TOPIC 12 TEST MS

1. (a) $[H_2O]$ is <u>very</u> high (compared with $[H^+]$ and $[OH^-]$)
OR
<u>Very few</u> H^+ and OH^- ions
OR
<u>Only / very</u> slightly dissociates
OR
Equilibrium lies <u>far</u> to the left

Not partially dissociates

M1

1

$[H_2O]$ 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

Equilibrium moves to RHS (at higher T) <u>to absorb heat or to lower T or oppose increase in T</u>

Allow to oppose change only if increase T mentioned

1

(c) $[H^+] = \sqrt{K_w}$ (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 pH = 7.<u>00</u> which scores 1

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

1

pH $= 6.63$

Final answer must have 2dp

1

(d) $[H^+] = K_w / [OH^-]$ 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 pH = 13.08 scores 3

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

1

pH = 12.34

If use alternative K_w (1.00×10^{-14}) ***not*** *as a repeat error, 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.

1

[10]

2. (a) $-\log [H^+]$

ecf if [ ] wrong and already penalised

1

4.57×10^{-3}

allow 4.6×10^{-3}

ignore units

1

(b) (i) $K_a = \frac{[H^+][X^-]}{[HX]}$ allow HA etc

not $\frac{[H^+]^2}{[HX]}$ but mark on

If expression wrong allow conseq units in (ii) but no other marks in (ii)

1

(ii) $\frac{[H^+]^2}{[HX]} = \frac{(4.57 \times 10^{-3})^2}{[0.150]}$

If use 4.6×10^{-3}

1

$K_a = 1.4(1) \times 10^{-4}$ and pKa = 3.85

$= 1.39 \times 10^{-4}$

allow $1.39 - 1.41 \times 10^{-4}$ mol dm^{-3}

1

(iii) $pK_a = 3.86$

Penalise dp of final answer < or > 2 in pH once in paper

1

(c) (i) $\frac{30}{1000} \times 0.480 = 0.0144$ or $1.4(4) \times 10^{-2}$

Mark is for answer (M1)

1

(ii) $\frac{18}{1000} \times 0.350 = 0.0063$ or 6.3×10^{-3}

Mark is for answer (M2)

1

(iii) $0.0144 - 2(0.0063) = 1.80 \times 10^{-3}$

M3 is for (i) – 2(ii)

If x 2 missed, CE i.e. lose M3 and the next mark gained

1

(iv) $1.80 \times 10^{-3} \times \frac{1000}{48} = 0.0375$ (0.038)

M4 is for answer

If vol is not 48×10^{-3} (unless AE) lose M4 and next mark gained
If multiply by 48 - this is AE - i.e. lose only M4
If multiply by 48×10^{-3} this is AE - i.e. lose only M4

1

(v) 10^{-14} / 0.0375 (10^{-14} / 0.038)

M5 for $K_w/[OH^-]$

1

(= 2.66×10^{-13}) (= 2.63×10^{-13})

or pOH

or pOH = 1.426 (or pOH = 1.420)

If no attempt to use K_w or pOH lose both M5 and M6

1

pH = 12.57 (12.58) M6

Allow M6 conseq on AE in M5 if method OK

1

[13]

3. (a) $K_a = \dfrac{[H^+][A^-]}{[HA]}$

(All three sets of square brackets needed, penalise missing brackets or missing charge once in the question)
(Don't penalise extra $[H^+]^2/[HA]$)

1

(b) $K_a = \dfrac{[H^+]^2}{[HA]}$ or $[H^+] = [A^-]$

$[H^+] = \sqrt{(1.45 \times 10^{-4}) \times 0.25}$

$= 6.02 \times 10^{-3}$ pH = 2.22

(must be to 2dp)
(allow 4th mark consequential on their $[H^+]$)

1

(c) (i) pH (almost) unchanged

(Must be correct to score explanation)

1

H^+ removed by A^- forming HA
or acid reacts with salt
or more HA formed

1

(ii) $[H^+] = 10^{-3.59} = 2.57 \times 10^{-4}$ or 2.6×10^{-4}

1

$[A^-] = \dfrac{K_a[HA]}{[H^+]}$

1

$= \dfrac{(1.45 \times 10^{-4}) \times 0.25}{2.57 \times 10^{-4}}$

1

$= 0.141$ (mol dm^{-3})

(Allow 0.139 to 0.141 and allow 0.14)

(If not used 3.59, to find $[H^+]$ can only score M2 for working)

(If 3.59 used but $[H^+]$ is wrong, can score M2 for correct method and conseq M4)

If wrong method and wrong expression, can only score M1)

(ii) *Alternative scheme for first three marks of part (c)(ii)*

$pH = pK_a - \log \frac{[HA]}{[A^-]}$ 1

$pK_a = 3.84$ 1

$3.59 = 3.84 - \log \frac{0.250}{[A^-]}$ 1 **[11]**

4. (a) (i) B; 1

C; 1

A; 1

(ii) cresolphthalein

OR

thymolphthalein; 1

(b) (i) $-\log[H^+]$; 1

(ii) $[H^+] = 1.259 \times 10^{-12}$ (or 1.26 or 1.3)

OR

OH = 14 – pH; 1

$[OH^-] = \frac{10^{-14}}{1.258 \times 10^{-12}}$

OR

= 2.10; 1

$= 7.9(4) \times 10^{-3}$;

(if [H^+] is wrong allow 1 for [OH] = K_w/[H^+] or as numbers)

1

(c) (i) $K_a = [H^+]^2/[CH_3CH_2COOH]$

OR

$[H+]^2/[HA]$

OR

$[H^+] = [A^-]$ etc;
1

$[H^+] = \sqrt{1.35 \times 10^{-5} \times 0.117}$ or expression without numbers;
1

$= 1.257 \times 10^{-3}$

pH = 2.9<u>0</u>;
1

(ii) $K_a = [H^+]$

OR

$pK_a = pH$;
1

pH = 4.8<u>7</u>;

(penalise 1dp once)
1

[13]

5. B **[1]**

6. B **[1]**

7. C **[1]**