

M1.(a) Proton donor or H⁺ donor
Allow donator 1

(b) (i) B B
Both need to be correct to score the mark 1

(ii) A A
Both need to be correct to score the mark 1

(iii) B A
Both need to be correct to score the mark 1

(c) **M1** [H⁺] = 10^{-1.25} OR 0.05623 1

M2 mol HCl = (25 × 10⁻³) × 0.0850 (= 2.125 × 10⁻³)
Mark for Working 1

M3 vol $\left(= \frac{2.125 \times 10^{-3}}{0.05623} \right) = 0.0378 \text{ dm}^3 \text{ or } 37.8 \text{ cm}^3$
allow 0.0375 – 0.038 dm³ or 37.5 – 38 cm³
Units and answer tied
Lose M3 if total given as (25 + 37.8) = 62.8 cm³
Ignore “vol added = 12.8 cm³” after correct answer 1

(d) (i) 4.52

Must be 2dp

1

(ii) $K_a = \frac{[H^+][H^-]}{[HX]}$ ignore = $\frac{[H^+]^2}{[HX]}$ but this may score M1 in (d)(iii)
Must have all brackets but allow () Allow HA etc
NO mark for 10^{-pK_a}

1

(iii) **M1** $K_a = \frac{[H^+]^2}{[HX]}$ or with numbers
Allow $[H^+] = \sqrt{(K_a \times [HA])}$ for M1

1

M2 $[H^+] = (\sqrt{(3.01 \times 10^{-5} \times 0.174)}) = \sqrt{(5.24 \times 10^{-6})}$
 $= 2.29 \times 10^{-3} - 2.3 \times 10^{-3}$
Mark for answer

1

M3 pH = 2.64 (allow more than 2dp but not fewer)
Allow 1 for correct pH from their wrong $[H^+]$
If square root forgotten, pH = 5.28 scores 2 for M1 and M3

1

(e) **M1** mol OH⁻ = $(10.0 \times 10^{-3}) \times 0.125 = 1.25 \times 10^{-3}$
Mark for answer

1

M2 orig mol HX = $(15.0 \times 10^{-3}) \times 0.174 = 2.61 \times 10^{-3}$
Mark for answer

1

M3 mol HX in buffer = orig mol HX – mol OH⁻
Mark for answer
 $= 2.61 \times 10^{-3} - 1.25 \times 10^{-3} = 1.36 \times 10^{-3}$

Allow conseq on their (M2 – M1)

$$([\text{HX}] = 1.36 \times 10^{-3} / 25 \times 10^{-3} = 0.0544)$$

If no subtraction, max 3 for M1, M2 & M4 (pH = 4.20)

If $[\text{H}^+] = [\text{X}^-]$ & $\sqrt{\quad}$ used, max 3 for M1, M2 & M3 (pH = 2.89)

1

M4 mol X^- in buffer = mol OH^- = 1.25×10^{-3}

$$([\text{X}^-] = 1.25 \times 10^{-3} / 25 \times 10^{-3} = 0.05)$$

May be scored in M5 expression

1

M5 $[\text{H}^+] = \frac{K_a \times [\text{HX}]}{[\text{X}^-]}$

If use $K_a = \frac{[\text{H}^+]^2}{[\text{HX}]}$ no further marks

$$= \frac{3.01 \times 10^{-5} \times 1.36 \times 10^{-3}}{1.25 \times 10^{-3}} \quad \text{OR} \quad \frac{3.01 \times 10^{-5} \times 0.0544}{0.05}$$

$$(\text{= } 3.27 \times 10^{-5})$$

If either value of HX or X^- used wrongly or expression upside down, no further marks

1

M6 pH = 4.48 or 4.49 (allow more than 2dp but not fewer)

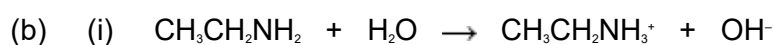
Do **not** allow M6 for correct calculation of pH using their $[\text{H}^+]$
- this only applies in (d)(iii) - apart from earlier AE

1

[18]

M2.(a) Proton acceptor

1



allow eq with or without \rightleftharpoons
allow $C_2H_5NH_2$ and $C_2H_5NH_3^+$ (plus can be on N or H or 3)
allow RHS as $C_2H_5NH_3OH$

1

(ii) Mark independently of (b)(i)

Allow

Ethylamine is only partly/slightly dissociated

OR

Ethylamine is only partly/slightly ionized

reaction/equilibrium lies to left or low $[OH^-]$ **OR** little OH^- formed

OR little ethylamine has reacted

Ignore "not fully dissociated" or "not fully ionized"

Ignore reference to ionisation or dissociation of water

1

(c) **M1** Ethylamine

If wrong no marks in (c)

1

M2 alkyl group is electron releasing/donating

OR alkyl group has (positive) inductive effect

1

M3 increases electron density on N(H₂)

OR increased availability of lp

OR increases ability of lp (to accept H(+))

Mark M3 is independent of M2

1

(d) $CH_3CH_2NH_3Cl$

Or any amine hydrochloride

allow name (ethylammonium chloride or ethylamine hydrochloride) or other halide for Cl

or a strong **organic acid**

NOT NH_4Cl

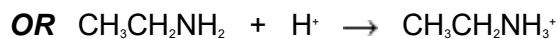
1

(e) Mark independently of (d)

Extra H⁺ reacts with ethylamine or OH⁻

Or makes reference to Equilibrium (in (b)(i)) with amine on LHS

1

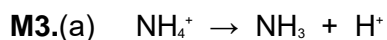


Equilibrium shifts to RHS

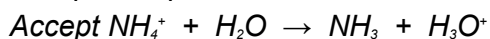
OR ratio $[\text{CH}_3\text{CH}_2\text{NH}_3^+]/[\text{CH}_3\text{CH}_2\text{NH}_2]$ remains almost constant

1

[9]



Accept multiples.



Ignore state symbols, even if incorrect.

1

(b) Test indicator / conc HCl

Do not accept 'smell'.

Do not accept precipitation reactions of aqueous ammonia.

1

Observation colour for an alkali / white fumes

If wrong test then lose second mark.

1

[3]

M4.D

[1]

M5.C

[1]