AOSC 431-Atmospheric Physics and Thermodynamics, Fall 2016, Dr. Kleist
Homework #5 – DUE: THURSDAY 17 NOVEMBER 2016 (5 PM)
All work needs to be shown for full credit.

Skew-T can be found at:
http://www.aosc.umd.edu/~dkleist/docs/classes/aosc431/WH-SkewTLogP_Color.pdf

1. [20 points] Solving problem with skewT-lnP chart: Chinook winds

An air parcel at 1000 hPa has a temperature of 25°C and a dew point temperature of 17ºC,

(a) Find its mixing ratio w, relative humidity RH, potential temperature θ.

(b) The air parcel is lifted up by passing over a mountain. Find the lifting condensation level (LCL).

(b) The air parcel is lifted further to 600 hPa at the top of the mountain. Assuming 80% of the condensed liquid water is precipitated out, what's the precipitation amount? What is the total amount of water (liquid+vapor) in the air?

(d) The air parcel then descends on the lee side of the mountain. At what level all the liquid water is re-evaporated?

(e) The air parcel then descends to 900 hPa. What's the temperature?

Please summarize your results in the following table, and complete ALL the four variables (T,w, RH, θ) for ALL the 5 levels (a,b,c,d,e), plus other things asked for above.
Show the trajectories on a skewT-logP chart.

	Pressure level	**T**	**w**	**RH**	θ	Other things
a	1000 hPa					
b	LCL=					
c	600 hPa					
d	Complete re-evaporation at pressure level=?					
e	900 hPa					

f) Repeat (c)-(e), but assuming that only 20%, rather than 80% as in (c), of the condensed water is precipitated out. What is the final temperature at 900hPa? (No need to show other variables)

g) Compare the final temperature in (e) (80% precipitation) and (f) (20% precipitation) with the initial temperature of 25°C. Are they warmer or colder than the initial temperature? Explain conceptually what made the difference in the two cases.

2. [10 points] From the following form of the Brunt-Vaisalla frequency:

$$N^2 = \left(\frac{1}{\theta}\frac{\partial \theta}{\partial z}\right)g$$

Rewrite to give N^2 in terms of the temperature (T) and lapse rates Γ and Γ_d instead of $\frac{\partial \theta}{\partial z}$.

3. [20 points] Plot the following sounding on a Skew-T diagram:

Pressure (hPa)	Temperature (ºC)	Dew Point (ºC)
1000	30	21.5
970	25	21
900	18.5	18.5
850	16.5	16.5
800	20	5
700	11	-4
500	-13	-20

For each layer, determine the stability (absolutely stable, moist or dry neutral, conditionally unstable, or absolutely unstable).

a. 1000-970 hPa
b. 970-900 hPa
c. 900-850 hPa
d. 850-800 hPa
e. 800-700 hPa
f. 700-500 hPa

g. Which layer(s) are potentially (convectively) unstable?
h. Find on the above sounding the LCL and the LFC.
i. Which layer(s) feature an inversion?
j. Indicate on your Skew-T any areas of CAPE and CIN

4. [5 points] If the pressure at the surface is 987 mb and the Level of Free Convection (LFC) is 900 mb, and the average temperature difference between a parcel and the environment between the surface and LFC is -2.0 K, what is the magnitude of the Convective Inhibition (CIN)? For your calculation, assume that there is some moisture in the air parcel resulting in a gas constant of 288 J kg^{-1} K^{-1}.

5. [5 points] If the pressure at the LFC is 900 mb and the pressure at the Equilibrium Level (EL) is 275 mb, and the average temperature difference between the parcel and the environment is 3.25 K, what is the Convective Available Potential Energy (CAPE)? You may again assume that the parcel has some moisture resulting in a gas constant of 288 J kg^{-1} K^{-1}. If all of the Convective Available Energy is converted to kinetic energy in the vertical motion, what would be the maximum updraft speed?