



### Topic 12 Exercise 3 - Buffer solutions

1. a) What is meant by the term "buffer solution"?
  - b) Calculate the pH of a buffer solution which contains the weak monoprotic acid, propanoic acid ( $\text{CH}_3\text{CH}_2\text{COOH}$ ), in concentration  $0.1 \text{ mol dm}^{-3}$  and sodium propanoate in concentration  $0.05 \text{ mol dm}^{-3}$ .  $K_a$  of propanoic acid is  $1.26 \times 10^{-5} \text{ mol dm}^{-3}$ .
  - c) Give equations to show how the above solution fulfills its buffer function.
  - d) Calculate the pH of the solution after 0.01 moles of NaOH are added to  $500 \text{ cm}^3$  of the solution.
  - e) Calculate the pH of the solution after 0.01 moles of HCl are added to  $500 \text{ cm}^3$  of the solution.
  - f) Calculate the pH after 0.01 moles of NaOH is added to  $500 \text{ cm}^3$  of water.
  - g) Comment on your answers to (d) and (f).
2. a) Calculate the pH of  $0.12 \text{ mol dm}^{-3}$  ethanoic acid ( $K_a = 1.7 \times 10^{-5} \text{ mol dm}^{-3}$ ).
  - b) Calculate the mass of sodium ethanoate ( $\text{CH}_3\text{COONa}$ ) which must be added to  $500 \text{ cm}^3$  this solution to give a buffer solution of  $\text{pH} = 4.60$ .
  - c) Calculate the pH of this solution after 0.01 moles of HCl are added.
  - d) Calculate the pH of this solution after 0.01 moles of NaOH are added.
3. Calculate the pH of a buffer which is  $0.2 \text{ mol dm}^{-3}$  with respect to ammonium sulphate and  $0.1 \text{ mol dm}^{-3}$  with respect to ammonia. ( $K_a$  of  $\text{NH}_4^+ = 5.6 \times 10^{-10} \text{ mol dm}^{-3}$ )
4. Methanoic acid,  $\text{HCOOH}$ , has a  $K_a$  value of  $1.58 \times 10^{-4} \text{ mol dm}^{-3}$ . What ratio of methanoic acid and sodium methanoate would give a buffer of  $\text{pH} = 4$ ?
5. a) Calculate the pH of a buffer solution which is  $0.1 \text{ mol dm}^{-3}$  with respect to HCN ( $K_a = 4.9 \times 10^{-10} \text{ mol dm}^{-3}$ ) and  $0.8 \text{ mol dm}^{-3}$  with respect to sodium cyanide.
  - b) Calculate the pH after 0.05 moles of HCl are added to  $1 \text{ dm}^3$  of this buffer.
  - c) Calculate the pH after 0.05 moles of NaOH are added to  $1 \text{ dm}^3$  of this buffer.
  - d) Calculate the pH after 0.2 moles of NaOH are added to  $1 \text{ dm}^3$  of this buffer.
  - e) Comment on your answer to (d).