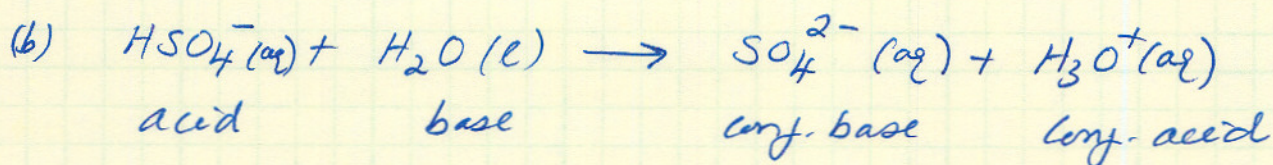
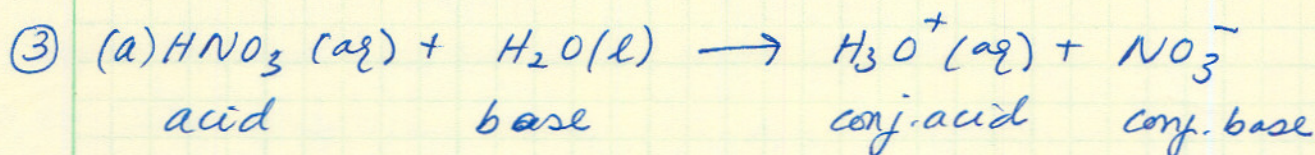
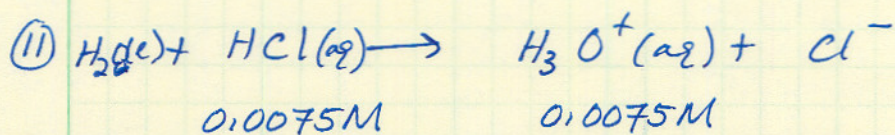
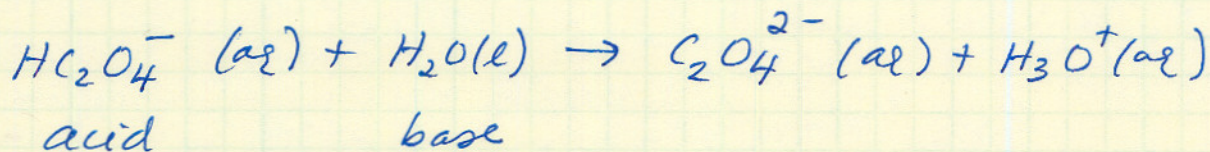
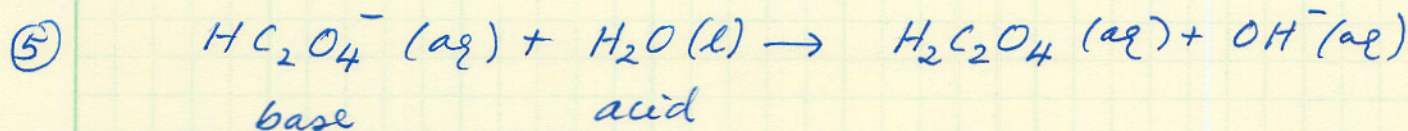
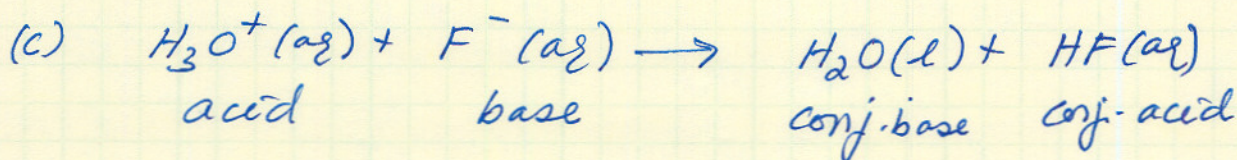
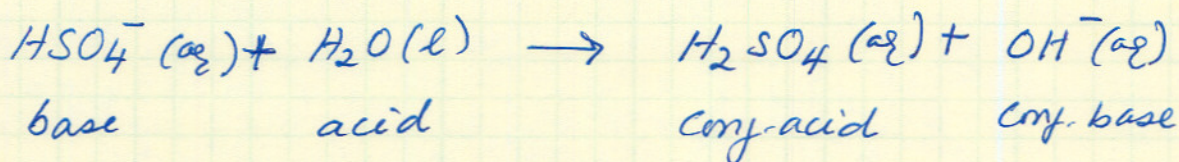


