Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) Thymol blue

1

(b) $K_a = \frac{[H^+][CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$

Square brackets essential

1

(c) **M1** $K_a = 10^{-pKa} = 1.35 \times 10^{-5}$

M2 $\frac{[H^+]^2}{[CH_3CH_2COOH]}$ OR $[H^+]^2 = K_a [CH_3CH_2COOH]$

M2 Square brackets or with numbers

M3 $[H^+] = \sqrt{(1.35 \times 10^{-5} \times 0.1)} = 1.16 \times 10^{-3}$ mol dm^{-3}

M4 $pH = -\log_{10} (1.16 \times 10^{-3}) = 2.94$

M4 = -log$_{10}$ M3
Answer to 2 decimal places
Allow 2.93

4

(d) **M1** Initial amount of butanoic acid = $25 \times 0.1 \times 10^{-3} = \underline{2.5 \times 10^{-3}}$ mol

M2 Initial amount of NaOH = $20 \times 0.1 \times 10^{-3} = \underline{2.0 \times 10^{-3}}$ mol

M3 Final amount of acid = $2.5 \times 10^{-3} - 2.0 \times 10^{-3} = 5.0 \times 10^{-4}$ mol

M3 *= M1-M2*

M4 $[H^+] = \frac{K_a \times [HX]}{[X^-]}$

Or $[H^+] = \frac{1.51 \times 10^{-5} \times 0.0111}{0.0444}$

M4 *allow volumes cancelled out*

$\frac{1.51 \times 10^{-5} \times 5.0 \times 10^{-4}}{2.0 \times 10^{-3}}$

M4 *Allow* $[H^+] = 3.775 \times 10^{-6}$ *mol dm*$^{-3}$

Alternative method for ***M4***

$pH = pKa + \log \frac{[X^-]}{[HX]} = 4.82 + \log \left(\frac{0.0444}{0.0111}\right)$

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M5 pH = 5.42

M5 *= dependent on a correct expression for* $[H^+]$ *in M4*

5

(e) **M1** This is a weak acid and weak base/alkali titration

M2 pH change is too gradual/not sharp (at the equivalence point so colour change of indicator is difficult to judge)

M2 *Allow no vertical/steep section on pH curve*

2

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Q2.

(a) **M1** amount of HCl = 0.010 mol **AND**

amount $Ca(OH)_2$ $\left(= \frac{0.6}{74.1}\right)$ = 0.00810

M2 0.00810 mol of $Ca(OH)_2$ requires 0.0162 mol HCl **OR**

0.01 mol of HCl requires 0.005 mol of $Ca(OH)_2$

NB There must be an indication that 0.005 is the amount of $Ca(OH)_2$ needed and not just 0.01/2

Alternative:

M1 *amount of HCl = 0.010 mol*

amount of $Ca(OH)_2$ needed = 0.0050 mol

NB *There must be an indication that 0.005 is the amount of $Ca(OH)_2$ needed and not just 0.01/2*

M2 *mass of $Ca(OH)_2$ needed = 0.0050 x 74.1 = 0.3705 g (so 0.6 g is excess)*

2

(b) **M1** 0.400 g dm^{-3} means 0.400 ÷ 74.1 (= 0.00540 mol dm^{-3})

M2 $[OH^-]$ = **M1** x 2 (= 0.0108 mol dm^{-3})

M3 $[H^+]$ = 6.80 x 10^{-15} ÷ **M2** (= 6.30 x 10^{-13} mol dm^{-3})

M4 pH = -log$[H^+]$

M5 = -log **M3 with answer to 2dp** (= 12.20)

Correct answer to 2 dp = 5 marks

ALLOW *12.21 for 5 marks*

M4 ALLOW *if calculation shown containing a number that has been calculated as $[H^+]$*

5

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