

Buffer Calculations

1.0 What is the pH of 50.00 mL buffer solution which is 2.00M in HC₂H₃O₂ and 2.00M in NaC₂H₃O₂ ?

$$pH = pKa + \log\left(\frac{\text{base}}{\text{acid}}\right) = -\log 1.8 \times 10^{-5} + \log\left(\frac{2.00M}{2.00M}\right) = 4.74 + 0.00 = 4.74$$

2.0 What is the new pH after 2.00 mL of 6.00M HCl is added to this buffer ?

Initial moles of acid and base in buffer is (2.00mol/L)(0.500L) = 0.100

Initial moles of H⁺ added is (6.00mol/L)(0.00200L) = 0.012

HCl is a strong acid and dissociates 100%. The H⁺ ion reacts quantitatively with the conjugate base, C₂H₃O₂⁻, form of the buffer, changing the base to acid ratio of the buffer and thus the pH.

	H ⁺	+	Base C ₂ H ₃ O ₂ ⁻	→	Acid HC ₂ H ₃ O ₂
Initial moles	0.012		0.100		0.100
Change in moles	-0.012		-0.012		+0.012
Final moles	0.000		0.088		0.112
New molarity	0.0		1.69		2.15

Remember that the final volume is 52.00 mL not 50.00 mL

The new pH is thus: $pH = -\log 1.8 \times 10^{-5} + \log\left(\frac{1.69M}{2.15M}\right) = 4.74 + (-0.10) = 4.64$

3.0 What is the new pH after 2.00 mL of 6.00M NaOH is added to the **original** buffer?

NaOH is a strong base and dissociates 100%. The OH⁻ ion reacts quantitatively with the conjugate acid, HC₂H₃O₂ form of the buffer. Again the base to acid ratio of the buffer is changed and thus the pH. 0.012 moles of OH⁻ is added.

	OH ⁻	+	Acid HC ₂ H ₃ O ₂	→	Base C ₂ H ₃ O ₂ ⁻	+	H ₂ O
Initial moles	0.012		0.100		0.100		
Change in moles	-0.012		-0.012		+0.012		
Final moles	0.000		0.088		0.112		
New Molarity	0.00		1.69		2.15		

The new pH is thus: $pH = -\log 1.8 \times 10^{-5} + \log\left(\frac{2.15}{1.69}\right) = 4.74 + 0.10 = 4.84$