is (-4, 0) When working with the vertex form of the quadratic equation, the value of 'h' and 'k' can be found as: ${h=-\dfrac{b}{2a}}$ k = f(h) as (h, k) lies on the given parabola, k = ah2 + bh + c. Substituting the value of 'h' from the above step Let us consider the above equation y = x2 + 8x + 16 Comparing this equation with the standard form of the equation ax2 + bx + c = 0, we get a = 1, b = 8, c = 16 Thus, ${h=-\dfrac{b}{2a}}$ = ${\dfrac{-8}{2\times 1}}$ = -4 Substituting the value of h in the form k = ah2 + bh + c, we get k = 1(-4)2 + 8(-4) + 16 = 0 Substituting these values (along with a = 1) in the vertex form y = a(x – h)2 + k, we get => y = 1(x – (-4))2 + 0 => y = (x + 4)2 Thus the vertex form of the equation y = x2 + 8x + 16is y = (x + 4)2 Write the vertex form of the quadratic equation y = 2x2 + 12x + 13.Solution:Comparing this equation with the standard form of the equation ax2 + bx + c = 0, we get a = 2, b = 12, c = 13Thus,h = ${\dfrac{-12}{2\times 2}}$ = -3Substituting the value of h in the form k = ah2 + bh + c, we getk = 2(-3)2 + 12(-3) + 13= -5Substituting these values (along with a = 2) in the vertex form y = a(x – h)2 + k, we gety = 2(x + 3)2 -5Thus the vertex form of the equation y = 2×2 + 12x + 13 is y = 2(x + 3)2 – 5 To convert vertex form of the quadratic equation to the standard form we need to simplify the vertex form y = a(x – h)2 + k algebraically to get to the ax2 + bx + c = 0 form. The steps to follow are: Step 1: Expand the square (x – h)2 using the identity (a – b)2 Step 2: Multiply with 'a' using the distributive property Step 3: Combine the like terms Convert equation y = 2(x – 3)2 + 4 to the standard form.Solution:Expanding the square (x – 3)2 using the identity (a – b)2 = x2 – 2 × x × 3 + (3)2= x2 – 6x + 9Multiplying with 2 using the distributive property= 2(x2 – 6x + 9)= 2x2 – 12x + 18Combining the like terms= 2x2 – 12x + 18 + 4= 2x2 – 12x + 22Thus, the standard form of the equation y = 2(x – 3)2 + 4 is2x2 – 12x + 22 Last modified on August 3rd, 2023 Definitions:The first equation that we see for the quadratic function is f(x) = ax2 + bx + c.We can transform that standard equation into another one called the vertex form, f(x) = a(x - h)2 + k. We can use this form to graph our equation better.We have two options for a parabola: opening upward or opening downward. Quadratic Model:Here we have two ways for our parabolic function to open where the symmetry is along the vertical axis.On the left the parabolic function open upwards, because a > 0. On the right the parabolic function open downwards, because a < 0.Theorems:The first theorem that is useful is how to find the vertex if our equation is in standard form. The x-coordinate or h can be found be using -b/ (2a) and the y-coordinate or k can found by substituting that value into the function.The second theorem that is useful is how to find the maximum or minimum. The result after substituting will be our maximum or our minimum depending if a is positive or negative. If a < 0 then we have a maximum. If we have a > 0, then we have a minimum.Quadratic Guide:Here we have a chart on how to find vertex and the x-intercepts.Example 1:Here we have a standard parabolic equation, f(x) = x2 - 3x + 5.Line 1 - Our equation.Line 2 - We added (b/a)2 to both sides of the equation.Line 3 - We substituted -3 for b.Line 4 - We squared our term.Line 5 - We subtracted 9/4 on both sides.Line 6 - We factored and subtracted the constants.Now we have our equation in vertex form, f(x) = (x - 3/2)2 + 11/4.Now let's graph.We have vertex form, f(x) = (x - 3/2)2 + 11/4, which means we have one point - the vertex, (3/2, 11/4). There are multiply ways to find other points: X/Y Table, finding the x-intercepts, find the y-intercepts, or just substituting a few numbers.Here we are going to find the x-intercepts in order to do that we need to substitute 0 for f(x).f(x) = (x - 3/2)2 + 11/40 = (x - 3/2)2 + 11/4-11/4 = (x - 3/2)2±sqrt(-11/4) = x - 3/2ØSubstituted 0 for f(x).Subtracted -11/4 on both sides.Square rooted both sides.No solution is radicand is a not real result.Since we have a negative underneath square root symbol, our graph does not cross the x-axis. Ah, that means we need to choose another way to graph our equation.Since we don't have x-intercepts, we have to do another way to find points. Let's do an X/Y Table.As we have our equation in vertex form, f(x) = (x - 3/2)2 + 11/4, we have one point already, (3/2, 11/4). Since parabolic equations are symmetric, we want to pick one point above the extrema and one point below the extrema. Make sure that they are equal distance from the vertex, because they