**Chemistry 6854: First Law exercises: part 1**

**Spring 2014 Alfred State**

**1.1 Units of measure**

1. McQuarrie uses dm3 and bars for volume and pressure.

a)Using the fact that 1 bar = 1\*102 kPa, 1 atm=1.01325\*102 kPa and 1 dm = 0.1 m, convert bars to atm and 1 dm3 to to m3 and liters .

b) Since PΔV = work and we want energy in joules, how many joules are expended expanding 1 dm3 at 1 bar in joules ? (1 bar = 100,000 newton/m2)

2a) R = 8.314 J/K mole using McQuarrie’s mks unit system. Verify that this becomes the familar R=0.08205 atm L/K mole used commonly in chemistry.

Note that 1 atm = 101,325 Pa =101,325 newtons/m2 ; 1 J = 1 newton\*m and 1 m3 = 103 L

Hint: as in text, multiply and divide by A = 1 m2 and reorganize J to P(Pa)\*V(m3)…then apply conversion factors above.

2b) R= 8.314 Joule/K mole. Convert it to bar\*dm3/K mole

**1.2 Isothermal, reversible expansions of ideal and Van Der Waal gases**

1. A mole of ideal gas is compressed from 1 bar at 10 dm3 to 1 dm3 at constant temperature. Assuming PV=nRT:
2. What (minimum) pressure is needed to achieve the compression ? (minimum => use PV=nRT)
3. How much work gets done ? (make sure to indicate + or -)

n= moles of gas

For O2 (see p 644, table 16.3 of text)

a= 1.382 dm6\*bar\*mol-2

b=0.03186 dm3 mol-1

1. For a van der Waals gas

P= nRT - an2

V-nb V2

1. If n= 1, , Vinitial =10 dm3 and T= 300 K, what is the minimum P that must be applied to compress the O2 to 1 dm3 ?
2. How much work is needed ?
3. 1 mole of ideal gas is compressed isothermally from 2 to 0.5 dm3 at 300 K.
4. Using the sign conventions for work in McQuarrie what is the work done (in J) ?
5. How much heat was absorbed to do the work ?
6. A 1 mole sample of monatomic ideal gas is compressed adiabatically from 2 to 0.5 dm3 starting at 300 K.
7. Without doing any calculations, will the temperature increase or decrease inside the system as the adiabatic compression occurs ? Explain your answer.
8. Compute the actual temperature the gas attains at 0.5 dm3.
9. Compute the work (with correct sign) carried out during this compression
10. Since the compression is done adiabatically, where does the energy come from to change the temperature ? Does it make sense that the compression stroke here is used as a model for a refrigerator run in reverse, e.g. a heat pump ?