Tutorial 3

1. Explain what is meant by regular solution. What information may we gain from the sign of the parameter ξ?

Consider the thermodynamic functions of mixing for your answer. Relate the parameter ξ to the strength of the intermolecular interactions.

1. The maximum value of the excess enthalpy of mixing of two liquids that form a regular solution at 20 °C is 800 J mol-1. What are the activities of the components at that composition? (Remember that for a regular solution *H*E would be at maximum when *x*1=*x*2=0.5 as long as ξ≤2, which we assume here.)
2. Determine the ratios of the mean speeds of H2 molecules and Hg atoms at 20 °C.

For this question you need to know the molar masses of H2 and Hg, which are 2.016 g mol-1 and 200.6 g mol-1, respectively.

1. The speed of molecules can be measured with a rotating slotted-disk apparatus, which consists of five coaxial 5.0 cm diameter disks being separated by 1.0 cm, the slots in their rims being displaced by 2.0° between neighbours. The relative intensities, *I*, of the detected beam of Kr atoms (83.7980 g mol-1) for two different temperatures and at a series of rotation rates were as follows;

*ν*/Hz 20 40 80 100 120

*I* (40 K) 0.846 0.513 0.069 0.015 0.002

*I*(100 K) 0.592 0.485 0.217 0.119 0.057

Find the distributions of molecular velocities, *f*(*v*x), at these temperatures, and check that they conform to the theoretical predictions for a one-dimensional system.

Consider the *v*x of for an atom to pass through the slot as the fraction of disk spacing and alignment time. The latter may be obtained from considering the time for the second disk to rotate as the inverse of the frequency (whole revolution is 360°).

You also need to recognise that , i.e. the intensity of the atoms flown through the rotating disks is proportional to their probability of having the velocity that enables them to pass through.

Useful equations and constants

R=8.314 J K-1 mol-1

and for a binary mixture