Shown below are five different aqueous solutions labeled **A** through **E**. For each solution a different property is listed.

**A:** $[H_3O^+] = 10^{-3}$ M **B:** $[OH^-] = 10^{-3}$ M **C:** pOH $= 4$ **D:** $[H^+] = 10^{-3}$ M **E:** pH $= 5$

Without using a calculator, RANK the five solutions (from smallest to largest) based on their acidity. Place a single letter in each blank below and then place either a "<" or a "=" between the blanks.

(Least Acidic) ____ ____ ____ ____ ____ (Most Acidic)

**Solution to Problem:**

In order to compare **A** through **E** we need a single property. We will use pH. First, a proton concentration $[H^+]$ is just short-hand for a hydronium concentration $[H_3O^+]$ so we can rewrite **D**

**A:** $[H_3O^+] = 10^{-3}$ M **B:** $[OH^-] = 10^{-3}$ M **C:** pOH $= 4$ **D:** $[H_3O^+] = 10^{-3}$ M **E:** pH $= 5$

We can use pH $= -\log_{10}[H_3O^+]$ to find the pH of **A** and **D** without using a calculator

**A:** pH $= 3$ **B:** $[OH^-] = 10^{-3}$ M **C:** pOH $= 4$ **D:** pH $= 3$ **E:** pH $= 5$

We can use pOH $= -\log_{10}[OH^-]$ to find the pOH of **B** without using a calculator

**A:** pH $= 3$ **B:** pOH $= 3$ **C:** pOH $= 4$ **D:** pH $= 3$ **E:** pH $= 5$

We can use pH + pOH $= 14$ to find the pH of **B** and **C** without using a calculator

**A:** pH $= 3$ **B:** pH $= 11$ **C:** pH $= 10$ **D:** pH $= 3$ **E:** pH $= 5$

Finally, **A** through **E** have a common property of pH. When comparing the pH of solutions, the *smaller* the pH then the *more acidic*. This means **A** and **D** tie for the most acidic and solution **B** is the least acidic. Sorting out the rest we can fill in the blanks and place $<$ or $=$ where appropriate

(Least Acidic) **B** $<$ **C** $<$ **E** $<$ **A** $=$ **D** (Most Acidic)

Note that we did not have to use pH for comparison. We could have used pOH, $[H_3O^+]$, or $[OH^-]$ and would have gotten the same final answer.