Name _________________________________________________

Circle the correct answers, each question is worth 20 points. (Bonus of 20 if all 6 are correct).

1. A liquid solution at $T = 300 \, K$ containing 25 mole % $A$, 40 mole % $B$ and 35 mole % $C$ was determined to have activity coefficients $\gamma_A = 1.1$, $\gamma_B = 0.7$ and $\gamma_C = 1.2$. Then the molar Gibbs energy change of mixing at this condition is given by

   a) $\Delta_{\text{mix}\,g} = (-0.055)RT$
   
   b) $\Delta_{\text{mix}\,g} = (-1.08)RT$
   
   c) $\Delta_{\text{mix}\,g} = (-1.14)RT$
   
   d) None of the above

2. A binary liquid mixture of $A$ and $B$ containing 0.3 mole fraction of $A$ is in equilibrium with a gas mixture of $A$ and $B$ containing 0.25 mole fraction of $A$. At a system pressure of 1 bar and temperature $T = 280 \, K$, the liquid fugacity of pure components are $f^\text{liq}_A = 1.2 \, \text{bar}$ and $f^\text{liq}_B = 0.8$, while the vapor phase behaves as an ideal gas. Then the activity coefficient of $B$ is approximately

   a) $\gamma_B = 0.69$
   
   b) $\gamma_B = 1.00$
   
   c) $\gamma_B = 1.34$
   
   d) None of the above

3. For a liquid mixture containing components $a$ and $b$ at temperature $T = 320 \, K$, the liquid fugacity of pure $a$ was found to be $f^\text{liq}_a = 0.9 \, \text{bar}$ and Henry’s law constant for $a$ was found to be $\mathcal{H}_a = 20 \, \text{bar}$. Using the Van Laar model for $g^E$, we have the following models for activity coefficients

   $RT \ln \gamma_a = A \left(\frac{Bx_b}{Ax_a + Bx_b}\right)^2$  and  $RT \ln \gamma_b = B \left(\frac{Ax_a}{Ax_a + Bx_b}\right)^2$

Then the parameter $A/(RT)$ is then approximately given by

   a) $A/(RT) = 0.862$
   
   b) $A/(RT) = 1.24$
   
   c) $A/(RT) = 3.10$
   
   d) Insufficient data available
   
   e) None of the above
4. Plots of $\ln(\gamma)$ and/or $\ln(\gamma^M)$ for binary liquid mixture of $A$ and $B$ are shown in Figure 1.

![Figure 1. Ln of Activity Coefficients.](image)

The two plots shown are based (referenced) on
a) Lewis-Randall model for $A$ and Henry’s model for $B$
b) Lewis-Randall model for $B$ and Henry’s model for $A$
c) Lewis-Randall model for $A$ and Lewis-Randall model for $B$
d) Henry’s model for $A$ and Henry’s model for $B$
e) None of the above

5. The partial molar volume of $A$ at $T = 400 \, K$ and $P = 15 \, bar$, in a mixture of $A$ and $B$, was found to be

$$\bar{V}_A = \frac{RT}{P} + (k_1 y_A + k_2 y_B + k_3)RT$$

where $k_1 = -0.02 \, bar^{-1}$, $k_2 = -0.004 \, bar^{-1}$ and $k_3 = -0.009 \, bar^{-1}$. Then the fugacity coefficient of $A$ at $y_A = 0.5$ is approximately given by

a) $\hat{\phi}_A = 0.591$
b) $\hat{\phi}_A = 0.730$
c) $\hat{\phi}_A = 0.867$
d) None of the above

6. The excess Gibbs energy for a mixture of 10 moles of $A$ and 20 moles of $B$ at $T = 420K$ is given by $G^E = -20 \, kJ$. The excess enthalpy for the mixture at the same conditions is given by $H^E = -10 \, kJ$. Then the excess molar entropy for the mixture is approximately given by

a) $s^E = 0.23 \frac{J}{mol \cdot K}$
b) $s^E = 0.79 \frac{J}{mol \cdot K}$
c) $s^E = 1.05 \frac{J}{mol \cdot K}$
d) None of the above