

Nitrogen monoxide, $\text{NO}(g)$, can undergo further reactions to produce acids, such as HNO_2 , a weak acid with a K_a of 4.0×10^{-4} and a $\text{p}K_a$ of 3.40.

(c) A student is asked to make a buffer solution with a pH of 3.40 by using $0.100\text{ M HNO}_2(aq)$ and $0.100\text{ M NaOH}(aq)$.

(i) Explain why the addition of $0.100\text{ M NaOH}(aq)$ to $0.100\text{ M HNO}_2(aq)$ can result in the formation of a buffer solution. Include the net ionic equation for the reaction that occurs when the student adds the $\text{NaOH}(aq)$ to the $\text{HNO}_2(aq)$.

<p>NaOH will neutralize some of the HNO_2 to produce NO_2^-. The resulting solution contains a mixture of a weak acid and its conjugate base, which is a buffer solution.</p> $\text{HNO}_2 + \text{OH}^- \rightarrow \text{NO}_2^- + \text{H}_2\text{O}$	<p>1 point is earned for the recognition that the solution produced is a mixture of a weak acid and its conjugate base.</p> <p>1 point is earned for the correct net ionic equation.</p>
---	--

(ii) Determine the volume, in mL, of $0.100\text{ M NaOH}(aq)$ the student should add to 100. mL of $0.100\text{ M HNO}_2(aq)$ to make a buffer solution with a pH of 3.40. Justify your answer.

<p>The student should add 50.0 mL of $0.100\text{ M NaOH}(aq)$.</p> <p>When half of the HNO_2 is converted to the conjugate base, $[\text{HNO}_2] = [\text{NO}_2^-]$, therefore the buffer has a pH equal to $\text{p}K_a$.</p> <p>OR</p> $\text{pH} = \text{p}K_a + \log \frac{[\text{NO}_2^-]}{[\text{HNO}_2]}$, thus $\text{pH} = \text{p}K_a$ when $[\text{HNO}_2] = [\text{NO}_2^-]$	<p>1 point is earned for the correct volume.</p> <p>1 point is earned for clearly indicating a 1 to 1 ratio of HNO_2 and NO_2^- (calculation not required).</p>
---	---

(d) A second student makes a buffer by dissolving $0.100\text{ mol of NaNO}_2(s)$ in 100. mL of $1.00\text{ M HNO}_2(aq)$. Which is more resistant to changes in pH when a strong acid or a strong base is added, the buffer made by the second student or the buffer made by the first student in part (c)? Justify your answer.

<p>The buffer made by the second student is more resistant to changes in pH because it contains a higher concentration of HNO_2 and NO_2^- to react with added H^+ or OH^- ions.</p>	<p>1 point is earned for the correct choice and a valid justification.</p>
--	--