Solutions – Molarity, Molality, and Dilutions

Example #1: What is the molarity if 25.0 g of sodium nitrate, NaNO₃, is dissolved 400.0 mL of solution?

\[ N = \frac{m}{M} = \frac{25.0}{85.0} = 0.294 \text{ mol} \]

\[ M = \frac{n}{V} = \frac{0.294}{0.400} = 0.735 \text{ mol/L} \]

Example #2: What volume (in mL) of 1.15 M potassium sulfate solution can be prepared using 75.0 g of K₂SO₄?

\[ N = \frac{m}{M} = \frac{75.0}{174.26} = 0.430 \text{ mol} \]

\[ V = \frac{n}{M} = \frac{0.430}{1.15} = 0.324 \text{ L} = 324 \text{ mL} \]

Example #3: What mass (in grams) of magnesium chloride is in 825 mL of a 1.50 M MgCl₂ solution.

\[ n = MV = 1.50(0.825) = 1.24 \text{ mol} \]

\[ m = FM(n) = 95.21(1.24) = 118 \text{ g} \]

Example #4: Calculate the molality when 35.0 g of ethyl alcohol, C₂H₅OH is dissolved in 1.25 kg of water.

\[ n = \frac{m}{M} = \frac{35.0}{46.08} = 0.761 \text{ mol} \]

\[ \text{molality} = \frac{n}{m} = \frac{0.761}{1.25} = 0.609 \text{ mol/kg} \]

Example #5: What mass (in grams) of sucrose, C₁₂H₂₂O₁₁, is present in a solution that contains 750.0 g of water and is 2.0 m?

\[ m = 0.750 \text{ kg} \]

\[ n = \text{molality (mass)} = 2.0(0.750) = 1.50 \text{ mol} \]

\[ m = FM(n) = 342.34(1.50) = 513 \text{ g} \]
Example #6: What mass of water (in grams) is present in a 1.75 m solution made with 65.0 g of urea (NH₂CONH₂)

\[ \text{FM(NH}_2\text{CONH}_2) = 60.07 \text{ g/mol} \]

\[ n = \frac{m}{\text{FM}} = \frac{65.0}{60.07} = 1.08 \text{ mol} \]

\[ m = \frac{n}{\text{molality}} = \frac{1.08}{1.75} = 0.619 \text{ kg} = 619 \text{ g} \]

Example #7: What is the new molarity if 250.0 mL of 0.500 M NaOH is diluted to 1.5 L?

\[ M_1V_1 = M_2V_2 \quad V_1 = 0.250 \text{ L} \quad 0.500(0.250) = M_2(1.5) \]

\[ M_2 = \frac{0.0833}{1.5} \text{ mol/L} \]

Example #8: What volume (in mL) of water must be added to 12.5 mL of concentrated HCl (12.0 M) to make a 0.250 M solution?

\[ M_1V_1 = M_2V_2 \quad V_1 = 0.0125 \text{ L} \quad 12.0(0.0125) = 0.250(V_2) \]

\[ V_2 = 0.600 \text{ L} = 600 \text{ mL} \]

\[ V_{\text{water}} = V_2 - V_1 = 600 - 12.5 = 588.5 \text{ mL} \]

Example #9: What volume (in mL) of concentrated H₂SO₄ (18.0 M) is needed to make 2.5 L of a 0.25 M solution?

\[ M_1V_1 = M_2V_2 \quad 18.0(V_1) = 0.25(2.5) \]

\[ V_1 = 0.0347 \text{ L} = 34.7 \text{ mL} \]
Solutions Homework

1. Find the molarity of a sol’n made by dissolving 44.2 g of ammonium sulfate, (NH₄)₂SO₄, in 600.0 mL of sol’n.
   0.557 M

2. What mass (in grams) of calcium nitrate, Ca(NO₃)₂, is present in 400.0 mL of a 0.150 M solution?
   9.85 g.

3. What volume (in mL) of a 3.00 M solution would contain 6.50 g of lithium silicate, Li₂SiO₃.
   24.1 mL

4. Find the mass(in grams) of potassium permanganate, KMnO₄, present in 2.50 L of a 2.00 M solution.
   790. g.

5. A 1.25 M sol’n was made using 65.0 g of aluminum chloride, AlCl₃. What volume (in mL) of sol’n was made?
   390. mL

6. A student dissolved 17.2 g of potassium phosphate, K₃PO₄, in 250.0 mL of solution. What was the molarity?
   0.324 M

7. How many grams of potassium iodide, KI, must be dissolved in 500.0 g of water to produce a 0.600 m solution?
   49.8 g.

8. A solution is prepared by dissolving 2.50 g of sodium chromate, Na₂CrO₄, in 23.2 g of water. Calculate the
   molality of the solution.
   0.665 mol/kg

9. What mass of water (in grams) must be added to 25.0 g of oxalic acid, H₂C₂O₄, to prepare a 2.50 m solution?
   111 g.

10. How many grams of glucose, C₆H₁₂O₆, are there in a 0.77 m glucose solution made with 450.0 g of water?
    62.4 g.

11. A solution contains 75.0 g of methyl alcohol, CH₃OH, dissolved in 600.0 g of water. What is the molality?
    3.9 mol/kg

12. What mass (in grams) of water must be used to make a 3.0 m solution of sucrose, C₁₂H₂₂O₁₁, if 15.0 g of
    sucrose is used?
    14.6 g.

13. What volume (in mL) of conc. nitric acid (HNO₃, 15.8 M) would be needed to make 100.0mL of 3.00M sol’n?
    19.0 mL

14. If 60.0 mL of water were added to 80.0 mL of a 0.500 M sodium carbonate, Na₂CO₃, solution, what would the
    final molarity be? (Hint – what is the total new volume?)
    0.286 M

15. What volume (in mL) of water would have to be added to 150.0 mL of 0.450 M potassium chloride, KCl, to
give a solution with a concentration of 0.100 M?
    525 mL