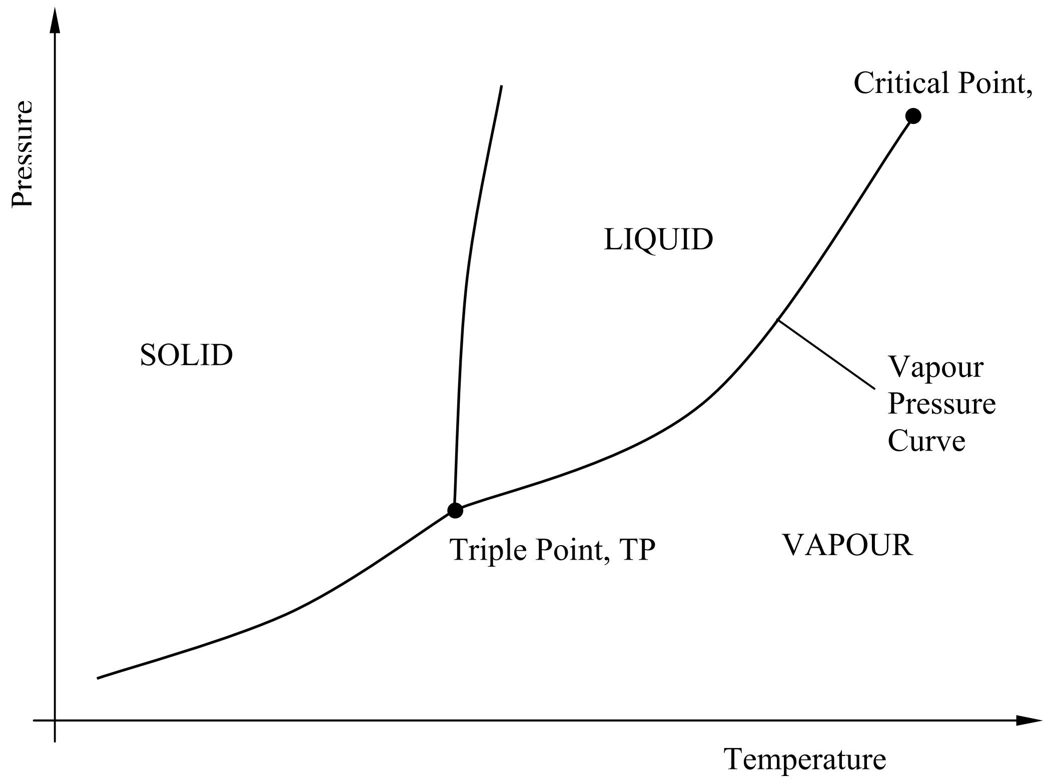
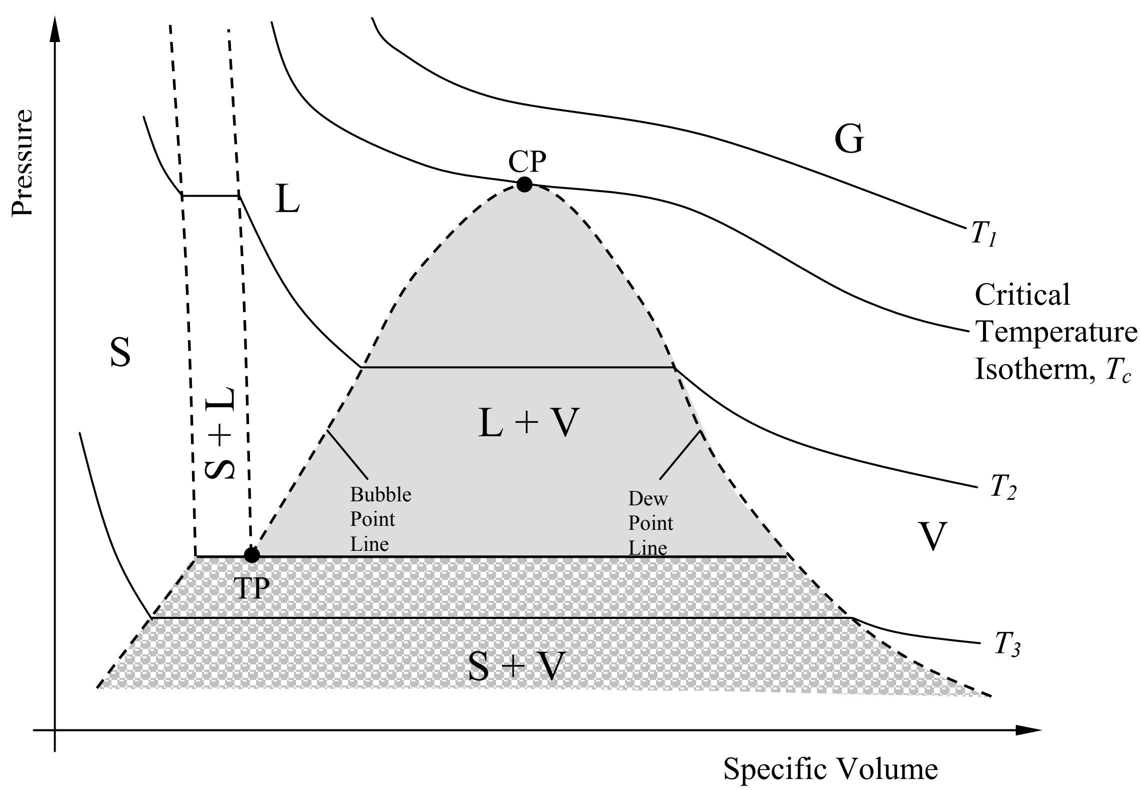
## ENGG201 Summary Notes 4 Ian Gates

