Chemical Calculations – 2

Binary Solution

A binary solution is a homogenous system which is in liquid state. One component here is a solute and other is the solvent.

The component with a higher number of mols is called the solvent and the other component is the solute.

Solute + Solvent = Solution

Concentration

This is the ratio that is used to express the amount of solute to the total amount of the solution. This is expressed in several forms.

1. As a mass fraction $\frac{w}{W}$
2. As a mass and volume fraction $\frac{w}{V}$
3. As a volume fraction $\frac{v}{V}$
4. As a mole fraction $\frac{n}{n_T}$
5. Molality $\frac{n}{m_{solvent}}$
6. Molarity $\frac{n}{V_{solution}}$

(1) As a mass fraction and a mass percentage.

$$mass\ fraction = \frac{w}{W} = \frac{mass\ of\ the\ solute}{mass\ of\ total\ system}$$

$$mass\ percentage = mass\ fraction\ \times\ 100\%$$

Mass fraction does not have units. Since the mass is independent of the temperature, mass fraction doesn't depend on the temperature as well.

(2) Mass-volume fraction and mass volume percentage

The ration of the mass of a solute to that of the total mass of the solution is called the mass-volume fraction

$$mass\ volumefraction = \frac{w}{V} = \frac{mass\ of\ the\ solute}{volume\ of\ the\ system}$$

$$mass\ volume\ percentage = mass\ volume\ fraction\ \times\ 100\%$$

As the volume depends on the temperature, mass-volume fraction depends on the temperature too. If solution with a lower concentration to be made starting with a solution with a larger concentration, The equation

$$C_1V_1 = C_2V_2$$

is used.

(3) Using volume fraction or a volume percentage. $\left(\frac{v}{V}\right)$

- This is the ratio of the volume of the solute to that of the total volume of the system.

$$volumefraction = \frac{v}{V} = \frac{volume\ of\ the\ solute}{volume\ of\ the\ system}$$

volume percentage = volume fraction ×100%

- No units and it will depend on the temperature.
- Since the mass fraction (w/W) and volume fraction (v/V) are very small numbers these are expresses using the units of (ppm) and (ppb). This is converted by multiplying by a bigger number.

Conversion to ppm (parts per million)

Parts per million (ppm) by mass = mass fraction × 10^6

Conversion to ppm (parts per million)

Parts per million (ppm) by volume = volume fraction × 10^6

(4) Expressing the concentration as a molar fraction or a molar percentage.

Molar fraction is the ratio of the number of mols of a certain component to that of the total number of mols in the system.

$$Molar\ fraction\ (X) = \frac{number\ of\ mols\ of\ the\ material}{total\ number\ of\ mols}$$

$$Molar\ percentage = molar\ fraction\ \times\ 100\%$$

Let's consider a mixture made of **A** and **B**. If the number of mols of **A** is n_A and number of mols of **B** is n_B,

$$X_A = \frac{n_A}{n_A + n_B} \qquad X_B = \frac{n_B}{n_A + n_B}$$

$$X_A + X_B = \frac{n_A + n_B}{n_A + n_B}$$

$$X_A + X_B = 1$$

$X_B = 1 - X_A$; $X_A = 1 - X_B$

Molar fraction doesn't have units and is independent of the temperature. Molar fraction cannot exceed 1.

Relationship between mols and molar fraction.

Let's consider a mixture made of **A** and **B**. If the number of mols of **A** is n_A and number of mols of **B** is n_B,

$$\frac{X_A}{X_B} = \frac{\frac{n_A}{n_A+n_B}}{\frac{n_B}{n_A+n_B}} = \frac{n_A}{n_B}$$

This relationship is extremely important in calculating mols percentages.

(5) Expressing the composition as the molality (*m*)

This is ratio of the number of mols of a solute to 1 kg mass of solute.

$$molality = \frac{mols\ of\ the\ solute}{mass\ of\ the\ solvent\ (1\ kg)}$$ Unit is mol kg^{-1}.

