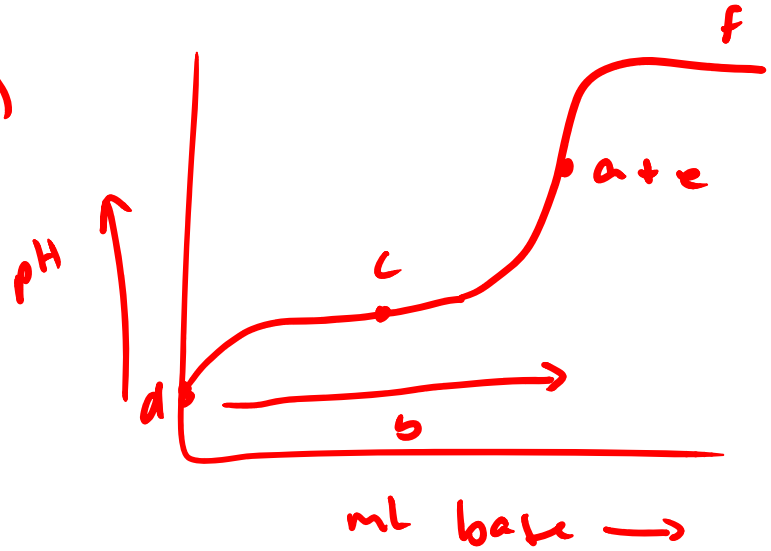
49)



$HA + OH^- \rightarrow A^- + H_2O$

51) $HClO_4 + KOH \rightarrow H_2O + KClO_4$

strong acid - strong base

$H^+ + OH^- \rightarrow H_2O$

a) only strong acid present

$[HClO_4]_0 = [H^+] = 0.200$

$pH = -\log(0.200) = 0.699$

b) $\text{mmol } OH^- = (100 \text{ mL})\left(0.100 \frac{\text{mmol}}{\text{mL}}\right) = 10.00 \text{ mmol } OH^-$

$\text{mmol } H^+ = (40.0 \text{ mL})\left(0.200 \frac{\text{mmol}}{\text{mL}}\right) = 8.00 \text{ mmol } H^+$

	H^+	+	OH^-	→	H_2O
I	8.00		10.00		
C	-8.00		-8.00		
E	0.00		2.00		

$[OH^-] = \frac{2.00 \text{ mmol}}{40.0 \text{ mL} + 100 \text{ mL}} = 0.0143 \text{ M}$

