You are provided with the solution of a hydrogen carbonate of a monovalent alkali metal (M) with strength equal to 10.0 gms per litre. Find out the atomic mass of the metal (M).

Requirement

Standard solution of HCl (say M/10 HC1).

Theory

The formula of metal hydrogen carbonate is $MHCO_3$.

This will react with HCl according to the equation

$$MHCO_3(aq) + HCl(aq) \longrightarrow MCl(aq) + CO_2(g) + H_2O(l).$$

Molecular mass of MHCO3 = (M + 1 + 12 + 48) = (M + 61).
Knowing the molarity and strength (given), the molecular mass can be calculated

$$Molecular \quad Mass = \frac{Strength}{Molarity}$$

Molecular mass = M + 61
M = Molecular mass – 61.

Chemical Equation.

$$MHCO_3(aq) + HCl(aq) \longrightarrow MCl(aq) + CO_2(g) + H_2O(l).$$

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

Procedure

1. Rinse and fill the burette with the $\frac{M}{10}$ HCl solution.
2. Rinse the pipette with the solution of alkali metal hydrogen carbonate and pipette out 20 ml of this solution in a titration flask.
3. Add 2-3 drops of methyl orange indicator.
4. Note the initial reading of burette and run the acid solution in the titration flask slowly and with constant shaking until the end point (colour change from yellow to light pink) is reached.

5. Note the final reading of burette and find out the volume of $\frac{M}{10}$ HCl used.
6. Repeat the procedure 5-6 times to get a set of atleast three concordant readings.

Observations

Molarity of given HCl = $\frac{M}{10}$
Volume of alkali metal hydrogen 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

Let the molarity of the standard HCl be = 0.1 M.

From the balanced chemical equation, it is clear that one mole of HCl reacts with one mole of metal hydrogen carbonate.

$$\frac{0.1 \times x}{M_{MHCO_3} \times 20.0} = \frac{1}{1}$$

$MHCO_3$ (Molarity of alkali metal hydrogen carbonate solution)

$= \frac{0.1 \times x}{20} = \frac{x}{200}$

since, $Molarity = \frac{Strength \quad per \quad litre}{Molar \quad mass}$

Molar mass of $MHCO_3$

$= \frac{10}{\frac{x}{200}}$

$= X \quad g \quad mol^{-1}$

But molar mass of $MHC0_3$ = (Atomic mass of alkali metal + 61) g mol^{-1}

Atomic mass of alkali metal = Molecular mass of $MHCO_a$ – 61

= X – 61.