should be same result.We picked 1/2 and 5/2 for out inputs and our result for both is 15/4 becausef(x) = (x - 3/2)2 + 11/4f(1/2) = (1/2 - 3/2)2 + 11/4= (1)2 + 11/4= 1 + 11/4= 4/4 + 11/4= 15/4GivenSubstituted 1/2 for x.Subtracted.Divided.Squared.Found common denominator.Added.f(x) = (x - 3/2)2 + 11/4f(1/2) = (5/2 - 3/2)2 + 11/4= (2/2)2 + 11/4= (1)2 + 11/4= 1 + 11/4= 4/4 + 11/4= 15/4GivenSubstituted 5/2 for x.Subtracted.Divided.Squared.Found common denominator.Added.Now we have two more points. Since we used the X/Y Table. The vertex is our third point. Since a > 0, we have a minimum. Now we just connect the dots.Example 2:Here we have a standard parabolic equation, f(x) = -x2 - 4x + 2.Right now we have a problem. We need a to be +1 to complete the square in order to for that to happen we need to factor out that negative.Line 1 - Our equation.Line 2 - On the right side we factored the negative out so a would be +1. We added (b/a)2 to both sides of the equation but on the left we multiplied (b/a)2 by the term outside the parenthesis on the right, -1. We have to do this because we need symmetry on both sides. If we redistributed the negative on the right side the term, (b/a)2, will be negative. That is why we have to multiply what we added on the left side by -1 so we have added the same term to both sides.Line 3 - We substituted 4 for b. Notice how b is not negative. We used the coefficients inside the parenthesis.Line 4 - We squared our term.Line 5 - We added 4 on both sides.Line 6 - We factored and added the constants.Now we have our equation in vertex form, f(x) = -(x + 2)2 + 6.Now let's graph.We have vertex form, f(x) = -(x + 2)2 + 6, which means we have one point - the vertex, (-2, 6). There are multiply ways to find other points: X/Y Table, finding the x-intercepts, find the y-intercepts, or just substituting a few numbers.Here we are going to find the x-intercepts in order to do that we need to substitute 0 for f(x).f(x) = -(x + 2)2 + 60 = -(x + 2)2 + 6-6 = -(x + 2)26 = (x + 2)2 ±sqrt(6) = x - 2x = -2 ± sqrt(6)GivenSubstituted 0 for f(x).Subtracted 6 on both sides.Divided by -1 on both sides.Square rooted both sides.Added 1 to both sidesNow we have two more points. Since we substituted 0 for f(x)/y, we just found our x-intercepts. So one point is (-2 - sqrt(6), 0) and our point is (-2 + sqrt(6), 0)The vertex is our third point. Since a < 0, we have a maximum. Now we just connect the dots.Example 3:Here we have a standard parabolic equation, f(x) = 3x2 - 6x - 3.Right now we have a problem. We need a to be +1 to complete the square in order to for that to happen we need to factor out that +3.Line 1 - Our equation.Line 2 - On the right side we factored the +3 out so a would be +1. We added (b/a)2 to both sides of the equation but on the left we multiplied (b/a)2 by the term outside the parenthesis on the right, +3. We have to do this because we need symmetry on both sides. If we redistributed the +3 on the right side the term, (b/a)2, will be +3 * (b/a)2. That is why we have to multiply what we added on the left side by +3 so we have added the same term to both sides.Line 3 - We substituted -2 for b. This time the b is the same, and this is because we did not have to factor out a negative number. Line 4 - We squared our term.Line 5 - We subtracted 3 on both sides.Line 6 - We factored and added the constants.Now we have our equation in vertex form, f(x) = 3(x - 1)2 - 6.Now let's graph.We have vertex form, f(x) = 3(x - 1)2 - 6, which means we have one point - the vertex, (1, 6). There are multiply ways to find other points: X/Y Table, finding the x-intercepts, find the y-intercepts, or just substituting a few numbers.Here we are going to find the x-intercepts in order to do that we need to substitute 0 for f(x).f(x) = 3(x - 1)2 - 60 = 3(x - 1)2 - 66 = 3(x - 1)22 = (x - 1)2±sqrt(2) = x - 1x = 1 ± sqrt(2)GivenSubstituted 0 for f(x).Added 6 on both sides.Divided by 3 on both sides.Square rooted both sides.Added 1 to both sidesNow we have two more points. Since we substituted 0 for f(x)/y, we just found our x-intercepts. So one point is (1 - sqrt(2), 0) and our point is (1 + sqrt(2), 0)The vertex is our third point. Since a > 0, we have a minimum. Now we just connect the dots. Quadratic equations are fundamental in algebra, often encountered in various forms. One common representation is the standard form and another useful form is the vertex form. Converting from standard form to vertex form allows for easier identification of the vertex and provides a clearer understanding of the graph's shape and direction.In this article, we'll explore what these forms are, the methods