

1. Explain how the perfect gas equation arises by the combination of Boyle's law, Charles' law and Avogadro's principle. (10 %)

2. What are "system" and the "standard state" in thermodynamics? (10 %)

3. On a pressure-volume plot, why the curves are steeper for an adiabatic process compared to isothermal process.

[Hint: You should provide equations and explain the physics behind the equations you present] (10 %)

4. Draw a two-component, temperature-composition, solid-liquid diagram for a system where compound of formula AB_2 forms that melts incongruently, and there is a negligible solid-solid solubility. Label the regions of the diagrams, stating what materials are present and whether they are solid or liquid. (15 %)

5. (a) Derive the phase rule. (10%)

(b) Draw a one-component phase diagram (pressure-temperature) and use phase rule to rationalize your diagram. [Hint: Why "point", "line" or "area" in the diagram] (10%)

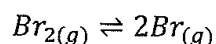
6. Derive the Clapeyron equation for liquid-vapor boundary:

$$\frac{dP}{dT} = \frac{\Delta_{vap}H}{T\Delta_{vap}V}$$

[Hint: Starting with the concept that the chemical potentials must be equal when two phases are in equilibrium] (10%)

7. For polymers, the glass transition and melting are either "first-order" or "second-order" phase transition? Please explain your answer. (10%)

8. Molecular bromine is 24 % dissociated at 1600 K and 1.00 bar in the equilibrium



Calculate equilibrium constant K at (i) 1600 K, (ii) 2000 K given that the standard reaction enthalpy $\Delta H^0 = +112 \text{ kJmol}^{-1}$ over the temperature range. (15%)