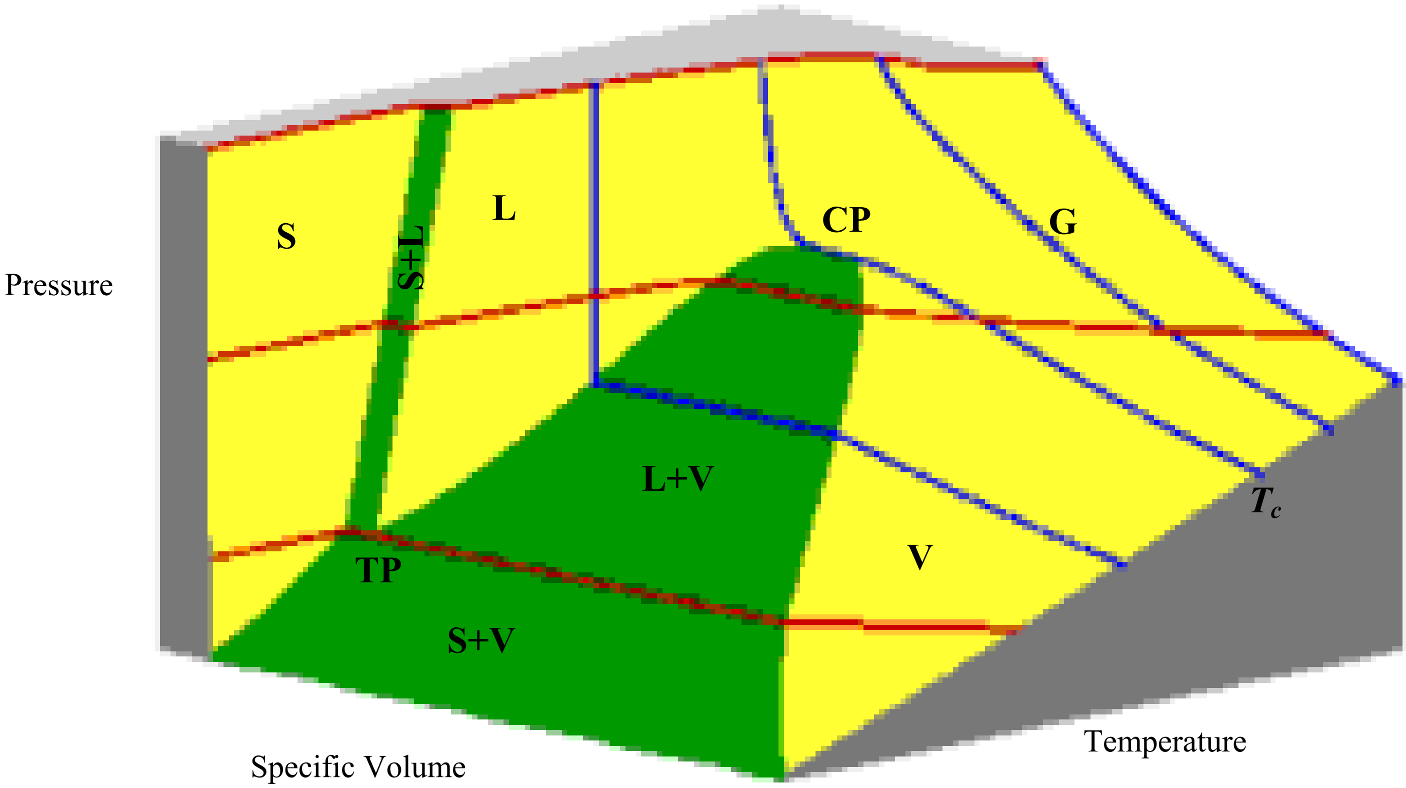
1. System at equilibrium means that there are no driving forces for thermal, mechanical, and diffusional changes.
2. Thermal equilibrium: achieved when system as at uniform temperature.
3. Mechanical equilibrium: achieved when system pressure is uniform.
4. Diffusional equilibrium: achieved when there are no net tendencies for substances to move between phases.
5. Phases: gas, liquid, solid (multiple), plasma.
6. Pure substances can exist in different phases.
7. Mixtures of substances can also exist in various phases.
8. Mixtures characterized by their compositions: mass or mole fraction.
9. If system contains $n_c$ components, the $n_c$-$1$ mass or mole fractions need to be specified.
10. The Phase Rule: $\mathbf{F + P = C + 2}$
11. **F** is the number of degrees of freedom (intensive variables) in the system which can be changed independently while still having **P** phases.
12. System can contain multiple liquid phases.
13. System can contain multiple solid phases.
14. System can only have one gas phase.
15. If no chemical reactions, the number of independent components is the number of distinct chemical species in the system.
16. Intensive variables are those properties that are independent of the size of the phase (e.g. density). Extensive variables vary with the size of the phase (e.g. mass, volume).
17. Most important intensive variables are T° and Pr., density, mole (or mass) fractions of components of each phase.
18. Single component (C=1), single phase (P=1) system: F = C+2-P = 2. Two intensive variables can be specified and all other intensive properties are then fixed.
19. Single component (C=1), two phase (P=2) system: F = C+2-P = 1. Single intensive variable can be specified and all other intensive properties are then fixed.
20. Single component (C=1), three phase (P=3) system: F = C+2-P = 0. This means that no intensive variables can be varied without at least one of the phases disappearing. The T°° and Pr. where three phases exit is called the triple point.