to convert between them, and why vertex form can be particularly advantageous in solving and graphing quadratic equations.What is Quadratic Equation? Quadratic Equation is a type of polynomial equation of degree two, which means the highest exponent of the variable is two. Quadratic equations are used to model various real-world situations, such as projectile motion, area problems, and optimization scenarios.The solutions to a quadratic equation, known as the roots, can be found using various methods, including factoring, completing the square, and the quadratic formula.Quadratic equations can have different forms such as:Standard Form of a Quadratic EquationStandard form of a quadratic equation is typically written as:ax2 + bx + c = 0Where:x is the variable,a, b, and c are constants with a ≠ 0.Components of the Standard Forma: coefficient of x2. It determines the direction and width of the parabola. If a is positive, the parabola opens upwards; if a is negative, the parabola opens downwards.b: coefficient of x. It affects the position and direction of the parabola.c: The constant term. It represents the y-intercept of the parabola, which is the point where the graph intersects the y-axis.Examples of Standard FormSome examples of quadratic equation in standard form In this equation a = 2, b = −4, and c = 1.In this equation a = 3, b = 5, and c = -2.In this equation a = 1, b = -4, and c = 4.Vertex Form of a Quadratic EquationThe vertex form of a quadratic equation is a way to express the equation such that it highlights the vertex of the parabola. The vertex form is written as:y = a(x − h)2 + kWhere:(h, k) is the vertex of the parabola,a is the same coefficient as in the standard form ax2 + bx + c, which affects the width and direction of the parabola.Components of the Vertex Forma: Determines the direction and the width of the parabola. If a is positive, the parabola opens upwards;If a is negative, the parabola opens downwards.h: The x-coordinate of the vertex. It represents the horizontal shift of the parabola from the origin.k: The y-coordinate of the vertex. It represents the vertical shift of the parabola from the origin.Examples of Vertex FormSome examples of quadratic equations in vertex form are:In this equation a = 2, h = 1, k = 3, and vertex is (1, 3).In this equation a = -3, h = -4, k = -5, and vertex is (-4, -5).In this equation a = 1/2, h = 2, k = 7, and vertex is (2, 7).Conversion from Standard Form to Vertex FormConverting a quadratic equation from standard form ax2 + bx + c to vertex form a(x − h)2 + k involves completing the square. Here's a step-by-step guide to the conversion process:Step 1: Start with the standard form.y = ax2 + bx + cStep 2: Factor out the coefficient of x2 from the x-terms:If a ≠ 1, factor out a from the x2 and x terms: y = a[x2 + (b/a)x] + cStep 3: Complete the square:Take the coefficient of x, divide it by 2, and square it: \left(\frac{b}{2a}\right)^2.Add and subtract this square inside the parentheses: y = a \left(x^2 + \frac{b}{a}x + \left(\frac{b}{2a}\right)^2 - \left(\frac{b}{2a}\right)^2 \right) + cSimplify inside the parentheses to form a perfect square trinomial: y = a \left(\left(x + \frac{b}{2a} \right)^2 - \left(\frac{b}{2a}\right)^2 \right) + cStep 4: Simplify the equation:Distribute a and simplify the constant terms: \left(x + \frac{b}{2a} \right)^2 - a \left(\frac{b}{2a}\right)^2 + c= y = a \left(x + \frac{b}{2a} \right)^2 - \frac{b^2}{4a} + cStep 4: Combine the constants:Combine the constants to get the final vertex form: y = a \left(x + \frac{b}{2a} \right)^2 + \left(c - \frac{b^2}{4a} \right)In the vertex form y = a(x-h)^2 + k, the vertex (h, k) can be identified as:h = -\frac{b}{2a}k = c - \frac{b^2}{4a}Read More about Completing the Square Method.Let's consider the example for better understanding.Example: Convert y = 2x2 + 8x + 5 to vertex form.Solution:Step 1: Start with the standard form:y = 2x2 + 8x + 5Step 2: Factor out the coefficient of x2 from the x-terms:y = 2(x2 + 4x) + 5Step 3: Complete the square:Take the coefficient of x, divide it by 2, and square it: (4/2)2 = 4.Add and subtract this square inside the parentheses:y = 2 [x2 + 4x + 4 - 4] + 5⇒ y = 2[(x + 2)2 - 4] + 5Step 4: Simplify the equation:Distribute 2 and simplify the constants:y = 2(x + 2)2 - 8 + 5⇒ y = 2(x + 2)2 - 3So, the vertex form of y = 2x2 + 8x + 5 is:y = 2(x + 2)2 - 3The vertex of the parabola is (-2, -3).Read More,Solved Examples of Converting Standard Form to Vertex FormExample 1: Convert the quadratic equation y = -3x2 + 6x - 1 from standard form to vertex form.Solution:Given: y = -3x2 + 6x - 1Factor out the coefficient of x2 