$pOH = -\log(0.0143) = 1.845$

$pH = 14.00 - 1.845 = 12.155$

c) mmol OH^- = $(40.0 ml)(0.100 \frac{mmol}{ml})$ = 4.00 mmol OH

H^+	+	OH^-	→	H_2O
8.00		4.00		
-4.00		-4.00		
4.00		0		

$[H^+] = \frac{4.00 mmol}{40.0 ml + 40.0 ml} = 0.0500 M$

$pH = -\log(0.0500) = 1.30$

d) mmol OH^- = $(80.0 ml)(0.100 \frac{mmol}{ml})$ = 8.00 mmol OH

H^+	+	OH^-	→	H_2O
8.00		8.00		
-8.00		-8.00		
0		0		

equivalence pt = pH = 7

e) mmol OH^- = $(100.0 ml)(0.100 \frac{mmol}{ml})$ = 10.0 mmol OH

H^+	+	OH^-	→	H_2O
8.00		10.0		
-8.00		-8.00		
0		2.00		

$[OH^-] = \frac{2.00 mmol}{40.0 ml + 100.0 ml} = 0.014 M$

$pOH = -\log(0.014) = 1.85$

$pH = 14 - 1.85 = 12.15$

53) $OH^- + HC_2H_3O_2 \rightarrow H_2O + C_2H_3O_2^-$

weak acid - strong base

a) $HC_2H_3O_2 \rightleftharpoons H^+ + C_2H_3O_2^-$

I	0.200	0	0
C	$-x$	$+x$	$+x$
E	$0.200 - x$	x	x

$$K_c = \frac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$$

$$1.8 \times 10^{-5} = \frac{x^2}{0.200 - x} \approx \frac{x^2}{0.200}$$

$x = [H^+] = 1.9 \times 10^{-3}\ M$

$\% = \frac{1.9 \times 10^{-3}}{0.200} \times 100 = 0.95\%$ ✓

$pH = -\log(1.9 \times 10^{-3}) = 2.72$

b) $mmol\ HC_2H_3O_2 = (100.0\ mL)\left(\frac{0.200\ mmol}{1\ mL}\right) = 20.0\ mmol\ HC_2H_3O_2$

$mmol\ OH^- = (50.0\ mL)\left(\frac{0.100\ mmol}{mL}\right) = 5.00\ mmol\ OH^-$

OH^-	$HC_2H_3O_2$	H_2O	$C_2H_3O_2^-$
5.00	20.0		0
−5.00	−5.00		+5.00
0	15.0		5.00

$pH = pK_a + \log\frac{B}{A}$

$= -\log(1.8 \times 10^{-5}) + \log\frac{5.00}{15.0} = 4.26$

d) mmol OH^- = $(100.0\ mL)\left(0.100\ \frac{mmol}{mL}\right)$ = 10.0 mmol OH^-

OH^-	+	$HC_2H_3O_2$	→	H_2O	+	$C_2H_3O_2^-$
10.0		20.0				0
-10.0		-10.0				+10.0
0		10.0				10.0

$[HC_2H_3O_2] = [C_2H_3O_2^-]$

½ equivalence $pH = pK_a = -\log(1.8 \times 10^{-5})$

pH: 4.74

e) mmol OH^- = $(150.0\ mL)\left(0.100\ \frac{mmol}{mL}\right)$ = 15.0 mmol

OH^-	+	$HC_2H_3O_2$	→	H_2O	+	$C_2H_3O_2^-$
15.0		20.0				0
-15.0		-15.0				+15.0
0		5.0				15.0

$pH = pK_a + \log\frac{B}{A}$

$= -\log(1.8 \times 10^{-5}) + \log\frac{15.0}{5.0} = 5.22$

e) mmol OH^- = $(200.0\,mL)\left(0.100\,\frac{mmol}{mL}\right)$ = 20.0 mmol OH^-

	OH^-	+	$HC_2H_3O_2$	→	H_2O	+	$C_2H_3O_2^-$
I	20.0		20.0				0
C	-20.0		-20.0				+20.0
E	0		0				20.0

@ equivalence pt

	$C_2H_3O_2^-$	+	H_2O	⇌	$HC_2H_3O_2$	+	OH^-
I	$\frac{20.0\,mmol}{300.0\,mL}$				0		0
C	-x				+x		+x
E	0.0667 - x				x		x

$K_b = \frac{1.0\times10^{-14}}{1.8\times10^{-5}} = 5.6\times10^{-9} = \frac{x^2}{0.0667 - x}$ ≈ $\frac{x^2}{0.0667}$

$\frac{5.6\times10^{-9}}{0.0667}\times100$ ✓

$x = [OH^-] = 6.1\times10^{-6}\,M$

$pOH = -\log(6.1\times10^{-6}) = 5.21$

$pH = 14.0 - 5.21 = 8.79$

P> mmol OH^- = $(250.0\,mL)\left(0.100\,\frac{mmol}{mL}\right)$ = 25.0 mmol OH^-

	OH^-	+ $HC_2H_3O_2$	⟶ H_2O	+ $C_2H_3O_2^-$
I	25.0	20.0		0
C	-20.0	-20.0		+20.0
E	5.0	0		20.0

$$[OH^-] = \frac{5.0\,mmol}{100.0\,mL + 250.0\,mL} = 0.014\,M$$

$$pOH = -\log(0.014) = 1.85$$

$$pH = 14.0 - 1.85 = 12.15$$