

Preview Sheet for Test 4
Entropy, Enthalpy, Gibbs Energy, and the Second Law
Thursday, December 17, 8:00 – 10:00 a.m., OR 301

Reading from Hanson and Green:

Chapter 5	(skip Sections 5.8, 5.9)
Chapter 7	(skip Sections 7.5, 7.9)
Chapter 8	(skip Sections 8.5, 8.7, 8.12)
Chapter 9	(skip Sections 9.1, 9.6)
Chapter 10	(skip Section 10.1)

Lectures from 11/13 to 12/11
Problem Sets 9, 10, and 11

Studying strategies:

- Focus on your lecture notes and homework first, then look at the textbook. Anticipate some conceptual questions not based on the homework.
- If a topic was not covered in homework or in lecture, you are not responsible for it! Please ask me if you are unsure about whether a particular topic is “fair game” for the exam.
- Expect a mixture of mathematical problems (~60 points) and short explanation questions (~40 points). You should be able to use equations not only to calculate numbers, but also to make qualitative arguments.

My Office Hours: By appointment; please feel to e-mail me questions as well.

[From the test booklet:]

Instructions before starting the test:

1. Write your name in the space above and on the backs of the other pages.
2. This exam is closed-everything.
3. Your exam booklet should have **nine** pages total, with questions on pp. 2-6, equations and constants on p. 7, and a periodic table and other reference data on pp. 8-9. Check to see you have nine pages now. If you do not, ask for another copy of the exam.
4. You may use programmable calculators, but chemical data should not be stored in them.
5. To receive full credit for a mathematical problem, you must show the method by which you obtained the final answer, including dimensional analysis. However, you do not need to justify how you calculated molar masses.
6. A final numerical answer must contain the correct units and number of significant figures to receive full credit.
7. You have **120 minutes** to work on this exam. Do not start until you are instructed to.

What not to memorize (they will be provided in the test booklet):

- (1) The periodic table
- (2) Possibly relevant chemical data
- (3) The information below:

$$N! = N(N-1)(N-2)\cdots 1$$

$$W = \frac{N!}{N_0!N_1!N_2!\cdots} \quad \frac{N_j}{N_i} = \exp\left(-\frac{E_j - E_i}{kT}\right) \quad \mu = \frac{m_1 m_2}{m_1 + m_2}$$

$$E_{\text{vib}} = \left(i + \frac{1}{2}\right) h\nu \quad \text{where } \nu = \frac{1}{2\pi} \sqrt{\frac{k_f}{\mu}} \text{ and } i = 0, 1, 2, \dots$$

$$E_{\text{rot}} = i(i+1) \frac{h^2}{8\pi^2} \left(\frac{1}{\mu R^2}\right) \quad \text{where } i = 0, 1, 2, \dots$$

$$E_{\text{trans}} = (n_x^2 + n_y^2 + n_z^2) \frac{h^2}{8} \left(\frac{1}{mV^{2/3}}\right) \quad \text{where } n = 1, 2, 3, \dots$$

$$\Delta U = \Delta U_C + \Delta U_T = q + w \quad \Delta U_T = C\Delta T \quad q_{\text{sys}} + q_{\text{surr}} = 0$$

$$w = -p_{\text{surr}}\Delta V \quad pV = nRT \quad T(\text{K}) = T(^{\circ}\text{C}) + 273.15 \text{ K}$$

$$\Delta S_{\text{sys}} + \Delta S_{\text{surr}} = \Delta S_{\text{univ}} \geq 0 \quad S = k \ln W \quad \Delta S_{\text{surr}} = \frac{q_{\text{surr}}}{T} = -\frac{\Delta H}{T}$$

$$\Delta S = nR \ln \frac{V_2}{V_1} \quad \Delta S = -nR \ln \frac{P_2}{P_1}$$

$$S_x = S_x^{\circ} - R \ln P_x / \text{bar} \quad \Delta_r S = \Delta_r S^{\circ} - R \ln Q$$

$$\text{For the reaction } a \text{ A}(g) + b \text{ B}(g) \rightleftharpoons d \text{ D}(g), \quad Q = \frac{P_D^d}{P_A^a P_B^b}$$

$$H = U + pV \quad \Delta H = \Delta U + p\Delta V \quad p\Delta V = RT\Delta n_{\text{gas}}$$

$$G = H - TS \quad \Delta G = \Delta H - T\Delta S \leq 0$$

$$\ln(vp) = -\frac{\Delta_{\text{vap}} H^{\circ}}{R} \left(\frac{1}{T}\right) + \frac{\Delta_{\text{vap}} S^{\circ}}{R}$$

$$N_A = 6.022 \times 10^{23} \text{ particle mol}^{-1} \quad k = 1.381 \times 10^{-23} \text{ J K}^{-1} \text{ particle}^{-1}$$

$$1 \text{ J} = 1 \text{ kg m}^2 \text{ s}^{-2} \quad 1 \text{ kJ} = 10^3 \text{ J}$$

$$R = 0.08315 \text{ L bar mol}^{-1} \text{ K}^{-1} = 8.315 \text{ J mol}^{-1} \text{ K}^{-1} \quad 1 \text{ L bar} = 100 \text{ J}$$