Chem 3321 homework #2 – due January 30, 2023

Problem 1, 10 marks – heating

A hiker caught in a thunderstorm loses heat when her clothing becomes wet. She has emergency rations that if completely metabolized will release 35 kJ of heat per gram of rations consumed. How much rations must the hiker consume to avoid a reduction in body temperature of 2.5 K as a result of heat loss? Assume the heat capacity of the body equals that of water and that the hiker weighs 50.0 kg. State any additional assumptions.

Problem 2, 20 marks – isothermal expansion

A 0.400 mol sample of an ideal gas expands isothermally from T = 300 K and V = 1.00 L to V = 3.00 L.

a) How much work does the gas do if the expansion is into an evacuated space (vacuum)?

b) How much work does the gas do if the expansion is done against an external pressure of 3.00 atm?

c) What is the maximum possible work done by the gas?

d) Draw a P-V sketch to illustrate parts a, b, and c in a similar fashion to Figs. 19.2 – 19.4 of the textbook.

Problem 3, 20 marks – adiabatic expansion

An automobile tire contains air at $320. \times 10^3$ Pa at 20.0 °C. The stem valve is removed and the air is allowed to expand adiabatically (since the tires are made of rubber which is insulating) against the constant external pressure of $100. \times 10^3$ Pa until $P = P_{\text{external}}$. Assume the air is an ideal gas with $\bar{C}_V = 5/2$ R (diatomic). Calculate the final temperature.

Problem 4, 25 marks – isothermal versus adiabatic

3.50 mol of an ideal gas is expanded from 450 K and an initial pressure of 5.00 bar to a final pressure of 1.00 bar, and $\bar{C}_P = 5/2$ R. Calculate w for the following two cases.

a) The expansion is isothermal and reversible.

b) The expansion is adiabatic and reversible.

c) Give a physical explanation as to why the result to part (b) is different than that of part (a).

<u>Problem 5</u>, 25 marks

One mole of an ideal gas with $\bar{C}_V = 3/2$ R is subjected to two <u>successive</u> changes in state: (1) From 25.0 °C and 100. $\times$ 10^3 Pa, the gas is expanded isothermally against a constant pressure of 20.0×10^3 Pa to twice the initial volume; (2) the gas is cooled at constant volume from 25.0 °C to −25.0 °C. Calculate q, w, ΔU, and ΔH for each of the stages and also for the complete process.