KEY

In Class 12: Periodic trends in acidity and basicity, predicting acid base reactions, and predicting acid base properties of salts

1. For the following incomplete acid base reaction, fill in the blanks in the reaction with plausible products. **Label the acid, base, conjugate acid and conjugate base.** Indicate whether you think the reaction as written will go to completion and support your answer **briefly (one phrase)**. (Hint, since HCO_3^- could be either an acid or a base, you need to think about the other species to figure out which one it could do.)

base acid conj base conj acid

$HCO_3^- + CH_3NH_3^+ \rightarrow CH_3NH_2 + H_2CO_3$

$pKa = 14 - 3.36 = 10.64$ ($pK_b(CH_3NH_2)$) $pKa = 6.37$ ← stronger acid ∴ not favored

2. Explain the following statement using pictures and words!

A solution of $NaNO_3$ has a lower pH than a solution of $NaNO_2$.

Na^+ NO_3^- Na^+ NO_2^-

$pKa > 14$ $pK_b > 14$ $pKa > 14$ $pK_b = 14 - pKa(HNO_2) = 14 - 3.40 = 10.60$

∴ nonacidic non basic

These are both salts w/ Na^+ as the cation. Since Na^+ has a $pKa > 14$, it won't contribute to the pH of the solution. NO_2^- has a lower pK_b (10.60) than NO_3^- (>14) so it will be a stronger base. Since the NO_2^- ion has −1 charge distributed over two O's rather than 3, it will be better able to attract an H^+ and act as a base. Better bases have higher pHs!

3. For the following salts, classify each as acidic, basic or neutral and rank them in order from most acidic to most basic. Provide brief phrases or supporting data for your conclusions.

NaClO $KClO_4$ $Cr(ClO_4)_3$ NH_4CN NH_3 KH_2PO_4

acid base acid base acid base

base acid acid or base!

Na^+ ClO^- K^+ ClO_4^- NH_4^+ CN^- K^+ $H_2PO_4^-$

$pKa > 14$ $pK_b = 14 - pKa(HClO) = 14 - 7.54 = 6.46$ $pKa > 14$ $pK_b > 14$ $pKa = 14 - pK_b(NH_3) = 14 - 4.75 = 9.25$ $pK_b = 14 - pKa(HCN) = 14 - 9.21 = 4.79$ $pKa > 14$ $pKa = 7.19$ $pK_b = 14 - pKa(H_3PO_4) = 14 - 2.16 = 11.84$

5 $pK_b = 4.75$ weak base!

non acidic

3 2 4 1

$pK_b < pKa$ ∴ basic

neutral

$pK_b < pKa$ ∴ basic

$pKa < pK_b$ ∴ acidic