INTRODUCTION TO NATURAL SCIENCE
CHEMISTRY HOMEWORK - WEEK 5 - SPRING

Chapter 17

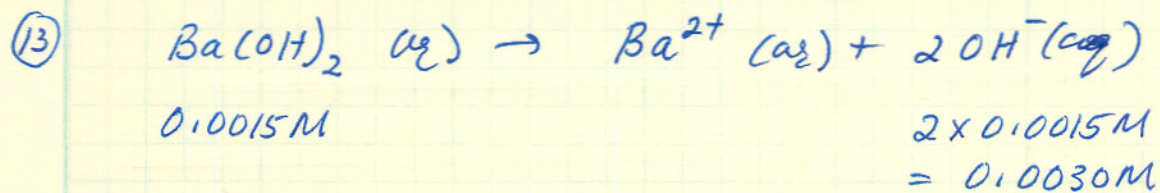


OR



$$[\text{H}_3\text{O}^+] = 0.0075 \text{ M}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+] = \underline{\underline{2.12}}$$



$$pOH = -\log(\text{OH}^-) = \underline{\underline{2.52}}$$

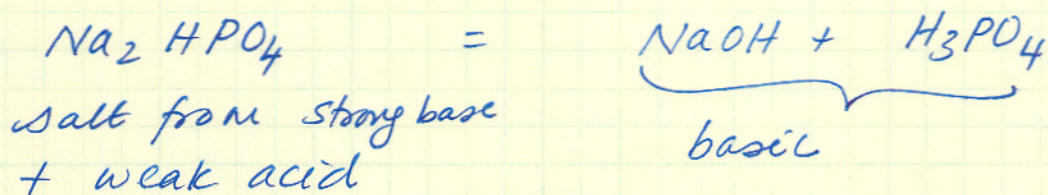
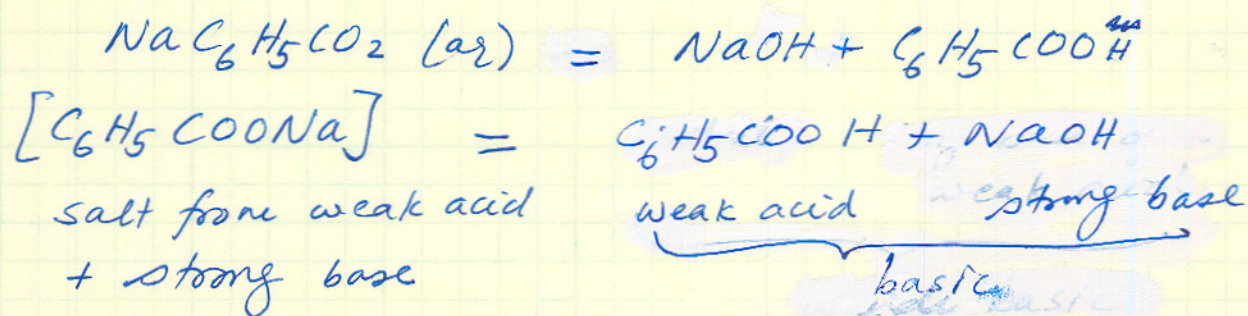
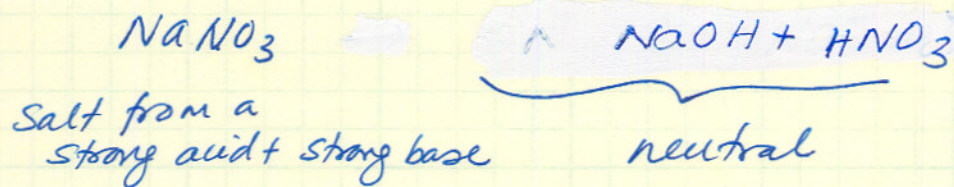
$\textcircled{15}$ (a) Strongest acid is the one with the largest K_a
 $(1.8 \times 10^{-4}) \therefore \underline{\underline{\text{HCOOH}}}$

weakest acid \Rightarrow smallest $K_a \Rightarrow \text{C}_6\text{H}_5\text{OH}$

(b) the strongest acid has the weakest conj. base.
 $\therefore \text{HCOOH}$ has the weakest conj. base.