(6) Expressing the composition as the concentration (M)

§ This the ratio of the number of mols of a solute to the total volume of the solution in dm^3.

$$\text{Concentration} = \frac{mols\ of\ the\ solute\ (n)}{volume\ of\ the\ solution\ (V)} \qquad C = \frac{n}{V}$$

§ units of concentration is mol dm^{-3}, A solution with a concentration of 1 mol dm^{-3} is also called a 1 M solution.
§ Though the SI unit is mol m^{-3} a more practical unit is mol dm^{-3}.
§ Since the volume depends on the temperature, concentration is dependent of the temperature too.

Expressing the concentration in ppm or ppb.

§ If the concentrations are quite small, them ppm and ppb units are used to express the concentration of such solutions.

§ ppm is the amount of matter of a certain material present in million equal parts of the total matter. Accordingly, 1 ppm = 1 mg dm^{-3}

§ ppb is the amount of matter of a certain material present in billion equal parts of the total matter. Accordingly, 1 ppb = 1 μg dm^{-3}

Relationship of mol dm^{-3} and ppm

Calculations

1. A mixture of KOH and $Ca(OH)_2$ contain 0.2 mol of KOH. The mass of the mixture is 26 g. Calculate the mols of $Ca(OH)_2$ and its' mass fraction.

2. A mixture contains 0.04 mol of NaOH and 0.05 mol of Mg. Determine the mass fraction of NaOH and its' ppm value.

3. $(NH_4)_2SO_4$ is used as fertilizer at the initial stage of plant growth. Such a fertilizer bag weigh 50 kg and the N mass percentage is 20%. If 1 acre of land requires 400 kg of N, determine the number of bags of fertilizer to this land.

4. You are provided with 20 mL aqueous NaOH solution having 0.08 g cm^{-3} with respect to NaOH. This was completely dissolved in water to form solution of 100 mL. Calculate the mass-volume percentage of NaOH.

5. Calculate the volume of this solution (q4) required to form 20 mL of 0.2 (w/V%) NaOH solution.

6. a. An acetic acid solution has a 1:25 (w/V) fraction. Calculate the volume required to be measured to make 5 mL of 10% (w/V) CH_3COOH solution.

   b. Calculate the amount of NaOH in ppm in a mixture of 0.2 mol of NaOH and 0.4 mol of Na.

a. A NaOH solution has concentration of 4000 ppm by mass and total mass is 200 g. Calculate the number mols of pure NaOH.

7. A certain volume of NaOH was mixed to form a solution of 80 mL. The concentration of NaOH related to volume (mg L^{-1}) is 25×10^{2}. The amount of the NaOH in the aqueous solution is 0.08 g cm^{-3}. Density of water = 1 g cm^{-3}.

    a. Calculate the number of mols of NaOH.

    b. Calculate the mass fraction of NaOH and report it in ppm.

8. 1 liter of atmospheric gases contain 5×10^{-5} cm^3 of CO gas. Calculate the volume percentage of CO(g) and report it in ppm.

21. Xe is a noble gas present in the atmosphere in small quantitates. This amount is usually 0.076 ppm by volume. Calculate the volume of Xe in dm^3 if 1000 km^3 atmospheric sample is provided to you.

9. A mixture containing CO_2 and N_2 gases occupy a volume of 1.12 mL at STP. If the volume percentage of N_2 is 80%, then

    a. Calculate the number of mols of CO_2 at STP.

    b. Calculate the number of mols of N_2.

c. What is the volume of N_2 occupied at STP.

d. Calculate the molar fraction of N_2.

10. Molar fraction of methane is 0.4. 6.4 g of methane has been mixed with 14.4 g of gaseous Y.

a. Calculate the molecular mass of Y.

b. Calculate the volume of Y at STP.

c. Calculate the molar percentage of Y.

d. Calculate the mass percentage of Y.