from the first two termsy = -3(x2 - 2x) - 1Take the coefficient of x, which is -2, divide it by 2, and square it: (-2/2)2Add and subtract this square inside the parentheses:y = -3(x2 - 2x + 1 - 1) - 1⇒ y = -3(x - 1)2 + 3 - 1⇒ y = -3(x - 1)2 + 2So, the vertex form of y = -3x2 + 6x - 1 is:y = -3(x - 1)2 + 2Example 2: Convert the quadratic equation y = x2 - 4x + 7 from standard form to vertex form.Solution:Given: y = x2 - 4x + 7Factor out the coefficient of x2 from the first two terms (coefficient is 1 here, so no factoring needed)y = x2 - 4x + 7Take the coefficient of x, which is -4, divide it by 2, and square it: (-4/2)2 = 4Add and subtract this square inside the parentheses:y = x2 - 4x + 4 - 4 + 7⇒ y = (x - 2)2 - 4 + 7⇒ y = (x - 2)2 + 3So, the vertex form of y = x2 - 4x + 7 is:y = (x - 2)2 + 3The vertex is (2, 3).Example 3: Convert the quadratic equation y = 2x2 - 8x - 5 from standard form to vertex form.Solution:Given: y = 2x2 - 8x - 5Factor out the coefficient of x2 from the first two termsy = (2x2 - 4x) - 5Take the coefficient of x, which is 4, divide it by 2, and square it: (4/2)2 = 4Add and subtract this square inside the parentheses:y = 2(x2 + 4x + 4 - 4) - 5y = 2((x - 2)2 - 4) - 5Distribute the 2 and combine like terms:y = 2(x - 2)2 - 8 - 5y = 2(x - 2)2 - 13So, the vertex form of y = 2x2 + 8x + 5 is:y = 2(x + 2)2 - 13Practice Problems on Standard Form to Vertex FormProblem 1: Convert the quadratic equation y = 3x2 + 12x + 5 from standard form to vertex form.Problem 2: Convert the quadratic equation y = -2x2 + 8x - 6 from standard form to vertex form.Problem 3: Convert the quadratic equation y = x2 - 6x + 10 from standard form to vertex form.Problem 4: Convert the quadratic equation y = -4x2 + 16x - 7 from standard form to vertex form.Problem 5: Convert the quadratic equation y = 5x2 + 20x + 15 from standard form to vertex form. Wojciech Sas, PhDPhD, Institute of Physics in ZagrebWojciech, PhD, is a physicist at the Institute of Physics in Zagreb, investigating materials under extreme conditions such as low temperatures and high pressures. He specializes in experimental work, including participation in Large-scale User Facilities such as synchrotrons. Wojciech uses his experience and knowledge to create calculators in physics, math, and statistics categories. In his free time, he likes swimming, playing board games, and looking for meteors while stargazing. See full profileCheck our editorial policySteven WoodingSteven Wooding is a physicist by training with a degree from the University of Surrey specializing in nuclear physics. He loves data analysis and computer programming. He has worked on exciting projects such as environmentally aware radar, using genetic algorithms to tune radar, and building the UK vaccine queue calculator. Steve is now the Editorial Quality Assurance Coordinator here at Omni Calculator, making sure every calculator meets the standards our users expect. In his spare time, he enjoys cycling, photography, wildlife watching, and long walks. See full profileCheck our editorial policy1 974 people find this calculator helpfulThis is the vertex form calculator (also known as vertex calculator or even find the vertex calculator). If you want to know how to find the vertex of a parabola, this is the right place to begin. Moreover, our tool teaches you what the vertex form of a quadratic equation is and how to derive the equation of the vertex form or the vertex equation itself. And this is not the end! This calculator also helps you convert from the standard to the vertex form of a parabola, or even the other way round, in a blink of an eye!The vertex of a parabola is a point that represents the extremal value of a quadratic curve. The quadratic part stands because the most significant power of our variable (x) is two. The vertex can be either a minimum (for a parabola opening up) or a maximum (for a parabola opening down). Alternatively, we can say that the vertex is the intersection of the parabola and its symmetry axis. Typically, we denote the vertex as a point P(h,k), where h stands for the x-coordinate, and k indicates the y-coordinate. That's enough on the definitions. But how to find the vertex of a quadratic function? It may be a surprise, but we don't need to evaluate any square root to do so! Whenever we face a standard form of a parabola y = a·x² + b·x + c, we can use the equations of the vertex coordinates: h = -b/(2a), k = c - b²/(4a). Knowing how to find these ratios, we can move one step further and ask: What is the vertex form of a parabola?Intuitively, the vertex form of a parabola is the one that includes the vertex's details