(c) the weakest acid has the strongest conj. base
 $\therefore \text{C}_6\text{H}_5\text{OH}$

$\textcircled{22}$



- (27) ~~(28)~~ benzoic acid $pK_a = 4.20$
 2-chlorobenzoic acid $pK_a = 2.88$

higher the pK_a , smaller the K_a , weaker the acid

⇒ 2-chlorobenzoic acid is stronger.

- (31) $(CH_3)_3NH^+$ $pK_a = 9.80$ let the pK_b of the conjugate base $(CH_3)_3N = x$

$$K_a \cdot K_b = K_w$$

$$\Rightarrow -\log(K_a \cdot K_b) = -\log K_w$$

$$-\log K_a - \log K_b = -\log K_w$$

$$pK_a + pK_b = pK_w$$

$$9.80 + x = 14$$

$$x = 14 - 9.80 = 4.20$$

$$pK_b = 4.20$$

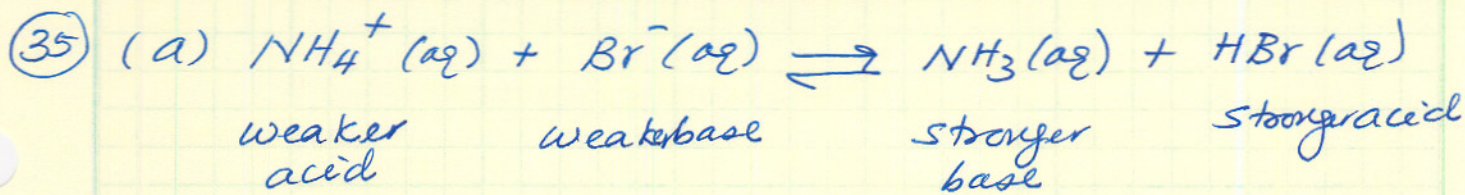
$$-\log K_b = 4.20$$

$$K_b = \underline{\underline{6.31 \times 10^{-5}}}$$

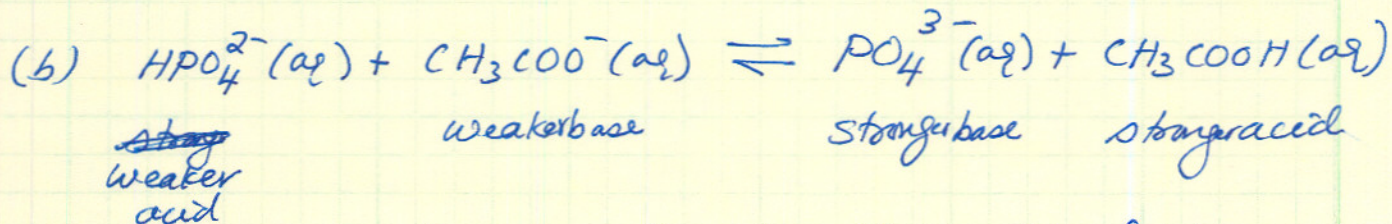
- (32) $pK_a + pK_b = pK_w = 14$

$$3.95 + pK_b = 14 \Rightarrow pK_b = 10.05$$

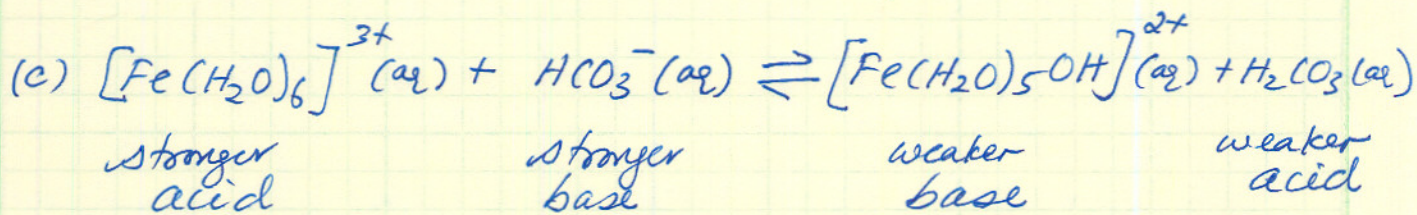
$$K_b = \underline{\underline{8.91 \times 10^{-11}}}$$



equilibrium lies to the left since strong acid + base are on the right, driving the reaction towards products. ($K < 1$)



