A solution of NaOH (molar mass 40 g mol-1) is prepared by dissolving 1.6g of NaOH in 500cm cube of water. Calculate molarity (M) of the solution.

Solution.

Find the mass of water (assume temperature 20 ^{0}C):

$$m_{H_2O} = \rho_{H_2O} * V_{H_2O} = \ 0.9982 * 500 = 499.1 \text{ g};$$

Find the total mass of the solution:

$$m_{sol} = \ m_{NaOH} + m_{H_2O} = 1.6 + 499.1 = 500.7 \ \text{ g};$$

Find the mass percentage of NaOH in solution:

$$w_{NaOH} = \frac{m_{NaOH}}{m_{sol}} * 100\% = \frac{1.6}{500.7} * 100\% = 0.32\%;$$

The density of the solution of such concentration is 1,0015 g/cm^3(assume temperature 20 ^{0}C).

Find the solution volume:

$$V_{sol} = \frac{m_{sol}}{\rho_{sol}} = \frac{500.7}{1.0015} = 499.95 \text{ cm}^3 = \ 0.49995 \text{ liter};$$

Find the number of moles for NaOH:

$$N_{NaOH} = \frac{m_{NaOH}}{M_{NaOH}} = \ \frac{1.6}{40} = 0.04 \text{ moles};$$

Find the molarity of the solution:

$$M(NaOH\ solution) = \ \frac{N_{NaOH}}{V_{sol}} = \frac{0.04}{0.49995} = 0.08 \text{ moles per liter};$$

Answer: the molarity of the solution is **0.08 moles per liter**.

Note that you can get almost the same result by applying simpler approach, which involves simplifications and doesn't require table values. Let's see.

Assume that the volume of solution is equal to the water volume:

$$V_{sol} = V_{H_2O} = 500 \text{ cm}^3 = 0.50 \text{ liter};$$

Find the number of moles for NaOH:

$$N_{NaOH} = \frac{m_{NaOH}}{M_{NaOH}} = \ \frac{1.6}{40} = 0.04 \text{ moles};$$

Find the molarity of the solution:

$$\text{M}(NaOH\ solution) = \ \frac{N_{NaOH}}{V_{sol}} = \frac{N_{NaOH}}{V_{H_2O}} = \frac{0.04}{0.50} = 0.08 \text{ moles per liter};$$

Answer: the molarity of the solution is **0.08 moles per liter**.