

1. Determine the change in entropy of one mole of a Van der Waals gas when isothermally expanded from  $V_1$  to  $V_2$ . (20 points)
2. Determine (a) The boiling point of silver, (b) Temperature and pressure corresponding to the triple point (c) The enthalpy of evaporation and the enthalpy of sublimation at the melting point of silver of  $961^\circ\text{C}$ . (30 points)  
 $\ln P_{\text{Ag}(s)} = -34,300/T - 0.85 \ln T + 21.46$   
 $\ln P_{\text{Ag}(l)} = -33,200/T - 0.85 \ln T + 20.31$
3. Consider a battery with an open circuit voltage of 1.5 volts, internal resistance of 10 ohms, and a total, initial charge of 500 Coulombs. The battery is in contact with a large heat reservoir at a constant temperature. It is known that the battery when connected to an external resistance drains power at constant voltage until it is fully discharged. The battery is connected to an external resistance of 40 ohms. The energy expanded in the external resistance is the work done. Determine the total change in the internal energy of the battery when it is fully discharged. How much of this change in energy is converted into useful work? How much is the heat effect? What happens to the heat? How long will the battery deliver power under the given conditions? If the objective is to extract 95 % of the total stored energy as the useful work from the given battery, what should be the magnitude of the external resistance? How long will the battery deliver power? (30 points)
4. For each of the following processes of a closed system, specify whether the entropy change  $\Delta S$  of the substance is positive, negative, zero or indeterminate. Provide a mathematical justification for your answer. (a) Five kilograms of ammonia are expanded adiabatically in a piston-cylinder device which experiences frictional losses. (b) One gram of water is cooled in a reversible process. (c) Two pounds of air are heated while undergoing a constant pressure expansion. (d) One kilogram of argon compressed isothermally. (20 points)