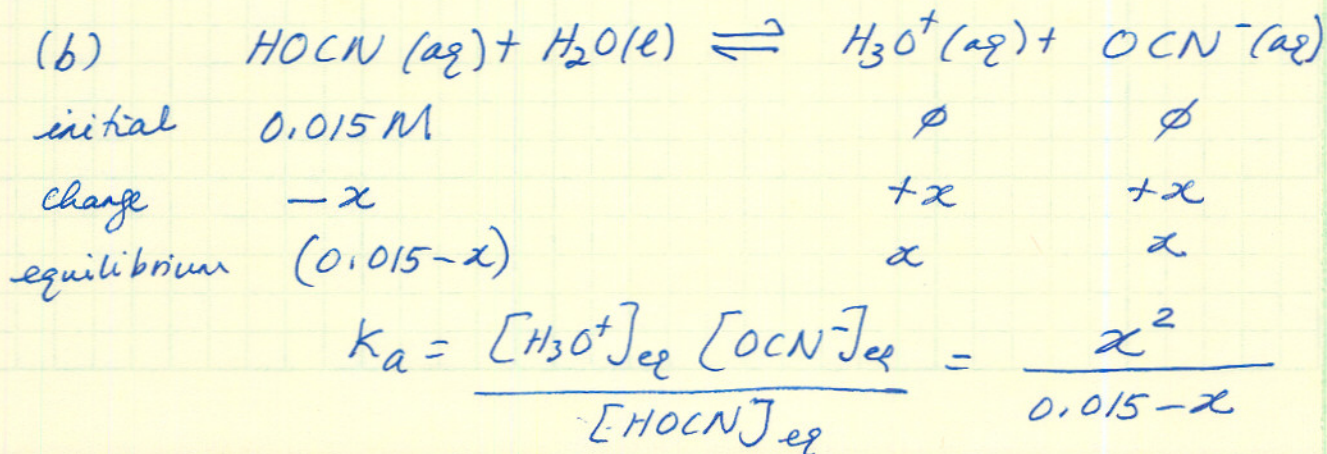
equilibrium lies to the left for the same reason as above. ($K < 1$)



The equilibrium lies to the right ($K > 1$) since stronger acid/base are on the left, driving the reaction forward.

(41) (a) $\text{pH} = 2.67 = -\log[\text{H}_3\text{O}^+]$

$[\text{H}_3\text{O}^+] = \underline{\underline{2.14 \times 10^{-3} \text{ M}}}$



$$x = [\text{H}_3\text{O}^+] = 2.14 \times 10^{-3} \text{ M}$$

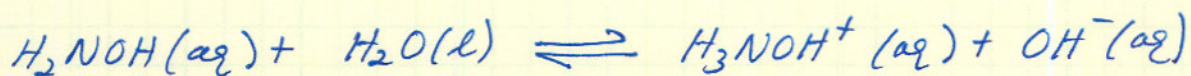
$$K_a = \frac{(2.14 \times 10^{-3})^2}{(0.1015 - 2.14 \times 10^{-3})} = \underline{\underline{3.56 \times 10^{-4}}}$$

(43)

$$\text{pH} = 9.11 \Rightarrow -\log [\text{H}_3\text{O}^+] = 9.11$$

$$\Rightarrow [\text{H}_3\text{O}^+] = 7.76 \times 10^{-10} \text{ M}$$

$$[\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14} \Rightarrow [\text{OH}^-] = \frac{10^{-14}}{7.76 \times 10^{-10}} = 1.29 \times 10^{-5} \text{ M}$$



initial 0.1025

0

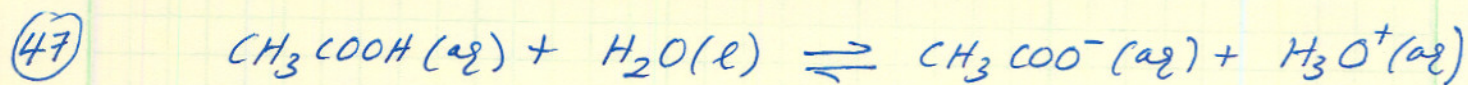
0

change $-x$ $+x$ $+x$ equilibrium $(0.1025 - x)$ x x

$$K_b = \frac{[\text{H}_3\text{NOH}^+]_{\text{eq}} [\text{OH}^-]_{\text{eq}}}{[\text{H}_2\text{NOH}]_{\text{eq}}} = \frac{x^2}{0.1025 - x}$$