inside. We can write the vertex form equation as: y = a·(x-h)² + k. As you can see, we need to know three parameters to write a quadratic vertex form. One of them is a, the same as in the standard form. It tells us whether the parabola is opening up (a > 0) or down (a < 0). The parameter a can never equal zero for a vertex form of a parabola (or any other form, strictly speaking). The remaining parameters, h and k, are the components of the vertex. That's where the vertex form equation gets its name. Additionally, it's worth mentioning that it's possible to draw a quadratic function graph having only the parameter a and the vertex.If you want to convert a quadratic equation from the standard form to the vertex form, you can use completing the square method (you can read more about it in our completing the square calculator). Let's discuss how this method works in our current context.To convert the standard form y = ax² + bx + c to vertex form: Extract a from the first two terms: y = a[x² + (b/a)x] + c. Add and subtract (b/(2a))² inside the bracket: y = a[x² + (b/a)x + (b/(2a))² - (b/(2a))²] + c. Use the short multiplication formula: y = a[(x + b/(2a))² - (b/(2a))²] + c. Expand the bracket: y = a(x + b/(2a))² - b²/(4a) + c. This is your vertex form with h = -b/(2a) and k = c - b²/(4a). That is one way how to convert to vertex form from a standard one. The second (and quicker) one is to use our vertex form calculator – the way we strongly recommend! It only requires typing the parameters a, b, and c. Then, the result appears immediately at the bottom of the calculator space. Our find the vertex calculator can also work the other way around by finding the standard form of a parabola. In case you want to know how to do it by hand using the vertex form equation, we will give the recipe in the next section.To convert a parabola from vertex to standard form: Write down the parabola equation in the vertex form: y = a(x-h)² + k. Expand the expression in the bracket: y = a(x² - 2hx + h²) + k. Multiply the terms in the parenthesis by a: y = ax² - 2ahx + ah² + k. Compare the outcome with the standard form of a parabola: y = ax² + bx + c. You have the standard from! Its parameters are b = -2·a·h, c = a·h² + k. There are two approaches you can take to use our vertex form calculator: The first possibility is to use the vertex form of a quadratic equation; The second option finds the solution of switching from the standard form to the vertex form. We've already described the last one in one of the previous sections. Let's see what happens for the first one: Type the values of parameter a and the coordinates of the vertex, h and k. Let them be a = 0.25, h = -17, k = -54; That's all! As a result, you can see a graph of your quadratic function, together with the points indicating the vertex, y-intercept, and zeros. Above the chart, you can find the detailed descriptions: Both the vertex and standard form of the parabola: y = 0.25(x + 17)² - 54 and y = 0.25x² + 8.5x + 18.25 respectively; The vertex: P = (-17, -54); The y-intercept: Y = (0, 18.25); The values of the zeros: X_1 = (-31.6969 , 0), X_2 = (-2.3031, 0). In case you're curious, we round the outcome to an accuracy of four decimal places. FAQsIf you know the parameters a, b, and c from the standard form of a parabola, you can find the vertex coordinates h and k by using the formulas: h = -b/(2a); and k = c - b²/(4a). Alternatively, you can evaluate the value of your parabola at the argument h, i.e., k = ah² + bh + c.The vertex form is y = a(x - 2)² + 5, where a is the same non-zero parameter as in the standard form. For each value of a, you get a different parabola, so you need to specify a to get a definite result.Vertex form: y = a(x-h)2 + kCheck out 46 similar coordinate geometry calculators The standard form of a quadratic equation is y = ax^2 + bx + c, where a, b, and c are coefficients and y and x are variables. It is easier to solve a quadratic equation when it is in standard form because you compute the solution with a, b, and c. However, if you need to graph a quadratic function, or parabola, the process is streamlined when the equation is in vertex form. The vertex form of a quadratic equation is y = m(x-h)^2 + k with m representing the slope of the line and h and k as any point on the line. Factor the coefficient a from the first two terms of the standard form equation and place it outside of the parentheses. Factoring standard form quadratic equations involves finding a pair of numbers that add up to b and multiply to ac. For instance, if you are converting 2x^2 – 28x + 10 to vertex form, you first need to write 