Finding roots to second-degree polynomial equations

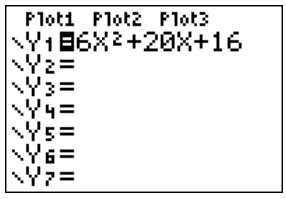
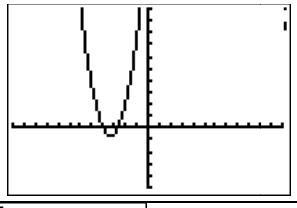
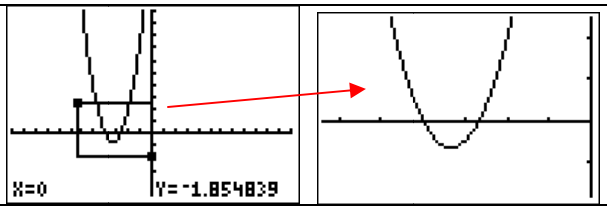
Three methods: By Groups, Graphing Calculator, and Quadratic Formula

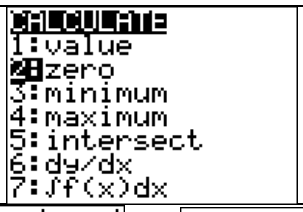
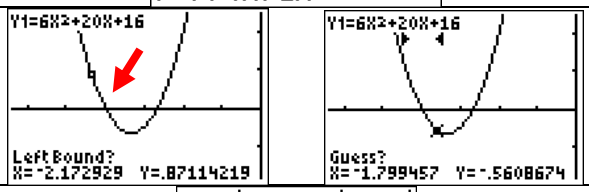
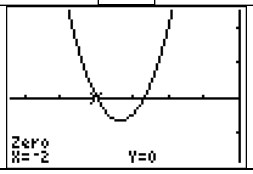
Given: $6x^2 + 20x + 16 = 0$

Method 1: , By Groups. Useful if you don't have a calculator, but time consuming, many steps.

1	**6** x **16** = 96	Multiply the first and last coefficients, 6 and 16 together
2	12 & 8. 12 x 8 = 96, and 12 + 8 = **20**	What numbers multiply to 96 and add to 20?
3	$6x^2$ + **12**x + **8**x + 16	Re-write equation using 12x & 8x instead of 20x
4	($6x^2$ + **8**x) + (**12**x + **16**) (remember, **8**x & **12**x is Is **20**x split up)	Group. Note, ($6x^2$ + 12x) + (8x + 16) is another way to group, but causes a problem when checking. At this step, grouping can only be done two ways. This is the only step of "guess and check"
5	2x(3x + 4) + 4(3x + 4)	Factor out- make sure the "(3x + 4)" are the same
6	(2x + 4)(3x + 4)	Re-write, combine terms
7	Does (2x + 4)(3x + 4) = $6x^2$ + 20x + 16 (?)	Check- yes it does.
8	Calculate the roots. (2(-2) + 4) = 0, and (3($\frac{-4}{3}$) + 4) = 0	Roots are -2, and -4/3

Method 2: TI-83/ TI-84 graphing calculator. Allows you to see the equation visually, but requires proficiency with a TI calculator. Answers are displayed as a decimal, not a fraction.

	Type in the equation in the Y= screen.
	View the graph. The function crosses the x-axis at two places, which means two places where y = 0. These are the roots. Use the Zoom Box to get a closer look.
	Using the "zoom" key, choose "ZBox" which is menu item 1. Form a box around the lower portion of the curve. The results should look similar to the picture on the right.

	To find the roots, use the "calc" menu above the TRACE key. Choose item 2, "zero."
	The calculator needs to know a boundary for which zero to calculate, because there are two. We'll find the left-most root first. Select a left and right on either side of the left-most root.
	One of the two roots is found to be -2. Repeat the same procedure for the right-most root. The result will be displayed as -1.333… which is -4/3

Method 3: Quadratic formula. Quick & easy, but may require a calculator with a square-root key. Mistakes are often made because of the complex order-of-operations in the formula.

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	The formula for solving a quadratic equation.
$x = \frac{-20 \pm \sqrt{20^2 - 4(6)(16)}}{2(6)}$	Substitute numbers for the letters. a = 6, b = 20, and c = 16. Compute both positive and negative roots, note the symbol "±" means there is a positive and negative operation (two in one)
$x_1 = \frac{-20 + 4}{12} \qquad x_2 = \frac{-20 - 4}{12}$	Clean up all the exponents and radicals, and your two roots are within reach…
$x_1 = -\frac{4}{3} \qquad x_2 = -2$	Here are the two roots