F325 Acids, Bases and Buffers test ms

1. (a) completely dissociates/ionised **(1)**
proton donor **(1)** 2

(b) NO_3^- **(1)** 1

(c) (i) pH = –log[H^+] / –log(0.015) **(1)** = 1.82 / 1.8 **(1)** (Not 2) 2

(ii) [H^+] = 0.0075 mol dm^{-3}
pH = –log(0.0075) = 2.12 / 2.1 **(1)** 1

[6]

2. (a) (i) H^+/proton donor **(1)** 1

(ii) partially dissociates/ionises **(1)** 1

(b) $C_6H_5OH(aq) + OH^-(aq) \rightleftharpoons C_6H_5O^-(aq) + H_2O(l)$
acid 1 base 2 **(1)** base 1 acid 2 **(1)**
1 mark for each acid-base pair

(c) (i) $K_a = \dfrac{[C_6H_5O^-][H^+]}{[C_6H_5OH]}$ **(1)** 1

(ii) concentration = 38/94 **(1)** = 0.40 mol dm^{-3} **(1)**
(first mark for M_r of phenol – incorrect answer here will give ecf for remainder of question)

$1.3 \times 10^{-10} \approx \dfrac{[H^+(aq)]^2}{0.40}$ **(1)**
('=' sign is acceptable)

[H^+] = √{$(1.3 \times 10^{-10}) \times (0.40)$} = 7.2×10^{-6} mol dm^{-3} **(1)**

pH = –log[H^+] = –log 7.2×10^{-6} = 5.14 **(1)** 5

3 marks: [H^+] **(1)**; pH expression **(1)**; calc of pH from [H^+] **(1)**

Common errors:
Without square root, answer = 10.28 **(1)(1)(0)**
Use of 38 as molar concentration does not score 1st 2 marks.
This gives an answer of 4.15 for 3 marks **(1)(1)(1)**

(d) [$H^+(aq)$] = 1.99×10^{-9} mol dm^{-3} **(1)**
[$C_6H_5O^-(aq)$] = K_a [$C_6H_5OH(aq)$] / [$H^+(aq)$]**(1)**
[$C_6H_5O^-(aq)$] = 0.013 mol dm^{-3} **(1)**

Calculation should use half the original concentration of phenol to find the concentration of sodium phenoxide in the buffer. This should then be doubled back up again.

*Do **not** penalise an approach that uses the original concentration of phenol in the expression above.*

[13]

3. (i) a solution that minimises/resists/opposes pH changes **(1)** 1

(ii) The buffer must contain both CH_3COOH and CH_3COONa / CH_3COO^- /weak acid and conjugate base(*) **(1)**

Solution **A** is a mixture of CH_3COOH(*) and CH_3COONa(*) / / has an excess of acid /is acidic **(1)**

Solution **B**, contains only CH_3COONa/ only CH_3COO^- /only the salt/ is neutral **(1)**

$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$ / acid/alkali has been neutralised/ CH_3COOH(aq) and NaOH react together **(1)** 4

[5]

4. Correct equation for a metal **(1)**
Correct equation for a carbonate **(1)**
Correct equation for a base **(1)** 3

[3]

5. moles HC*l* in 23.2 $cm^3 = 0.200 \times 23.2/1000 = 4.64 \times 10^{-3}$ **(1)**
moles **B** in 25 cm^3 = moles HC*l* $= 4.64 \times 10^{-3}$ **(1)**
moles **B** in 250 $cm^3 = 4.64 \times 10^{-3} \times 10 = 4.64 \times 10^{-2}$ **(1)**
4.64×10^{-2} mol **B** has a mass of 4.32 g
molar mass of **B** $= 4.32/4.64 \times 10^{-2} = 93$ g mol^{-1} **(1)**
93 – 16 = 77 **(1)**
Therefore **B** is phenylamine / $C_6H_5NH_2$ **(1)** 6

There may be other valid structures that are amines. These can be credited provided that everything adds up to 93.
Answer could be a primary, secondary or tertiary amines.

[6]

6. (a) (i) Ionic product **(1)** 1

(ii) $K_w = [H^+(aq)]\,[OH^-(aq)]$ **(1)** *state symbols not needed* 1

(b) moles of HCl $= \frac{5 \times 10^{-3} \times 21.35}{1000} = 1.067 \times 10^{-4}$ mol **(1)**

moles of $Ca(OH)_2 = \frac{1.067 \times 10^{-4}}{2} = 5.34 \times 10^{-5}$ mol **(1)**

concentration of $Ca(OH)_2 = 40 \times 5.34 \times 10^{-5}$
$= 2.136 \times 10^{-3}$ mol dm^{-3} **(1)**

2 marks for 4.27×10^{-3}/ 8.54×10^{-3} mol dm^{-3}
(no factor of 4) 3

(c) $[OH^-] = 2 \times 2.7 \times 10^{-3} = 5.4 \times 10^{-3}$ mol dm^{-3} **(1)**

$[H^+(aq)] = \frac{K_w}{[OH^-(aq)]} = \frac{1.0 \times 10^{-14}}{5.4 \times 10^{-3}} = 1.85 \times 10^{-12}$ mol dm^{-3} **(1)**

pH = –log (1.85×10^{-12}) = 11.73/11.7 **(1)** 3

ecf is possible for pH mark providing that the $[H^+]$
value has been derived from $K_w/[OH^-]$
If pOH method is used, pOH = 2.27. would get 1st mark,
pH = 14 – 2.27 = 11.73 gets 2nd mark.
Commonest mistake will be to not double OH^- and to use 2.7×10^{-3}
This gives ecf answer of 11.43/11.4, worth 2 marks.
pH = 11.13 from dividing by 2: worth 2 marks

(d) 8 **(1)** 1

[9]

7. (i) $HCOOH + NaOH \rightarrow HCOONa + H_2O$ **(1)** 1
state symbols not needed

(ii) n(HCOOH) = $0.0150 \times 25.00/1000 = 3.75 \times 10^{-4}$ **(1)**
volume of NaOH(aq) that reacts is 30 cm^3 **(1)**
so [NaOH] = $3.75 \times 10^{-4} \times 1000/30 = 0.0125$ mol dm^{-3} **(1)** 3

(iii) $K_w = [H^+(aq)][OH^-(aq)]$ **(1)**
pH = $-\log(1 \times 10^{-14}/0.0125)$ = 12.10/12.1 **(1)**
(calc 12.09691001) 2

(iv) metacresol purple **(1)**
pH range coincides with pH change **during sharp rise** OR
pH 6-10 /coincides with equivalence point/end point **(1)** 2

[8]