1. The Pr. versus T° diagram.
2. The Pr.-versus Specific Volume ($v$) diagram.

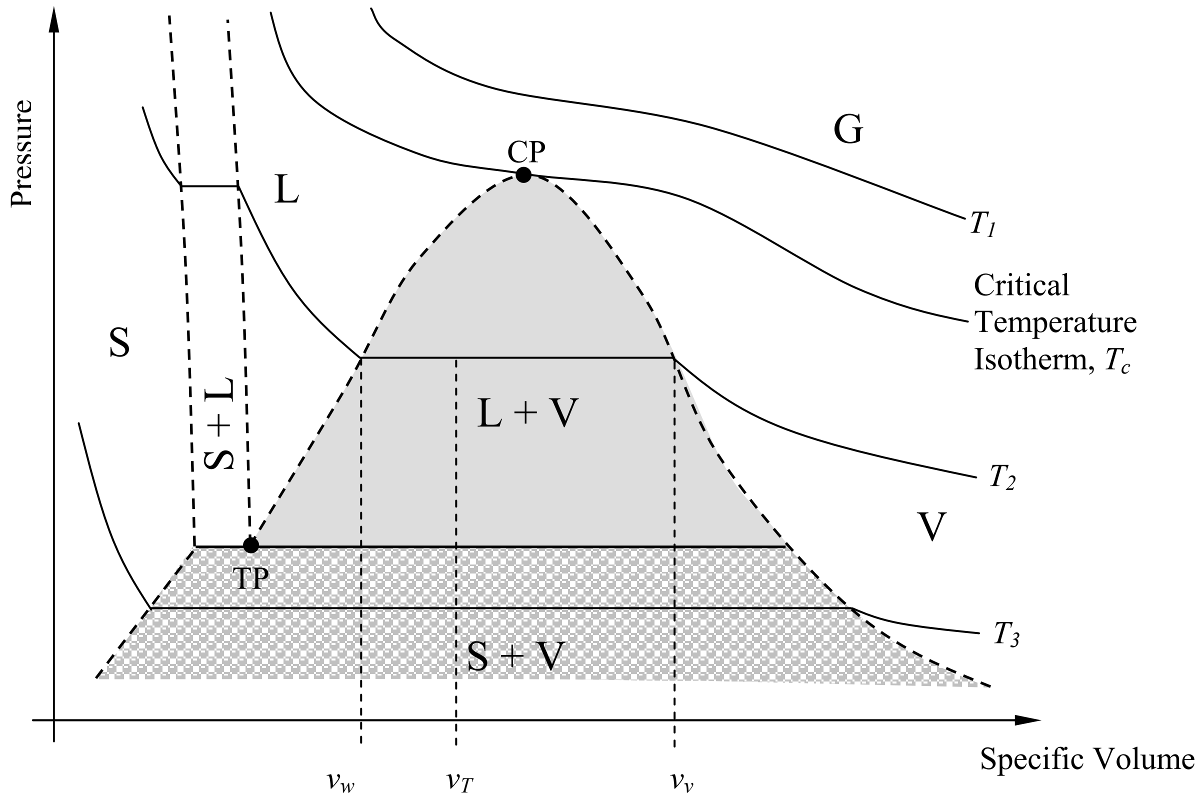


1. The Pr.-versus Specific Volume ($v$) versus T° diagram.



1. The Lever Rule.



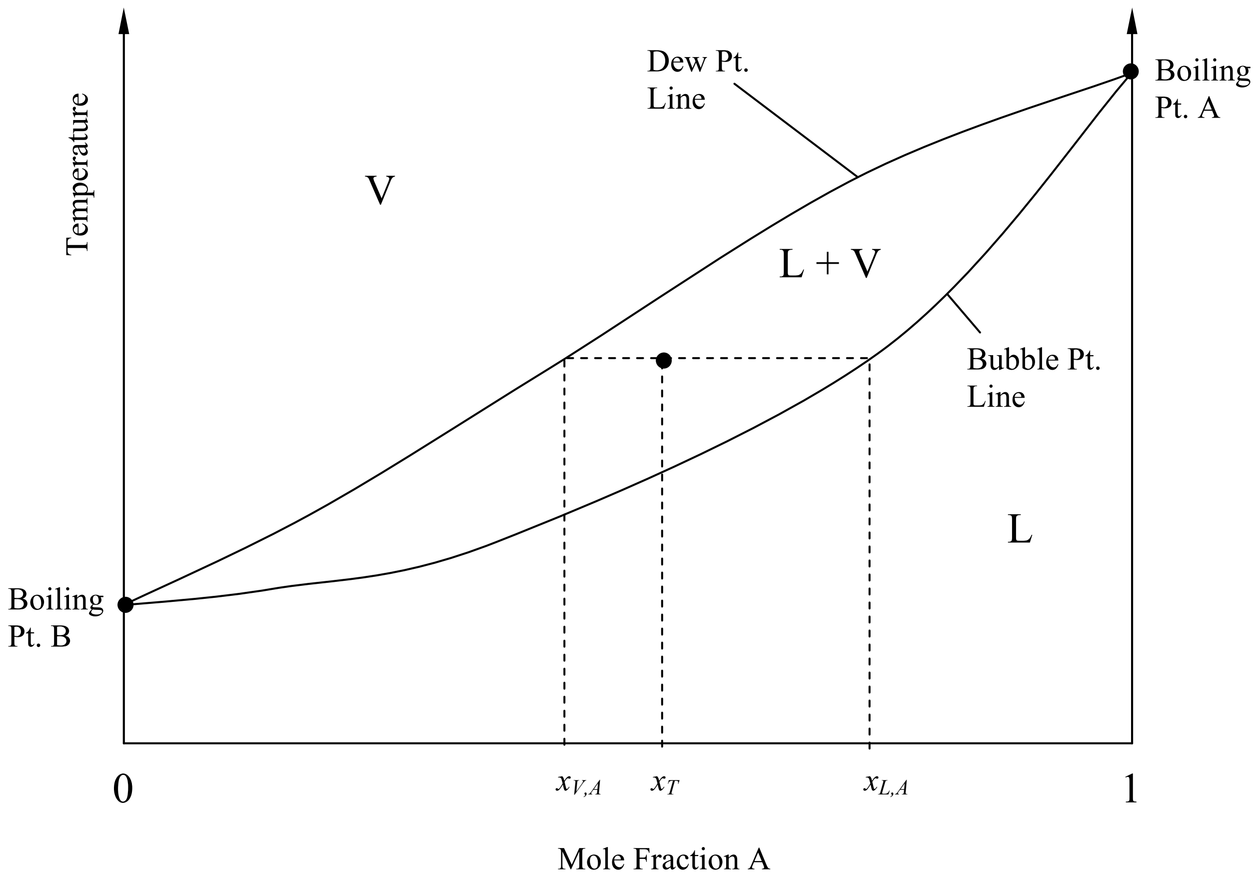

$$\frac{m_v}{m_T} = \frac{v_T - v_w}{v_v - v_w}$$

$$\frac{m_v}{m_w} = \frac{v_T - v_w}{v_v - v_T}$$

Length of lines in L-V region on P-v diagram

**ENGG201 Summary Notes 8** **Ian Gates**

1. Binary mixtures: $F=4-P$, $x_A + x_B = 1$, $w_A + w_B = 1$.
2. Miscible = capable of mixing in any ratio without separation into two phases
3. **Two completely miscible liquids.**

