



TOPIC 12 TEST MS

1. (a) $[H_2O]$ is very high (compared with $[H^+]$ and $[OH^-]$)
OR
Very few H^+ and OH^- ions
OR
Only / very slightly dissociates
OR
 Equilibrium lies far to the left
Not partially dissociates
- M1 1
- $[H_2O]$ 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) to absorb heat or to lower T or oppose increase in T
Allow to oppose change only if increase T
 \checkmark *mentioned* 1
- (c) $[H^+] = K_w$ (or = 5.48×10^{-14})
Correct pH answer scores 3 1
- If wrong method no marks
Using alternative K_w (1.00×10^{-14}) gives pH = 7.00 which scores 1
- = 2.34×10^{-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

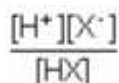
1

$$4.57 \times 10^{-3}$$

allow 4.6×10^{-3}

ignore units

1



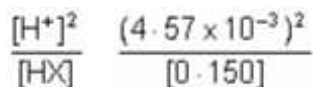
(b) (i) $K_a =$ allow HA etc



not $[HX]$ but mark on

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

1



(ii)

If use 4.6×10^{-3}

1

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

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

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

1

2



(iii) $pK_s = 3.86$

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

1

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- (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) $K_a = \frac{[H^+][A^-]}{[HA]}$
 (All three sets of square brackets needed, penalise missing brackets or missing charge once in the question)
 (Don't penalise extra $[H^+]/[HA]$)

(b) $K_a = \frac{[H^+]^2}{[HA]}$ or $[H^+] = [A^-]$
 $\sqrt{(1.45 \times 10^{-4}) \times 0.25}$
 $[H^+] = 6.02 \times 10^{-3} \text{ pH} = 2.22$
 (must be to 2dp)
 (allow 4th mark consequential on their $[H^+]$)

(c) (i) pH (almost) unchanged
 (Must be correct to score explanation)

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

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

$[A^-] = \frac{K_a [HA]}{[H^+]}$
 $\frac{(1.45 \times 10^{-4}) \times 0.25}{2.57 \times 10^{-4}}$

= 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)*

$$\text{pH} = \text{pK}_a + \log \frac{[\text{HA}]}{[\text{A}^-]} \quad 1$$

$$\text{pK}_a = 3.84 \quad 1$$

$$3.59 = 3.84 + \log \frac{0.250}{[\text{A}^-]} \quad 1$$

[11]

4. (a) (i) B; 1

C; 1

A; 1

(ii) cresolphthalein

OR

thymolphthalein; 1

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

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

OR

$$\text{pOH} = 14 - \text{pH}; \quad 1$$

$$[\text{OH}^-] = \frac{10^{-14}}{1.259 \times 10^{-12}}$$

OR

$$= 2.10; \quad 1$$

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



(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

$$[H^+] = [A^-] \text{ etc;}$$

1

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

1

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

$$pH = 2.90;$$

1

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

OR

$$pK_a = pH;$$

1

$$pH = 4.87;$$

(penalise 1dp once)

1

[13]

5. B

6. B

7. C

[1]

[1]

[1]