

Using Stoichiometry in Simple Chemistry Experiments

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November 2020

Practical Problem: It was decided to inflate a common latex balloon to 5cm radius by the hydrogen gas produced during a single-displacement reaction: $2\text{HCl(aq)} + \text{Zn(s)} \longrightarrow \text{ZnCl}_2\text{(s)} + \text{H}_2\text{(g)}$ that uses an $N/10$ i.e. 0.1M HCl solution (available in many drugstores, typically in 200ml bottles). How much reactants are needed?

Solution: We need to inflate the balloon to about 5cm radius. Assuming the balloon to be a sphere gives us the volume of balloon, V_b , as: $V_b = \frac{4}{3} \cdot \pi r^3 \text{cm}^3 = 523.599 \text{cm}^3$.

Assuming the density of hydrogen¹ at STP as $0.0000899 \text{g cm}^{-3}$, the mass of hydrogen is $523.599 \times 0.0000899 \text{g} = 0.0471 \text{g}$. Since 1mol of $\text{H}_2\text{(g)}$ has a mass of $2 \times 1.008 \text{g} = 2.016 \text{g}$, we need $\frac{0.0471}{2.016} \text{mol} = 0.0233 \text{mol H}_2\text{(g)}$.

Balancing the reaction, $2\text{HCl(aq)} + \text{Zn(s)} \longrightarrow \text{ZnCl}_2\text{(s)} + \text{H}_2\text{(g)}$, we see that to produce 1mol $\text{H}_2\text{(g)}$ we need 2mol HCl(aq) and 1mol Zn(s) .

This means that to produce 0.0233mol $\text{H}_2\text{(g)}$ we need $2 \times 0.0233 \text{mol} = 0.0466 \text{mol HCl(aq)}$. We have a 0.1M HCl (aqueous) solution which means that $\frac{\text{mol of solute}}{\text{litres of solution}} = 0.1$. Clearly, we need $\frac{0.0466}{0.1} = 0.466 \text{L}$ or **466ml HCl**.

The amount of zinc needed = $0.0233 \times \text{molar mass of zinc} = 0.0233 \times 65.38 \text{g} = \mathbf{1.523 \text{g}}$.

¹See <https://ptable.com/#Properties/Weight>

Author wishes to thank Apoorv Mhaswade and Rujuta Mhaswade for verifying the correctness of the calculations

See [Chemistry Stack Exchange](#) for a discussion