Ideal mixtures and ideal dilute solutions

P34. Calculate the changes in enthalpy, entropy, and Gibbs free energy at 25 °C when 2.0 mol of toluene and 1,0 mol of benzene is mixed. *[$\Delta_{mix}H = 0$ J, $\Delta_{mix}S = 15.88$ J/K, $\Delta_{mix}G = -4733$ J]*

P35. The freezing point depression of a 5.0%(w/w) camphoric solution is 10.0 °C. Calculate the molar weight of the solute. Camphor has a molar weight of 152.2 g mol^{-1}, its melting point is 178.8 °C, and its heat of fusion is –6.48 kJ mol^{-1}. *[202 g/mol]*

P36. How high can a tree grow if the maximum ion concentration is 0.10 mol dm^{-3} in its cells and it is assumed that only osmosis supplies water to the highest point of the tree? The daily average temperature is 10 °C and the density of water is 1.0 g cm^{-3}. *[24.0 m]*

P37. A corrupt bartender tries to produce 100.0 cm^3 of alcoholic drink by mixing 30.0 cm^3 of ethanol and 70.0 cm^3 of water. How many cm^3 of alcoholic drink can he make with this method? The molar volume of water and ethanol in this mixture is 18.0 cm^3 mol^{-1} and 53.6 cm^3 mol^{-1}, respectively. The density of water and ethanol is 0.997 g cm^{-3} and 0.789 g cm^{-3}, and the molar masses are 18 g/mol and 46 g/mol. *[97.37 cm^3]*

P38. Use Henry's law to calculate the solubility of oxygen in water (in molality) at 25.0 °C and 190 Torr. The Henry constant for oxygen in water is $3.30 \cdot 10^7$ Torr. *[$3.20 \cdot 10^{-4}$ mol/kg]*

Mixtures of volatile liquids

P39. Substances A and B form an ideal mixture. The vapor pressure of A and B in the pure state is 30 kPa and 50 kPa, respectively. Which one is more volatile? How much will the molar fraction of A and B in the vapor phase be when the liquid phase contains 0.90 mol A and 0.10 mol B? *[B is more volatile. $y_A = 0.844$, $y_B = 0.156$]*

P40. Ethylene (A) and styrene (B) form an ideal liquid mixture. The following table shows the equilibrium vapor pressure of the pure A and B at different temperatures. These temperatures represent the boiling points of mixtures with different concentrations at 66.5 kPa. The boiling point of pure components at this pressure is 57.7 °C (A) and 65.6 °C (B). Which is the more volatile component?

T /°C	64.0	63.0	62.0	60.5	59.5	58.8	58.3
p_A* /kPa	87.5	83.8	80.3	75.1	71.9	69.7	68.3
p_B* /kPa	61.8	59.1	56.5	53.8	50.6	49.0	40.0

Draw the temperature–composition graph and determine the theoretical plate number if a $x_A = 0.5$ molar fraction liquid is purified by fractional distillation and the aim is to produce $x_A = 0.8$ molar fraction distillate. *[A is more volatile. Theoretical plate number = 4]*

P41. Calculate the equilibrium vapor phase composition of a system containing hexane and water at 50 °C. Hexane and water do not mix. The vapor pressure of hexane at 50 °C is 53.2 kPa and the vapor pressure of water at 50 °C is 12.3 kPa. *[$y_{hexane} = 0.812$, $y_{water} = 0.188$]*