- Trichloroacetic acid, CCl_3COOH, a corrosive acid used to precipitate proteins, has a K_a of 0.16 M. What is the pH of a 0.050 M solution of trichloroacetic acid? 4

Hint: If $ax^2 + bx + c = 0$, then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

The reaction table is:

	CCl_3COOH	H_2O	$\rightleftharpoons$	H_3O^+	CCl_3COO^-
initial	**0.050**	**large**		**0**	**0**
change	$-x$	**negligible**		$+x$	$+x$
final	$0.050 - x$	**large**		x	x

The equilibrium constant K_a is given by:

$$K_a = \frac{[H_3O^+(aq)][CCl_3COO^-(aq)]}{[CCl_3COOH(aq)]} = \frac{x^2}{0.050 - x} = 0.16$$

K_a is not sufficiently small that any approximation to this equation can be made. Hence, the quadratic expression must be solved:

$$x^2 = (0.16 \times 0.050) - 0.16x \text{ or } x^2 + 0.16x - 0.0080$$

With a = 1, b = +0.16 and c = -0.0080, the roots are:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-0.16 \pm \sqrt{(0.16)^2 - (4 \times 1 \times -0.0080)}}{(2 \times 1)} = \frac{-(0.16) \pm 0.24}{2}$$

Only the positive root has physical significance so $x = \dfrac{-0.16 + 0.24}{2} = 0.04$

As $[H_3O^+(aq)]$ = $\underline{x}$ = 0.04 M and pH = $-\log_{10}([H_3O^+(aq)])$:

$$pH = -\log_{10}(0.04) = 1.4$$

Answer: **pH = 1.4**