

ChE 214 PHYSICAL CHEMISTRY Lecturer: Dr. Bedriye Ucpinar Durmaz Email: bedriyeucpinar@hotmail.com Course 1 Books: 1– Ira N. Levine, Physical Chemistry, 6th Ed., McGraw Hill, Higher Education, 2002. Plotting V vs n_B (measured values), slope of the curve; V^*

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CONTENT OF PHYSICAL CHEMISTRY

- o Solution Composition
- o Partial Molar Quantities
- o Ideal Solutions
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Course 1– Ch. 9: SOLUTIONS

Let's find an expression for the V of a solution; V depends on T , P , and the mole numbers. For fixed values of T , P , and solution mole fractions x_i , the volume is directly proportional to the n $V = n \cdot f(T, P, x_1, x_2, \dots)$ and $n = \sum_i n_i$ Relation between Solution Volume and Partial Molar Volumes $dV = f(T, P, x_1, x_2, \dots) \cdot dn$ $dV = \sum_i V_i dn_i$ $V = \sum_i V_i n_i$ $V^* = 9.2$ Partial Molar Quantities $V_m^*, 1 = V/n$ (single comp) Ex.: 50 mL water + 50 mL ethanol $\neq$ 100 mL = 96.5 mL at 20°C The difference between V of the solution and V^* results from (a) Differences between intermolecular forces in the solution and those in the pure components (b) differences in sizes and shapes of the mixed molecules

Partial molar volume We can write the above equation as: This equation gives the infinitesimal volume change dV that occurs when the T , P , n_i of the solution are changed by dT , dP , dn_1 , dn_2 , ... (one by one) V_m : mean molar volume $V_m = V/n$ $n = \sum_i n_i$ Problem 9.11 At 25 °C and 1 atm, a 0.500 mol/kg solution of NaCl in water has V ?

B Soln.: Draw the tangent line at 0.1 mol of $MgSO_4$ per kg of H_2O Slope = $1001.9 - 1001.7 / 0.3 - 0.1 = 1 \text{ (cm}^3/\text{mol)} = V_B$ Hence $V_{MgSO_4} = 1.0 \text{ (cm}^3/\text{mol)}$, from curve $V = 1001.7 \text{ cm}^3$ Measurement of Partial Molar Volume Ex.: Use Fig.2– Robert G. Mortimer, , Physical Chemistry 3rd Ed., Elsevier

3– G. W. Castellan, Physical Chemistry, 3rd Ed., Addison Wesley – Benjamin Cummings Publishing Company, 1983. $w_B = n_B/n_A$ M_A ; Number of moles of B divided by the mass of the solvent (moles/kg)

9.1 Solution Composition $\partial V/\partial n_i$ (T, P, $x_i = \text{const.}$) f Relation between Solution Volume and Partial Molar Volumes H_2O in $MgSO_4$ (aq) at $T=20^\circ\text{C}$, $P=1\text{atm}$, with molality 0.1 (mol/kg) Soln.: This solution has 0.1 mol of $MgSO_4$ and 1000 g of H_2O , which is 55.51 mol of H_2O . $n_i V$: solutions volume For liquid solutions, it is called molarity (moles/l)

9.1 Solution Composition V of the solution depends on T & P $c_i = f(T, P)$ m : independent of T , P .

9.1 Solution Composition Partial molar volume We form a solution by mixing of