Determine volumetrically, the value of 'n' i.e., the number of water molecules of crystallisation in washing soda $Na_2CO_3.nH_2O$, 7.0 g of which have been dissolved per litre of the given solution. Provided $\frac{M}{10}HCl$

Chemical Equation:

$$Na_2CO_3.nH_2O(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + (n+1)H_2O(l) + CO_2(g)$$

Indicator. Methyl orange.
End Point. Yellow to light pink (Acid in burette)

Procedure

1. Rinse and fill the burette with the standard HCl solution.
2. Rinse the pipette with the sodium carbonate solution and pipette out 20 ml of this solution in the titration flask.
3. Add 2-3 drops of methyl orange indicator to the titration flask. The colour of the solution becomes yellow.
4. Note the initial reading of the burette and run acid solution slowly in the titration flask till the solution becomes light pink.
5. Note the final reading of the burette and find out the volume of acid used.
6. Repeat the procedure 4-5 times to get a set of at least three concordant readings.

Observations

Molarity of given HCl solution = $\frac{M}{10}$

Volume of sodium carbonate solution taken for each titration = 20.0 ml

S.No.	Initial reading of the burette	Final reading of the burette	Volume of the acid solution used
1.	—	–	— ml
2.	—	—	— ml
3.	—	—	— ml
4.	—	—	— ml

Concordant volume = x ml (say).

Calculations

The molarity of standard HCl = 0.1 M

Since in the balanced equation two moles of HC1 react with one mole of $Na_2C0_3.nH_20$.

$$\frac{M_{HCl} \times V_{HCl}}{M_{Na_2CO_3} \times V_{Na_2CO_3}} == \frac{2}{1}$$

$$\frac{0.1 \times x}{M_{Na_2CO_3} \times 20.0} = \frac{2}{1}$$

$$M_{Na_2CO_3} = \frac{1 \times x \times 0.1}{2 \times 20.0} = \frac{x}{400}$$

$$M_{Na_2CO_3} = \frac{Streanth \quad per \quad litre}{Molar \quad mass \quad of \quad Na_2CO_3.nH_2O}$$

$$Molar \quad mass \quad of \quad Na_2CO_3.nH_2O = \frac{Streanth \quad per \quad litre}{M_{Na_2CO_3}}$$

$$= \frac{7.0}{\frac{x}{400}} \quad gmol^{-1}$$

But molar mass of hydrated sodium carbonate = (106 + 18n) g mol^{-1}

therefore,

$$\frac{7.0}{\frac{x}{400}} = 108 + 18n$$

Knowing the titre value, x, the value of n can be calculated.

Result

The number of the molecules of water of crystallisation in washing soda is …..
Note. The result is expressed as nearest whole number. The value of n is 10 in this case.