Do 3 of the following 9 exercise problems (must be one from each chapter, 15 points each):

6.1 The vapor pressure of dichloromethane at 24.1˚C is 400 torr and its enthalpy of vaporization is 28.7 kJ mol⁻¹. Estimate the temperature at which its vapor pressure is 500 torr.

6.8 In July in Los Angeles, the incident sunlight at ground level has a power density of 1.2 kW m⁻² at noon. A swimming pool of are 50 m² is directly exposed to the sun. What is the maximum rate of loss of water?

6.10 On a cold, dry morning after a frost, the temperature was -5˚C and the partial pressure of water in the atmosphere fell to 2 torr. Will the frost sublime? What partial pressure of water would ensure that the frost remained?

7.8 The addition of 100 g of a compound to 750 g of CCl₄ lowered the freezing point of the solvent by 10.5 K. Calculate the molar mass of the compound.

7.13 Calculate the Gibbs function, entropy and enthalpy of mixing when 500 g of hexane (C₆H₁₄) is mixed with 500 g of heptane (C₇H₁₆) at 298 K.

7.19 The enthalpy of fusion of anthracene is 28.8 kJ mol⁻¹ and its melting point is 217 ˚C. Calculate its maximum ideal solubility (mole fraction) in benzene at 25 ˚C.

8.4 A saturated solution of Na₂SO₄, with excess of the solid, is present at equilibrium with its vapor in a closed vessel. How many phases and components are present. What is the variance of the system. Identify the independent variables.

8.12 UF₄ and ZrF₄ melt at 1035˚C and 912˚C respectively. They form a continuous series of solid solutions with a minimum melting temperature of 765˚C and composition of \( x(\text{ZrF}_4) = 0.77 \). At 900˚C, the liquid solution of composition \( x(\text{ZrF}_4) = 0.28 \) is in equilibrium with a solid solution of composition \( x(\text{ZrF}_4) = 0.14 \). At 850˚C two of the possible compositions are liquid \( x(\text{ZrF}_4) = 0.87 \) and solid \( x(\text{ZrF}_4) = 0.90 \). Sketch the phase diagram for this system and state what is observed when a liquid of composition \( x(\text{ZrF}_4) = 0.40 \) is cooled slowly from 900˚C to 500˚C.

8.20 Figure 8.18 shows the phase diagram for the ternary system NH₄Cl/(NH₄)₂SO₄/H₂O at 25˚C. Identify the number and type of phases present for the mixtures of compositions (a) (0.2, 0.4, 0.4), (b) (0.4, 0.4, 0.2), (c) (0.2, 0.1, 0.7) and (d) (0.4, 0.16, 0.44). The numbers are mole fractions of the three components in the order (NH₄Cl, (NH₄)₂SO₄, H₂O).
Do 3 of the following 6 numerical and theoretical problems (must be one from each chapter, 25 points each. If the problems are too difficult, you may substitute one of the exercises from the above section to replace one problem, but this will be graded out of 15 not 25 points.):

6.3 Calculate the difference in slope of the chemical potential against pressure on either side of (a) the normal freezing point of water and (b) the normal boiling point of water. The densities of ice and water at 0°C are 0.917 g cm$^{-3}$ and 1.000 g cm$^{-3}$, and those of water and water vapor at 100°C are 0.958 g cm$^{-3}$ and 0.598 g L$^{-1}$. By how much does the chemical potential of water vapor exceed that of liquid water at 1.2 atm and 100°C?

6.13 Show that for a transition between two solid phases of the same density, that $\Delta G$ is independent of the pressure.

7.6 What proportions of ethanol and water should be mixed in order to produce 100 cm$^3$ of a mixture containing 50 per cent by mass of ethanol? What change in volume is brought about by adding 1.00 cm$^3$ of ethanol to the mixture? (Use data from figure 7.1)

7.18 Use the Gibbs-Helmholtz equation to find an expression for $d \ln x_A$ in terms of $dT$ for a binary mixture. Integrate $d \ln x_A$ from $x_A = 1$ to the value of interest, and integrate the $dT$ portion from the transition temperature for the pure liquid A to the value in the solution. Show that, if the enthalpy of transition is constant, equations 15 and 16 are obtained.

8.1 The compound p-azoxyanisole forms a liquid crystal. 5.0 g of the solid was placed in a tube, which was then evacuated and sealed. Use the phase rule to prove that the solid will melt at a definite temperature and that the liquid crystal phase will make a transition to a normal liquid phase at a definite temperature.

8.8 Iron(II) chloride (melting point 677°C) and potassium chloride (melting point 776°C) form the compounds KFeCl$_3$ and K$_2$FeCl$_4$ at elevated temperatures. KFeCl$_3$ melts congruently at 399°C and K$_2$FeCl$_4$ melts incongruently at 380°C. Eutectics are formed with compositions $x = 0.38$ (melting point 351°C) and $x=0.54$ (melting point 393°C), where $x$ is the mole fraction of FeCl$_2$. The KCl solubility curve intersects the K$_2$FeCl$_4$ curve at $x = 0.34$. Sketch the phase diagram. State the phases that are in equilibrium when a mixture of composition $x = 0.36$ is cooled from 400°C to 300°C.