

So I will do the solution for question 2. Question 1 works the same way.
 Question 3 is done exactly like 2b
 Question 4 and 5 is like 2c

2 a) Before Titration

$$H_2O_{(l)} + HCO_2H_{(aq)} \rightleftharpoons HCO_2^-_{(aq)} + H^+_{(aq)}$$

I	0.20	0	10^{-7}
C	$-x$	$+x$	$+x$
E	$0.20 - x$	x	x

Check
 $0.20 - x \approx 0.20$

$$K_a = \frac{[HCO_2^-][H^+]}{[HCO_2H]}$$

$$1.78 \times 10^{-4} = \frac{[x][x]}{[0.20]}$$

$$x = 0.0060$$

$$pH = -\log[H_3O^+]$$

$$= -\log[0.0060]$$

$$= 2.22$$

2 b) After 10.0 mL have been added:

$$n_{NaOH} = CV$$

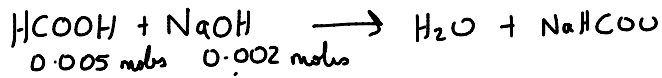
$$= 0.010L \times 0.2 \text{ mol/L}$$

$$= 0.002 \text{ mol}$$

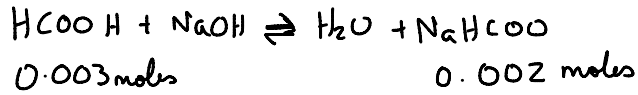
$$n_{HCOOH} = CV$$

$$= 0.025L \times 0.2 \text{ mol/L}$$

$$= 0.005 \text{ moles}$$



becomes



$$\text{new volume} = 0.035L$$

$$\text{new conc} = 0.086 \text{ mol/L} \qquad 0.057 \text{ mol/L}$$

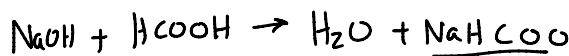
$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

$$= pK_a + \log \frac{[NaHCOO]}{[HCOOH]}$$

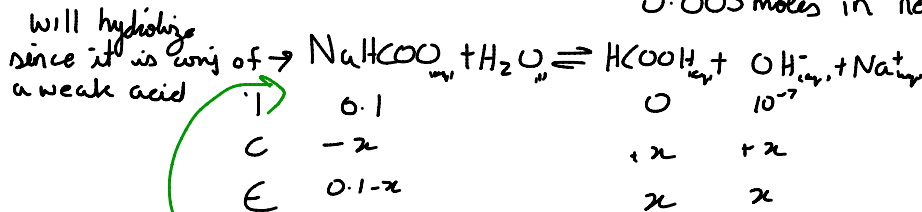
$$= 3.75 + \log \frac{[0.057]}{[0.086]}$$

$$= 3.57$$

2 c) At equivalence: all acid has been converted to salt



0.005 moles in new volume of 50 mL
 $C = \frac{n}{V} = 0.1 \text{ mol/L}$



Check
 $0.1 - x \approx 0.1$

$$K_b = \frac{K_w}{K_a} = 5.6 \times 10^{-11}$$

$$K_b = \frac{[OH^-][HCOOH]}{[NaHCOO]} = \frac{x^2}{0.1} = 2.4 \times 10^{-6}$$

$$pOH = -\log[OH^-]$$

$$pH = 14 - pOH$$

since this is a base