Chemistry 201

Types of buffers

NC State University

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There are inorganic buffers, e.g. phosphate, but there are many more organic buffers. In fact, the number of buffers is staggering.

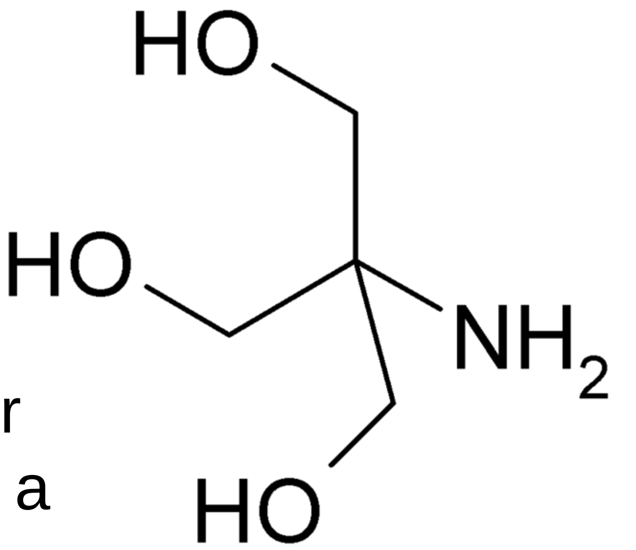
Organic buffers: Tris, HEPES, MOPS, MES…

“Biological” buffers: citrate, acetate, carbonate, malonate,

Proteins themselves are polyelectrolytes and therefore tend to the buffer the solution they are in. This can have important physiological impact (e.g. hemoglobin).

Tris buffer

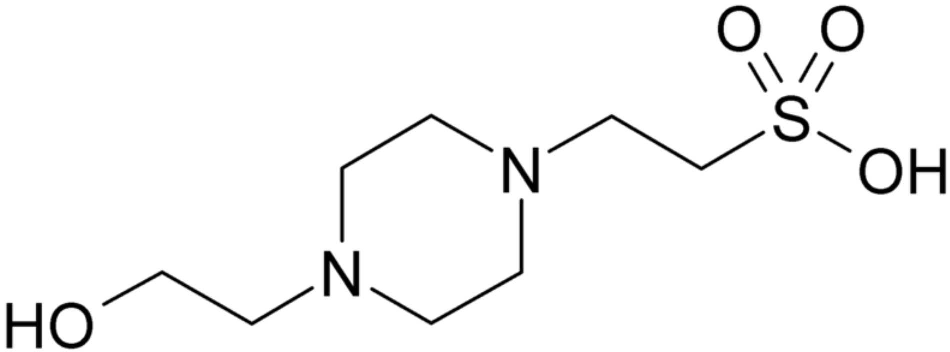
Tris(hydroxymethyl)aminomethane), is an organic buffer with the formula $(HOCH_2)_3CNH_2$. Tris has a pKa = 8.07. The buffer range is 7.07 – 9.07.
It is is widely used as a component for solutions of nucleic acids, proteins and for any application in which phosphate is not a good choice.



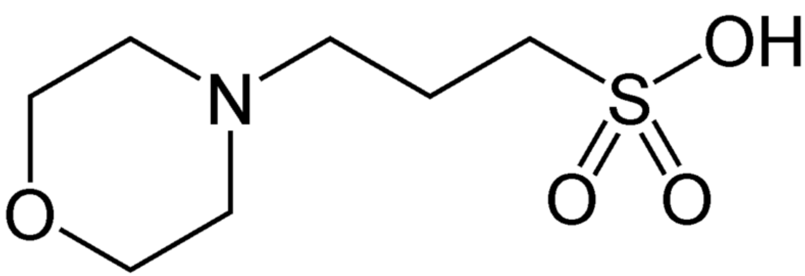
For example, calcium phosphate has a low solubility product, Which means that phosphate buffers are a poor choice in any application where calcium is present.

Important point: Tris can react with aldehydes since it is a primary amine. Choice of buffer should done by consulation of the chemical interactions in your application.

