Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

H_2O; OH^-

2.2

(a) **2.30**; (b) $[H^+] = \dfrac{1.0 \times 10^{-14}}{0.010} = 1.0 \times 10^{-12}$; pH = **12.00**

2.3

HCl ionizes completely, ethanoic acid only partly; so ethanoic acid has a lower $[H^+]$; ethanoic acid conducts electricity less well / reacts more slowly with Mg (fewer bubbles)

2.4

it can donate a proton; and it can accept a proton; $HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$

2.5

$[H^+] = \sqrt{K_a c} = \sqrt{1.8 \times 10^{-4} \times 0.050} = 3.0 \times 10^{-3}$; pH = **2.52**

2.6

$[OH^-] = \sqrt{1.8 \times 10^{-5} \times 0.020} = 6.0 \times 10^{-4}$; pOH = 3.22; pH = **10.78**

2.7

acidic; NH_4^+ is a weak acid / the conjugate acid of a weak base; $NH_4^+ \rightleftharpoons NH_3 + H^+$

3.1

(a) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

(b) $n(\text{NaOH}) = 0.100 \times 0.02150 = 2.150 \times 10^{-3}$ mol; $n(\text{HCl}) = 2.150 \times 10^{-3}$ mol; $c = \dfrac{2.150 \times 10^{-3}}{0.0250} = \mathbf{0.0860\ mol\ dm^{-3}}$

3.2

(a) at half-equivalence (12.5 cm^3) pH = pK_a = 4.74 (accept 4.7–4.8); $K_a = 10^{-4.74} = \mathbf{1.8 \times 10^{-5}}$

(b) the solution contains ethanoate ions, a weak base; $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$

(c) phenolphthalein; its range lies within the steep part of the curve

(d) it is a buffer with equal amounts of CH_3COOH and CH_3COO^-; added H^+ reacts with CH_3COO^- to form CH_3COOH, so $[H^+]$ hardly changes

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