**More examples of Buffer calculations**

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| 0.15 mol L-1 NH3 and 0.50 mol L-1 NH4Cl make up a buffer solution. What is the pH of the buffer solution? Ka NH4+ = 5.8 x 10-10  NH4+(aq) + H2O(l) ⇄ NH3(aq) + H3O+(aq)  **Using Ka**  Ka = [NH3][H3O+]  [NH4+]  5.8 x 10-10 = [0.15][H3O+]  [0.50]  (5.8 x 10-10) (0.50) = [H3O+]  0.15  1.933 x 10-9 =[H3O+]  pH = - log 1.933 x 10-9  pH = 8.713  ***Answer: 8.71***  **OR**  **alternative method using H-H equation**  pKa = - log Ka  pKa = - log (5.8 x 10-10)  pKa =9.236  pH = 9.236 + log 0.15  0.50  pH = 9.236 + log 0.3  pH = 9.236 + (-0.5228)  pH = 8.713  ***Answer: 8.71*** | 5.78g of sodium ethanoate was added to 1 litre of 0.1 mol L-1 ethanoic acid. What is the pH of the buffer solution? Ka (CH3COOH) = 1.8 x 10-5  M(CH3COONa) = 82 g mol-1  Assume that the added mass of sodiumethanoate does not change the total volume of solution  CH3COOH(aq) + H2O(l) ⇄ CH3COO-(aq) + H3O+(aq)  n = m  M  n (CH3COONa) = 5.78  82  n (CH3COONa) = 0.07048 mol  C (CH3COONa) = n  V  C (CH3COONa) = 0.07048 = 0.07048 mol L-1  1  **Using Ka**  Ka = [CH3COO-][H3O+]  [CH3COOH]  1.8 x 10-5 =0.07048 [H3O+]  1  2.553 x 10-4 = [H3O+]  pH = - log 2.553 x 10-4  pH = 3.59  ***Answer: 3.59***  **OR**  **alternative method using H-H equation**  pKa = - log Ka  pKa = - log (1.8 x 10-5 )  pKa =4.744  pH = 4.744 + log 0.07048  0.1  pH = 4.744 + log 0.77048  pH = 4.744 + 1.151  pH = 3.59  ***Answer: 3.59*** | 2.64g of Na2HPO4.12H2O and 0.31g of  NaH2PO4.2H2O made up a buffer solution with a volume of 1 litre. What is the pH of the buffer solution? Ka H2PO4- = 6.3 x 10-8  M (Na2HPO4.12H2O) = 358 g mol-1  M (NaH2PO4.2H2O) = 156 g mol-1  H2PO4-(aq)+ H2O(l) ⇄ HPO42-(aq)+ H3O+(aq)   |  |  | | --- | --- | | n = m  M | | | n (Na2HPO4.12H2O) = 2.64  358  n (Na2HPO4.12H2O) = 7.374 x 10-3 | n (NaH2PO4.2H2O) = 0.31  156  n (NaH2PO4.2H2O) = 1.987 x 10-3 | | C = n  V | | | C (Na2HPO4.12H2O) = 7.374 x 10-3  1  C = 7.37 x 10-3 mol L-1 | C (NaH2PO4.2H2O) = 1.987 x 10-3  1  C = 1.99 x 10-3 mol L-1 |   **Using Ka**  Ka = [HPO42][H3O+]  [H2PO4-]  6.3 x 10-8 =7.37 x 10-3 [H3O+]  1.99 x 10-3  1.703 x 10-8 = [H3O+]  pH = - log 1.703 x 10-8  pH = 7.768  ***Answer: 7.77***  **OR**  **alternative method using H-H equation**  pKa = - log Ka  pKa = - log (6.3 x 10-8)  pKa =7.2  pH = 7.2 + log 7.37 x 10-3  1.99 x 10-3  pH = 7.2 + log 3.703  pH = 7.2 + 0.5686  pH = 7.768  ***Answer: 7.77*** |
