

Exam IV Key

① a) $\text{pH} = \text{pK}_a + \log \frac{[\text{B}]}{[\text{BH}^+]}$ $\text{pK}_a = -\log(1.10 \times 10^{-6}) = 5.959$

$6.20 = 5.959 + \log \frac{[\text{B}]}{[\text{BH}^+]}$ $\Rightarrow \frac{[\text{B}]}{[\text{BH}^+]} = 1.743$
 $\Rightarrow [\text{B}] = 1.743 [\text{BH}^+]$

$[\text{B}] + [\text{BH}^+] = 0.350 \text{ M}$

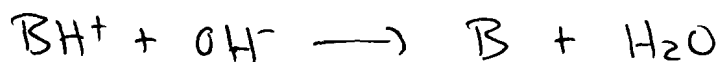
$1.743 [\text{BH}^+] + [\text{BH}^+] = .350$ $\Rightarrow [\text{BH}^+] = 0.1276 \text{ M}$

$[\text{B}] = 0.2224 \text{ M}$

$\Rightarrow (0.1276 \text{ M BH}^+)(.500 \text{ L}) = .0638 \text{ mol} \left(\frac{69.49 \text{ g}}{\text{mol}} \right) = \boxed{4.43 \text{ g HONH}_3\text{Cl}}$

$\Rightarrow (0.2224 \text{ M B})(.500 \text{ L}) = .1112 \text{ mol} \left(\frac{33.03 \text{ g}}{\text{mol}} \right) = \boxed{3.67 \text{ g HONH}_2}$

b) $(0.350 \text{ M})(.500 \text{ L}) = .175 \text{ mol BH}^+ \left(\frac{69.49 \text{ g}}{\text{mol}} \right) = \boxed{12.16 \text{ g BH}^+}$



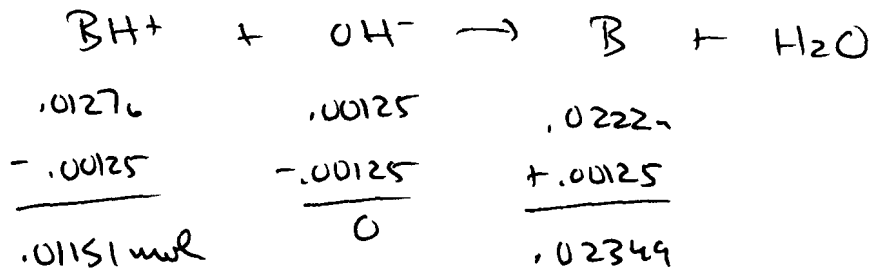
.175 mol	x	0
-x	-x	+x
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.175-x	0	x

$\text{pH} = \text{pK}_a + \log \frac{[\text{B}]}{[\text{BH}^+]}$ $\Rightarrow 6.20 = 5.959 + \log \frac{[\text{B}]}{[\text{BH}^+]}$

$\frac{[\text{B}]}{[\text{BH}^+]} = 1.743 = \frac{x}{.175-x}$ $\Rightarrow x = .1112 \text{ mol OH}^- = \text{M} \cdot \text{V}$
 $= (1 \text{ M})(\text{V})$

$\Rightarrow \text{V} = .1112 \text{ L} = \boxed{111 \text{ mL}}$

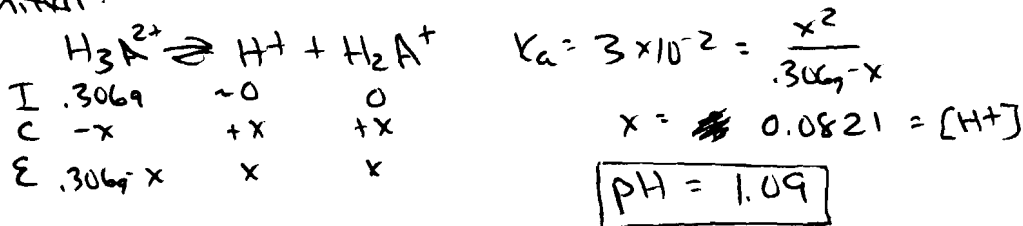
c) $[BH^+] = .1276 M \times .100 L = .01276 \text{ mol } BH^+$
 $[B] = .222 M \times .100 L = .0222 \text{ mol } B$
 $\text{mol } OH^- = .125 M \times .010 L = .00125 \text{ mol } OH^-$



