1. The pKₐ of acetic acid is 4.76. Calculate the pH of the following solutions:
   (a) 0.2 M acetic acid
   (b) 0.2 M sodium acetate
   (c) A buffer that is 0.2 M in acetic acid and 0.2 M in sodium acetate

2. Histidine is an amino acid of importance in maintaining the catalytic activity of proteolytic (protein cleaving) enzymes.

   The pK₁, pK₂ and pK₃ values for histidine are 1.81, 6.05 and 9.15. These values correspond to the α-COOH group, the imidazole ring and the α-NH₃⁺ group respectively.

   ![Histidine structure]

   In a buffer solution where pH = pKₐ, the concentration of the acid and its conjugate base are equal. Give the constitutional formulas of the acid species and its conjugate base associated with the following pKₐ values.
   (a) 1.81  (b) 6.05  (c) 9.15

3. A buffer at physiological pH of 7.40 is required. What quantities of 0.10 M HPO₄²⁻ and H₂PO₄⁻ are required to make 1.0 L of this buffer? (pKₐ (H₂PO₄⁻) = 7.20)

4. In a titration experiment, 50.0 mL of 0.100 M acetic acid (pKₐ = 4.76) is reacted with NaOH.
   (a) Calculate the pH when the following quantities of 0.100 M NaOH have been added:
       (i) 0.0 mL (initial pH)
       (ii) 25.0 mL
       (iii) 45.0 mL
       (iv) 50.0 mL
       (v) 55.0 mL
       (vi) 75.0 mL
   (b) Using the calculated values, plot the pH curve for the titration.
   (c) Compare your curve with that obtained for Q7 on Sheet 5.