Year 12 Chemistry Mini-Assignment Term 1 Week 9

[36 marks]

Name: SOLUTIONS

1. Write equations for each reaction and calculate the volume of 0.500 mol L^{-1} sodium hydroxide solution required to neutralise

   (a) 100.0 mL of 2.00 mol L^{-1} hydrochloric acid,
   (b) 150.0 mL of 1.50 mol L^{-1} ethanoic (acetic) acid,
   (c) 20.0 mL of 0.250 mol L^{-1} sulfuric acid, and
   (d) 75.0 mL of 0.800 mol L^{-1} phosphoric acid.

(16 marks)

(a) $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$ ①

$n(HCl) = c \times V = 2.00 \times 0.100 = 0.200$ moles ①

from equation $n(NaOH) = n(HCl) = 0.200$ moles ①

$V(NaOH) = n(NaOH)/c(NaOH) = 0.200/0.500 = 0.4$ L ①

(b) $NaOH(aq) + CH_3COOH(aq) \longrightarrow NaCH_3COO(aq) + H_2O(l)$ ①

$n(CH_3COOH) = c \times V = 1.50 \times 0.150 = 0.225$ moles ①

from equation $n(NaOH) = n(CH_3COOH) = 0.225$ moles ①

$V(NaOH) = n/c = 0.225/0.500 = 0.45$ L ①

(c) $2NaOH(aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$ ①

$n(H_2SO_4) = c \times V = 0.250 \times 0.020 = 5 \times 10^{-3}$ moles ①

from equation $n(NaOH) = 2 \times n(H_2SO_4) = 2 \times 5 \times 10^{-3} = 0.01$ mol ①

$V(NaOH) = n/c = 0.01/0.500 = 0.02$ L ①

(d) $H_3PO_4(aq) + 3NaOH(aq) \longrightarrow Na_3PO_4(aq) + 3H_2O(l)$ ①

$n(H_3PO_4) = c \times V = 0.800 \times 0.075 = 0.06$ moles ①

from equation $n(NaOH) = 3 \times n(H_3PO_4) = 3 \times 0.06 = 0.18$ mol ①

$V(NaOH) = n/c = 0.18/0.500 = 0.36$ L ①

2. Write equations for each reaction and calculate the volume of 0.200 mol L^{-1} sulfuric acid required to neutralise

   (a) 200.0 mL of 0.600 mol L^{-1} sodium hydroxide solution.
   (b) 50.0 mL of 0.100 mol L^{-1} barium hydroxide solution.

(8 marks)

(a) $H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$ ①

$n_{NaOH} = cV = 0.600 \times 0.200 = 0.120$ mole ①

From eqn $n_{H_2SO_4} = \frac{n_{NaOH}}{2} = \frac{0.120}{2} = 0.060$ mole ①

$V_{H_2SO_4} = \frac{n}{c} = \frac{0.060}{0.200} = 0.300$ L ①

(b) $H_2SO_4(aq) + Ba(OH)_2(aq) \longrightarrow BaSO_4(s) + 2H_2O(l)$ ①

$n_{Ba(OH)_2} = cV = 0.100 \times 0.050 = 5 \times 10^{-3}$ moles ①

eqn. $n_{H_2SO_4} = n_{Ba(OH)_2} = 5 \times 10^{-3}$ moles ①

$V_{H_2SO_4} = \frac{n}{c} = \frac{5 \times 10^{-3}}{0.200} = 0.025$ L ①

3. In a titration, 0.105 mol L^{-1} hydrochloric acid is used to standardise a potassium hydroxide solution using phenolphthalein as an indicator. 21.1 mL of the hydrochloric acid is needed to neutralise 25.0 mL of potassium hydroxide solution. What is the concentration of the potassium hydroxide solution?

(4 marks)

$HCl(aq) + KOH(aq) \longrightarrow KCl(aq) + H_2O(l)$ ①

$n_{HCl} = cV = 0.105 \times 0.0211 = 2.2155 \times 10^{-3}$ moles ①

From eqn $n_{KOH} = n_{HCl} = 2.2155 \times 10^{-3}$ ①

$c_{KOH} = \frac{n}{V} = \frac{2.2155 \times 10^{-3}}{0.025} = 0.0886$ M ①

$= 8.86 \times 10^{-2}$ M

4. A 5.00 mL sample of sulfuric acid from a lead-acid accumulator or car battery required 22.2 mL of 2.00 mol L^{-1} sodium hydroxide for complete neutralisation. Calculate the concentration of the sulfuric acid in the battery.

(4 marks)

$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$ (1)

$n_{NaOH} = cV = 2.00 \times 0.0222 = 0.0444$ moles (1)

FROM EQN $n_{H_2SO_4} = \frac{n_{NaOH}}{2} = \frac{0.0444}{2} = 0.0222$ moles (1)

$C_{H_2SO_4} = n/V = \frac{0.0222}{0.005} = 4.44M$ (1)

5. The concentration of an unknown sodium carbonate solution was to be determined by titration with 1.00 mol L^{-1} nitric acid using methyl orange indicator. 3.5 mL of nitric acid was added to 25.0 mL of sodium carbonate solution when a colour change from yellow to red indicated the end-point of the titration. What is the concentration of the sodium carbonate solution?

(4 marks) (1)

$Na_2CO_3(aq) + 2HNO_3(aq) \rightarrow H_2O(l) + CO_2(g) + 2NaNO_3(aq)$

$n_{HNO_3} = cV = 1 \times 0.0035 = 0.0035$ mol (1)

FROM EQN $n_{Na_2CO_3} = \frac{n_{HNO_3}}{2} = \frac{0.0035}{2} = 1.75 \times 10^{-3}$ mol (1)

$C = n/V = \frac{1.75 \times 10^{-3}}{0.025} = 7.00 \times 10^{-2}$ M (1)