| 50mL of 0.15 mol L-1 Lactic acid (HLac) is mixed with 35mL of 0.25 mol L-1 Sodium lactate (Lac-)  what is the pH of the buffer solution?  Ka (HLac) = 1.38 x 10-4  HLac(aq) + H2O(l) ⇄ Lac-(aq) + H3O+(aq)   |  |  | | --- | --- | | final concentration = original concentration x original volume  final volume | | | C (HLac) = 0.15 x 0.05  0.085  C (HLac) = 0.0882 mol L-1 | C (Lac-) = 0.25 x 0.035  0.085  C (Lac-) = 0.1029 mol L-1 |   **Using Ka**  Ka = [Lac-][H3O+]  [HLac]  1.38 x 10-4 =0.1029 [H3O+]  0.0882  1.182 x 10-4 = [H3O+]  pH = - log 1.182 x 10-4  pH = 3.926  ***Answer: 3.93***  **OR**  **alternative method using H-H equation**  pKa = - log Ka  pKa = - log (1.38 x 10-4)  pKa =3.86  pH = 3.86 + log 0.1029  0.0882  pH = 3.86 + log 1.166  pH = 3.86 + (0.0669)  pH = 3.926  ***Answer: 3.93*** | Calculate the ratio of carbonic acid concentration to bicarbonate ion concentration buffer in the blood which maintains a pH of 7.4.  Ka (H2CO3) = 4.3 x 10-7  H2CO3(aq) + H2O (l) ⇄ HCO3-(aq) + H3O+(aq)  pH = - log [H3O+]  inverse log – 7.4 = [H3O+]  3.98 x 10-8 = [H3O+]  **Using Ka**  Ka = [HCO3-][3.98 x 10-8 ]  [H2CO3]  4.3 x 10-7=[HCO3-][3.98 x 10-8 ]  [H2CO3]  4.3 x 10-7 = [HCO3-]  3.98 x 10-8 [H2CO3]  10.8 = [HCO3-]  [H2CO3]  ***Answer: [HCO3-] : [H2CO3] = 11 : 1***  **OR**  **alternative method using H-H equation**  pKa = - log Ka  pKa = - log 4.3 x 10-7  pKa = 6.366  7.4 = 6.366 + log [HCO3-]  [H2CO3]  7.4 – 6.366 = log [HCO3-]  [H2CO3]  inverse log 1.033 = [HCO3-]  [H2CO3]  10.78 = [HCO3-]  [H2CO3]  [HCO3-] : [H2CO3] = 11 : 1  ***Answer: [HCO3-] : [H2CO3] = 11 : 1*** | Calculate the concentration of C3H5O2- in a buffer solution which has a pH of 4.5 if the concentration of HC3H5O2 is 0.50 mol L-1  Ka (HC3H5O2) = 1.34 x 10-5  HC3H5O2 (aq) + H2O (l)⇄ C3H5O2- (aq) + H3O+ (aq)  pH = - log [H3O+]  inverse log – 4.5 = [H3O+]  3.16 x 10-5 = [H3O+]  **Using Ka**  Ka = [C3H5O2-] [H3O+]  [HC3H5O2]  1.34 x 10-5=[C3H5O2-] 3.16 x 10-5  0.50  (1.34 x 10-5) (0.50) = [C3H5O2-]  3.16 x 10-5  0.2120 = [C3H5O2-]  ***Answer 0.212 mol L-1***  **OR**  **alternative method using H-H equation**  pKa = - log Ka  pKa = - log (1.34 x 10-5)  pKa = 4.872  4.5 = 4.872 + log [C3H5O2-]  0.50  4.5 – 4.872 = log [C3H5O2-]  0.50  -0.372 = log [C3H5O2-]  0.5  inverse log (-0.372) = [C3H5O2-]  0.5  (0.4246) (0.5) = [C3H5O2-]  0.2120 = [C3H5O2-]  ***Answer 0.212 mol L-1*** |

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