1.

a) How much base (e.g. NaOH) would you have to add to a one liter of a 1M solution of H_3PO_4 to raise the pH to 12.4. The individual pKa's of phosphate are 2.14, 7.20, 12.40.

$$H_3PO_4 \overset{2.14}{\rightleftharpoons} H_2PO_4^- \overset{7.20}{\rightleftharpoons} HPO_4^{2-} \overset{12.40}{\rightleftharpoons} PO_4^{3-}$$

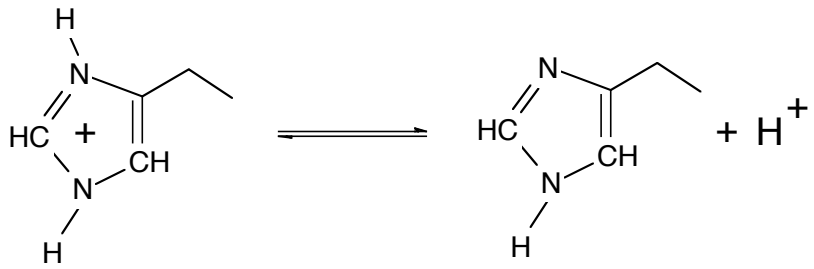
b) Would this solution be a good buffer at this pH? Why?

2. A biochemist is measuring the rate of the following enzyme catalyzed reaction at a pH of 7.0

$$NAD^+ + \text{Malate} \rightleftharpoons NADH + \text{Oxaloacetate} + H^+$$

In addition to the above compounds, the biochemist has included 0.1 M phosphate in the reaction. Why?

3. An enzyme has a Histidine residue that must be deprotonated (i.e. uncharged) for the enzyme to function. Although the normal pKa of the sidechain of Histidine is 6.0, this particular Histidine has a pKa of 5.0.



a) Is the Histidine in the protein a weaker or stronger acid than Histidine in water?

b) Since the pKa is decreased by one unit the histidine must be in a different environment than water. What environments would cause a reduced pKa?