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CHMG 142

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**Mastery Questions:**

Dissociation constants of acids:

HOAc Ka = 1.78x10-5

H2SO4 Ka1 = 1x107 Ka2 = 1.0x10-2

HCNO Ka = 2x10-4

H2CO3 Ka1 = 4.3x10-7 Ka2 = 5.6x10-11

H2O Ka = 1.0x10-14

HIO Ka = 2.3x10-11

HIO3 Ka = 1.7x10-4

HF Ka = 3.5x10-4

H2C2O4 Ka1 = 6.0x10-2 Ka2 = 6.1x10-5

|  |  |
| --- | --- |
| Strong Acids | Strong Bases |
| HCl | KOH |
| HNO3 | NaOH |
| H2SO4 (Ka1) | Ba(OH)2 |
| HClO4 | Ca(OH)2 |
| HBr | Sr(OH)2 |
| HI | LiOH |

Dissociation constants of bases:

NH3 Kb = 1.76x10-5

CH3NH2 Kb = 4.4x10-4

HONH2 Kb = 1.1x10-8

C2H5NH2 Kb = 5.6x10-4

**Mastery #1**: I mix together 25.0 mL of 0.100 M NaOCN, 50.00 mL of 0.100 M HCl, and 25.0 mL of 0.100 M HCNO. What is the pH of the mixture?

|  |  |  |
| --- | --- | --- |
| HCNO | H3O | CNO |
| 0.025 | 0.05 | 0.025 |
| - x | + x | + x |
| 0.025 - x | 0.05 + x | 0.025 + x |

[0.05 + x] [0.025 + x] / [0.025 - x] = 2 \* 10-4 -> x = -0.0246

pH = - log [ H3O ] -> -log[0.05 + (-0.0246)] = -log[0.0254] = 1.595

The mixture has a pH of **1.6**.

**Mastery #2:** I have 50.00 mL of 0.100 M methyl amine (CH3NH2). I gradually add a solution of 0.025 M nitric acid (HNO3) to the methyl amine solution.

1. What is the pH before I add any HNO3?

Kb = 4.4 x 10-4 -> pKb = - log(4.4 x 10-4) = - (-3.356) = 3.356

Kb = (x2 / c - x) = ½ \* [ pKb + log (c) ]

= 0.5 \* [ 3.356 + log (0.100) ] = 0.5 \* 2.356 = 1.178

pH = 14 – 1.178 = **12.822**

1. What is the pH after I’ve added a total of 10.00 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.01 L (Volume of Nitric Acid)

v2 = 0.06 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.01 L ) / (0.06 L) = 0.00416 M

pH = - log[0.00416 M] = **2.38**

1. What is the pH after I’ve added a total of 50.00 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.05 L (Volume of Nitric Acid)

v2 = 0.1 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.05 L ) / (0.1 L) = 0.0125 M

pH = - log[0.0125 M] = **1.90**

1. What is the pH after the addition of a total of 196 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.196 L (Volume of Nitric Acid)

v2 = 0.246 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.196 L ) / (0.246 L) = 0.019918 M

pH = - log[0.019918 M] = **1.7007**

1. What is the pH after the addition of a total of 197 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.197 L (Volume of Nitric Acid)

v2 = 0.247 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.197 L ) / (0.247 L) = 0.019939 M

pH = - log[0.019939 M] = **1.7003**

1. What is the pH after the addition of a total of 198 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.198 L (Volume of Nitric Acid)

v2 = 0.248 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.198 L ) / (0.248 L) = 0.019959 M

pH = - log[0.019959 M] = **1.6998**

1. What is the pH after the addition of a total of 199 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.199 L (Volume of Nitric Acid)

v2 = 0.249 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.199 L ) / (0.249 L) = 0.019979 M

pH = - log[0.019979 M] = **1.6994**

1. What is the pH after the addition of a total of 200 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.200 L (Volume of Nitric Acid)

v2 = 0.250 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.200 L ) / (0.250 L) = 0.02 M

pH = - log[0.02 M] = **1.6989**

1. What is the pH after the addition of a total of 201 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.201 L (Volume of Nitric Acid)

v2 = 0.251 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.201 L ) / (0.251 L) = 0.02001 M

pH = - log[0.02001 M] = **1.6985**

1. What is the pH after the addition of a total of 202 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.202 L (Volume of Nitric Acid)

v2 = 0.252 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.202 L ) / (0.252 L) = 0.02003 M

pH = - log[0.02003 M] = **1.6981**

1. What is the pH after the addition of a total of 205 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.205 L (Volume of Nitric Acid)

v2 = 0.255 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.205 L ) / (0.255 L) = 0.02009 M

pH = - log[0.02009 M] = **1.6968**

1. What is the pH after the addition of a total of 225 mL of the nitric acid?

(M1v1) / v2 = M2

M1 = 0.025 M (Molarity of Nitric Acid)

v1 = 0.225 L (Volume of Nitric Acid)

v2 = 0.275 L (Total Volume of solution)

M2 = ( 0.025 M \* 0.225 L ) / (0.275 L) = 0.02045 M

pH = - log[0.02045 M] = **1.6892**