Note: items marked with * you should be able to perform on a closed book exam.

Chapter 10 Learning Objective Checklist

Be sure to review the margin notes and boxed comments for major concepts. Also read the chapter summary.

Sections 10.1-10.13

After studying this chapter you should be able to:

- ❑ find pure component properties on a binary P-x-y or T-x-y diagram.*
- ❑ identify bubble, dew, flash conditions on P-x-y and T-x-y diagrams.*
- ❑ read a P-x-y or T-x-y diagram at specified conditions to find x, y, L/F, V/F.*
- ❑ given a P-x-y OR T-x-y qualitatively sketch the other.*
- ❑ apply the lever rule.*
- ❑ list the properties that are *always* equal in two phases at phase equilibrium.*
- ❑ provide the fugacity of a component in an ideal gas mixture given the mole fraction and the pressure.*
- ❑ provide the fugacity of a component in an ideal solution given the mole fraction and the pure component fugacity.*
- ❑ write down Raoult's law.*
- ❑ rearrange Raoult's law to give the VLE K-ratio.*
- ❑ identify systems where Raoult's law is likely to apply.*
- ❑ properly execute a bubble or dew calculation given the overall composition and the Antoine parameters. (if an iterative solution is required, the first step is expected and an outline of the solution method).*
- ❑ describe the easiest procedure to create a complete P-x-y or T-x-y diagram.*
- ❑ given the first iteration of a flash calculation, indicate how the final answer would be obtained.
- ❑ calculate emissions for filling or charging, purging, heating, or depressurizing a tank containing a VOC or mixture.
- ❑ given the vapor pressure of a pure substance (e.g. Antoine coefficients) find either the LFL or flashpoint if given the other.
- ❑ given a liquid composition, estimate the flashpoint of the mixture given the LFLs.
- ❑ choose between bubble, dew, flash calculations from a problem statement.
- ❑ characterize deviations from Raoult's law as positive or negative.*

Chapter 11, 12, 13 Learning Objective Checklist

Be sure to review the margin notes and boxed comments for major concepts. Also read the chapter summary.

Sections 11.1 – 11.14, 12.1 –12.4.

After studying this chapter you should be able to:

- obtain the partial molar properties graphically from a plot of a molar property with respect to composition at fixed T,P.*
- write down Modified Raoult's Law.*
- determine activity coefficients from measurements of $\{x_i\}$, $\{y_i\}$, T, P for substances with known P_i^{sat}s.*
- calculate the excess Gibbs energy from measurements of $\{x_i\}$, $\{y_i\}$, T, P for substances with known P_i^{sat}s.
- perform bubble or dew calculations using MRL using a simple activity coefficient model (Margules, van Laar, Flory) with given parameter values and activity coefficent expressions. If an iterative solution is required, provide the first calculation and robust method that will lead to the solution.*
- fit the one or two-parameter Margules equation or the van Laar equation to results of a single VLE measurement or to infinite dilution activity coefficients.
- write one or two statements describing how the van Laar and Scatchard-Hildebrand models are similar.*
- describe azeotropic behavior.*
- describe the easiest procedure to create a complete P-x-y or T-x-y diagram.*
- identify whether an azeotropic phase diagram has the correct appearance.*
- shift activity coefficients from the Lewis-Randall rule to Henry’s law.
- Describe in words and a sketch the difference between a Lewis-Randall ideal solution and a Henry’s law ideal solution.*
- Describe the direction of solvent flow across an membrane permeable to solvent but not solute, when the concentrations are different. Describe how pressure can be used to reverse flow.*
- Properly relate osmotic pressure data and coefficients to solvent activity.
- Use solubility parameters to predict activity coefficients for Scatchard-Hildebrand.
- Explain the assumptions of the Flory equation and the property modeled.*
- Explain the origin of the Flory-Huggins equation.*

Chapter 13 Learning Objective Checklist

Be sure to review the margin notes and boxed comments for major concepts. Also read the chapter summary.

