4.3 TEST MS

1. (a) (i) *Expression for* K_a $K_a = \frac{[H^+][CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$ **(1)**

(ii) *Expression for* pK_a p$K_a = -\log_{10}K_a$ **(1)**

(iii) $K_a = \frac{[H^+]^2}{[CH_3CH_2COOH]}$ **(1)**

$[CH_3CH_2COOH] = 0.10$ M **(1)**
$\therefore [H^+] =$ **(1)** $\sqrt{(0.1 \times 1.35 \times 10^{-5})}$
$= 1.16 \times 10^{-3}$ **(1)**
$\therefore$ pH = 2.93 **(1)** 6

(b) $[CH_3CH_2COO^-]$ high <u>or</u> $CH_3CH_2COO^-$ strong electrolyte **(1)**
$CH_3CH_2COO^-$ ions react with H^+ **(1)**
CH_3CH_2COOH weak acid <u>or</u> very little dissociated **(1)** 3

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2. (a) HA $\rightleftharpoons$ $H^+(aq) + A^-(aq)$ **or** HA + $H_2O \rightleftharpoons H_3O^+ + A^-$ **(1)** 1

(b) $Ka = [H^+][A^-]/[HA]$ or $Ka = [H_3O^+][A^-]/[HA]$ **(1)** 1

(c) (i) Increases **(1)**

(ii) Decreases **(1)**

(iii) No change **(1)** 3

(d) Sodium ethanoate or sodium hydroxide **(1)**

Buffer solution **(1)** 2

[7]

3. (a) $K_w = [H^+][OH^-]$ 1

(b) $pH = -\log_{10}[H^+]$ 1

(c) $pH = -\log_{10}(2.00)$
$= -0.30$ 1

(d) $[H^+] = \frac{10^{-14}}{2.50} = 4.0 \times 10^{-15}$ mol dm^{-3} **(1)**
$\therefore$ pH = 14.40 **(1)** 2

(e) number of moles of acid and base:

$H^+ = 19.0 \times \frac{2.00}{1000} = \underline{0.0380}$ & $OH^- = 16.0 \times \frac{2.50}{1000} = \underline{0.0400}$ **(1)**

Total volume:

V = 19.0 + 16.0 = 35.0 cm^3 **(1)**

Concentration and pH:

$\therefore$ XS $[OH^-] = (0.0400 - 0.0380)$ **(1)** $\times \frac{1000}{35.0}$ **(1)** = 0.0571 M **(2)**

$\therefore [H^+] = \frac{K_w}{[OH^-]} = \frac{10^{-14}}{0.0571} = \underline{1.75 \times 10^{-13}}$ M **(1)**

$\therefore$ pH = 12.76 **(1)** 6

[11]

4. (i) H+ or proton acceptor **(1)**

$CH_3NH_2 + H_2O \rightleftharpoons CH_3{}^+NH_3 + OH^-$ **(1)**

(ii) CH_3NH_3Cl or HCl **(1)**

Or any ammonium compound or strong acid name or formula

(iii) extra OH^- reacts with $CH_3\overset{+}{N}H_3$

or reaction / equilibrium moves to left

or ratio salt / base remains almost constant **(1)**

Any 2

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[5]

5. (i) $NaHSO_3$ 1

(ii) $NaHSO_3 + NaOH \rightarrow Na_2SO_3 + H_2O$

or $HS_3^- + OH^- \rightarrow SO_3^{2-} + H_2O$ 1

(iii) Phenolphthalein or alizarin yellow or thymol blue 1

[3]

6. (a) before any KOH added: $K_a = \frac{[H^+][A^-]}{[HA]}$ **or** $\frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$ **(1)**

y $K_a = \frac{[H^+]^2}{[CH_3COOH]]}$ **(1)**

y $[H^+] = \sqrt{1.74 \times 10^{-5} \times 0.160} = 1.67 \times 10^{-3}$ **(1)**

$\therefore$ pH = 2.78 **(1)** 4

(b) at 8 cm^3 KOH:

Moles KOH added = $(8 \times 10^{-3}) \times (0.210 = 1.68 \times 10^{-3}$ **(1)**

y moles of CH_3COO^- formed = 1.68×10^{-3} **(1)**

Original moles of $CH_3COOH = (25 \times 10^{-3}) \times 0.160 = 4.0 \times 10^{-3}$ **(1)**

y moles of CH_3COOH left = $(4.0 \times 10^{-3}) - (1.68 \times 10^{-3})$

$= 2.32 \times 10^{-3}$ **(1)**

$$[H^+] = K_a \times \frac{[CH_3COOH]}{[CH_3COO^-]} \quad \textbf{(1)}$$

$$= 1.74 \times 10^{-5} \times \frac{2.23 \times 10^{-3}/V}{1.68 \times 10^{-3}/V} = 2.40 \times 10^{-5} \quad \textbf{(1)}$$

$\therefore$ pH = 4.62 **(1)**

It forget subtraction : max 5

If K_a expression not used max 5

if moles of CH_3COOH wrong but substitution used max 5

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(c) at 40 cm^3 of KOH:

Total moles of KOH = $(40 \times 10^{-3}) \times 0.21 = 8.4 \times 10^{-3}$ **(1)**

$\therefore$ excess moles of KOH = $(8.4 \times 10^{-3}) - (4.0 \times 10^{-3})$

$= 4.4 \times 10^{-3}$ **(1)**

in total volume = 40 + 25 = 65 cm^3 **(1)**

$$\therefore [OH^-] = 4.4 \times 10^{-3} \times \frac{1000}{65} = 0.0677 \quad \textbf{(1)}$$

$$\therefore [H^+] = \frac{10^{-14}}{0.0677}$$

OR pOH =1.17

$= 1.477 \times 10^{-13}$ **(1)**

$\therefore$ pH = 12.8<u>3</u> **(1)**

If volume missed : max 4

If moles of acid wrong but method includes subtraction : max 5

If no subtraction : max 4

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[Max 15]