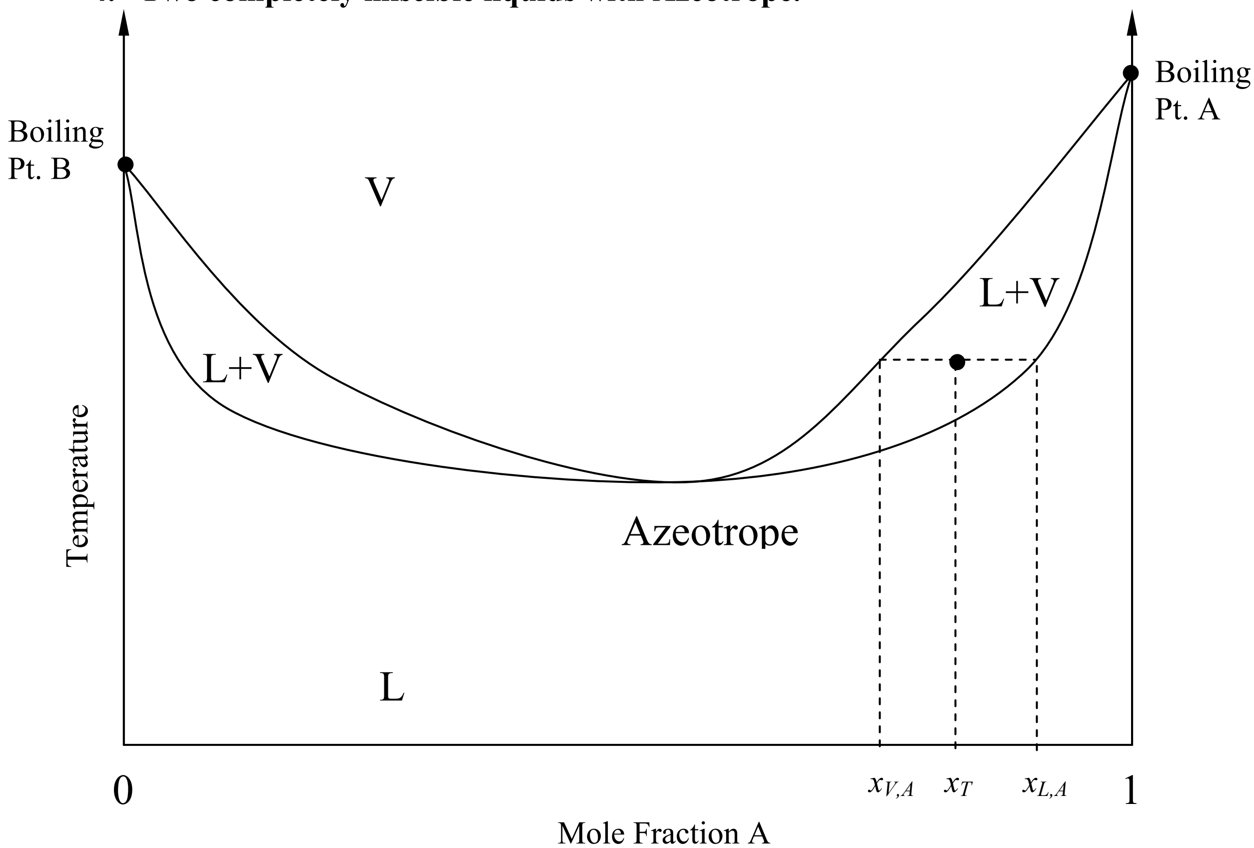



$$\frac{n_V}{n_T} = \frac{x_{L,A} - x_T}{x_{L,A} - x_{V,A}}$$

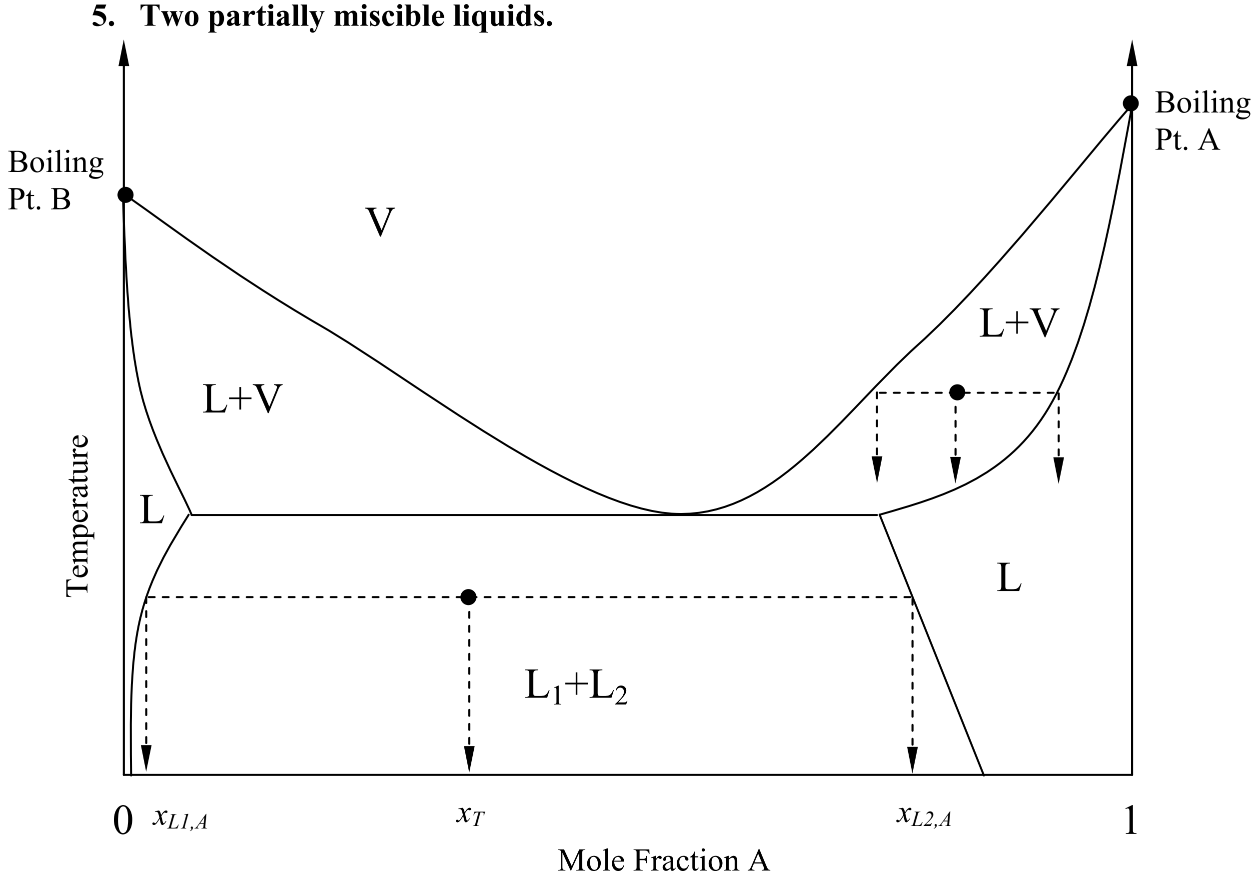
Length of lines in L-V region

$$\frac{n_L}{n_T} = \frac{x_T - x_{V,A}}{x_{L,A} - x_{V,A}}$$

