Assay of Borax

Sodium borate or Sodium tetraborate

**$Na_2B_4O_7.10H_2O$ M. wt. 381.4**

❑ **Introduction**

Borax (sodium tetraborate decahydrated) is soluble in 20 parts of water. It should be kept in well closed container. Borax is used as antiseptic and astringent in mouth paints.

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❑ <u>**Chemical principle**</u>

Borax is a salt derived from a weak acid and a strong base, so its aqueous solution can be assayed using a standard *N*/2 hydrochloric acid solution in an acid- base titration.

$$Na_2B_4O_7.10H_2O + 2HCl \longrightarrow 2NaCl + 4H_3BO_3 + 5H_2O$$
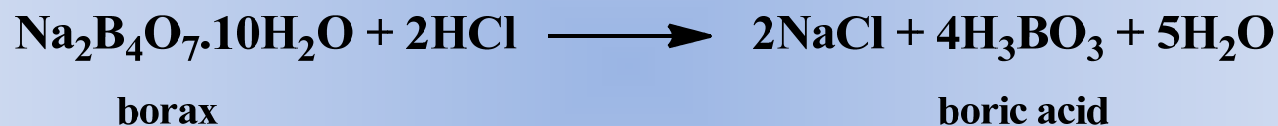
borax   boric acid

Borax samples may sometimes be contaminated with boric acid or sodium carbonate. Thus two titrations are carried out;
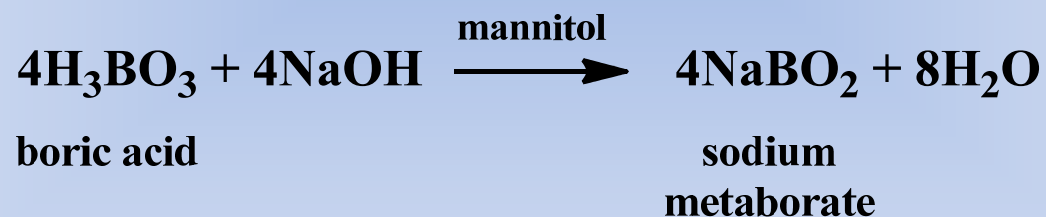- ▪ **the first is for borax (and sodium carbonate if present) with hydrochloric acid, and**
- ▪ **the second is for boric acid with sodium hydroxide.**

The corrected volumes of the two titrations can then tell the presence and type of impurities, besides the quantities of each.
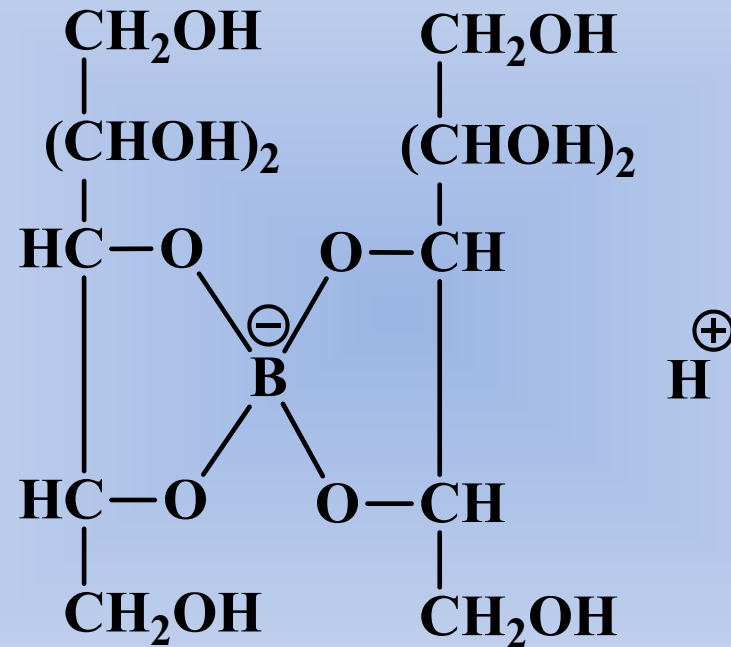
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❑ **Chemical principle**

Reaction between borax and hydrochloric acid liberates boric acid (H_3BO_3), a very weak acid that needs to increase its acidity (by converting it into a strong complex acid) so that it can react with sodium hydroxide by direct titration. This is achieved by the addition of excess of mannitol, a poly hydroxylated alcohol. Mannityl boric acid complex is formed which is a strong acid.

