A cook is baking a small cake. It needs 500 cm^3 (at STP) of CO_2 to make the cake rise. The cook decides to add baking powder which contains sodium bicarbonate.
This generates CO_2 by thermal decomposition. $2NaHCO_3 \rightarrow CO_2 + Na_2CO_3 + H_2O$. What mass of baking powder must be added to the cake mixture?

Solution:

Let's find amount of moles for this volume of CO_2:

$n(CO_2) = \frac{V(CO_2)}{V_m} = \frac{0.5\ L}{22.71\ L/mol} = 0.022$ mol

(Where V_m – molar volume, V – volume of gas in liters).

(**Note:** Molar volume – volume of 1 mole of any gas at STP.)

Since coefficients ratio in equation for $NaHCO_3$ and CO_2 is 2:1, we are making a conclusion, that amount of moles of $NaHCO_3$ in reaction is twice times bigger than amount of moles of CO_2. Then, $n(NaHCO_3) = 2\ n(CO_2) = 0.022*2 = 0.044$ mol.

Now we know number of moles for $NaHCO_3$ and we can calculate its mass:

$m(NaHCO_3) = n(NaHCO_3) * M(NaHCO_3) = 0.044$ mol * (23+1+12+16*3) g/mol = 0.044 mol * 84 g/mol = 3.696 g.

(Where M – molar mass in grams per mole).

Answer:

The amount of baking powder that must be added to the cake mixture is 3.696 grams, which approximately equal to 3.7 g.