11. a. A mixture containing Ca and Ag weigh 25 g. This mixture reacts with dil. HCl to form 8.96 mL of H_2 at STP. Calculate the mass percentage of Ag.

b. A certain CH_3COOH aqueous solution has a molar fraction of 0.8 for acetic acid. Calculate the mass percentage of acetic acid in this mixture.

08. a. 1.6 g of NaOH is dissolved in 200 mL of water. Calculate the molar fraction of NaOH if the density of water is 1 g cm^{-3}.

b. 20 mL of a glucose solution was mixed with 250 mL of water to form a new mixture of glucose. The molarity of glucose in the new mixture is 0.8 mol dm^{-3}. Calculate the number of mols of glucose and the mass to volume percentage of the initial glucose solution.

22. A $Ca(OH)_2$ solution has a molality of 0.2 mol kg^{-1}. If this solution is prepared by using 250 mL of water having 1 g cm^{-3}, calculate the $Ca(OH)_2$ dissolved.

Determining the concentration when masses are provided.

23. a. Calculate the molarity of the solution prepared by dissolving 2.96 g of $Ca(OH)_2$ in water and making up to 200 mL volume.

b. Calculate the concentration of NaOH in mol dm^{-3} and ppm when 2.4 g of NaOH is dissolved in water to form a solution of 250 mL.

c. Solution **A** was prepared by dissolving 3.2 g of NaOH in water to make up a volume of 100 mL. Solution **B** was made by pipetting 10 mL of solution **A** and making a volume of 50 mL. Final solution **C** was made by taking 20 mL of **B** and diluting up to 200 mL. Calculate the NaOH concentration of **C** in mol dm^{-3} and ppm.

d. The Glucose in a solution is 0.72 g cm^{-3}. 20 mL of this solution is mixed with 200 mL of water to form a new solution. Calculate the concentration of the new solution in mol dm^{-3} and report it in ppm.

e. HNO_3 vapor takes up a volume of 11.2 mL at STP. Calculate the concentration of the acid if this was dissolved to form a volume of 200 mL solution.

Determining the mass dissolved when the concentration is given.

24. (i) Calculate the mass of KOH present in 200 mL of 0.2 mol dm^{-3} aqueous solution of KOH.

(ii) Calculate the number of mols of NaOH present in 250 mL of 800 ppm NaOH solution.

(iii) You are provided with a 200 mL HCl solution of 365 ppm. This was prepared by mixing 20 mL of HCl in water, calculate the density of the initial HCl solution.

(iv) 200 g of a mixture containing NaOH and a water-soluble inert substance was dissolved in water to make 500 mL solution. 50 mL from this solution was taken out and a 100 mL solution was made by mixing water (Solution **S**). 20 mL of solution **S** was taken out to make another solution with a volume of 200 mL. If the last solution has 80 ppm concentration of NaOH, then calculate the percentage purity by mass of the initial sample.

Calculating the concentration of ionic solutions

11. 200 mL of 0.8 mol dm^{-3} Na_2CO_3 solution was provided. 10 mL of this solution was separated, and 50 mL of water was mixed. Calculate the concentration of Na^+ present in this solution. Calculate it in ppm too.

ii. Na_3PO_4 aqueous solution has a concentration of 0.4 mol dm^{-3}. 250 mL of this solution is provided to you. Calculate the concentration of Na^+ in ppm.

iii. 200 mL of a Na_2CO_3 solution is provided to you. Concentration of Na^+ in this solution is 460 ppm. Calculate the concentration of the initial solution and the density of Na_2CO_3.

iv. 200 mL of 0.1 mol dm^{-3} Na_2CO_3 and 100 mL of 0.2 mol dm^{-3} NaCl solutions were mixed. Calculate Na^+ concentration of the solution in ppm.

v. 200 mL of 0.04 mol dm^{-3} $NaNO_3$ and 50 mL of a $Mg(NO_3)_2$ with unknown concentration were mixed together. The resulting solution has a concentration of 12000 ppm for NO_3^-. Determine the $Mg(NO_3)_2$ concentration.