Other organic buffers



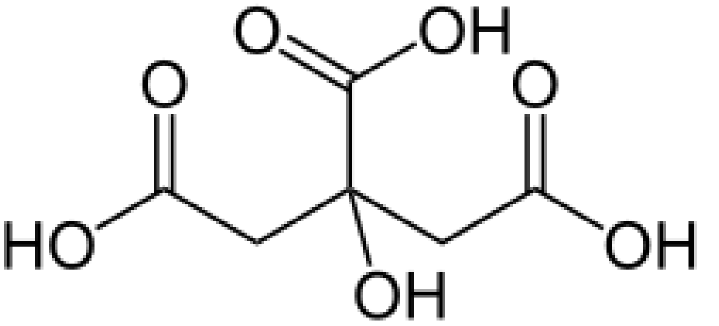
HEPES: pKa = 7.5



MOPS: pKa = 7.2

Citrate buffer

Citric acid is found in abundance in citrus fruits. It is also part of the citric acid cycle in biochemistry. It is a triprotic acid, with three carboxylic acid groups as seen by its structure (on the right).



$$C_6O_7H_4 \rightarrow C_6O_7H_3^- + H^+$$

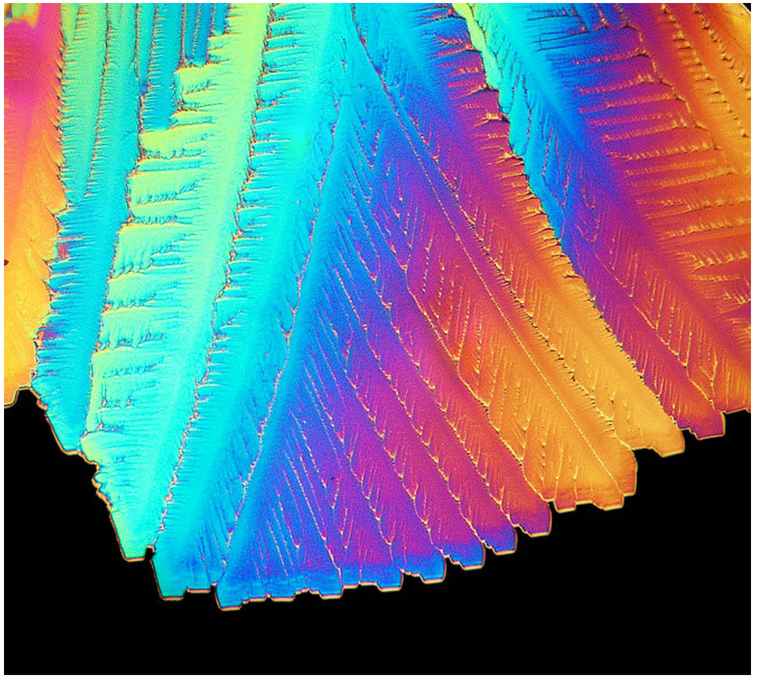
$pK_{a1} = 3.14$

$$C_6O_7H_3^- \rightarrow C_6O_7H_2^{2-} + H^+$$

$pK_{a2} = 4.75$

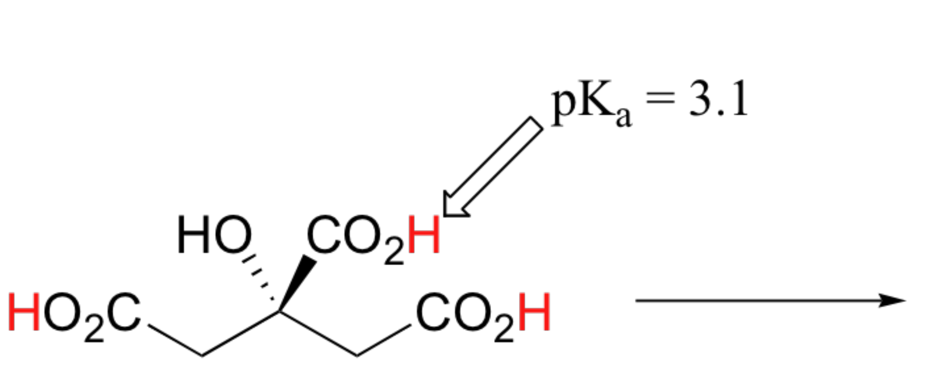
$$C_6O_7H_2^{2-} \rightarrow C_6O_7H_1^{3-} + H^+$$

$pK_{a3} = 6.40$



Citric acid crystals under polarized light

Citrate buffer: species in solution



citric acid

The middle H atom has the lowest pKa. This is because the neighboring OH group has an electron withdrawing effect that stabilizes the negative charge created.

Citric acid (AH_3) speciation