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Subject: Chemistry

Topic: Neutralization Reactions

Given and Introduction

To determine the volume of 0.160 M KOH required to completely neutralize 55.0 mL of 0.170 M HClO<sub>4</sub>, utilize the concept of molarity and the stoichiometry of the reaction between KOH and HClO<sub>4</sub>.

Step-by-Step Solution

Step 1: Write the balanced chemical equation for the reaction



Explanation: The reaction shows that one mole of KOH reacts with one mole of HClO<sub>4</sub> to form potassium perchlorate (KClO<sub>4</sub>) and water (H<sub>2</sub>O).

Supporting Statement: Writing the balanced chemical equation is essential to understand the mole ratio between reactants.

Step 2: Calculate the moles of HClO<sub>4</sub> in the given solution

Moles of HClO<sub>4</sub> = Molarity of HClO<sub>4</sub> × Volume of HClO<sub>4</sub>  
Convert the volume of HClO<sub>4</sub> from mL to L:  
Volume in Liters = 55.0 mL × (1 L / 1000 mL) = 0.055 L  
Calculate the moles:  
Moles of HClO<sub>4</sub> = 0.170 M × 0.055 L = 0.00935 moles

Explanation: The number of moles of HClO<sub>4</sub> is determined using the given molarity and converted volume.

Supporting Statement: Knowing the exact number of moles helps in determining the moles of KOH required for neutralization.

Step 3: Determine the moles of KOH required for neutralization

Since the reaction is a 1:1 mole ratio from the balanced chemical equation:  
Moles of KOH required = Moles of HClO<sub>4</sub> = 0.00935 moles

Explanation: The mole ratio is 1:1, so the moles of KOH required are equal to the moles of HClO<sub>4</sub>.

Supporting Statement: Utilizing mole ratios from the balanced equation guarantees that the reaction proportions are accurate.

Step 4: Calculate the volume of 0.160 M KOH needed

Volume of KOH (L) = Moles of KOH / Molarity of KOH  
Volume of KOH (L) = 0.00935 moles / 0.160 M = 0.0584375 L  
Converting Liters to mL:  
Volume of KOH (mL) = 0.0584375 L × 1000 mL/L = 58.4375 mL

Explanation: By dividing the moles of KOH by its molarity, the required volume in liters is found, followed by conversion to milliliters for practical use.

Supporting Statement: Calculating volume in liters and converting ensures the quantity of KOH solution measured matches laboratory standards.

Final Solution

To completely neutralize 55.0 mL of 0.170 M HClO<sub>4</sub>, 58.4 mL of 0.160 M KOH is required.

Explanation: The calculated volume of 58.4 mL is rounded to a reasonable precision point considering the significant figures in the given data.

Rechecking

- 1. Moles of HClO<sub>4</sub> = 0.170 M × 0.055 L = 0.00935 moles (verified)
- 2. Moles of KOH needed = 0.00935 moles (verified)
- 3. Volume of KOH required = 0.00935 moles / 0.160 M = 0.0584375 L = 58.4375 mL ≈ 58.4 mL (verified)

Thus, the calculations are confirmed accurate, providing a comprehensive and precise solution to the problem.

