CheggSolutions - Thegdp

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## Subject: Chemistry - Acid-Base Equilibrium

### Problem Summary:

A tank contains 8400 m³ of wastewater with a pOH of 10.5. The goal is to adjust the pH to 9.0. It is necessary to determine which solution and how many liters should be added to the tank from given samples of NaCl (1.6 M), $Ba(OH)_2$ (2 M), and HCl (0.8 M).

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### Step-by-Step Solution:

#### Step 1: Understanding the given data and target conditions

- Initial pOH of wastewater = 10.5
- Target pH of wastewater = 9.0
- Volume of wastewater V = 8400 m³ = 8400 x 1000 L = 8,400,000 L (since 1 m³ = 1000 L)

Supporting statement: The aim is to calculate the volume of solution needed to alter the pH of the wastewater.

#### Step 2: Determine pOH from the target pH

Using the relationship $pH + pOH = 14$,

$pOH = 14 - pH = 14 - 9 = 5$

Supporting statement: Calculation of target pOH from the given pH value of 9.

#### Step 3: Calculate the initial and target $[OH^-]$ concentrations

Using $\text{pOH}$ to find $[OH^-]$:

$$[OH^-]_{\text{initial}} = 10^{-\text{pOH}} = 10^{-10.5}$$

$$[OH^-]_{\text{target}} = 10^{-\text{pOH}} = 10^{-5}$$

Supporting statement: Conversion of pOH values to hydroxide ion concentration.

#### Step 4: Conversion of concentrations to molarity

- $[OH^-]_{\text{initial}} = 10^{-10.5} \approx 3.16 \times 10^{-11}$
- $[OH^-]_{\text{target}} = 10^{-5} = 1 \times 10^{-5}$

Supporting statement: Determination of molar concentrations for both initial and target solutions.

#### Step 5: Calculate moles of $OH^-$ in the target solution

For the target $OH^-$:

$$\text{Moles of } OH^-_{\text{target}} = [OH^-]_{\text{target}} \times V$$

$$= 1 \times 10^{-5} \text{ mol/L} \times 8,400,000 \text{ L} = 84 \text{ mol}$$

Supporting statement: Calculation of moles of $OH^-$ required to achieve the target pOH.

#### Step 6: Calculate required moles of $OH^-$ to add

Required moles of $OH^-$ to add:

$$\Delta OH^- = \text{Moles of } OH^-_{\text{target}} - \text{Moles of } OH^-_{\text{initial}}$$

Initial moles of $OH^-$:

$$\text{Moles of } OH^-_{\text{initial}} = 3.16 \times 10^{-11} \text{ mol/L} \times 8,400,000 \text{ L} \approx 2.65 \times 10^{-4} \text{ mol}$$

Therefore:

$$\Delta OH^- \approx 84 \text{ mol} - 2.65 \times 10^{-4} \text{ mol} \approx 84 \text{ mol}$$

Supporting statement: Calculation of additional moles of $OH^-$ needed to achieve target concentration.

#### Step 7: Select the appropriate solution and its volume

Use $Ba(OH)_2$ because it provides $OH^-$ ions.
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Given:

$$ M_{Ba(OH)_2} = 2 \text{ M} $$

Each mole of $Ba(OH)_2$ provides 2 moles of OH^-:

$$ \text{Moles of } Ba(OH)_2 = \frac{\Delta OH^-}{2} = \frac{84}{2} = 42 \text{ mol} $$

$$ V_{\text{required}} = \frac{\text{Moles of } Ba(OH)_2}{M_{Ba(OH)_2}} = \frac{42}{2} = 21 \text{ L} $$

Supporting statement: Calculation of required volume of $Ba(OH)_2$ solution to add for desired OH^- concentration.

Final Solution:

To adjust the pH of the tank to 9.0, 21 litres of 2 M $Ba(OH)_2$ solution should be added to the tank.

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