

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

Mark Schemes

Q1.			
(a)	(i)	G	1
	(ii)	F	1
	(iii)	H	1
(b)	(i)	cresol purple	1
	(ii)	yellow to red <i>both colours needed and must be in this order</i>	1
	(iii)	yellow or pale yellow <i>Not allow any other colour with yellow</i>	1
			[6]

Q2.

- (a) $[\text{H}_2\text{O}]$ is very high (compared with $[\text{H}^+]$ and $[\text{OH}^-]$)

OR

Very few H^+ and OH^- ions

OR

Only / very slightly dissociates

OR

Equilibrium lies far to the left

Not partially dissociates

M1

1

$[\text{H}_2\text{O}]$ is (effectively) constant

OR is incorporated into the constant K

Allow changes by only a very small amount

M2

1

- (b) (Dissociation OR breaking bonds) is endothermic

1

$\therefore$ Equilibrium moves to RHS (at higher T) to absorb heat or to lower T or oppose increase in T

Allow to oppose change only if increase T mentioned

1

- (c) $[\text{H}^+] = \sqrt{K_w}$ (or $= \sqrt{5.48 \times 10^{-14}}$)

Correct pH answer scores 3

1

If wrong method no marks

Using alternative K_w (1.00×10^{-14}) gives $\text{pH} = 7.00$ which scores 1

$$= 2.34 \times 10^{-7}$$

1

$$\text{pH} = 6.63$$

Final answer must have 2dp

1

- (d) $[\text{H}^+] = K_w / [\text{OH}^-]$ or $(= 5.48 \times 10^{-14} / 0.12)$

Correct pH answer scores 3

1

If wrong method no marks

If use alternative K_w (1.00×10^{-14}) again, do not penalise repeat error so $\text{pH} = 13.08$ scores 3

$$= 4.566 \times 10^{-13}$$

1

$$\text{pH} = 12.34$$

*If use alternative K_w (1.00×10^{-14}) **not** as a repeat error, $\text{pH} = 13.08$ scores 1*

If AE in K_w value made in part (c) is repeated here, do not penalise again.

Final answer must have 2dp, but if dp penalised in (c) allow more than

2dp here but not fewer.

Q3.

$$(a) \quad [H^+] = \frac{K_a \times [CH_3COOH]}{CH_3COO^-} \text{ or } = 1.74 \times 10^{-5} \times \frac{0.186}{0.105}$$

Allow ()

M1
1

$$= 3.08 \times 10^{-5}$$

If $[HX] / [X^-]$ or $\frac{0.186}{0.105}$ upside down, or any addition or subtraction lose M1 & M2.

M2
1

$$pH = 4.51 \quad (\text{correct answer scores 3})$$

Can score M3 for correct pH conseq to their $[H^+]$, so pH = 5.01 scores one

Must be to 2 dp

M3
1

Alternative using Henderson-Hasselbach Equation

$$pH = pK_a - \log[HX] / X^- = -\log(1.74 \times 10^{-5}) - \log\left(\frac{0.186}{0.105}\right)$$

Allow ()

M1

$$pK_a = 4.76 - 0.248$$

If $[HX] / [X^-]$ or $\frac{0.186}{0.105}$ upside down, can only score 1

M2

$$pH = 4.51$$

so pH = 5.01

Must be to 2 dp

M3

$$(b) \quad \text{mol HX after addition} (= 0.251 + 0.015) = 0.266$$

For HX, if no addition or error in addition (other than AE) (or subsequent extra add or sub) MAX 3

M1
1

$$\text{mol } X^- \text{ after subtraction} (= 0.140 - 0.015) = 0.125$$

For X^- if no subtraction or error in subtraction (other than AE) (or subsequent extra add or sub) MAX 3

M2
1

$$[H^+] = \left(\frac{K_a \times [CH_3COOH]}{[CH_3COO^-]} \right) = \frac{1.74 \times 10^{-5} \times 0.266}{0.125}$$

If errors above in both addition AND subtraction can only score M3 for insertion of their numbers in rearranged expression. One exception, if addition and subtraction reversed then pH = 4.58 scores 2

M3
1

$$[H^+] = 3.703 \times 10^{-5} \text{ (mol dm}^{-3}\text{)}$$

If [HX] / [X⁻] upside down, lose M3 & M4 (or next two marks) but can score M5 for correct pH consequent to their [H⁺], so if M1 & M2 correct, pH = 5.09 scores 3.

M4
1

$$\text{pH} = 4.43$$

Correct use of HX and X⁻ values from (d) gives
pH = 4.41 and scores 4

If wrong method, e.g. $\sqrt{\quad}$ or no use of rearranged K_a expression, may score M1 & M2 but no more.

Allow more but not fewer than 2dp here.

M5
1

Alternative using Henderson-Hasselbach Equation

$$\text{mol acid after addition} = 0.251 + 0.015 = 0.266$$

For HX, if no addition or error in addition (other than AE) (or subsequent extra add or sub) MAX 3

M1

$$\text{mol salt after addition} = 0.140 - 0.015 = 0.125$$

For X⁻ if no subtraction or error in subtraction (other than AE) (or subsequent extra add or sub) MAX 3

M2

$$\text{pH} = (\text{pK}_a - \log[HX] / [X^-]) = -\log(1.74 \times 10^{-5}) - \log(0.266 / 0.125)$$

If errors above in both addition AND subtraction can only score M3 for insertion of their numbers – except if addition and subtraction reversed then pH = 4.58 scores 2

M3

$$\text{pH} = 4.76 - 0.328$$

M4

$$\text{pH} = 4.43$$

If [HX] / [X⁻] upside down, lose M3 & M4 (or next two marks) but can score M5 for correct pH consequent to their working, so if M1 & M2 correct, pH = 5.09 scores 3.

Allow more but not fewer than 2dp here.

M5

[8]