Sections 13.1 – 13.5

After studying this chapter you should be able to:

- ❑ write a statement describing the concept of local composition.*
- ❑ write a statement describing the importance of shape in each of Wilson's equation, NRTL, UNIQUAC, UNIFAC.*
- ❑ Calculate volume fractions and surface area fractions given a table of R and Q group parameters and a mole fraction.
- ❑ describe what is meant by the 'combinatorial term' and the 'residual term' in UNIQUAC and UNIFAC.*

Chapter 14 Learning Objective Checklist

Be sure to review the margin notes and boxed comments for major concepts. Also read the chapter summary.

Sections 14.1 – 14.7, 14.10

After studying this chapter you should be able to:

LLE
- ❑ write the equilibria criteria using fugacities and activities.*
- ❑ explain and use a G vs. x plot to identify whether LLE exists in a binary, and the compositions of coexisting phases if LLE does exist.*
- ❑ explain and use a ΔG_{mix} vs. x plot to identify whether LLE exists in a binary, and the compositions of coexisting phases if LLE does exist.*
- ❑ generate the calculations necessary to create a ΔG_{mix} vs. x plot for a given activity coefficient model.*
- ❑ use activity coefficients to calculate LLE K-ratios.*
- ❑ read and plot ternary data on rectangular coordinates.*
- ❑ calculate LLVE for systems with liquid components that are totally immiscible.*
- ❑ set up the procedure for LLE calculation using the iterative technique applied to homework problems.

SLE

Section 14.10
- ❑ Use the heat of fusion and melting temperature to calculate solubility in ideal and non-ideal solutions where solids are totally immiscible.
- ❑ Use the heat of fusion and melting temperature to calculate the temperature of first freezing for a mixture for ideal and non-ideal solutions where solids are totally immiscible.
- ❑ Explain how the eutectic composition is located using calculations.*

Advanced Level

- ❑ derive the formulas used in the text to iterate on the K-ratios.*

Chapter 15 Learning Objective Checklist

Be sure to review the margin notes and boxed comments for major concepts. Also read the chapter summary.

Sections 15.1 – 15.6, not responsible for differentiating section 15.3 at the undergraduate level

After studying this chapter you should be able to:

- ❑ Calculate the fugacity coefficient of a component in a mixture using the virial equation of state.
- ❑ write the criteria for VL phase equilibria using an EOS for both phases and rearrange the expression to give the VLE K-ratio in terms of variables.*
- ❑ given equation of state parameter values, verify the arbitrary steps of the calculations by performing hand calculations.
- ❑ identify stable roots for a mixture given calculation output.*
- ❑ given the results of an iteration (e.g. spreadsheet output from PRFUG for two phases at same T and P) determine whether the system is at equilibrium. *
- ❑ if the system immediately above is not at equilibrium, to reach equilibrium if P is fixed, how should T change. If T is fixed, how should P change?

Advanced Level

- ❑ differentiate a mixing rule to find the expression for the fugacity coefficient of a mixture.

Chapter 16 Learning Objective Checklist

Be sure to review the margin notes and boxed comments for major concepts. Also read the chapter summary.

Sections 16.1, 16.3

After studying this chapter you should be able to:

Section 16.1 Phase Behavior

- ❑ Be able to sketch a P-x-y given a T-x-y and vice versa.*
- ❑ Be able to recognize when a P-x-y or T-x-y for a system showing VLLE has been improperly generated assuming VLE.*
- ❑ Be able to convert an improperly generated P-x-y or T-x-y to a proper VLLE diagram.*

Advanced Level

- Calculate SLE in systems that have solid solutions.

Section 16.3 Residue curves

- Explain what a residue curve represents.*
- Explain in words the steps necessary to generate a residue curve.*
- Sketch separatrices given a residue curve map.*
- Use principles 1-6 from listed in section.*
- Draw the bow tie for a given feed, if given a residue curve map, and the temperatures of the origin and terminus points, properly labeling the attainable distillate and bottoms regions.*

Advanced Level

- apply residue curve maps for multiple column distillation separations of heteroazetrope systems, with superimposed LLE and residue curves.*