**4. Two completely miscible liquids with Azeotrope.**

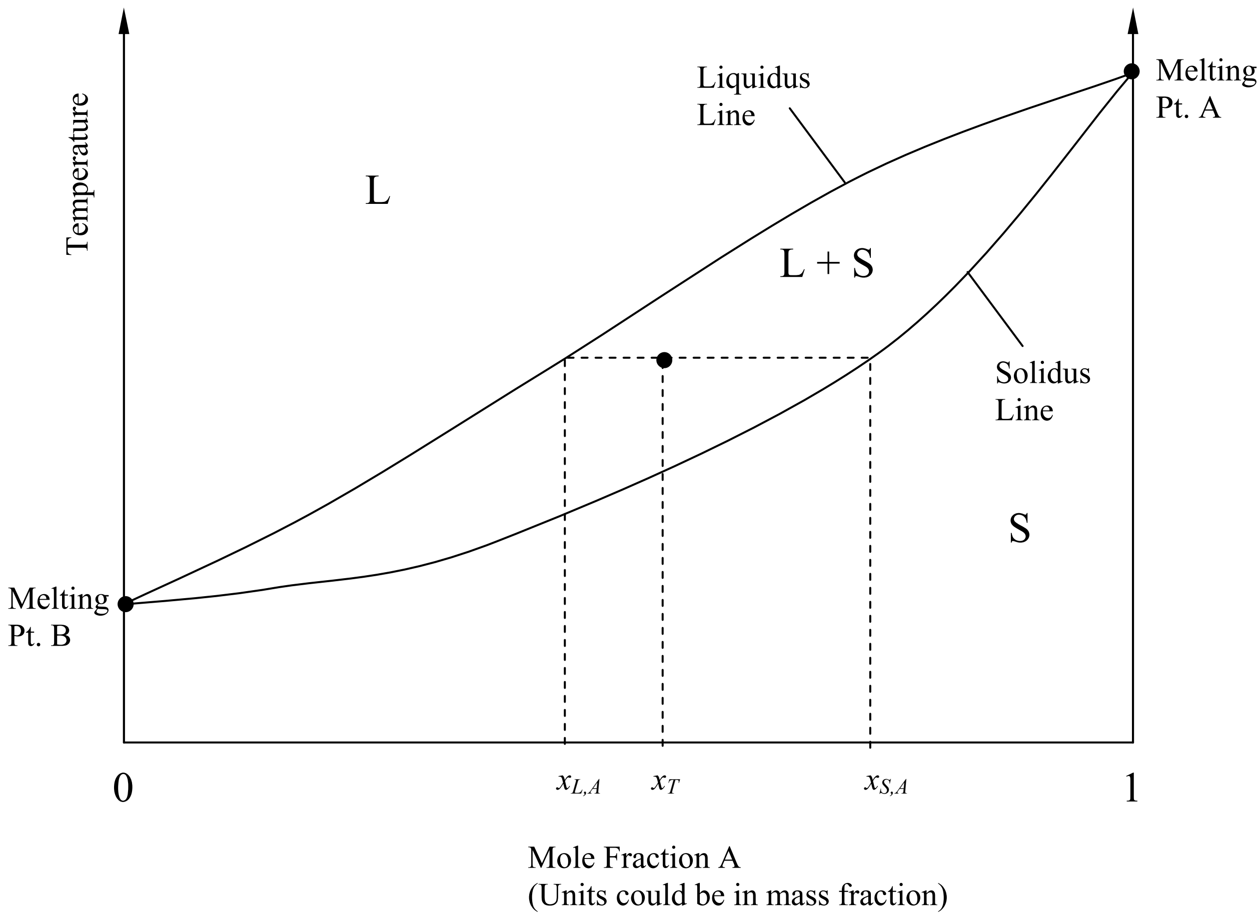



**5. Two partially miscible liquids.**



**ENGG201 Summary Notes 9** **Ian Gates**

