

## Answer on Question #63744 - Chemistry – General Chemistry

Calculate the pH change when 10. mL of 3.0 M HCl are added to 500. mL of the following A) pure water B) aqueous solution of 3.0g of formic acid C) aqueous solution of 4.0g potassium formate D) aqueous solution containing 3.0 g of formic acid and 4.0 g of potassium formate.

### Solution.

a)  $\text{pH}(\text{H}_2\text{O}) = 7$

$$n(\text{HCl}) = 3.0 \text{ M} \times 0.01 \text{ L} = 0.03 \text{ mol}$$

$$C_2(\text{HCl}) = 0.03 \text{ mol} / (0.5+0.01) = 0.0588 \text{ mol/L}$$

$$\text{pH} = -\lg C(\text{HCl}) = -\lg 0.0588 = 1.22$$

pure water:  $\text{pH} = 7$ ; final  $\text{pH} = 1.22$ ; change = 5.78

b)  $n(\text{HCOOH}) = m(\text{HCOOH})/M(\text{HCOOH}) = 3/46 = 0.0652 \text{ mol}$

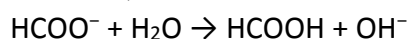
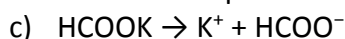
$$C(\text{HCOOH}) = n(\text{HCOOH})/0.5 \text{ L} = 0.0652/0.5 = 0.13 \text{ M}$$

$$K_{a, \text{HCOOH}} = 1.8 \cdot 10^{-4}; \text{p}K_{a, \text{HCOOH}} = -\lg K_{a, \text{HCOOH}} = 3.75$$

$$\text{pH} = \frac{1}{2} \text{p}K_{a, \text{HCOOH}} - \frac{1}{2} \lg C_{\text{HCOOH}} = 1/2 \times 3.75 - 1/2 \times \lg(0.13) = 2.32$$

HCl – strong acid;  $\text{pH} = 1.22$

formic acid :  $\text{pH} = 2.32$ ; final  $\text{pH} = 1.22$ ; change = 1.1

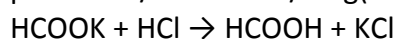


$$C(\text{HCOOK}) = 4/(84 \times 0.5) = 0.095 \text{ M}$$

$$K_{a, \text{HCOOH}} = 1.8 \cdot 10^{-4}; \text{p}K_{a, \text{HCOOH}} = 3.75$$

$$\text{pH} = 7 + \frac{1}{2} \text{p}K_{a, \text{HCOOH}} + \frac{1}{2} \lg C_{\text{HCOOK}}$$

$$\text{pH} = 7 + 1/2 \times 3.75 + 1/2 \times \lg(0.095) = 8.36$$



$$C(\text{HCOOH}) = 0.0588 \text{ mol/L}$$

$$C(\text{HCOOK}) = 0.095 - 0.0588 = 0.0362$$

$$\text{pH} = \text{p}K_{a, \text{HCOOH}} - \lg \frac{C_{\text{HCOOH}}}{C_{\text{HCOOK}}}$$

$$\text{pH} = 3.75 - \lg (0.0588/0.0362) = 3.54$$

potassium formate :  $\text{pH} = 8.36$ ; final  $\text{pH} = 3.54$ ; change = 4.82

d)  $\text{pH} = \text{p}K_{a, \text{HCOOH}} - \lg \frac{C_{\text{HCOOH}}}{C_{\text{HCOOK}}}$

$$\text{pH} = 3.75 - \lg (0.13/0.095) = 3.61$$

$$C(\text{acid}) = 0.13 + 0.0588 = 0.1888 \text{ M}$$

$$C(\text{salt}) = 0.095 - 0.0588 = 0.0362 \text{ M}$$

$$\text{pH} = 3.75 - \lg (0.1888/0.0362) = 3.03$$

buffer:  $\text{pH} = 3.61$ ; final  $\text{pH} = 3.03$ ; change = 0.58

**Answer:** a) pure water:  $\text{pH} = 7$ ; final  $\text{pH} = 1.22$ ; change = 5.78

b) formic acid :  $\text{pH} = 2.32$ ; final  $\text{pH} = 1.22$ ; change = 1.1

c) potassium formate :  $\text{pH} = 8.36$ ; final  $\text{pH} = 3.54$ ; change = 4.82

d) buffer:  $\text{pH} = 3.61$ ; final  $\text{pH} = 3.03$ ; change = 0.58

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