Marks

- Solid sodium hydroxide reacts with carbon dioxide to produce sodium carbonate and water. Calculate the mass of sodium hydroxide required to prepare 53.0 g of sodium carbonate.

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The chemical reaction is:

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

The molar mass of Na_2CO_3 is:

$$\text{molar mass} = (2 \times 22.99\ (Na)) + 12.01\ (C) + (3 \times 16.00\ (O))) = 105.99\ \text{g mol}^{-1}$$

The number of moles of this in 53 g is therefore:

$$\text{number of moles} = \frac{\text{mass (in g)}}{\text{molar mass (in g mol}^{-1})} = \frac{53.0}{105.99}\ \text{mol} = 0.50\ \text{mol}$$

For every 1 mole of Na_2CO_3 produced, 2 moles of NaOH are required. To make 0.50 mol therefore requires 1.00 mol of NaOH. The molar mass of NaOH is:

$$\text{molar mass} = 22.99\ (Na) + 16.00\ (O) + 1.008\ (H) = 39.998\ \text{g mol}^{-1}$$

As 1.00 mol is required, the mass required is 40.0 g.

Answer: **40.0 g**

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- Analysis of an unknown compound returned the following percentage composition by weight:

  nitrogen: 26.2%; chlorine: 66.4% hydrogen 7.5%

  What is the empirical formula of this compound?

	N	**Cl**	**H**
amount in 100 g	**26.2**	**66.4**	**7.5**
ratio (divide by atomic mass)	$\frac{26.2}{14.01} = 1.87$	$\frac{66.4}{35.45} = 1.87$	$\frac{7.5}{1.08} = 7.44$
divide by smallest	$\frac{1.87}{1.87} = 1.00 \sim 1$	$\frac{1.87}{1.87} = 1.00 \sim 1$	$\frac{7.44}{1.87} = 3.98 \sim 4$

Answer: **$NClH_4$**