



A. 7 pts 0.160 M sol'n CH_3NH_2 4.790

$$0.160 \text{ M } (0.047) = 7.5 \times 10^{-3} \text{ M} \quad [\text{CH}_3\text{NH}_2] = 0.16 - 7.5 \times 10^{-3}$$

$$7.5 \times 10^{-3} \text{ M} = [\text{CH}_3\text{NH}_3^+] = [\text{OH}^-] = 0.152$$

$$[\text{H}_3\text{O}^+] = \frac{1.0 \times 10^{-14}}{7.5 \times 10^{-3}} = 1.3 \times 10^{-12} \text{ M}$$

$$\text{pH} = 11.89$$

B. 3 pts

$$K_b = \frac{[\text{CH}_3\text{NH}_3^+][\text{OH}^-]}{[\text{CH}_3\text{NH}_2]}$$

$$K_b = \frac{(7.5 \times 10^{-3})^2}{0.152} = 3.7 \times 10^{-4}$$

C. 5 pts

0.050 mole $\text{La}(\text{NO}_3)_3$
1.00 L solution

0.20 mole CH_3NH_2

0.20 mole $\text{CH}_3\text{NH}_3\text{Cl}$

will $\text{La}(\text{OH})_3$ ppt?

$$K_{sp} = [\text{La}^{+3}][\text{OH}^-]^3 = 1 \times 10^{-19}$$

$$Q = \left[\frac{0.050}{1.00} \right] [3.7 \times 10^{-4}]^3$$

$$Q = 2.5 \times 10^{-12}$$

$$Q > K_{sp}$$

yes, $\text{La}(\text{OH})_3$ ppt

$$K_b = \frac{[\text{CH}_3\text{NH}_3^+][\text{OH}^-]}{[\text{CH}_3\text{NH}_2]}$$

$$3.7 \times 10^{-4} = \frac{(0.20)(x)}{0.20}$$

$$x = [\text{OH}^-] = 3.7 \times 10^{-4}$$

25.

a) two points

1S increases

Dissolving converts highly organized solid to less organized hydrated ions

OR

dissociates, break down, etc.

OR

less particles => more particles

OR

1G negative, 1H positive => $-T^1S$ negative => 1S positive

b) two points

K_{sp} decreases

lowering T decreases the solubility since the reaction is endothermic

OR

if T decreases, $-T^1S$ becomes less negative or 1G becomes more positive, i.e., less soluble; K_{sp} decreases

c) two points

There is no effect on $[I^-]$

PbI_2 is a solid; its concentration does NOT change on addition of more PbI_2

OR

$PbI_2(s)$ is NOT included in the expression for K_{sp} or Q

OR

the solution is saturated => no more solid will dissolve

d) two points

1G becomes more positive (increases, gets larger, etc.)

Due to the common ion effect; the increase in $[Pb^{2+}]$ shifts the equilibrium to the left.

OR

the reverse reaction becomes more spontaneous as [Pb²⁺] increases due to the common ion effect

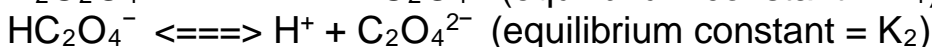
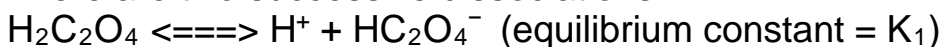
a)

$$5.00 \times 10^{-3} \text{ mol H}_2\text{C}_2\text{O}_4 = 1.00 \times 10^{-2} \text{ mol H}^+ = 1.00 \times 10^{-2} \text{ mol OH}^-$$
$$1.00 \times 10^{-2} \text{ mol OH}^- / 0.400 \text{ M} = 0.0250 \text{ L (25.0 mL)}$$

Calculation from moles to volume; use of incorrect moles still earns point.

b)

There are two successive dissociations:



Acceptable alternatives are the use of H₂O as reactant and H₃O⁺ as product or writing of correct equilibrium constant expressions. Consistent errors (such as missing atoms or charges) are only penalized once.

c)

pH = 0.5 therefore H⁺ = 0.32M (pH controls 1 sig. fig. in answer)

(This point also earned if conversion of K to pK is correct.)

