Solving quadratics using zero product property worksheet

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The "Zero Product Property" says that: If a × b = 0 then a = 0 or b = 0 (or both a=0 and b=0) It can help us solve equations: The "Zero Product Property" says: If (x−5)(x−3) = 0 then (x−5) = 0 or (x−3) = 0 Now we just solve each of those: For (x−5) = 0 we get x = 5 For (x−3) = 0 we get x = 3 And the solutions are: x = 5, or x = 3 Here it is on a graph: y=0 when x=3 or x=5 Standard Form of an Equation Sometimes we can solve an equation by putting it into Standard Form and then using the Zero Product Property: The "Standard Form" of an equation is: (some expression) = 0 In other words, "= 0" is on the right, and everything else is on the left. Standard Form and the Zero Product Property So let's try it out: It is tempting to divide by (x+3), but that is dividing by zero when x = −3 So instead we can use "Standard Form": 5(x+3) − 5x(x+3) = 0 Which can be simplified to: (5−5x)(x+3) = 0 5(1−x)(x+3) = 0 Then the "Zero Product Property" says: (1−x) = 0, or (x+3) = 0 And the solutions are: x = 1, or x = −3 And another example: It is tempting to divide by x, but that is dividing by zero when x = 0 So let's use Standard Form and the Zero Product Property. Bring all to the left hand side: x3 − 25x = 0 Factor out x: x(x2 − 25) = 0 x2 − 25 is a difference of squares, and can be factored into (x − 5)(x + 5): x(x − 5)(x + 5) = 0 Now we can see three possible ways it could end up as zero: x = 0, or x = 5, or x = −5 Copyright © 2017 MathsIsFun.com Solve Quadratic Equations by Factoring Learning Objective(s) · Solve equations in factored form by using the Principle of Zero Products. · Solve quadratic equations by factoring and then using the Principle of Zero Products. · Solve application problems involving quadratic equations. When a polynomial is set equal to a value (whether an integer or another polynomial), the result is an equation. An equation that can be written in the form ax2 + bx + c = 0 is called a quadratic equation. You can solve a quadratic equation using the rules of algebra, applying factoring techniques where necessary, and by using the Principle of Zero Products. The Principle of Zero Products The Principle of Zero Products states that if the product of two numbers is 0, then at least one of the factors is 0. (This is not really new.) Principle of Zero Products If ab = 0, then either a = 0 or b = 0, or both a and b are 0. This property may seem fairly obvious, but it has big implications for solving quadratic equations. If you have a factored polynomial that is equal to 0, you know that at least one of the factors or both factors equal 0. You can use this method to solve quadratic equations. Let's start with one that is already factored. Example Problem Solve (x + 4)(x – 3) = 0 for x. (x + 4)(x – 3) = 0 Applying the Principle of Zero Products, you know that if the product is 0, then one or both of the factors has to be 0. x + 4 = 0 or x – 3 = 0 Set each factor equal to 0. x + 4 – 4 = 0 – 4 x – 3 + 3 = 0 + 3 x = −4 or x = 3 Solve each equation. Answer x = −4 OR x = 3 You can check these solutions by substituting each one at a time into the original equation, (x + 4)(x – 3) = 0. You can also try another number to see what happens. Checking x = −4 Checking x = 3 Trying x = 5 (x + 4)(x – 3) = 0 (x + 4)(x – 3) = 0 (x+ 4)(x – 3) = 0 (−4 + 4)(−4 – 3) = 0 (3 + 4)(3 – 3) = 0 (5 + 4)(5 – 2) = 0 (0)(−7) = 0 (7)(0) = 0 (9)(3) = 0 0 = 0 0 = 0 27 ≠ 0 The two values that we found via factoring, x = −4 and x = 3, lead to true statements: 0 = 0. So, the solutions are correct. But x = 5, the value not found by factoring, creates an untrue statement—27 does not equal 0! Solve for x. (x – 5)(2x + 7) = 0 A) x = 5 or B) x = 5 or −7 C) x = 0 or D) x = 0 Show/Hide Answer A) x = 5 or Correct. To find the roots of this equation, apply the Principle of Zero Products and set each factor, (x – 5) and (2x + 7), equal to 0. x – 5 = 0, so x = 5; you also find that 2x + 7 = 0, so 2x = −7, and x = . Both answers, x = 5 and , are solutions. B) x = 5 or −7 Incorrect. While x = 5 does make the equation true, the Principle of Zero Products states if (x – 5)(2x + 7) = 0 then either x – 5 = 0 or 2x + 7 = 0. This happens when x = 5 or. C) x = 0 or Incorrect. While x = does make the equation true, the Principle of Zero Products states if (x – 5)(2x + 7) = 0 then either x – 5 = 0 or 2x + 7 = 0. This happens when x = 5 or. D) x = 0 Incorrect. A value of x = 0 does not make the equation true: (0 – 5)[2(0) + 7] = (−5)(7) = −35, not 0. The Principle of Zero Products states if (x – 5)(2x + 7) = 0 then either x – 5 = 0 or 2x + 7 = 0. This happens when x = 5 or. Let's try solving an equation that looks a bit different: 5a2 + 15a = 0. Example Problem Solve for a: 5a2 + 15a = 0. 5a2 + 15a = 0 Begin by factoring the left side of the equation. 5a(a + 3) = 0 Factor out 5a, which is a common factor of 5a2 and 15a. 5a = 0 or a + 3 = 0 Set each factor equal to zero. or a = 0 a + 3 – 3 = 0 – 3 a = −3 Solve each equation. Answer a = 0 OR a = −3 To check your answers, you can substitute both values directly into the original equation and see if you get a true sentence for each. Checking a = 0 Checking a = −3 5a2 + 15a = 0 5a2 + 15a = 0 5(0)2 + 15(0) = 0 5(−3)2 + (15)(−3) = 0 5(0) + 0 = 0 5(9) – 45 = 0 0 + 0 = 0 45 – 45 = 0 0 = 0 0 = 0 Both solutions check. You can use the Principle of Zero Products to solve quadratic equations in the form ax2 + bx + c = 0. First factor the expression, and set each factor equal to 0. Example Problem Solve for r: r2 – 5r + 6 = 0. r2 – 3r + −2r + 6 = 0 Rewrite −5r as −3r – 2r, as (−3)(−2) = 6, and −3 + −2 = −5. (r2 – 3r) + (−2r + 6) = 0 Group pairs. r(r – 3) – 2(r – 3) = 0 Factor out r from the first pair and factor out −2 from the second pair. (r – 3)(r – 2) = 0 Factor out (r – 3). r – 3 = 0 or r – 2 = 0 Use the Principle of Zero Products to set each factor equal to 0. r = 3 or r = 2 Solve each equation. Answer r = 3 OR r = 2 The roots of the original equation are 3 or 2. Note in the example above, if the common factor of 2 had been factored out, the resulting factor would be (−r + 3), which is the negative of (r – 3). So factoring out −2 will result in the common factor of (r – 3). If we had gotten (−r + 3) as a factor, then when setting that factor equal to zero and solving for r we would have gotten: (−r + 3) = 0 Principle of Zero Products (−1)(−r + 3) = (−1)0 Multiplying both sides by −1. r − 3 = 0 Multiplying. r = 3 Adding 3 to both sides. More work, but the same result as before, r = 3 or r = 2. Solve for h: h(2h + 5) = 0. A) h = 0 B) h = 2 or 5 C) h = 0 or D) h = 0 or Show/Hide Answer A) h = 0 Incorrect. While h = 0 does make the equation true (since the first factor is h), there is another solution when 2h + 5 = 0. The correct answer is h = 0 or . B) h = 2 or 5 Incorrect. The Principle of Zero Products says if h(2h + 5) = 0 then either h = 0 or 2h + 5 = 0. This happens when h = 0 or. C) h = 0 or Incorrect. While h = 0 does make the equation true (since the first factor is h), the second factor is 0 when h = , not . The correct answer is h = 0 or . D) h = 0 or Correct. To find the roots of this equation, apply the Principle of Zero Products and set each factor, h and (2h + 5), equal to 0. Then solve those equations for h. Both answers are possible solutions. Applying Quadratic Equations There are many applications for quadratic equations. When you use the Principle of Zero Products to solve a quadratic equation, you need to make sure that the equation is equal to zero. For example, 12x2 + 11x + 2 = 7 must first be changed to 12x2 + 11x + −5 = 0 by subtracting 7 from both sides. Example Problem The area of a rectangular garden is 30 square feet. If the length is 7 feet longer than the width, find the dimensions. A = l • w 30 = (w + 7)(w) The formula for the area of a rectangle is A = l • w. width = w length = w + 7 area = 30 30 = w2 + 7w Multiply. w2 + 7w – 30 = 0 Subtract 30 from both sides to set the