12. i. Calculate the CO_3^{2-} concentration in ppm when 200 mL of 0.04 mol dm^{-3} Na_2CO_3 and 200 mL of 0.06 mol dm^{-3} $Al_2(CO_3)_3$ are mixed.

ii. SO_4^{2-} concentration of $K_2SO_4.Cr_2(SO_4)_3.24H_2O$ hydrated salt is 0.2 mol dm^{-3}. Calculate the concentration of Cr^{3+} in this solution in ppm. (Cr= 52)

iii. Calculate the concentration of Na^+ of a solution formed mixing 100 mL of 0.2 mol dm^{-3} $Na_2C_2O_4$ and 100 mL of 0.1 mol dm^{-3} Na_2CO_3 in ppm.

13. An aqueous solution of K_2SO_4. $Cr_2(SO_4)_3.12H_2O$ contains 1.04 g of Cr^{3+}. Calculate the SO_4^{2-} concentration in mol dm^{-3}.

a. 0.01 b. 0.02 c. 0.03 d.0.04 e. 0.05

14. Calculate mass of K_2SO_4. $Cr_2(SO_4)_3.24H_2O$ required to form 1 L of 10.4 ppm Cr^{3+} solution (Cr =52).

a. 8.94 mg b.0.894 mg c. 17.88 mg d. 178.8 mg e. 99.8 mg

15. An ammonium molybdate $(NH_4)_2MoO_4$ contains a Mo content of 48 ppm. Calculate the molarity of the solution. (Mo =96)

a. 2.5×10^{-5} mol dm^{-3} b. 7.5×10^{-5} mol dm^{-3} c. 5×10^{-3} mol dm^{-3}

b. 2.5×10^{-4} mol dm^{-3} f. 5×10^{-4} mol dm^{-3}

16. 500 mL of an aqueous solution of $Ca(NO_3)_2$ contains 20 mg of Ca^{2+}. Calculate the NO_3^- concentration in mol dm^{-3}. (Ca = 40)

a. 5×10^{-4} b. 1×10^{-3} c. 2×10^{-3} d. 4×10^{-3} e. 1×10^{-2}

17. 142 mg of Na_2SO_4 was dissolved in water and the solution was diluted up to the mark in 500 mL volumetric flask. Calculate the concentration of Na^+ in ppm. (O =16, Na = 23, S=32)

   a. 2×10^{-3} b. 4×10^{-3} c. 46 d. 92 184

18. A solution has been made by mixing 250 mL of 0.15 mol dm^{-3} Na_2SO_4 solution and 750 mL of 0.1 mol dm^{-3} NaCl solution. Calculate the concentration of Na^+ in ppm.

   a. 3450 b. 2588 c. 1725 d. 3.45 e. 0.15

Calculating the H^+ concentration when two or more acids are mixed.

19. 200 mL of 0.4 mol dm^{-3} H_2SO_4 solution is mixed with 200 mL of 0.2 mol dm^{-3} HCl solution. Calculate the concentration of H^+ if all H_2SO_4 gets completely dissociates.

20. 0.2 mol dm^{-3} H_2SO_4 1L, 0.2 mol dm^{-3} HCl 1 L were mixed to form a 2 L solution. If H_2SO_4 is completely dissociates, then calculate the concentration of H^+ in the solution.

   a. 0.1 mol dm^{-3} b. 0.15 mol dm^{-3} c. 0.2 mol dm^{-3} d. 0.3 mol dm^{-3}

   c. 0.4 mol dm^{-3}

Calculating the total OH^- concentration when two bases are mixed.

21. 100 mL of 0.2 mol dm^{-3} solution of NaOH and 100 mL of 0.5 mol dm^{-3} solution of $Ca(OH)_2$ were mixed together. Calculate the concentration of the OH^- solution if the volume is additive.

