2025 Ch H2 Q11

Section: Chemistry in Society
Topic: Getting the Most from Reactants

Question Summary:
The question asks how the mass of sodium hydrogencarbonate in an indigestion tablet could be determined experimentally, based on its thermal decomposition and its reaction with acids.

Worked Solution

Sodium hydrogencarbonate decomposes on heating to produce CO_2 gas, and it also reacts with acids to produce CO_2. Either process can be used to determine the mass of $NaHCO_3$ in a tablet.

One suitable experimental method is as follows:
- Crush the indigestion tablet and add it to an excess of dilute acid in a conical flask.
- The hydrogencarbonate ions react with hydrogen ions to form CO_2 gas and water.
- Collect the CO_2 released using a gas syringe, or measure the mass lost from the flask as CO_2 escapes.
- From the measured volume (or mass loss), calculate the number of moles of CO_2 produced.
- Using the reaction relationship $HCO_3^- + H^+ \rightarrow H_2O + CO_2$, the moles of CO_2 equal the moles of $NaHCO_3$.
- Multiply the moles of $NaHCO_3$ by its gram formula mass to obtain the mass in the tablet.

An alternative method is to heat the tablet gently to decompose $NaHCO_3$ and measure the mass loss. Since CO_2 and H_2O are released, the mass lost corresponds to gaseous products. Using stoichiometry, the initial mass of $NaHCO_3$ can be calculated.

Revision Tips

- Gas syringes or mass-loss methods are standard in determining amounts of gas-producing reactants.
- Always relate moles of gas collected to moles of reactant using the balanced equation.
- Ensure excess acid is used so that $NaHCO_3$ is the limiting reactant.