

Ch 18 - Acid-Base Reactions

NChO 1999

38. Which acid, together with its sodium salt, would be best for preparing a buffer with a pH = 4.5?
- (A) HCN ($K_a = 4.9 \times 10^{-10}$)
(B) $C_3H_5O_2H$ ($K_a = 1.3 \times 10^{-5}$)
(C) HF ($K_a = 6.8 \times 10^{-4}$)
(D) $ClC_2H_2O_2H$ ($K_a = 1.4 \times 10^{-3}$)

39. What is the pH of a solution that contains 0.50 M sodium benzoate and 0.75 M benzoic acid? ($K_a = 6.8 \times 10^{-5}$)
- (A) 3.99 (C) 4.57
(B) 4.34 (D) 5.22

NChO 1998

38. Which of these solutions, appropriately combined, could be used to produce a buffer?
- (A) HCl and NaOH
(B) HNO_2 and $NaNO_3$
(C) KI and KOH
(D) HF and NaOH

NChO 1997

36. Which pair of chemicals would produce a buffer solution when equal numbers of moles of each are mixed?
- (A) HF and NaF (C) HCl and NH_3
(B) HF and $HC_2H_3O_2$ (D) HNO_2 and NaOH

39. Which titration will have an equivalence point at the lowest pH?
- (A) HCl and KOH (C) HF and NH_3
(B) HF and NaOH (D) HCl and NH_3

NChO 1995

39. A 0.100 M solution of acetic acid ($K_a = 1.8 \times 10^{-5}$) is titrated with a 0.1000 M solution of NaOH. What is the pH when 50% of the acid has been neutralized?
- (A) 2.38 (C) 5.70
(B) 4.74 (D) 7.00

44. Which indicator is most appropriate for titrating a 0.100 M solution of NH_3 with 0.100 M HNO_3 ? The equilibrium constant, K_a , for NH_3 equals 1.8×10^{-5}

Indicator	pH color transition range
(A) cresol red	1-2
(B) methyl red	4-6
(C) phenolphthalein	8-10
(D) alizarin yellow	10-12

NChO 1993

35. When a particular aqueous solution is diluted by a factor of ten with H_2O , the pH increases by one pH unit. This solution most likely contains a
- (A) weak acid (C) strong acid
(B) strong base (D) buffer

NChO 1992

29. When 50.0 mL of 0.200 M HCl is mixed with 150.0 mL of 0.100 M NaOH, the reaction is as shown.
- $$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$
- What is the concentration of the resulting solution?
- (A) 0.0500 M NaCl
(B) 0.100 M NaCl
(C) 0.0500 M NaCl and 0.0250 M NaOH
(D) 0.0500 M NaCl and 0.0500 M NaOH

NChO 1991

26. Which pair constitutes a buffer ?
- (A) HCl and KCl
(B) NaOH and NaCl
(C) HNO_2 and $NaNO_2$
(D) HNO_3 and NH_4NO_3
32. The best acid for preparing a buffer of pH = 3.2 has a K_a near
- (A) 2.0×10^{-5} (C) 3.2×10^{-2}
(B) 6.0×10^{-4} (D) 4.0×10^{-6}

Ch 18 - Acid-Base Reactions

Annotated Answers:

1999-38.	<p>(B) C₃H₅O₂H – The best buffer has a pH = pK_a of the acid. HCN pK_a = 9.31; C₃H₅O₂H pK_a = 4.89; HF pK_a = 3.17; ClC₂H₂O₂H pK_a = 2.85</p>
1999-39	<p>(A) 3.99 Note: benzoate ion is the conjugate base of the acid, benzoic acid.,, just like nitrate ion is the conjugate base of the acid, nitric acid. If the buffer was 50:50 Acid:Conjugate Base, the pH = pK_a = 4.17 You have more of the acid, so the pH will be lower. The only answer less than 4.17 is 3.99.</p>
1998-38.	<p>(D) HF and NaOH (A) HCl & NaOH strong acid & strong base will never make a buffer. (B) HNO₂ & NaNO₃ this could work if the salt were NaNO₂. (C) KI and KOH a salt and a strong base... no buffer here (D) This will form a buffer if you have <i>half as much NaOH</i> as HF. When you neutralize HF with NaOH, you form F⁻, the conjugate base of HF.</p>
1997-36.	<p>(A) HF and NaF – classic weak acid (HF) and its conjugate base (F⁻) Notice the question states “equal numbers of moles of each”. (B) HF and HC₂H₃O₂ -- two weak acids (C) HCl and NH₃ -- this would make a buffer if you had half as much HCl as NH₃. See above. (D) HNO₂ and NaOH – this would work if you had half as much NaOH as HNO₂.</p>
1997-39.	<p>(D) HCl and NH₃ Notice: “Lowest pH = most acidic” Look for a strong acid titrated with a weak base.</p>
1995-39.	<p>(B) 4.74 When the acid has been 50% titrated, you have a buffer where [HC₂H₃O₂] = [C₂H₃O₂⁻] and the pH = pK_a. $-\log(1.8 \times 10^{-5}) = 4.74$</p>
1995-44.	<p>(B) methyl red pH color transition range: 4-6 Strong acid + weak base will form an acidic solution at the end point of the titration. A 0.100 <u>M</u> solution of HCl would have a pH of 1.00 A solution of NH₄⁺ will be much closer to 7. The pH CAN be calculated: Equal volumes of HNO₃ and NH₃ are needed to reach the endpoint. All of the NH₃ is converted to NH₄⁺, but the volume is doubled. [NH₄⁺] = 0.100 ÷ 2 = 0.0500 <u>M</u>. The question to answer is: What is the pH of a 0.0500 M solution of NH₄⁺? K_a of NH₄⁺ = K_w/K_b = 5.56 x 10⁻¹⁰ Shortcut: $x = [H^+] = \sqrt{(0.0500)(5.56 \times 10^{-10})} = 5.27 \times 10^{-6}$ pH = 5.28</p>
1993-35.	<p>(C) strong acid This is kind of a logic problem using information you know about acids and pH's. When you dilute the substance, the pH increases. Is it an acid? 3→4 or base? 8→9. But you know that diluting an acid or a base would move it closer to 7, so 3→4 makes sense. The fact that diluting it 10x changes the pH by 1 means it must be a strong acid. A weak acid only partially dissociates (breaks up). Diluting it would lower the [H⁺], but by 10x.</p>
1992-29.	<p>(C) 0.0500 M NaCl and 0.0250 M NaOH First, remember that volume x molarity = moles. You have 0.0100 moles HCl and 0.150 moles NaOH .</p>

	<p>All of the HCl gets used up and 0.0100 moles of NaCl is formed. Divide these moles by the total volume (200 mL or 0.200 L) to get the answer. I did this with an ICE box.</p>
1991-26.	<p>(C) HNO₂ and NaNO₂ Classic buffer. Weak acid (HNO₂) and its conjugate base (NO₂⁻). Remember, Na⁺ is a spectator ion. (A) HCl and KCl – strong acid and its conjugate base. This is not a buffer (B) NaOH and NaCl -- strong base and its conjugate acid. This is not a buffer (D) HNO₃ and NH₄NO₃ -- strong acid and the conjugate acid of NH₃. This is not a buffer.</p>
1991-32.	<p>(B) 6.0 x 10⁻⁴ The pH of a buffer is the pK_a of the acid. K_a = 10^{-pK_a} A K_a with “x 10⁻⁴” will result in a pK_a near 3.2.</p>