K small therefore amount of dissociation small therefore assume

$$[\text{H}_2\text{C}_2\text{O}_4] = 0.015$$

$$K_{12} = \frac{[\text{H}^+]^2 [\text{C}_2\text{O}_4^{2-}]}{[\text{H}_2\text{C}_2\text{O}_4]}$$

$$\text{then } [\text{C}_2\text{O}_4^{2-}] = \frac{[(3.78 \times 10^{-6}) (0.015)]}{(0.32)^2} = 6 \times 10^{-7}$$

(Here 1, 2, or 3 sig. fig.'s accepted) Two points for correct set-up with substitution and final calculation (-1 point for each error).

Alternative methods, included proper use of Henderson-Hasselbalch equation, can earn credit.

(d)

$\text{C}_2\text{O}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{HC}_2\text{O}_4^- + \text{OH}^-$ is the only significant reaction, so $K_b = K_w / K_2 = 1.00 \times 10^{-14} / 6.40 \times 10^{-5} = 1.56 \times 10^{-10}$

No credit earned if K₁ or K₁₂ used; 1, 2, or 3 sig. fig.'s accepted since number of significant figures for value of K_w not indicated in table on examination.



A. 3 p + 5 $K_b = \frac{[\text{CH}_3\text{NH}_3^+][\text{OH}^-]}{[\text{CH}_3\text{NH}_2]} = 5.24 \times 10^{-4}$

	$[\text{CH}_3\text{NH}_2]$	$[\text{CH}_3\text{NH}_3^+]$	$[\text{OH}^-]$
I	0.225	0	0
C	-x	+x	+x
E	0.225 - x	x	x

$$5.25 \times 10^{-4} = \frac{x^2}{0.225}$$

$$x = [\text{OH}^-] = 1.09 \times 10^{-2}$$

B. 3 + 5

NO_3^-)

0.0100 mole (CH_3NH_3^+) (
120.0 ml 0.225M CH_3NH_2

$$[\text{CH}_3\text{NH}_3^+] = \frac{0.0100 \text{ mole}}{0.120 \text{ L}} = 0.0833 \text{ M}$$

$$5.25 \times 10^{-4} = \frac{(0.0833)(x)}{(0.225)}$$

$$x = [\text{OH}^-] = 1.42 \times 10^{-3} \text{ M}$$

$$\text{pOH} = 2.85 \quad \text{pH} = 11.15$$

05

$$\text{pH} = \text{pK}_a + \log \frac{\text{base}}{\text{acid}}$$
$$\text{pH} = 10.7 + \frac{0.225}{0.0833}$$

c. ZPTs

want pH = 11 (NaOH or HCl)

HCl added

$$\text{pH} = \text{pK}_a + \log \frac{\text{base}}{\text{acid}}$$

$$11.00 = 10.72 + \log \frac{\text{base}}{\text{acid}}$$

$$\log = 0.28 \quad \frac{\text{base}}{\text{acid}} = 1.906 = \frac{[\text{CH}_3\text{NH}_3^+ - x]}{[\text{CH}_3\text{NH}_2 + x]}$$

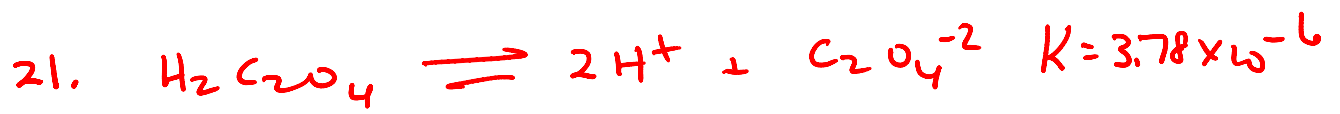
$$x = 0.0227 \text{ M}$$

$$(0.0227 \text{ M})(0.120 \text{ L}) = 2.73 \times 10^{-3} \text{ mole HCl}$$

d.

The $\frac{[\text{CH}_3\text{NH}_3^+]}{[\text{CH}_3\text{NH}_2]}$ ratio does not

change in the buffer solution



$5.00 \times 10^{-3} \text{ mole HA}$ produces $1.00 \times 10^{-2} \text{ mole H}^+$
(diprotic)

$1.00 \times 10^{-2} \text{ mole H}^+$ needs $1.00 \times 10^{-2} \text{ mole OH}^-$

$$\frac{1.00 \times 10^{-2} \text{ mole OH}^-}{0.400 \text{ M}} = 0.0250 \text{ L (25.0 ml)}$$

B. $K_2 = 6.46 \times 10^{-5}$



$$K = K_1 \times K_2$$



$$K_b = \frac{K_w}{K_2} = \frac{1.00 \times 10^{-14}}{6.40 \times 10^{-5}} = 1.56 \times 10^{-10}$$