



5. Phenol is a weak acid that partially dissociates in water according to the equation above.
- What is the pH of a 0.75 M $\text{C}_6\text{H}_5\text{OH}(aq)$ solution? (2 points)
 - For a certain reaction involving $\text{C}_6\text{H}_5\text{OH}(aq)$ to proceed at a significant rate, the phenol must be primarily in its deprotonated form, $\text{C}_6\text{H}_5\text{O}^-(aq)$. In order to ensure that the $\text{C}_6\text{H}_5\text{OH}(aq)$ is deprotonated, the reaction must be conducted in a buffered solution. On the number scale below, circle each pH for which more than 50 percent of the phenol molecules are in the deprotonated form ($\text{C}_6\text{H}_5\text{O}^-(aq)$). Justify your answer. (2 points)

1 2 3 4 5 6 7 8 9 10 11 12 13 14

$$a.) K_a = \frac{[\text{C}_6\text{H}_5\text{O}^-][\text{H}_3\text{O}^+]}{[\text{C}_6\text{H}_5\text{OH}]} = \frac{x^2}{0.75-x} \approx \frac{x^2}{0.75} = 1.12 \times 10^{-10}$$

$K_a \ll 1$, assume
 x negligible

$$x = [\text{H}_3\text{O}^+] = \sqrt{(0.75)(1.12 \times 10^{-10})} = 9.2 \times 10^{-6} \text{ M}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] = -\log(9.2 \times 10^{-6}) = \boxed{5.04}$$

b.) When $\text{pH} > \text{p}K_a$, the deprotonated form will predominate.

$$\text{p}K_a = -\log(K_a) = -\log(1.12 \times 10^{-10}) = 9.95 \Rightarrow \text{at pH of 10 or greater, } [\text{C}_6\text{H}_5\text{O}^-] > [\text{C}_6\text{H}_5\text{OH}].$$