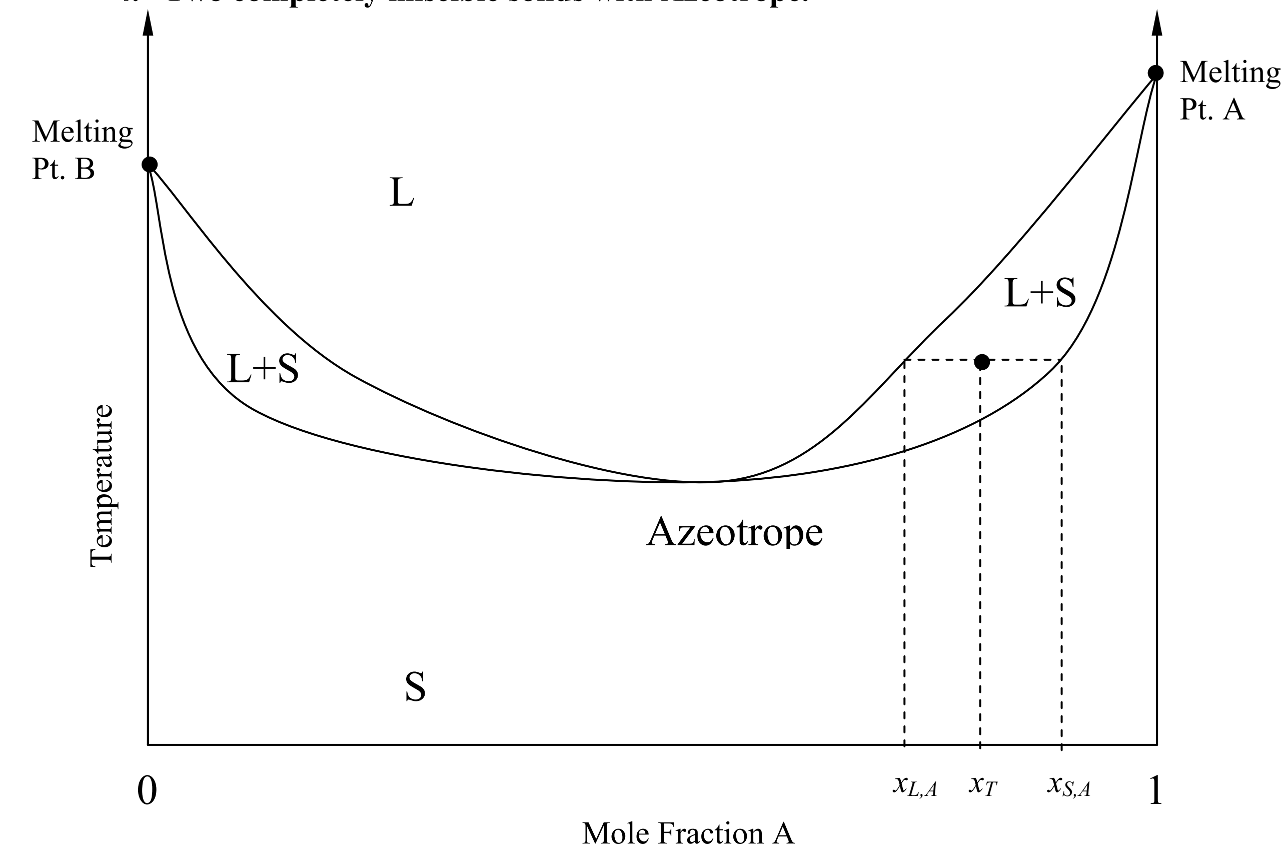
1. Binary mixtures: $F=4-P$, $x_A + x_B = 1$, $w_A + w_B = 1$.
2. Miscible = capable of mixing in any ratio without separation into two phases
3. **Two completely miscible solids.**