$$4H_3BO_3 + 4NaOH \xrightarrow{\text{mannitol}} 4NaBO_2 + 8H_2O$$

boric acid   sodium
                                    metaborate

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❑ **Chemical principle**

$$
\begin{array}{ccc}
CH_2OH & & CH_2OH \\
| & & | \\
(CHOH)_2 & & (CHOH)_2 \\
| & & | \\
HC-O \quad\quad O-CH \\
\diagdown_{\ominus}\diagup \\
B \quad\quad\quad H^{\oplus} \\
\diagup\quad\diagdown \\
HC-O \quad\quad O-CH \\
| & & | \\
CH_2OH & & CH_2OH
\end{array}
$$

mannityl boric acid

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❑ **Procedure**

  ▪ wash two burettes with D. W. and the titrant (HCl solution for the first one; and NaOH solution for the second one)

  ▪ fill the first one with $N/2$ HCl solution and the other with $N/1$ NaOH solution to a level (adjust them)

  ▪ put 10 mL of your unknown borax solution in a clean conical flask

  ▪ add 10 mL of D. W.

  ▪ add 2 drops of methyl red solution

  ▪ start the first titration by adding $N/2$ HCl drop wise with shaking until the colour chnages from yellow (pH=6) to pink (pH=4.4)

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❑ **<u>Procedure</u>**

▪ **boil the titration liquid to expell the generated carbon dioxide (if any) and cool. If the colour changes back into yellow, resume titration with HCl until you get the pink colour**
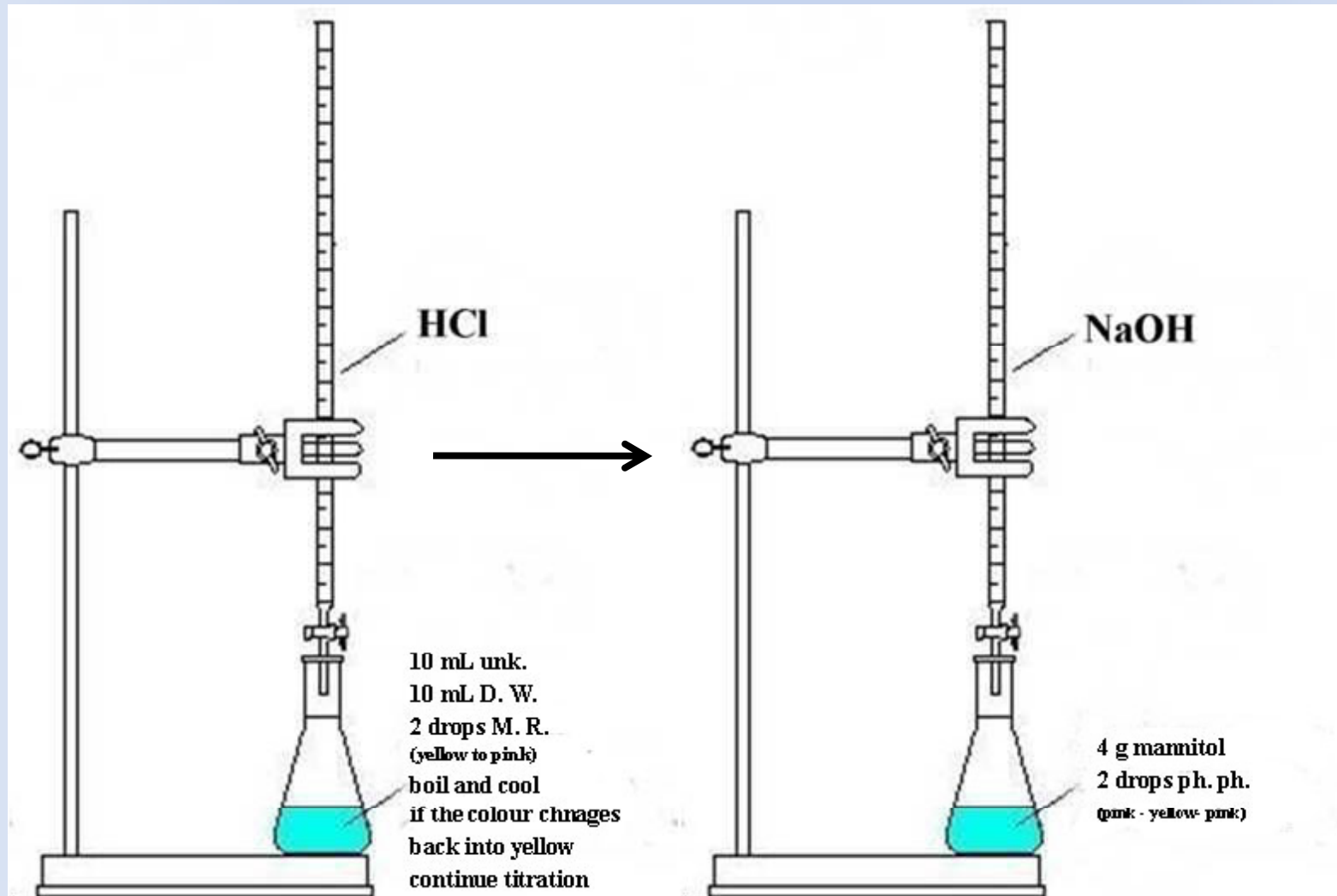
▪ **record the volume of HCl used**

