Answer on Question #39041-Chemistry-Organic Chemistry

Question

A solution is prepared by dissolving 400 g of NaOH in water and then diluting to one liter. The density of the resulting solution is 1.31 g/ml. Express the concentration of NaOH as
(a) percentage by weight
(b) molarity
(c) normalty
(d) molality

Solution

Given:
m = 400 g – mass of the solute,
V = 1L = 1000 mL – volume of the solution,
ρ = 1.31 g/ml – density of the solution,
M = 40.0 g/mol – molar mass of the solute.

(a) Mass of the solution: $m_s = V \cdot \rho = 1000 \cdot 1.31 = 1310\ g = 1.31\ kg$
Percentage by weight:

$$wt.\% = \frac{m}{m_s}100\% = \frac{400 \cdot 100}{1310} = 30.5\ \%_{by\ wt.}$$

(b) Molarity:

$$C_M = \frac{n}{V} = \frac{m}{M \cdot V} = \frac{400}{40.0 \cdot 1} = 10\ M$$

(c) Equivalence factor for NaOH – f_{eq} = 1, so the normality:

$$C_N = \frac{C_M}{f_{eq}} = \frac{10}{1} = 10\ N$$

(d) Mass of solvent:

$$m_{sol} = m_s - m = 1310 - 400 = 910\ g = 0.91\ kg$$

Molality:

$$b = \frac{n}{m_{sol}} = \frac{m}{M \cdot m_{sol}} = \frac{400}{40.0 \cdot 0.91} = 11.0\ mol/kg$$

Answer: (a) 30.5 $\%_{by\ wt.}$, (b) 10 M, (c) 10 N, (d) 11.0 mol/kg.