2(x^2 – 14x) + 10. Next, divide the coefficient of the x term inside the parentheses by two. Use the square root property to then square that number. Using that square root property method helps to find the quadratic equation solution by taking the square roots of both sides. In the example, the coefficient of the x inside the parentheses is -14. Add the number inside the parentheses, and then to balance the equation, multiply it by the factor on the outside of parentheses and subtract this number from the whole quadratic equation. For example, 2(x^2 – 14x) + 10 becomes 2(x^2 – 14x + 49) + 10 – 98, since 49*2 = 98. Simplify the equation by combining the terms at the end. For example, 2(x^2 – 14x + 49) – 88, since 10 – 98 = -88. Langdon, Nucreisha. "How To Convert Quadratic Equations From Standard To Vertex Form" sciencing.com, . 25 June 2018. APA Langdon, Nucreisha. (2018, June 25). How To Convert Quadratic Equations From Standard To Vertex Form. sciencing.com. Retrieved from Chicago Langdon, Nucreisha. How To Convert Quadratic Equations From Standard To Vertex Form last modified March 24, 2022. In this mini-lesson, we will explore the process of converting standard form to vertex form and vice-versa. The standard form of a parabola is y = ax2 + bx + c and the vertex form of a parabola is y = a (x - h)2 + k. Here, the vertex form has a square in it. So to convert the standard to vertex form we need to complete the square. Let us learn more about converting standard form to vertex form along with more examples. Standard Form and Vertex Form of a Parabola The equation of a parabola can be represented in multiple ways like: standard form, vertex form, and intercept form. One of these forms can always be converted into the other two forms depending on the requirement. In this article, we are going to learn how to convert standard form to vertex form and vertex form to standard form Let us first explore what each of these forms means. Standard Form The standard form of a parabola is: Here, a, b, and c are real numbers (constants) where a ≠ 0. x and y are variables where (x, y) represents a point on the parabola. Vertex Form The vertex form of a parabola is: Here, a, h, and k are real numbers, where a ≠ 0. x and y are variables where (x, y) represents a point on the parabola. How to Convert Standard Form to Vertex Form? In the vertex form, y = a (x - h)2 + k, there is a "whole square". So to convert the standard form to vertex form, we just need to complete the square. But apart from this, we have a formula method also for doing this. Let us look into both methods. By Completing the Square Let us take an example of a parabola in standard form: y = -3x2 - 6x - 9 and convert it into the vertex form by completing the square. First, we should make sure that the coefficient of x2 is 1. If the coefficient of x2 is NOT 1, we will place the number outside as a common factor. We will get: y = −3x2 − 6x − 9 = −3 (x2 + 2x + 3) Now, the coefficient of x2 is 1. Here are the steps to convert the above expression into the vertex form. Step 1: Identify the coefficient of x. Step 2: Make it half and square the resultant number. Step 3: Add and subtract the above number after the x term in the expression. Step 4: Factorize the perfect square trinomial formed by the first 3 terms using the suitable identity. Here, we can use x2 + 2xy + y2 = (x + y)2. In this case, x2 + 2x + 1= (x + 1)2 The above expression from Step 3 becomes: Step 5: Simplify the last two numbers and distribute the outside number. Here, -1 + 3 = 2. Thus, the above expression becomes: This is of the form y = a (x - h)2 + k, which is in the vertex form. Here, the vertex is, (h, k)=(-1,-6). By Using the Formula In the above method, ultimately we could find the values of h and k which are helpful in converting standard form to vertex form. But the values of h and k can be easily found by using the following steps: Find h using h = -b/2a. Since (h, k) lies on the given parabola, k = ah2 + bh + c. Just use this to find k by substituting the value of 'h' from the above step. Let us convert the same example y = -3x2 - 6x - 9 into standard form using this formula method. Comparing this equation with y = ax2 + bx + c, we get a = -3, b = -6, and c = -9. Then (i) h = -b/2a = -(-6) / (2 × -3) = -1 (ii) k = -3(-1)2 - 6(-1) - 9 = -3 + 6 - 9 = -6 Substitute these two values (along with a = -3) in the vertex form y = a (x - h)2 + k, we get y = -3 (x + 1)2 - 6. Note that we have got the same answer as in the other method. Which method is easier? Decide and go ahead. Tips and Tricks: If the above processes seem difficult, then use the following