$$x = [\text{OH}^-] \Rightarrow K_b = \frac{(1.29 \times 10^{-5})^2}{(0.1025 - 1.29 \times 10^{-5})}$$

$$= \underline{\underline{6.66 \times 10^{-9}}}$$



initial	0.20 M	ϕ	ϕ
change	$-x$	$+x$	$+x$
equilibrium	$(0.20-x)$	x	x

$$K_a = \frac{[\text{CH}_3\text{COO}^-]_{\text{eq}} [\text{H}_3\text{O}^+]_{\text{eq}}}{[\text{CH}_3\text{COOH}]_{\text{eq}}} = \frac{x^2}{0.20-x}$$

$$1.8 \times 10^{-5} = \frac{x^2}{0.20-x}$$

$$x^2 + 1.8 \times 10^{-5} x - 3.6 \times 10^{-6} = 0$$

$$x = \frac{-1.8 \times 10^{-5} \pm \sqrt{(1.8 \times 10^{-5})^2 + 4(3.6 \times 10^{-6})}}{2}$$

$$x = 1.89 \times 10^{-3}$$

$$[\text{CH}_3\text{COOH}]_{\text{eq}} = 0.20 - x = \underline{\underline{1.98 \times 10^{-1} \text{ M}}}$$

$$[\text{CH}_3\text{COO}^-]_{\text{eq}} = [\text{H}_3\text{O}^+]_{\text{eq}} = x = \underline{\underline{1.89 \times 10^{-3} \text{ M}}}$$

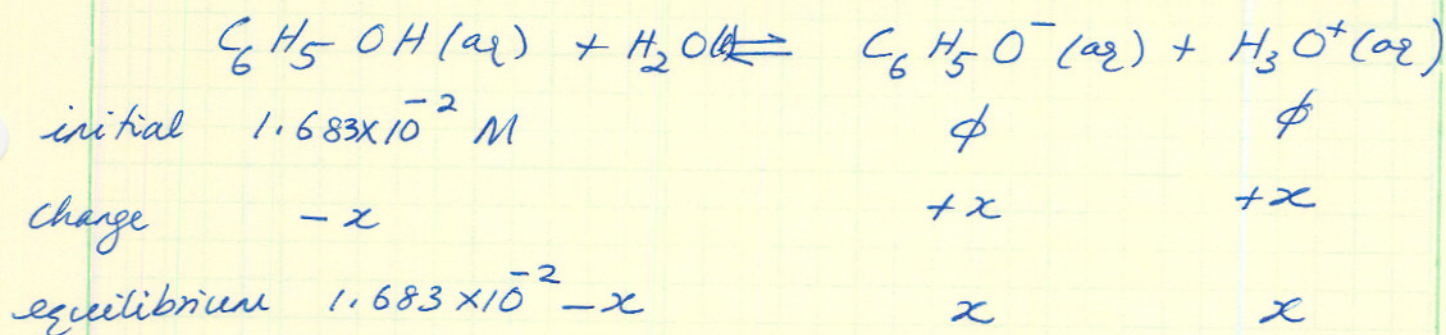
$$(50) \quad \text{molar mass of phenol} = 94.108 \text{ g/mol}$$

$$0.198 \text{ g phenol} = 0.198 \text{ g} \times \frac{\text{mol}}{94.108 \text{ g}} = 2.104 \times 10^{-3} \text{ mol}$$

$$\text{molarity of phenol solution} = \frac{2.104 \times 10^{-3} \text{ mol}}{125 \text{ mL}} \times \boxed{\frac{10^3 \text{ mL}}{\text{L}}}$$

$$= 1.683 \times 10^{-2} \text{ M}$$

7



$$K_a = \frac{[\text{C}_6\text{H}_5\text{O}^-]_{\text{eq}} [\text{H}_3\text{O}^+]_{\text{eq}}}{[\text{C}_6\text{H}_5\text{OH}]_{\text{eq}}} = \frac{x^2}{1.683 \times 10^{-2} - x}$$

