Name of the Student:_____
Max. Marks : 16 Marks **Time : 16 Minutes**

Mark Schemes

Q1.

(a) **M1** $K_a \frac{[H^+][CH_3COO^-]}{[CH_3COOH]} = \frac{[H^+]^2}{[CH_3COOH]}$

1

M2 $[H^+] = \left(= \sqrt{1.74 \times 10^{-5} \times 0.150}\right) = 1.62 \times 10^{-3}$ (mol dm^{-3})

1

M3 pH = 2.79

M3 = −log M2

answer must be to 2 decimal places

1

(b) **M1** $[OH^-]$ = **2 ×** 0.01 = 0.02

1

M2 $[H^+ \left(= \frac{K_w}{[OH^-]} = \frac{2.93 \times 10^{-15}}{0.02}\right) = 1.47 \times 10^{-13}$

allow $\frac{2.93 \times 10^{-15}}{M1}$

1

M3 pH = 12.83

allow 12.8

M3 = −log M2

1

*if pH = 12.5(3) allow **2** marks (not used factor of 2 in M1)*

(c) 22.45 or same

1

same $[OH^-]$ **or** amount/number of OH^- ions

1

(d) add excess ethanoic acid to KOH
or
add enough KOH to the ethanoic acid so that the acid is partially neutralised
or
add enough KOH so that the acid contains a mixture of ethanoic acid and ethanoate ions.

1

$KOH + CH_3COOH \longrightarrow CH_3COOK + H_2O$

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allow $KOH + CH_3COOH \longrightarrow CH_3COO^-K^+ + H_2O$

1

CH_3COO^- (from salt) reacts with (added) acid/H^+

ignore equilibrium shifts

1

(e) **M1** (at start) n(NaOH) = $\frac{2.00}{40}$ = 0.05 (mol)

and

$n(CH_3COOH) = \frac{500 \times 1.0}{1000}$ = 0.5 (mol)

1

M2 (after adding NaOH)

$n(CH_3COOH)$ = (0.50 − 0.05) = 0.45 (mol)

1

M3 $n(CH_3COO^-)$ = (n NaOH) = 0.05 (mol)

M3 = n(NaOH) from M1

1

M4 $[H^+] = \left(\frac{K_a \times [CH_3COOH]}{[CH_3COO^-]} \text{ or } \frac{1.74 \times 10^{-5} \times 0.9}{0.1} \text{ or } \frac{1.74 \times 10^{-5} \times 0.45/V}{0.05/V} \right)$

$= 1.57 \times 10^{-4}$ (mol dm^{-3})

$M4 = \frac{1.74 \times 10^{-5} \times M2}{M3}$

V cancels out so not needed in expression

1

M5 pH = 3.80

answer to 2 decimal places

M5 allow 3.81

allow pH = −log M4

1

Henderson–Hasselbach method

M1 (at start) n(NaOH) = $\frac{2.00}{40}$ = 0.05 (mol)

and

$n(CH_3COOH) = \frac{500 \times 1.0}{1000}$ = 0.5 (mol)

1

M2 (after adding NaOH)

$n(CH_3COOH)$ = (0.50 − 0.05) = 0.45 (mol)

or $[CH_3COOH]$ = 0.9(0)

1

M3 $n(CH_3COO^-) = n$(NaOH) = 0.05 (mol)

or $[CH_3COO^-]$ = 0.1(0)

M3 = n(NaOH) from M1

1

M4 $pH = 4.759 + \log \frac{[CH_3COO^-]}{[CH_3COOH]}$

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or $4.759 + \log\frac{0.1}{0.9}$ **or** $4.759 + \log\frac{0.05/V}{0.45/V}$

V cancels out so not needed in this expression

1

M5 pH = 3.80

answer to 2 decimal places

M5 allow 3.81

1

[16]

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