steps: Compare the given equation with the standard form (y = ax2 + bx + c) and get the values of a,b, and c. Apply the following formulas to find the values the values of h and k and substitute it in the vertex form (y = a(x - h)2 + k): h = -b/2a k = -D/4a Here, D is the discriminant where D = b2 - 4ac. How to Convert Vertex Form to Standard Form? To convert vertex form into standard form, we just need to simplify a (x - h)2 + k algebraically to get into the form ax2 + bx + c. Technically, we need to follow the steps below to convert the vertex form into the standard form. Expand the square, (x − h)2. Distribute 'a'. Combine the like terms. Example: Let us convert the equation y = -3 (x + 1)2 - 6 from vertex to standard form using the above steps: y = -3 (x + 1)2 - 6 y = -3 (x + 1)(x + 1) - 6 y = -3 (x2 + 2x + 1) - 6 y = -3x2 - 6x - 3 - 6 y = -3x2 - 6x - 9 Important Notes on Standard Form to Vertex Form: In the vertex form, (h, k) represents the vertex of the parabola where the parabola has either maximum/minimum value. If a > 0, the parabola has the minimum value at (h, k) and if a < 0, the parabola has the maximum value at (h, k). ☛ Related Topics: Vertex Calculator Quadratic Function Calculator Example 1: Find the vertex of the parabola y = 2x2 + 7x + 6 by completing the square. Solution: The given equation of parabola is y = 2x2 + 7x + 6. To find its vertex, we will convert it into vertex form. To complete the square, first, we will make the coefficient of x2 as 1. We will take the coefficient of x2 (which is 2 in this case) as the common factor. 2x2 + 7x + 6 = 2 (x2 + 7/2 x + 3) The coefficient of x is 7/2, half it is 7/4, and its square is 49/16. Adding and subtracting it from the quadratic polynomial that is inside the brackets of the above step, 2x2 + 7x + 6 = 2 (x2 + 7/2 x + 49/16 - 49/16 + 3) Factorizing the quadratic polynomial x2 + 7/2 x + 49/16, we get (x + 7/4)2. Then 2x2 + 7x + 6 = 2 ((x + 7/4)2 - 49/16 + 3) = 2 ((x + 7/4)2 - 1/16) = 2 (x + 7/4)2 - 1/8 By comparing this with a (x - h)2 + k, we will get (h, k) = (-7/4, -1/8). Answer: The vertex of the given parabola is (-7/4, -1/8). Example 2: Find the vertex of the same parabola as in Example 1 without converting into vertex form. Solution: The given parabola is y = 2x2 + 7x + 6. So a = 2, b = 7, and c = 6. The x-coordinate of the vertex is, h = -b/2a = -7/[2(2)] = -7/4. The y-coordinate of the vertex is, k = 2(-7/4)2 + 7(-7/4) + 6 = -1/8 Answer: We have got the same answer as in Example 1 which is (h, k) = (-7/4, -1/8). Example 3: Find the equation of the following parabola in standard form. Solution: We can see that the parabola has the maximum value at the point (2, 2). So the vertex of the parabola is, (h, k) = (2, 2). So the vertex form of the above parabola is, y = a (x - 2)2 + 2 ... (1). To find 'a' here, we have to substitute any known point of the parabola in this equation. The graph clearly passes through the point (1, 0) = (x, y). Substitute it in (1): 0 = a (1 - 2)2 + 2 0 = a + 2 a = -2 Substitute it back into (1) and expand the square to convert it into the standard form: y = -2 (x - 2)2 + 2 y = -2 (x2 - 4x + 4) + 2 y = -2x2 + 8x - 8 + 2 y = -2x2 + 8x - 6 Answer: Thus, the standard form of the given parabola is: y = -2x2 + 8x - 6. View Answer > go to slidego to slidego to slide Great learning in high school using simple cues Indulging in rote learning, you are likely to forget concepts. With Cuemath, you will learn visually and be surprised by the outcomes. Book a Free Trial Class FAQs on Standard Form to Vertex Form To convert standard form to vertex form, Convert y = ax2 + bx + c into the form y = a (x - h)2 + k by completing the square. Then y = a (x - h)2 + k is the vertex form. How Do You Convert Vertex Form to Standard Form? Converting vertex form into standard form is so easy. Just expand the square in y = a (x - h)2 + k, then expand the brackets, and finally simplify. How to Convert Standard Form to Vertex Form Using Completing the Square? To convert standard form to vertex form by using completing the square method, Take the coefficient of x2 as the common factor if it is other than 1. Make the coefficient of x half and square it. Add and subtract this number to the quadratic expression of the first step. Then apply algebraic identities to write it in the vertex form. How to Find the Vertex of a Parabola in Standard Form? Vertex can't be directly identified from standard form. Convert standard form into vertex form y = a (x - h)2 + k, then (h, k) would give the vertex of the parabola. How to Convert Standard Form to Vertex Form Without Completing the Square? To convert y = ax2 + bx + c into y = a (x - h)2 + k without completing the square, just find 'h' and 'k' using the following formulas h = -b / 2a k = - (b2 - 4ac) / 4a What is the Use of Converting Standard Form into Vertex Form? Vertex form is more helpful in graphing quadratic functions where we can easily identify the vertex, and by finding one/two points on either side of the vertex would give the perfect shape of a parabola. Use this vertex form calculator to find how to derive the vertex of a quadratic equation along with a graphical representation. You can convert a quadratic equation from its standard form (ax² + bx + c) to vertex form (a(x-h)² + k), or vice versa. What Is the Vertex Form? Vertex form is a specific way to write a quadratic equation. It is a point or place where it turns. If the quadratic function converts to vertex form, then the vertex is (h, k). Typically, it is represented as: y = a(x - h)² + k Where: h = x-coordinate of the vertex k = y-coordinate of the vertex What Is the Vertex of a Parabola? "The point at the intersection of the parabola and its line is a symmetry known as the vertex of the parabola". How to Find the Vertex of a Parabola? The vertex of a parabola is a specific point that represents the different values of the quadratic curve. The vertex can be either maximum (when parabola going downward) or minimum (when parabola going up). Therefore, the vertex form is the intersection of a parabola with its symmetric axis. A standard form of a parabola ax² + bx + c, so we can use quadratic equations of the vertex coordinates: \(h = -b / 2a\) \(k = c – b^2 / 4a\) Finding the vertex of a parabola for the equation: = 2(x -(-6))2 - 13 Solution: According to given equation Vertex form is: y = 2 (x + 6)2 - 13 Standard form of given equation is: y = 2 x2 + 24 x + 59 Where, Characteristic Points are: Vertex = P (-6, -13) Y-intercept = P (0, 59) How To Convert Standard Form To Vertex Form? The standard form of a quadratic equation is ax² + bx + c = 0, where m and x are variables and a, b, and c are the coefficients. It is simple to solve an equation when it is in standard form because we calculate the answer with a, b, and c. The process is smooth when the equation is in vertex form. The standard to vertex form of a quadratic equation is Q = m(x - h)2 + k, where m represents the slope. If you want to get vertex from the standard form, follow these points: Write the standard form of a quadratic function: m = a x2 + b x + c . Divide first two terms by a: m = a (x2 + b/a x) + c. Complete the square for the expression with x. Then, add and subtract (b/(2a))2 from the equation: m = a [x2 + x (b/a) + (b/(2a))2 - (b/(2a))2] + c. Now, according to square formula, we can say write: m = a [(x + (b/(2a))2 - (b/(2a))2] + c and multiply the terms with a: m = a (x + (b/(2a))2 - b^2/4a + c. Then compare the vertex equation: m = a (x - h)2 + k , the vertex of parabola is: h = - b / 2a and k = c - b2 / 4a. How To Convert Vertex Form To Standard Form? This tool can convert vertex form to the standard form of a parabola. If you want to know how to change the vertex to standard form, let's start! Write an equation in vertex form: m = a (x - h)2 + k. Now, expand the square formula: m = a (x2 + y2 + 2hx) + k. Multiply the inner side or bracket: a x2 + a y2 + 2 ahx + k. Then, compare with quadratics in vertex form of a parabola: m = a x2 + b x + c. Estimate the values of parameter: b = - 2 ah and c = a h2 + k. Reference: From the source of Wikipedia: Etymology, Coefficients, Variables, The one-variable case, Bivariate case, Forms of a univariate quadratic function, Graph of the univariate function. When written in "vertex form": • (h, k) is the vertex of the parabola, and x = h is the axis of symmetry. • the h represents a horizontal shift (how far left, or right, the graph has shifted from x = 0). • the k represents a vertical shift (how far up, or down, the graph has shifted from y = 0). • notice that the h value is subtracted in this form, and that the k value is added. If the equation is y = 2(x - 1)2 + 5, the value of h is 1, and k is 5. If the equation is y = 3(x + 4)2 - 6, the value of h is -4, and k is -6. To Convert from f (x) = ax2 + bx + c Form to Vertex Form: Method 1: Completing the Square To convert a quadratic from y = ax2 + bx + c form to vertex form, y = a(x - h)2+ k, you use the process of completing the square. Let's see an example. Convert y = 2x2 - 4x + 5 into vertex form, and state the vertex. Equation in y = ax2 + bx + c form. y = 2x2 - 4x + 5 Since we will be "completing the square" we will isolate the x2 and x terms ... so move the + 5 to the other side