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SOLUTION CONCENTRATION

1. Percentage concentration from mass

Problem. A sodium hydrogen carbonate solution is prepared by dissolving 50 g of $NaHCO_3$ in water and making up to a final volume of 1000 mL. Calculate its % (w/v) concentration.

Calculation. % (w/v) = mass of solute (g) ÷ final volume (mL) × 100

= 50 g ÷ 1000 mL × 100 = 5 % (w/v)

ANSWER **The concentration of $NaHCO_3$ is 5 % (w/v).**

2. Mass needed for a percentage solution

Problem. Prepare 15 mL of a 0.5% (w/v) fluorescein solution using fluorescein powder. Calculate the mass required.

Calculation. 0.5% (w/v) means 0.5 g of solute in 100 mL of final solution.

0,5 g - 100 mL

m - 15 mL

m = (0.5 g × 15 mL) ÷ 100 mL) = 0.075 g = 75 mg

ANSWER **Weigh 0.075 g (75 mg) of fluorescein, transfer to a suitably calibrated small-volume vessel, add 15 mL of water and mix thoroughly.**

3. Preparing a molar solution

Problem. Prepare 300 mL of 0.1 mol/dm³ $KMnO_4$ (a) from a solid or (b) from a 0.5 mol/ dm³ stock solution. Calculate the required amounts. Use M($KMnO_4$) = 158 g/mol.

Calculation A — from a solid. Use n = C × V, then m = n × M.

n = 0.1 mol/ dm³ × 0.3 dm³ = 0.03 mol

m = 0.03 mol × 158 g/mol = 4.74 g

Calculation B — from a stock. Use $C_1V_1 = C_2V_2$.

V_1 = (0.1 mol/L × 300 mL) ÷ 0.5 mol/L = 60 mL

ANSWER **(a) Weigh 4.74 g $KMnO_4$, dissolve in some distilled water, transfer quantitatively to a calibrated container and add water to the calibration mark to obtain final volume of 300 mL. Mix.**
(b) Measure 60 mL of the 0.5 mol/ dm³ stock solution, transfer it to a calibrated container, dilute to a FINAL volume of 300 mL with distilled water and mix.

4. Diluting hydrogen peroxide

Problem. Prepare 150 mL of a 3% (w/v) H_2O_2 solution from a 30% (w/v) H_2O_2 stock solution. Find the volume of stock required.

Calculation. Use $C_1V_1 = C_2V_2$.

V_1 = (3% × 150 mL) ÷ 30% = 15 mL

Water: add enough to reach 150 mL total (approximately 135 mL under the stated assumption).

ANSWER **Measure 15 mL of the 30% stock using suitable equipment. Transfer to a calibrated vessel, add distilled water to a FINAL volume of 150 mL and mix.**

5. Calculating molarity and pH after dilution

Problem. To 20 mL of a 2% (w/v) NaOH solution, 80 mL of water is added. Calculate the molar concentration and theoretical pH of the resulting solution. Use M(NaOH) = 40.0 g/mol; assume that the temperature is 25° C.

Calculation. A 2% (w/v) solution contains 2 g NaOH per 100 mL of solution. First calculate the mass and number of moles of NaOH in the 20-mL sample.

m(NaOH) = (2.0 g / 100 mL) × 20.0 mL = 0.4 g

n(NaOH) = m / M = 0.4 g / (40 g/mol) = 0.01 mol

V(final) = 20 mL + 80 mL = 100 mL = 0.1 L

c(NaOH) = n / V = 0.01 mol / 0.1 L = 0.1 mol/L

Calculating pH: NaOH is a strong base and dissociates completely: $NaOH \rightarrow Na^+ + OH^-$. Therefore, $[OH^-] = 0.1$ mol/L.

$pOH = -\log_{10}[OH^-] = -\log_{10}(0.1) = 1$

pH = 14 − pOH = 14 − 1 = 13

ANSWER **Molar concentration of NaOH is 0.1 mol/L, and theoretical pH = 13.**