22. 100 mL of 0.4 mol dm^{-3} $Ca(OH)_2$ solution and 100 mL of 0.6 mol dm^{-3} KOH solutions are mixed together. Calculate the concentration of OH^- solution in ppm.

Calculating the H^+ or OH^- concentration when acids and bases are mixed.

1. Determine the amount of H^+ given by the dissociation of the acid.
2. Determine the amount of OH^- given by the dissociation of the base.
3. H^+ reacts with OH^- to form H_2O. Calculate the excess H^+ or OH^- in the solution.
4. Then calculate the concentration.

23. 100 mL of 0.2 mol dm^{-3} H_2SO_4 solution was mixed with 100 mL of 0.6 mol dm^{-3} NaOH solution. Determine the concentration of the OH^- in the solution.

24. 100 mL of 0.8 mol dm^{-3} KOH solution was mixed with 100 mL of 0.02 mol dm^{-3} H_2SO_4 solution. Calculate the concentration of the OH^- in the resulting solution.

25. 100 mL of 0.2 mol dm^{-3} KOH solution was mixed with 100 mL of a H_2SO_4 solution. The resulting mixture has a concentration of 0.2 mol dm^{-3} with respect to H^+. Calculate the initial concentration of H_2SO_4 in ppm.

Preparing a standard solution.

Using a solid substance to form a standard solution.

1. Calculate the required mass by considering the concentration and the volume.
2. Measure the required mass using a chemical balance.
3. Transfer the solid into a volumetric flask using a funnel and water.
4. Once dissolved add water to bring the meniscus up to the mark.

Preparation of a standard solution.

26. Explain how you would prepare a 250 mL solution of 0.4 mol dm^{-3} NaOH solution.

Using a pure liquid substance to form a standard solution.

- Calculate the required number of mols of solute.
- $n = \frac{d \times V}{M}$ can be used to get the total volume required. Make necessary correction if it is not pure.
- Obtain the required volume using a pipette or a burette.
- Dissolve this in a minimum volume of water and volume up to the required volume in a volumetric flask.

27. Indicate how you would attempt to prepare a 250 mL solution of 0.4 mol dm^{-3} H_2SO_4 using a solution having a density of 1.96 g cm^{-3}. The solution has a 98% mass purity.

Using a hydrated salt prepare standard solution.

Some compounds in the laboratory exists as hydrated salts. Eg: $Na_2CO_3.10H_2O$, $CaSO_4.2H_2O$, $MgSO_4.7H_2O$

When calculating the molar mass make sure to include water molecules as well.

28. How would you make a 500 mL solution of 0.8 mol dm^{-3} Na_2CO_3 solution using $Na_2CO_3.10H_2O$.

29. 8.58 g of $Na_2CO_3.10H_2O$ was dissolved in water to prepare a solution of 100 mL. Calculate the concentration of Na_2CO_3 in mol dm^{-3} and in ppm.

30. Crystalline Na_2CO_3 has the molecular formula of $Na_2CO_3.10H_2O$. Calculate the mass of anhydrous Na_2CO_3 required to prepare 2.5 L of 4 mol dm^{-3} solution.
    a. 106 g   b. 286 g   c. 530 g   d. 1060 g   e. 2860 g

31. 0.2495 g of $CuSO_4.5H_2O$ is dissolved in water and made to a 100 mL solution. Calculate the Cu^{2+} concentration in ppm.
    a. 24.9   b. 63.5   c. 159   d. 29   e. 635

Preparing a solution with a higher concentration using a solution with a lower concentration.

- Calculate the number of mols of the solution that should be present.
- Calculate the number of mols in the solution provided.
- Calculate number of mols required to be added.
- Calculate mass of the compound needed to be added.

32. You are provided with a 100 mL of 0.2 moldm^{-3} NaOH solution. How would you attempt prepare a 100 mL solution of NaOH having a concentration of 0.6 mol dm^{-3}? Assume that there is no volume change due to dissolution.

