

Name of the Student: _____

Max. Marks : 27 Marks

Time : 27 Minutes

Mark Schemes

Q1.

- (a) Correct orientation of graph (pH on y-axis) 1

Scale – plotted points cover at least half the grid and y-axis should start at pH 4 1

All points plotted correctly
 + / – one small square. 1

Curve of best fit drawn correctly

Allow some leniency here with a complex graph – it is important that the section between pH 8.5 and 9.7 is close to linear.

Lose this mark if the line is pulled towards the anomaly at 3.0 cm³.

Lose this mark if first point at pH 5.1 is treated as an anomaly.

Do not accept doubled lines but allow some slight discontinuity where the curve changes direction.

1

- (b) 11.6-11.9 (cm³) only 1
Do not mark consequentially to student's graph.

- (c) pK_a = value of pH related to part (b) **M1** 1
Mark consequentially on student's graph – ideally 9.0-9.1
Do not penalise precision of answer.

K_a = 10^{-pK_a} **M2**

Ideally 1.0 × 10⁻⁹ to 7.9 × 10⁻¹⁰

*Ignore precision of answer but lose **M2** for 1 significant figure here.*

1

- (d) pH 8.7 1
 Ineffective stirring / swirling of the mixture
Both points needed for this mark.
Do not allow pH 5.1
Do not allow 'overshooting (at 3 cm³ addition)'.

- (e) Take more pH readings around the end-point / add smaller volumes of NaOH near the

end-point

Do not allow 'use a more accurate / reliable pH meter / probe'.

Do not allow the use of a thermostatted mixture.

1

[9]

Q2.

(a) Proton donor or H^+ donor

1

(b) (i) $K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$ or $\frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]}$

If K_a wrong, can only score M1 below.

Must be ethanoic acid not HA

Must have square brackets (penalise here only) but mark on in (b)(ii).

1

(ii) M1 $[H^+] = 10^{-2.69}$ **OR** $2.042 \times 10^{-3} \text{ (mol dm}^{-3}\text{)}$

1

M2 $[CH_3COOH] = \frac{[H^+]^2}{K_a}$

Ignore ()

Mark for correctly rearranged expression incl $[H^+]^2$

1

M3

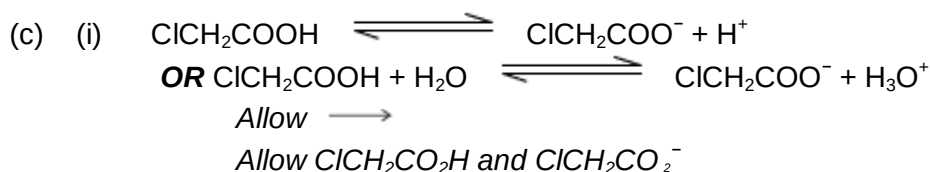
$$= \frac{(2.042 \times 10^{-3})^2}{1.75 \times 10^{-5}}$$

If M2 wrong no further marks.

1

M4 = $0.238 \text{ (mol dm}^{-3}\text{)}$ Allow 0.229 – 0.24

1



1

(ii) M1 Cl is (more electronegative so) withdraws electrons
OR negative inductive effect of Cl

Ignore electronegativity.

Ignore chloroethanoic acid has a lower K_a value.

Allow Cl reduces +ve inductive effect of methyl group.

1

M2 Weakens O–H bond

OR O–H bond is more polar

OR reduces negative charge on COO^-

OR stabilizes COO^- (more)

M1 & M2 are independent marks.

Ignore H^+ lost more easily.

1

(d) (i) **A**

1

(ii) C

1

(iii) D

1

(e) M1 $\text{Mol NaOH} = \text{mol OH}^- = (19.6 \times 10^{-3}) \times 0.720 = 1.41(1) \times 10^{-2}$
Mark for answer.

1

M2 $\text{Mol H}_2\text{SO}_4 = (26.4 \times 10^{-3}) \times 0.550 = 1.45(2) \times 10^{-2}$
Mark for answer.

1

M3 $\text{Mol H}^+ \text{ added} = 2 \times (1.452 \times 10^{-2}) = 2.90(4) \times 10^{-2}$

OR

XS $\text{mol H}_2\text{SO}_4 = 7.46(4) \times 10^{-3}$

If factor $\times 2$ missed completely ($\text{pH} = 2.05$)

or used wrongly later,

can score max 4 for M1, M2, M5 & M6

1

M4 XS $\text{mol H}^+ = 0.0149(3)$

1

M5 For dividing by volume

$[\text{H}^+] = 0.0149(3) \times (1000 / 46.0) = 0.324 - 0.325 \text{ mol dm}^{-3}$

If no use or wrong use of volume lose M5 and M6

ie can score 4 for $\text{pH} = 1.83$ (no use of vol)

Treat missing 1000 as AE (-1) & score 5 for $\text{pH} = 3.49$

1

M6 $\text{pH} = 0.49$

2dp (penalise more or less).

If $\times 2$ missed & vol not used, $\text{pH} = 3.39$ scores M1 & M2 only.

1

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