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❑ **Procedure**

▪add 4 gm of mannitol and 2 drops of phenolphthalein solution (pH=8.2, colourless; pH-10, pink)
▪ start the second titration by adding N/1 NaOH solution drop wise with shaking until the solution changes from pink to yellow and then to pink again
▪record the volume of NaOH solution used

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HCl

10 mL unk.
10 mL D. W.
2 drops M. R.
(yellow to pink)
boil and cool
if the colour chnages
back into yellow
continue titration

NaOH

4 g mannitol
2 drops ph. ph.
(pink - yellow- pink)

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❑ **Discussion**

The solution of the first titration should be boiled after the end point to expell carbon dioxide generated (if sodium carbonate is present):

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

This is to prevent the formation of carbonic acid which may affect the result of the second titration with sodium hydroxide solution.

Mannitol is added in excess quantity to prevent backword hydrolysis of mannityl boric acid complex.

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❑ **Results and calculations**

Note *You must correct the volumes of both HCl and NaOH solutions into the specified normalites*

V_1 is the volume of $N/2$ HCl solution consumed (by borax and sodium carbonate if present)

V_2 is the volume of $N/1$ NaOH solution consumed (by liberated boric acid and contaminat boric acid if present)

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❑ **<u>Results and calculations</u>**

1. Both volumes of *N*/2 HCl solution consumed and *N*/1 NaOH solution consumed are equal:

$$V_1 = V_2$$

   then the sample of borax is pure.

Sometimes a difference of not more than 0.3 mL between the two volumes is allowed. In this case use the average.

Calculate the weight and percentage w/v of borax in your sample.

Each 0.09535 gm of borax is equivalent to 1 mL of *N*/2 HCl solution

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❑ **Results and calculations**

2. The volume of $N/2$ HCl solution consumed is more than the volume of $N/1$ NaOH solution consumed :

$$V_1 > V_2$$

then the sample of borax is impure and contains, in addition to borax, sodium carbonate.

$V_1 - V_2 =$ the volume of $N/2$ HCl solution consumed by sodium carbonate

Calculate the weights and percentages w/v of both borax and sodium carbonate in your sample.

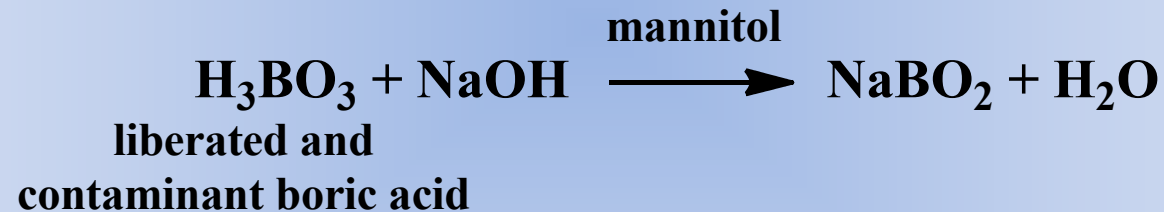Each 0.09535 gm of borax is equivalent to 1 mL of $N/1$ NaOH solution

Each 0.0265gm gm of sodium carbonateis equivalent to 1 mL of $N/2$ HCl solution

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❑ **Results and calculations**

3. The volume of $N/1$ NaOH solution consumed is more than the volume of $N/2$ HCl solution consumed :

$$V_2 > V_1$$

$$H_3BO_3 + NaOH \xrightarrow{\text{mannitol}} NaBO_2 + H_2O$$

liberated and contaminant boric acid

then the sample of borax is impure and contains, in addition to borax, boric acid.

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❑ **Results and calculations**

$V_2 - V_1$ = the volume of N/1 NaOH solution consumed by the contaminat boric acid

Calculate the weights and percentages w/v of both borax and contaminant boric acid in your sample.

Each 0.06184gm gm of boric acid is equivalent to 1 mL of N/1 NaOH solution

Each 0.09535 gm of borax is equivalent to 1 mL of N/2 HCl solution