Preparing a solution with a lower concentration using a solution with a higher concentration.

33. Calculate the volume of 0.8 mol dm^{-3} of H_2SO_4 required to prepare 200 mL of 0.4 mol dm^{-3} H_2SO_4 solution.

34. 20 mL of concentrated NaOH solution was pipetted out to prepare 200 mL of 0.6 mol dm^{-3} NaOH solution. Calculate the concertation of the initial solution in mol dm^{-3} and ppm.

35. 20 mL of 2 mol dm^{-3} $C_6H_{12}O_6$ solution was used to prepare a solution with a 100 mL volume. 20 mL of this new solution was taken, and total solution was made to 200 mL. Calculate the concentration of the new solution.

Preparing a solution with an intermediate concentration.

36. How would you attempt to prepare 300 mL of 0.3 mol dm^{-3} H_2SO_4 solution using 0.2 mol dm^{-3} and 0.6 mol dm^{-3} H_2SO_4 solutions?

37. A 500 mL 0.4 mol dm^{-3} NaOH solution is prepared by mixing a certain volume of 0.1 $moldm^{-3}$ NaOH and 0.6 $moldm^{-3}$ NaOH solutions. Calculate the volume of 0.1 mol dm^{-3} solution required.

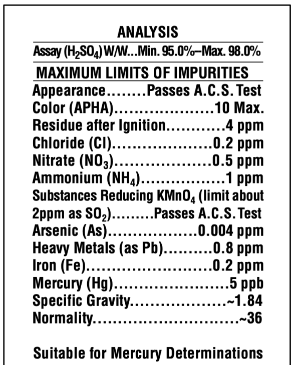
Also, calculate the volume of 0.02 mol dm^{-3} solution that can be prepared using the volume of 0.1 mol dm^{-3} calculated above.

Calculating the concentration using Industrial acids and bases.

Eg for acids: H_2SO_4, HNO_3, HCl, H_3PO_4 and for bases NaOH, NH_3, $Ca(OH)_2$

Such storage bottles contain labels that provide two main data.

- Mass percentage $\frac{w}{W}\%$
  - Mass percentage is 98 %: which means there is 98 g of H_2SO_4 in 100 g of the total solution.
- Density (g cm^{-3}) : 1.84 g cm^{-3} which means 1 cm^3 contains 1.84



A label that shows the analysis of sulfuric acid.

38. . Density of a $Ca(OH)_2$ solution is 1.48 g cm^{-3} and its' percentage purity is 80% by mass. Calculate the concentration of the solution.

39. A H_2SO_4 solution has a density of 1.96 g cm^{-3} and its percentage purity by mass (w/W%) is 80 %. 50 mL of this solution is used to prepare 200 mL of H_2SO_4.

(i) Calculate the concentration of the acid in mol dm^{-3}.

(ii) Calculate the concentration of the resulting H^+ solution if 50 mL of 0.2 mol dm^{-3} HCl was added to the above solution.

(iii) If the solution prepared in (i) above has a mass purity (w/W) % of 40. Calculate the density of the sample.

40. A glucose solution having a density of 0.36 g cm^{-3} contains 80% of glucose by weight. Calculate the new concentration of the solution prepared if 20 mL of this solution is diluted to 200 mL solution by adding distilled water.

41. A 80 mL of a $Ca(OH)_2$ solution having 40% mass percentage was used to make 100 mL of 0.4 mol dm^{-3} solution. Calculate the density of the initial solution.