$$1.3 \times 10^{-10} = \frac{x^2}{1.683 \times 10^{-2} - x}$$

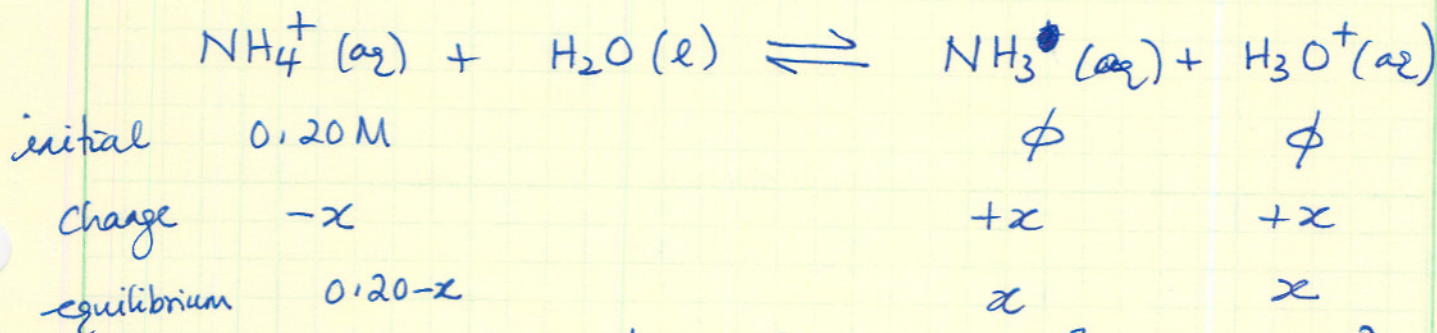
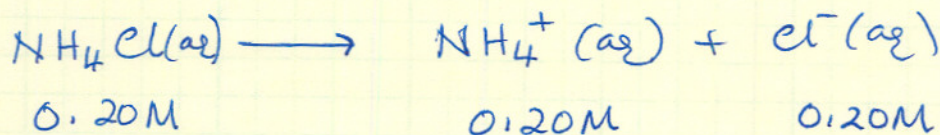
$$x^2 + 1.3 \times 10^{-10} x - 2.188 \times 10^{-12} = 0$$

$$x = \frac{-1.3 \times 10^{-10} \pm \sqrt{(1.3 \times 10^{-10})^2 + 4(2.188 \times 10^{-12})}}{2}$$

$$x = \underline{\underline{1.479 \times 10^{-6} \text{ M}}} = [\text{H}_3\text{O}^+]_{\text{eq}}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+]_{\text{eq}} = \underline{\underline{5.83}}$$

(57)



$$K_a \text{ of } \text{NH}_4^+ = \frac{[\text{NH}_3]_{\text{eq}} [\text{H}_3\text{O}^+]_{\text{eq}}}{[\text{NH}_4^+]_{\text{eq}}} = x^2$$

9

$$x = \underline{8.77 \times 10^{-6} \text{ M}} = [\text{OH}^-]_{\text{eq}}$$

$$[\text{H}_3\text{O}^+]_{\text{eq}} [\text{OH}^-]_{\text{eq}} = 1 \times 10^{-14}$$

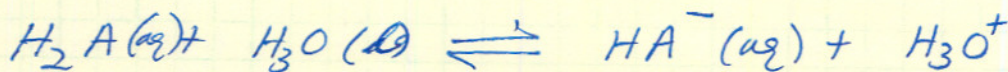
$$[\text{H}_3\text{O}^+]_{\text{eq}} = \frac{1 \times 10^{-14}}{8.77 \times 10^{-6}} = \underline{1.14 \times 10^{-9} \text{ M}}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] = \underline{8.94}$$

(66)

molar mass of ascorbic acid = 176.124 g/mol

$$\frac{5.0 \text{ mg}}{\text{mL}} \times \frac{1 \text{ g}}{10^3 \text{ mg}} \times \frac{1 \text{ mol}}{176.124 \text{ g}} \times \frac{10^3 \text{ mL}}{\text{L}} = 0.0284 \text{ M}$$



diprotic acid

initial 0.0284 M

ϕ

ϕ

change $-x$

$+x$

$+x$

equilibrium $0.0284 - x$

x

x

$$K_{a_1} = \frac{[\text{HA}^-]_{\text{eq}} [\text{H}_3\text{O}^+]_{\text{eq}}}{[\text{H}_2\text{A}]_{\text{eq}}} = \frac{x^2}{(0.0284 - x)}$$

$$6.8 \times 10^{-5} = \frac{x^2}{0.0284 - x}$$

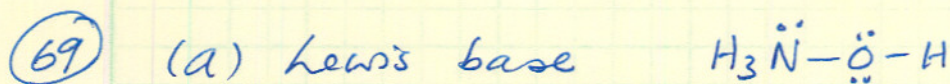
$$x^2 + 6.8 \times 10^{-5} x - 1.9305 \times 10^{-6} = 0$$

$$x = \frac{-6.8 \times 10^{-5} \pm \sqrt{(6.8 \times 10^{-5})^2 + 4(1.931 \times 10^{-6})}}{2}$$

