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Use of quadratic roots in acid- base pH calculations

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Subject taught: AP chemistry

Topic: Use of quadratic roots in acid- base pH calculations

Objectives:
Students will make a program for the TI calculator to find both roots of a quadratic equation, regardless of the parameters.

Key Ideas and standards:

Each year the first problem on the AP exam is some type of equilibrium. The most common of these are acid- base equilibriums. Most of the calculations students will do in acid – base equilibriums will require finding the root of a quadratic equation. While it is important to decide which of the solutions is a possible solution based on boundary conditions, it is important for you to be able to find roots quickly. As a chemistry exam, math is only a tool you use to find solutions.

Equipment:
Programmable Calculator.

Description
Faster ways to find mathematical solutions mean you will spend less time on math and more time is left for the chemistry. Your assignment is to create for the TI calculator a program which takes in the three coefficients for the 2nd order polynomial. These are typically the parameters a, b and c in the equation: $0= ax^2 + bx + c$.

Any solution will work, but it's important for you to be able to enter numbers easily and find both solutions quickly. For the sake of testing you may use the equation: $(2x – 6)(x+2) =0$ for which the solutions are +3 and -2 and for which the equation you should be able to solve for is: $2x^2 – 2x -12 =0$. This would require you to enter the values a=2, b=-2 and c = -12 in order to get the 2 solutions back.

Questions to answer:
Find the pH of a solution whose [H+] may be found by solving these quadratic roots:

1. $x^2 + 7.12 \times 10^{-5}x + 4.3 \times 10^{-9} = 0$

2. $3.5x^2 + 2.44 \times 10^{-4}x + 9.5 \times 10^{-7} = 0$

3. $2x^2 + 8.25 \times 10^{-6}x + 4.1 \times 10^{-10} = 0$

4. $1.2x^2 + 5.22 \times 10^{-8}x + 7.6 \times 10^{-12} = 0$

5. $1.5x^2 + 1.9 \times 10^{-3}x + 9.2 \times 10^{-9} = 0$

6. $7x^2 + 2 \times 10^{-5}x + 3 \times 10^{-9} = 0$

Assessment and evaluation

5 points	3 to 4 points	1 to 2 points
Student programs the calculator with a solution that labels clearly where input variables are and what the solutions become. Allows the resulting root to easily be processed into logarithmic interpretation for display of pH.	Student is able to use the calculator in with a program that works but lack labeling	Student attempts to make the program and has many parameters correct but the program does not produce the correct solution.