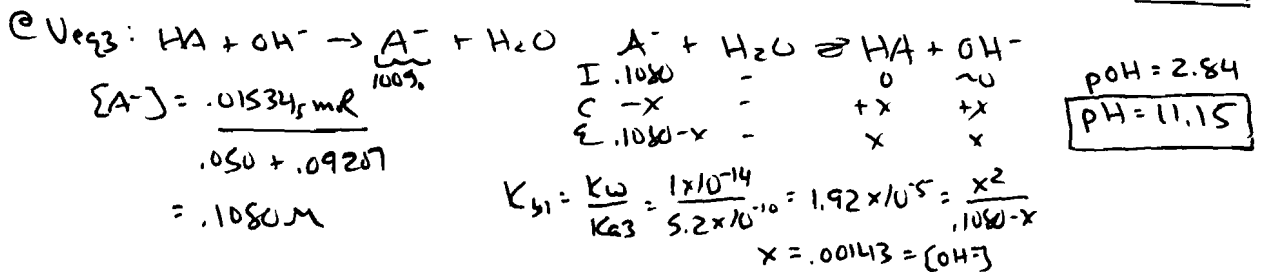
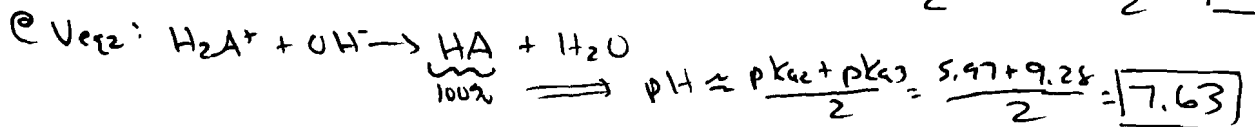
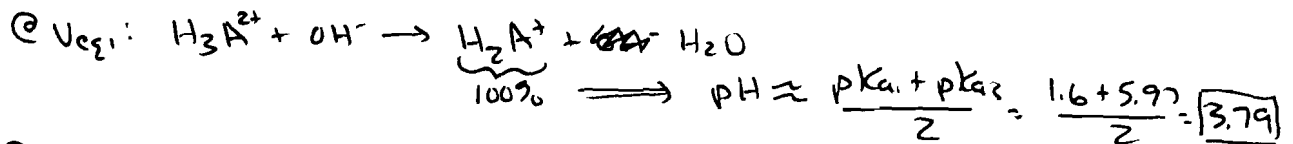
$$pH = pK_a + \log \frac{[B]}{[BH^+]} = 5.959 + \log \frac{.02349}{.01151} = \boxed{6.27}$$

② $(3.50 \text{ g } H_3A^{2+}) \left(\frac{1 \text{ mol } H_3A^{2+}}{228.085} \right) = .015345 \text{ mol } H_3A^{2+} / .0500 L = .3069 M H_3A^{2+}$

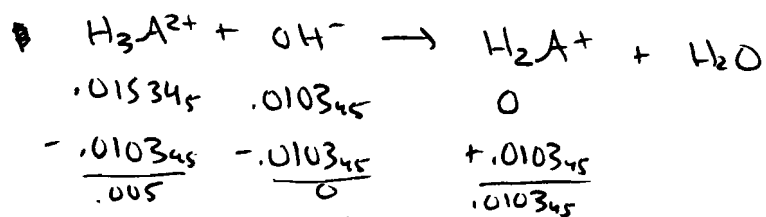
a) initial:



b) @ V_{eq1} : $\text{mol } OH^- = \text{mol } H_3A^{2+}$
 $(.500 M) V_{eq1} = .015345 \text{ mol} \Rightarrow V_{eq1} = .03069 L = 30.69 \text{ mL}$
 $V_{eq2} = 2V_{eq1} = 61.38 \text{ mL}$
 $V_{eq3} = 3V_{eq1} = 92.07 \text{ mL}$



$$c) V = 20.69 \text{ mL} \Rightarrow \text{mol OH}^- = (.500 \text{ M})(.02069 \text{ L}) = .010345 \text{ mol OH}^-$$