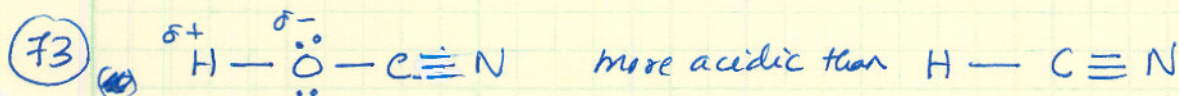
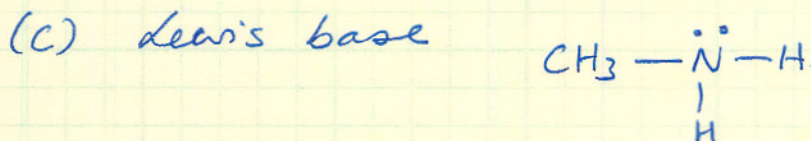
$$\alpha = 1.36 \times 10^{-3} \text{ M} = [\text{H}_3\text{O}^+]_{\text{eq}}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+] = \underline{\underline{2.87}}$$

The acid HA^- can dissociate further but since $K_{a2} \ll K_{a1}$, the contribution of H_3O^+ to the solution from this second dissociation is so small, it can be neglected.

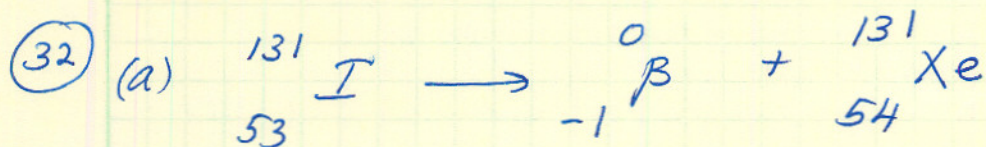


(b) Lewis acid



The H atom in HOCN is attached to the electronegative O atom, which makes that H atom more acidic.

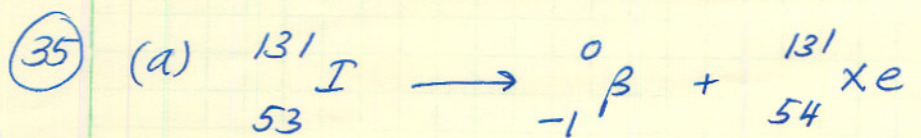
Chapter 23



(b) $t_{1/2} = \frac{0.693}{k}$ $k = \frac{0.693}{8.04 \text{ d}} = 8.62 \times 10^{-2} \text{ d}^{-1}$

$$A_t = A_0 e^{-kt} = (2.4 \mu\text{g}) e^{-(8.62 \times 10^{-2} \text{ d}^{-1})(40.2 \text{ d})}$$

$$A_t = 7.5 \times 10^{-2} \mu\text{g}$$



$$(b) \quad \frac{A_t}{A_0} = \frac{35.0}{100} = e^{-kt}$$

$$e^{-kt} = 0.35 \Rightarrow -kt = \ln(0.35)$$

$$kt = -\ln(0.35) = 1.05$$

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{8.04 \text{ d}} = 8.62 \times 10^{-2} \text{ d}^{-1}$$

$$\therefore t = \frac{1.05}{k} = \frac{1.05}{8.62 \times 10^{-2} \text{ d}^{-1}} = \underline{\underline{12.2 \text{ days}}}$$

$$(38) \quad \frac{A_t}{A_0} = \frac{72}{100} = e^{-kt} = 0.72$$

$$kt = 3.29 \times 10^{-1}$$

$$t_{1/2} \text{ for } {}^{14}\text{C} = 5.73 \times 10^3 \text{ yrs} \Rightarrow k = \frac{0.693}{t_{1/2}}$$

$$k = 1.209 \times 10^{-4} \text{ y}^{-1}$$

$$\therefore t = \frac{3.29 \times 10^{-1}}{1.209 \times 10^{-4} \text{ y}^{-1}} = \underline{\underline{2.72 \times 10^3 \text{ yrs}}}$$