To get full credit: Show your work and EXPLAIN answers not based on calculation.

Exercises 3.1.-3.3, 3.5, 3.8

Exercise A.   Given one mole of an ideal gas with $C_v=5R/2$, initially at 300. K and 30 bar. A process carries it to a final pressure of 1 bar. Calculate ΔS (in J/K) for the following processes from Homework #2.:

Part	Type of Expansion	Final T (K)	q (J)
A	adiabatic and reversible	113 K	0
B	adiabatic into an evacuated container	300 K	0
C	isothermal against a constant opposing pressure of one bar	300 K	+2400

So that you will not have to recalculate answers to these problems which are from Problem Set #3, some of the data you might need are provided.

Problem 1.   As Exercise A, but for the following cases.

Part	Type of Expansion	Final T (K)	q (J)
D	isothermal and reversible	300 K	+8480
E	isothermal into an evacuated container	300 K	0
F	adiabatic against a constant opposing pressure of one bar	217 K	0
F	at constant volume	10. K	-6020
H	heating at constant pressure to a volume ten times the initial volume followed by cooling at constant volume until the final pressure falls to 1 bar	100. K	+18200

Exercise B: What is $\Delta S_{universe}$ for the three questions in Exercise A, assuming the surroundings are at 300 K?

Problem 2.   What is $\Delta S_{universe}$ for the five questions in Problem 1, assuming the surroundings are at 300 K?

Problem 3.   Look up the data on the fusion (melting) of cyclohexane from the NIST WebBook at https://webbook.nist.gov/chemistry/form-ser/
    a) enter the molecular formula for cyclohexane on line 1
    b) check the box for Thermodynamic Data / Phase Change in section 4
    c) click Search
    d) select cyclohexane

        Are the data listed for the melting point (T_{fus}), enthalpy of fusion, and entropy of fusion (at T_{fus}) of cyclohexane consistent with each other?

Problem 4.   1.00 moles of an ideal gas undergoes an isothermal compression at 298 K from $V_1 = 0.200 \text{ m}^3$ to an unknown V_2. The work for the process is $+2.00 \times 10^3$ Joules.
What is the value of V_2?

Exercise C. ΔS°_{vap} of cyclohexane is +83.9 kJ/mole at its normal boiling point of 353.9 K.

a)   What is ΔH°_{vap} for cyclohexane?
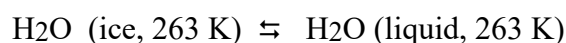
b)   The molar heat capacity of liquid cyclohexane is roughly described as:
$$C_{P,m} \text{ (J/(mole K))} = 57.2 + 0.333 \times T \text{ (where T is in Kelvin)}$$
How much does the entropy of *liquid* cyclohexane change between 298 K and 353.9 K?

Problem 5.   Consider the following process for 1.00 moles of water at $P_{ext} = 1$ atm:
$$H_2O \text{ (ice, 263 K)} \leftrightarrows H_2O \text{ (liquid, 263 K)}$$

$C_{P,m}$ (ice) $= 36.9$ J/(mole K)) $C_{P,m}$ (liquid water) $= 75.3$ J/(mole K)
       ΔH°_{fus} **(273** K) $= 6000.$ J/mole   (fusion = melting)

Use a thermodynamic cycle to compute ΔH°_{fus} and ΔS°_{fus} of water at 263 K.

Exercise D.   Use the data in Table 2.8 in the back of the book for this question.

a)   Show that ΔG°_f for H_2O (liq) is not equal to $\Delta H^{\circ}_f - TS^{\circ}_m$ at 298.15 K.

b)   Compute ΔS°_r at 298.15 K for the reaction $H_2 + \frac{1}{2} O_2$ (g) $\leftrightarrows H_2O$ (liq)

Problem 6.a   Show that ΔG°_f for H_2O (liq) <u>does</u> equal $\Delta H^{\circ}_r - T\Delta S^{\circ}_r$ at 298.15 K, where ΔH°_r and ΔS°_r are for the reaction in part b.

Problem 6.b   Using the data for H_2O (liq) and H_2O (g) in Table 2.8 in the back of the book, compute ΔG°_{vap} of H_2O at 298.15 K.