Study Guide (sort of)

The following are questions meant to remind you of concepts that you may miss during studying. This is not meant to be comprehensive. Add to it as you study. If the list is confusing or intimidating, drop it and make your own summary that you are comfortable with.

Important note: Try to avoid saying, "I sort of understand it, kind of. Well… I'm not really comfortable doing problems of that kind. But if it does come up in the exam, I'll look it up in the book." My own experience is that whenever I have this feeling about a concept, later on I realize only too late that that's actually my weak point. Rather than avoiding difficult concepts, try doing a problem on it (look for examples in the textbook or problem sets). If you still have problems, talk to your classmates or TAs.

Material Balance

1) What is the generic form of our balance? _____ + _____ =_____ + _____
2) Explain the concept of "steady state". In this case the _____ = 0.
3) What is the best system to choose when doing balance? _____ There's no real answer for this one. You just have to practice a lot and keep an open mind.
4) What's the purpose of choosing a basis? Do we have to choose a basis? Is it chosen arbitrarily in all cases?
5) What is the composition of air, in terms of two most abundant gases? Is that mole fraction or mass fraction?
6) When we have generation terms (reaction), the terms for all the species are related through their _____ coefficient in that: _____ / ν_j = ____ / ν_k
7) Conversion is defined as _____ divided by _____. What is single-pass conversion? What is overall conversion?

1st Law Concepts

8) What is the 1st Law of Thermodynamics for a closed system?
9) Work is calculated as W = _____
10) What is our sign convention for work and heat?
11) For an ideal gas, ΔU and ΔH only depend on _____.
12) This means U and H are constant for _____ process on ideal gas.
13) The meaning of life is _____.
14) What is Q for a constant pressure process? For a constant volume process?
15) For adiabatic process, ____ = ____. How would you try to make a process adiabatic in real world?
16) The above allows us to get this relationship for T and P for adiabatic case: _____

Phases

17) What is the statement of the Gibbs' Phase Rule?
18) Draw a typical PT diagram of a pure phase. Label them as much as you can. Show that Gibbs' Phase Rule works for the boundaries and the triple point.
19) Draw a typical PV diagram of a pure phase. Identify the regions. Draw (roughly) isotherms. Why do they have that shape in the dome?

Equations of States

20) What characterizes an ideal gas? What's the equation? By definition, Z = _____ for ideal gas.
21) Depending on what you wrote above: What does the "V" mean? Intensive, extensive? What is the unit? Is 'n' involved in your equation? Check the units to make sure it works.
22) We learned several equations of states (EOS). The direct use of EOS is to have an equation to relate ___, ___, and ____.
23) Why did people make cubic EOS? What's the need for three roots, i.e. why not have only one like in ideal gas?
24) Find your table where cubic EOS are listed. What are the parameters? What information do you need? Where do you find them?
25) The concept behind the Generalized Correlations is that all gases behave similarly if they have the same ____, ____, and _____.
26) There are two main ways to represent the generalized correlations. The general way (applies everywhere) is using _____. What variables do we need?
27) The second way to use generalized correlation is at low to moderate pressures, where an equation can be used. What is this equation or where can you find it?
28) A generalized observation: I _____ this _____ place.
29) If you are given n and T, can you calculate V using an EOS? If you are given V and T, can you calculate P? Given n, V^t, and P, what can you calculate?
30) Draw a PV diagram with vapor and liquid. Identify where ideal gas applies. Where does cubic EOS apply? Generalized correlation?

Thermodynamic Properties

31) Review how these variables were defined: H, G, A. Realize that we started with the 1^{st} Law.
32) We have an equation that has this kind of form: dX = AdB + MdN. What does it mean? How does X vary with B and N?

33) Maxwell's equations was based on some mathematical identities. We use Maxwell's equations to be able to express U, H, S, A, and G as a function of ___, ___, and ___ because these are the measurable variables.

34) In the sense given in 33), dG is quite special because dG = _d_ + _d_, and we can measure changes in T and P rather easily, whereas dU = _d_ + _d_ and we cannot measure d__ directly.

35) (Rather long and involved calculation, but it's done in class). Using Maxwell's equations and the cyclic rule if necessary, express dH = _____dT + _____dP. Do the same for dS. Evaluate the resulting expressions for the ideal gas case.

36) Getting tired? A little bit more.

37) What is $(\partial S/\partial T)_P$? $(\partial S/\partial T)_V$?

38) For what cases is dH = CpdT? For _____ gas and, generally, for a process where ___ = 0.

39) For what cases is dU = CvdT? For _____ gas and, generally, for a process where ___ = 0.

40) Show that for ideal gas Cp = Cv + R using the definitions: $Cv = (\partial U/\partial T)_V$, $Cp = (\partial H/\partial T)_P$, and H = U + _____.

41) If there is no extra information given (say, on the test), how do you calculate Cp(T) for a given substance?

42) Two of the most common ways Cp is used is to calculate ΔH and ΔS at constant pressure. Integration is necessary. Since this is so common, try writing down the integrated form of ΔH and ΔS for an ideal gas with a change of temperature from T_1 to T_2 and at constant pressure.

Heat of Reactions

43) What is the heat generated / required during reaction?

44) How do you calculate heat of reaction for T = 25°C? How do you calculate it for any T?

45) Explain the concept of theoretical / adiabatic flame temperature in words. What's going on?

2nd Law

46) What characterizes the Carnot cycle, i.e. what are the steps?

47) What is the efficiency of Carnot cycle? What's so special about Carnot efficiency?

48) One of the simplest form of 2nd Law (in words) is that heat must be transferred from _____ to _____, not the other way round.

49) Defining entropy in this way : dS = _____ , we're able to formulate the 2nd Law in mathematical form.

50) The 2nd Law statement is: ΔS_____ ≥ 0

51) The 2nd Law is so cool because _____.

52) ΔS_{sys} for an isothermal reversible case = _____

53) ΔS_{sys} for an adiabatic reversible case = _____

54) If we take our surroundings to be some constant T reservoir, ΔS_{surr} is calculated as _____.