C. MAKING DILUTE SOLUTIONS FROM CONCENTRATED SOLUTIONS

Again, this calculation is based on the fact that the moles of chemical in the diluted solution equals the moles of chemical poured from the concentrated solution. That is, $n_{CONC} = n_{DIL}$.

$$c_{CONC} \times V_{CONC} = c_{DIL} \times V_{DIL}$$

EXAMPLE: **What volume of 6.00 M HCl is used in making up 2.00 L of 0.125 M HCl?**

The equation: $c_{CONC} \times V_{CONC} = c_{DIL} \times V_{DIL}$

is rearranged to solve for the volume of concentrated solution required.

$$V_{CONC} = \frac{c_{DIL} \times V_{DIL}}{c_{CONC}} = \frac{0.125\ M \times 2.00\ L}{6.00\ M} = \mathbf{0.0417\ L}$$

EXAMPLE: **A student mixes 100.0 mL of water with 25.0 mL of a sodium chloride solution having an unknown concentration. If the student finds the molarity of the sodium chloride in the diluted solution is 0.0876 M, what is the molarity of the original sodium chloride solution?**

The diluted volume is 100.0 mL + 25.0 mL = 125.0 mL

Therefore $c_{CONC} = c_{DIL} \times \frac{V_{DIL}}{V_{CONC}} = 0.0876\ M \times \frac{125.0\ mL}{25.0\ mL} = \mathbf{0.438\ M}$

EXERCISES:

78. If 20.0 mL of 0.75 M HBr is diluted to a total volume of 90.0 mL, what is the molar concentration of the HBr in the resulting solution?
79. What is the molar concentration of the KOH solution resulting from mixing 55 mL of 0.15 M KOH and 75 mL of 0.25 M KOH?
80. If 1 drop (0.050 mL) of 0.20 M NaBr is added to 100.00 mL of water, what is the molarity of the NaBr in the resulting solution?
81. What is the molar concentration of the HNO_3 solution resulting from mixing 5.0 mL of 3.5 M HNO_3 and 95 mL of 0.20 M HNO_3?
82. Concentrated HNO_3 is 15.4 M. How would you prepare 2.50 L of 0.375 M HNO_3?
83. Concentrated H_3PO_4 is 14.6 M. How would you prepare 45.0 L of 0.0600 M H_3PO_4?
84. If 300.0 mL of solution A contains 25.0 g of KCl and 250.0 mL of solution B contains 60.0 g of KCl, what is the molarity of the KCl in the solution resulting from mixing solutions A and B?
85. If 500.0 mL of 0.750 M NaCl is boiled down until the final volume is reduced to 300.0 mL, what is the final molarity of the NaCl? (Assume no salt is lost during the boiling process.)
86. How would you prepare 250.0 mL of 0.350 M HCl, starting with 6.00 M HCl?
87. What mass of NaCl is needed to prepare 500.0 mL of 0.400 M NaCl?
88. What is the concentration of the NaOH solution produced by mixing 125.0 mL of 0.250 M NaOH with 200.0 mL of 0.175 M NaOH?
89. What volume of 12.0 M NaOH is required in order to prepare 3.00 L of 0.750 M NaOH?
90. What is the concentration of $CaCl_2$ produced when 55.0 mL of 0.300 M HCl is mixed with 80.0 mL of 0.550 M $CaCl_2$?

91. When 350.0 mL of 0.250 M $MgCl_2$ is boiled down to a final volume of 275.0 mL, what is the molarity of the $MgCl_2$ in the resulting solution?

92. If 20.0 mL of 0.350 M NaCl and 75.0 mL of 0.875 M NaCl are mixed and the resulting solution is boiled down to a volume of 60.0 mL, what is the molarity of the NaCl in the final solution?

93. A solution is made by mixing 100.0 mL of 0.200 M $BaCl_2$ and 150.0 mL of 0.400 M NaCl. What is the concentration of sodium chloride in the final solution?

94. If 75.0 mL of 0.200 M Na_3PO_4 is added to 25.0 mL of 0.800 M K_3PO_4, what is the concentration of Na_3PO_4 in the mixture?

AN OVERVIEW OF MOLARITY PROBLEMS

The 5 basic types of molarity problems and the equations relevant to the problems are shown below.

A. Making a solution with a given concentration

$$c = \frac{n}{V}, \quad \text{where} \quad n = \text{mass (g)} \times \frac{1 \text{ mol}}{\text{molar mass (g)}}$$

You may also be given moles (or mass) and concentration, and be asked to find the volume, or some variation of this problem.

B. Dilution of a single solution

$$c_{DIL} = c_{CONC} \times \frac{V_{CONC}}{V_{DIL}}$$

C. Mixing two solutions

$$c_{DIL}(\#1) = c_{CONC}(\#1) \times \frac{V_{CONC}(\#1)}{V_{DIL}} \quad \text{and} \quad c_{DIL}(\#2) = c_{CONC}(\#2) \times \frac{V_{CONC}(\#2)}{V_{DIL}}$$

$$c\,(\text{total}) = c_{DIL}(\#1) + c_{DIL}(\#2)$$

D. Converting a density to a molarity and vice versa

$$c = d\frac{(\text{g})}{(\text{L})} \times \frac{1 \text{ mol}}{\text{molar mass (g)}} \quad \text{and} \quad d = c\frac{(\text{mol})}{(\text{L})} \times \frac{\text{molar mass (g)}}{1 \text{ mol}}$$

E. Making a dilute solution from a concentrated solution

$$c_{CONC} \times V_{CONC} = c_{DIL} \times V_{DIL}$$

(Note that this is essentially the same as type B, above.)

MOLARITY REVIEW PROBLEMS

95. What is the molarity of each of the following solutions?
    (a) 5.62 g of $NaHCO_3$ is dissolved in enough water to make 250.0 mL
    (b) 184.6 mg of K_2CrO_4 is dissolved in enough water to make 500.0 mL
    (c) 0.584 g of oxalic acid ($H_2C_2O_4$) is diluted to 100.0 mL

96. What is the actual experimental procedure you would use to make
    (a) 1.00 L of 0.100 M NaCl, starting with solid NaCl?
    (b) 250.0 mL of 0.09000 M KBr, starting with solid KBr?
    (c) 500.0 mL of 0.125 M $Ca(NO_3)_2$, starting with solid $Ca(NO_3)_2{\cdot}3H_2O$?