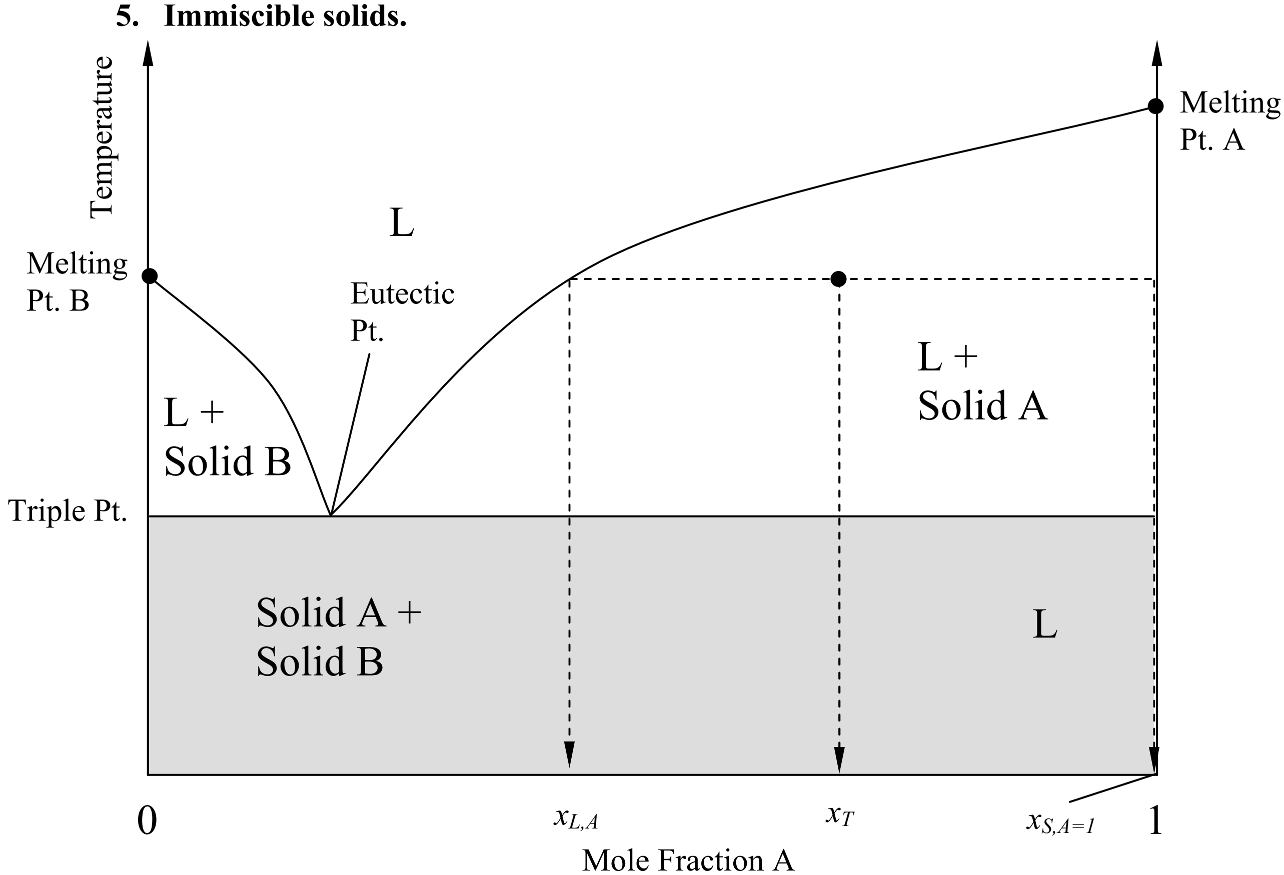

$$\frac{n_L}{n_T} = \frac{x_{S,A} - x_T}{x_{S,A} - x_{L,A}} \qquad \frac{m_L}{m_T} = \frac{w_{S,A} - w_T}{w_{S,A} - w_{L,A}}$$

$$\frac{n_S}{n_T} = \frac{x_T - x_{L,A}}{x_{S,A} - x_{L,A}} \qquad \frac{m_S}{m_T} = \frac{w_T - w_{L,A}}{w_{S,A} - w_{L,A}}$$

**4. Two completely miscible solids with Azeotrope.**




**5. Immiscible solids.**



**6. Partially miscible solids.**