Chem 130, Eppley

KEY

In Class 10: pKa and pKb values, acidity of metal ions, and predominance diagrams

1. Write a reaction that shows how the polyatomic ion, HPO_4^{2-} could act as an acid in aqueous solution.

$HPO_4^{2-}(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + PO_4^{3-}(aq)$ $pK_a = 12.32$

Write a reaction that shows how the polyatomic ion HPO_4^{2-} could act as a base in aqueous solution.

$HPO_4^{2-}(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + H_2PO_4^-(aq)$

$pK_b = 14 - pK_a(H_2PO_4^-)$
$= 14 - 7.19$
$= 6.91$

For each of the processes above, look up and /or calculate the appropriate pK_a or pK_b value from the table that is relevant and write the corresponding values next to the appropriate equation above.

Consider the pK_a and pK_b values for those equations. Which reaction will occur to a greater extent in pure water? Explain and indicate whether you expect the solution to be acidic or basic overall.

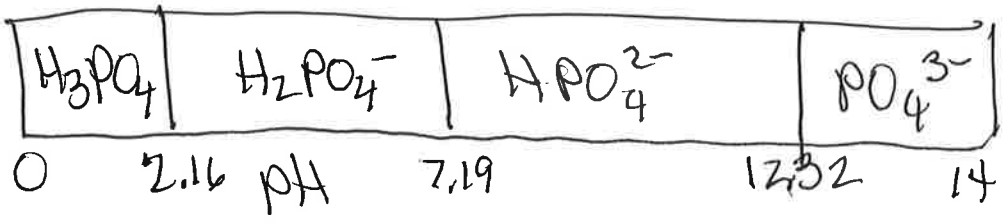
Since the pKa for HPO_4^{2-} acting as an acid is larger than the pK_b for HPO_4^{2-} acting as a base, the base reaction is more favored and so the solution will be basic!

Of all the HPO_4^{2-} based species in the equations above (products or reactants), which would be the strongest acid? The strongest base?

$H_2PO_4^-$ best acid $pK_a = 7.19$

PO_4^{3-} - best base $pK_b = 1.68$

Draw a predominance diagram for these species based on the pKa and pKb values on the table provided.



2. Consider the two metal ions, Be^{2+} and Al^{3+} dissolved in aqueous solution. For each of them, write a series of reaction showing how they can act as acids in aqueous solution.

$Be^{2+}(aq) + 2H_2O(l) \rightleftharpoons Be(OH)^+(aq) + H_3O^+(aq)$

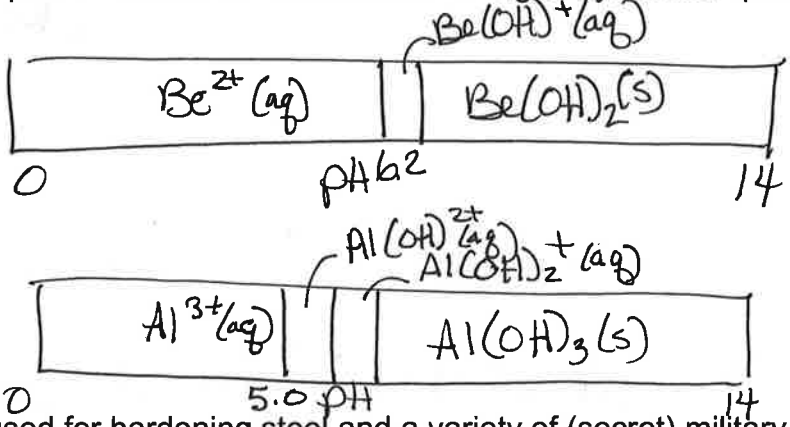
$Be(OH)^+(aq) + 2H_2O(l) \rightleftharpoons Be(OH)_2(s) + H_3O^+(aq)$

$Al^{3+}(aq) + 2H_2O(l) \rightleftharpoons Al(OH)^{2+}(aq) + H_3O^+(aq)$

$Al(OH)^{2+}(aq) + 2H_2O(l) \rightleftharpoons Al(OH)_2^+(aq) + H_3O^+(aq)$

$Al(OH)_2^+(aq) + 2H_2O(l) \rightleftharpoons Al(OH)_3(s) + H_3O^+(aq)$

Draw a predominance or ladder diagram for each showing which species will dominate at various pH's ranging from 0-14 (you can assume that there are just small areas of predominance for intermediate charged hydroxide species).



If toxic Be^{2+} (used for hardening steel and a variety of (secret) military and nuclear applications) were accidentally released into a stream with a slightly acidic normal pH of about 5.0, would you expect it to be present as a soluble or insoluble form? Explain.

Be^{2+} should be in a soluble (bioavailable) form. That is not good!