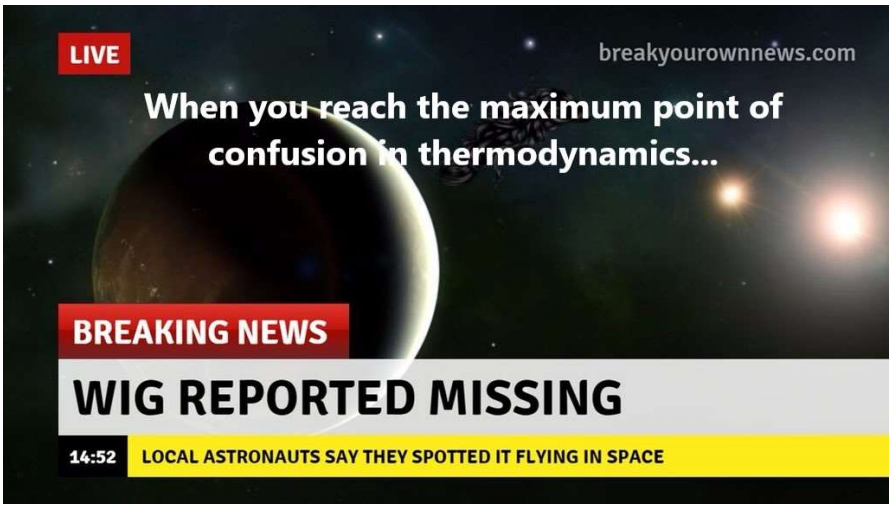

1. Calculate the changes in entropy in the system, the surroundings, and the universe when 0.5 mols of an ideal gas at room temperature (25 ^{o}C) doubles its volume in an isothermal reversible expansion.

2. One kilogram of air is heated reversibly at constant pressure from an initial state of 300 K and 1 bar until its volume triples. Calculate W, q, ΔE, and ΔH for the process. Assume for air that PV/T = 83.14 bar cm^3 mol-1 K-1 and C_P = 29 J mol^{-1} K^{-1}.

3. Liquid water at 25°C is introduced into an evacuated, insulated vessel. Identify the signs of the following thermodynamic functions for the process that occurs: ΔH, ΔS, ΔG, ΔT_{water}, $\Delta S_{surroundings}$, $\Delta S_{universe}$.

4. Impure nickel, refined by smelting sulfide ores in a blast furnace, can be converted into metal from 99.90% to 99.99% purity by the Mond process. The primary reaction involved in the Mond process is

$$Ni(s) + 4CO(g) \leftrightharpoons Ni(CO)_4(g)$$

   a. Without referring to Appendix 4, predict the sign of ΔS^o for the preceding reaction. Explain.
   b. The spontaneity of the preceding reaction is temperature-dependent. Predict the sign of $\Delta S_{surroundings}$ for this reaction. Explain.
   c. For $Ni(CO)_4$, ΔH_f^o = -607 kJ/mol and S^o = 417 J K^{-1} mol^{-1} at 298 K. Using these values and data in Appendix 4, calculate ΔH^o and ΔS^o for the preceding reaction.

5. You take liquid water from your freezer that is set to 0.°C and place the water outside on a winter day in which the temperature is -15°C.
   a. What happens and why?

b. The magnitude for the standard (25°C and 1 atm) change in enthalpy of fusion water is 6.03 kJ/mol and the freezing point of water is 0°C, 1 atm. The heat capacity of ice is 37.5 J/molK, and the heat capacity of liquid water is 75.3 J/molK. Assume ΔH, ΔS, and the heat capacities are independent of temperature.

c. Determine ΔS, $\Delta S_{surroundings,}$ and $\Delta S_{universe}$ for the process that occurs when you place 1.00 mole of 0.°C water outside when the temperature is -15°C and explain how they support what you explain above

6. A 1.00-mole sample of an ideal, monatomic gas is in a container fitted with a piston (V_i = 5.00 L and P_i = 2.00 atm). The external pressure is changed to 1.00 atm and the gas expands isothermally in one step. The gas is then compressed isothermally and reversibly back to 5.00-L and 2.00 atm. Find ΔS and ΔS_{univ} for the overall process (expansion and compression).

7. Calculate ΔS and $\Delta S_{universe}$ when 50.0 g of ice at 0°C is dropped onto 100.0 g of water at 75°C in a perfectly insulated vessel.
   ΔH_{fusion} for ice is 6.02 kJ/mol at 0°C and C_P for water is 75.3 J/(K mol). Also, assume C_P is constant over the temperature range in question.
   .