42. HCl 36.5% contained in an HCl solution provided to you. Its' density is 1.15 g cm^{-3}. Calculate the concentration of HCl in mol dm^{-3}.

a. 0.869 b.1.15 c.11.5 d. 115 e. 8.69

43. An aqueous solution $Na_2S_2O_3.5H_2O$ contains a mass percentage of 20% Density of the solution at the room temperature is 1.24 g cm^{-3}. Calculate the molarity of the solution.

a. 1.0 b. 0.001 c. 0.050 d.1.6 e. 0.1

44. Solution having $(NH_4)_2SO_4$ 18% by weight has a density of 1.1 g cm^{-3}. Calculate the molarity of this solution.

a. 1.4 M b. 1.5 M c. 1.7 M d. 2 M e. 2.1 M

MIXED CALCULATIONS

Percent Solutions

45. If 10.0 mL of acetic acid ($HC_2H_3O_2$) is diluted with water to a total solution volume of 200. mL, what is the percent by volume of acetic acid in solution?

46. A 75.0 gram sample of a solution contains 18.7 grams of potassium iodide. What is the mass percentage of this solution?

47. A 900. mL solution is known to contain 150. mL of ethanol. Calculate the volume percentage of this solution.

48. How many grams of magnesium sulphate are required to make 250 g of a 1.6% solution?

49. A solution contains 2.7 grams of $CuSO_4$ in 75 g of solution. What is the percentage mass of the solution?

50. How many grams of glucose ($C_6H_{12}O_6$) would you need to prepare 2.0 kg of 2.0% solution?

Mole Fractions

51. If 42.0 grams of calcium chloride is dissolved in 600. grams of water, what is the mole fraction of calcium chloride in water? ()Ca =40, Cl= 35.5)

52. If 600.0 grams of potassium iodide is dissolved in 1300. grams of water, what is the mole fraction of potassium iodide in water? (K = 39, I =127)

53. If 550.0 grams of potassium nitrate are dissolved in 750. grams of water, what is the mole fraction of potassium nitrate in water? (K =39, N =14, O =16)

54. If 70.0 grams of HCl are added to 200. grams of water, what is the mole fraction of HCl in water?

Molality

55. A saline solution contains 12.0 moles of NaCl in 2.00 kg of water. What is its molality?

56. How many moles of calcium chloride are necessary to dissolve in 250. grams of water to make a 2.0 *m* solution?

57. How many kilograms of solvent would be needed if you use 5.00 moles of sodium chloride to produce a 6.00 mol kg^{-1} solution?

58. How many grams of table sugar (sucrose: $C_{12}H_{22}O_{11}$) should be dissolved in 3.50 kilograms of water to make a 1.15 mol kg^{-1} solution?

Dilutions

59. How would you prepare 100. mL of 0.40 M $MgSO_4$ from a stock solution of 2.0 M $MgSO_4$?

60. Describe how to prepare 500. mL of 0.250 M NaOH solution starting from 6.00 M NaOH solution.

61. If 650 mL of water is added to 250. mL of 0.20 M KBr what is the new molarity?

62. How much water should be added to 400. mL of a 2.50 M sodium chloride solution to dilute it to a 1.00 M solution?

Mixed Problems

63. Calculate the molality of a 20.0 percent by weight aqueous solution of NH_4Cl.

64. What is the mole fraction of ethanol, C_2H_5OH, in an aqueous solution in which the ethanol concentration is 4.6 mol dm^{-3}? Assume volume of water is unchanged due to dissolution.

65. A solution of toluene (molecular weight 92.1) in benzene (molecular weight 78.1) is prepared. The mole fraction of toluene in the solution is 0.100. What is the molality of the solution?

66. A bottle of wine contains 12.5% ethanol by volume. The density of ethanol (C_2H_5OH) is 0.789 g/cm^3. Calculate the concentration of ethanol in wine in terms of molality, and mass percent.

67. An aqueous antifreeze solution is 40.0% ethylene glycol ($C_2H_6O_2$) by mass. The density of the solution is 1.05 g/cm^3. Calculate the molality, molarity and mole fraction of the ethylene glycol.

68. A solution is prepared by mixing 25.0 g ethanol (C_2H_5OH) with 100.0 g water to give a final volume of 120 mL. Calculate the molarity, mass percent, mole fraction and molality of ethanol in this solution.