ANSWER KEY.

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8.8 Properties of Buffers

AP Chemistry | ANSWER KEY

Answer in complete sentences. Write reactions as net ionic equations.

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1. Circle each pair that could be used to make a buffer. Write one short reason next to each pair you did not circle.

HCl and NaCl HF and NaF NH_3 and NH_4Cl

HNO_3 and $NaNO_3$ CH_3COOH and CH_3COONa NaH_2PO_4 and Na_2HPO_4

Buffers: HF and NaF; NH_3 and NH_4Cl; CH_3COOH and CH_3COONa; NaH_2PO_4 and Na_2HPO_4. Each has a weak acid and its conjugate base.

Not buffers: HCl and NaCl, HNO_3 and $NaNO_3$. HCl and HNO_3 are strong acids, and Cl^- and NO_3^- are not bases.

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2. A buffer contains NH_3 and NH_4^+. Write the net ionic equation for what happens when a small amount of each is added. Name the buffer component that reacts.

(a) HCl

(b) NaOH

(a) $\mathbf{NH_3(}\boldsymbol{aq}\mathbf{) + H_3O^+(}\boldsymbol{aq}\mathbf{) \rightarrow NH_4^+(}\boldsymbol{aq}\mathbf{) + H_2O(}\boldsymbol{l}\mathbf{)}$. The weak base NH_3 reacts.

(b) $\mathbf{NH_4^+(}\boldsymbol{aq}\mathbf{) + OH^-(}\boldsymbol{aq}\mathbf{) \rightarrow NH_3(}\boldsymbol{aq}\mathbf{) + H_2O(}\boldsymbol{l}\mathbf{)}$. The weak acid NH_4^+ reacts.

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3. You need a buffer with a pH near 4.50. Choose the best weak acid and its conjugate base from the list, and explain your choice.

Formic acid, HCOOH (pK_a = 3.74) Acetic acid, CH_3COOH (pK_a = 4.76)

Hypochlorous acid, HOCl (pK_a = 7.54) Ammonium ion, NH_4^+ (pK_a = 9.25)

Acetic acid and acetate, CH_3COOH and CH_3COO^-.

A buffer works best when the pH is within about 1 unit of the pK_a. Acetic acid has pK_a = 4.76, the closest to 4.50. This is a 0.26 difference, so the acid and its conjugate base can both be present in useful amounts.

4. A buffer contains 0.50 *M* HA and 0.50 *M* A^-. Water is added until the volume is exactly doubled.

(a) Does the pH change? Explain.

(b) Does the buffer capacity change? Explain.

(a) **The pH stays about the same.** Both concentrations drop to 0.25 *M*, so the ratio $[A^-]$ / [HA] is still 1 and pH = pK_a.

(b) **The capacity decreases.** There are now fewer moles of HA and A^- per liter available to react with added acid or base.

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