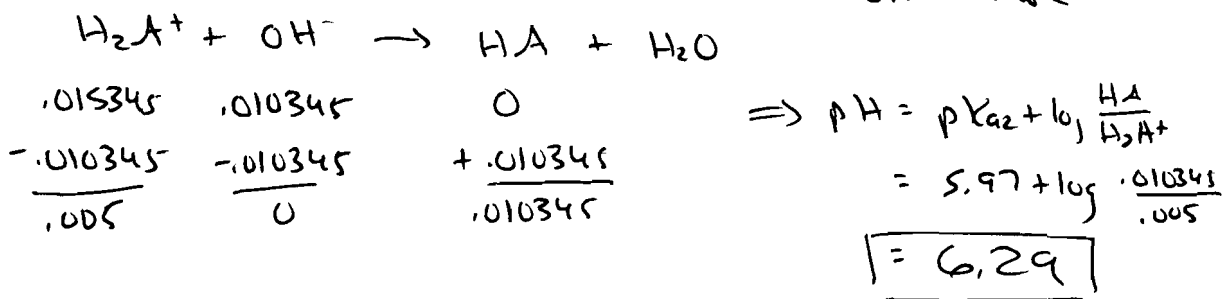


$$\text{pH} = \text{p}K_{a1} + \log \frac{\text{H}_2\text{A}^+}{\text{H}_3\text{A}^{2+}} = 1.6 + \log \frac{.010345}{.005} = \boxed{1.92}$$

$$V = 51.38 \text{ mL} \Rightarrow \text{mol OH}^- = (.500 \text{ M})(.05138 \text{ L}) = .02569 \text{ mol OH}^-$$

$$- .015345 \text{ to reach } \text{Ve}_1$$

$$.010345 \text{ mol}$$



$$V = 82.07$$

$$\text{pH} = \text{p}K_{a3} + \log \frac{\text{A}^-}{\text{HA}} = 9.28 + \log \frac{.010345}{.005} = \boxed{9.60}$$

$$d) V = 112.07 \text{ mL} \Rightarrow \text{mol OH}^- = (.500 \text{ M})(.11207 \text{ L}) = .056035 \text{ mol OH}^-$$

$$- 3(.015345)$$

$$\frac{.0100 \text{ mol OH}^-}{\text{left over}}$$

$$[\text{OH}^-] = \frac{.0100 \text{ mol}}{.050 + .11207} = .0617 \text{ M}$$

$$\text{pOH} = \frac{14}{1.21} \Rightarrow \boxed{\text{pH} = \frac{14}{12.79}}$$

④ Titration #1:

$$\text{mol EDTA} = \text{mol Ni}$$

$$(.02614 \text{ L})(.05831 \text{ M}) = .001524_2 \text{ mol Ni (in 50 mL)}$$

$$(.001524_2 \text{ mol Ni}) \left(\frac{58.71 \text{ g Ni}}{\text{mol Ni}} \right) = .08948_7 \text{ g Ni (in 50 mL)}$$

$$(.08948_7 \text{ g Ni}) \left(\frac{250.0 \text{ mL}}{50.00 \text{ mL}} \right) = 0.4474_4 \text{ g Ni (in 250 mL)}$$

$$\Rightarrow \% \text{ Ni} = \frac{.4474_4 \text{ g}}{.7176 \text{ g}} \times 100 = \boxed{62.35\% \text{ Ni}}$$

Titration #2:

$$\text{mol EDTA} = \text{mol Ni} + \text{mol Fe}$$

$$(.03543 \text{ L})(.05831 \text{ M}) = .002065_3 \text{ mol Ni + Fe (in 50 mL)}$$
$$\underline{- .001524_2 \text{ mol Ni}}$$
$$.0005417 \text{ mol Fe (in 50 mL)}$$

$$(.0005417 \text{ mol Fe}) \left(\frac{55.85 \text{ g Fe}}{1 \text{ mol Fe}} \right) = .03025_5 \text{ g Fe (in 50 mL)}$$

$$.03025_5 \text{ g Fe} \left(\frac{250.0 \text{ mL}}{50.0 \text{ mL}} \right) = .1512_6 \text{ g Fe (in 250 mL)}$$

$$\Rightarrow \frac{.1512_6 \text{ g}}{.7176 \text{ g}} \times 100 = \boxed{21.08\% \text{ Fe}}$$

Titration #3:

$$\text{mol EDTA} = (.05831 \text{ M})(.0500 \text{ L}) = .002915_5 \text{ mol EDTA}$$

$$\text{mol Cu}^{2+} = (.06316 \text{ M})(.00621 \text{ L}) = .0003922_2 \text{ mol Cu}^{2+}$$

$$.002915_5 - .0003922_2 = .002523_3 \text{ mol Ni + Fe + Cr (in 50 mL)}$$
$$\underline{- .002065_3 \text{ mol Ni + Fe (in 50 mL)}}$$
$$.0004573_8 \text{ mol Cr}$$

$$(.0004573_8 \text{ mol Cr}) \left(\frac{250}{5} \right) (52.00 \text{ g/mol}) = .1189 \text{ g Cr}$$

$$\frac{.1189}{.7176} \times 100 = \boxed{16.57\% \text{ Cr}}$$