equation equal to 0. w2 + 10w – 3w – 30 = 0 Find two numbers whose product is −30 and whose sum is 7, and write the middle term as 10w – 3w. w(w + 10) – 3(w + 10) = 0 Factor w out of the first pair and −3 out of the second pair. (w – 3)(w + 10) = 0 Factor out w + 10. w – 3 = 0 w = 3 or w + 10 = 0 or w = −10 Use the Zero Product Property to solve for w. The width = 3 feet The length is 3 + 7 = 10 feet The solution w = −10 does not work for this application, as the width cannot be a negative number, we discard the −10. So, the width is 3 feet. Substitute w = 3 into the expression w + 7 to find the length: 3 + 7 = 10. Answer The width of the garden is 3 feet, and the length is 10 feet. The example below shows another quadratic equation where neither side is originally equal to zero. (Note that the factoring sequence has been shortened.) Example Problem Solve 5b2 + 4 = −12b for b. 5b2 + 4 + 12b = −12b + 12b The original equation has −12b on the right. To make this side equal to 0, add 12b to both sides. 5b2 + 12b + 4 = 0 Combine like terms. 5b2 + 10b + 2b + 4 = 0 Rewrite 12b as 10b + 2b. 5b(b + 2) + 2(b + 2) = 0 Factor out 5b from the first pair and 2 from the second pair. (5b + 2)(b + 2) = 0 Factor out b + 2. 5b + 2 = 0 or b + 2 = 0 Apply the Zero Product Property. or b = −2 Solve each equation. Answer OR b= = −2 If you factor out a constant, the constant will never equal 0. So it can essentially be ignored when solving. See the following example. Example Problem A small toy rocket is launched from a 4-foot pedestal. The height (h, in feet) of the rocket t seconds after taking off is given by the formula h = −2t2 + 7t + 4. How long will it take the rocket to hit the ground? h = −2t2 + 7t + 4 0 = −2t2 + 7t + 4 The rocket will be on the ground when the height is 0. So, substitute 0 for h in the formula. 0 = −2t2 + 8t – t + 4 Factor the trinomial by grouping. 0 = −2t(t – 4) – 1(t – 4) 0 = (−2t − 1)(t – 4) 0 = −1(2t + 1)(t – 4) Factor. 2t + 1 = 0 or t – 4 = 0 Use the Zero Product Property. There is no need to set the constant factor -1 to zero, because -1 will never equal zero. t = or t = 4 Solve each equation. t = 4 Interpret the answer. Since t represents time, it cannot be a negative number; only t = 4 makes sense in this context. Answer The rocket will hit the ground 4 seconds after being launched. Solve for m: 2m2 + 10m = 48. A) m = −8 or 3 B) m = −3 or 8 C) m = 0 or −5 D) m = 0 or 5 Show/Hide Answer A) Correct. The original equation has 48 on the right. To make this side equal to 0, subtract 48 from both sides: 2m2 + 10m – 48 = 0. Then factor out the common factor, 2: 2(m2 + 5m – 24) = 0. Then set the trinomial to 0 and solve for m. You find that 2(m + 8)(m – 3) = 0, so m = −8 or 3. B) Incorrect. You probably either factored the quadratic incorrectly or you solved the individual equations incorrectly. The correct answer is m = −8 or 3. C) Incorrect. You probably factored 2m2 + 10m as 2m(m + 5) and then set the factors equal to 0. However, the original equation is not equal to 0, it's equal to 48. To use the Zero Product Property, one side must be 0. The correct answer is m = −8 or 3. D) Incorrect. You probably factored 2m2 + 10m as 2m(m + 5) and then set the factors equal to 0, as well as making a sign mistake when solving m + 5=0. However, the original equation is not equal to 0, it's equal to 48. The correct answer is m = −8 or 3. You can find the solutions, or roots, of quadratic equations by setting one side equal to zero, factoring the polynomial, and then applying the Zero Product Property. The Principle of Zero Products states that if ab = 0, then either a = 0 or b = 0, or both a and b are 0. Once the polynomial is factored, set each factor equal to zero and solve them separately. The answers will be the set of solutions for the original equation. Not all solutions are appropriate for some applications. In many real-world situations, negative solutions are not appropriate and must be discarded.

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