

Problems of Acid–base equilibria: Titrations

1) Calculate the pH at the equivalence point, at 25 °C, when 37 mL of 0.15 mol/L HClO solution are titrated with 0.345 mol/L NaOH solution.

Data: $K_a(\text{HClO}) = 3.000 \times 10^{-8}$, $K_w = 1 \times 10^{-14}$.

2) We titrate 20 mL of 0.78 mol/L NaOH with 0.325 mol/L HNO₃. Find out the pH after the following volumes of acid have been added:

a) 47.5 mL, b) 48 mL, c) 48.5 mL.

3) We titrate 16 mL of 0.21 mol/L HCl with 0.12 mol/L NaOH. Calculate the pH after the following volumes of base have been added:

a) 27.8 mL, b) 28 mL, c) 28.2 mL.

4) Find out the volume of 0.135 mol/L sodium hydroxide (NaOH) solution needed to titrate the following solutions:

a) 38 mL HClO 0.09 mol/L.

b) 15 mL H₂SO₃ 0.09 mol/L.

c) 24 mL HNO₃ 0.2 mol/L.

5) Calculate the volume of 0.23 mol/L hydrochloric acid (HCl) needed to titrate the following solutions:

a) 22 mL C₂H₅NH₂ 0.18 mol/L.

b) 43 mL K₂CO₃ 0.04 mol/L.

c) 20 mL Al(OH)₃ 0.14 mol/L.

6) We have 13 mL of vinegar (solution of acetic acid CH₃COOH) with a density of 1.005 g/mL. This vinegar is titrated with 58.52 mL of 0.16 mol/L NaOH solution.. Calculate the molar concentration of acetic acid in the vinegar and its weight percentage.

7) We dissolve 1.8 g of pure Na₂CO₃ in water. The obtained solution is titrated with 53.91 mL of HCl solution. Calculate the molar concentration of the hydrochloric acid solution.

8) We dissolve 1 g of pure HCl in water. The obtained solution is titrated with 49.43 mL of NaOH solution. Find out the molar concentration of the sodium hydroxide solution.

9) 0.9 g of a monoprotic acid are dissolved in water. The obtained solution is titrated with 27.04 mL of 0.32 mol/L NaOH solution. Calculate the molar mass (g/mol) of the acid.

10) 2.35 g of an impure sample of NaOH are dissolved in water. The obtained solution is titrated with 36.09 mL of 0.7 mol/L HCl solution. Find out the weight percentage of pure NaOH in the sample.

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11) Find out the pH at the equivalence point, at 25 °C, when 21 mL of 0.435 mol/L $C_6H_5NH_2$ solution are titrated with 0.185 mol/L HCl solution.

Data: $K_b(C_6H_5NH_2) = 3.800 \times 10^{-10}$, $K_w = 1 \times 10^{-14}$.

Answers:

- 1) pH = 10.27.
- 2) a) 11.38 b) 7 c) 2.62
- 3) a) 3.26 b) 7 c) 10.73
- 4) a) 25.33 mL b) 20 mL c) 35.56 mL.
- 5) a) 17.22 mL b) 14.96 mL c) 36.52 mL.
- 6) 0.7202 mol/L, 4.3 %.
- 7) 0.63 mol/L.
- 8) 0.555 mol/L.
- 9) 104 g/mol.
- 10) 43 %.
- 11) pH = 2.736.