General Meteorology	**Laboratory #6**
Name _____	Date _____
Partners _____	Section _____

Thermodynamic Chart - Skew T-ln p

Purpose:

Become familiar with a Skew T-ln p thermodynamics chart and use it for some basic meteorological calculations.

I. Skew T-ln p Thermodynamics Chart

The skew T-ln p chart is named because the coordinate representing temperature runs at a 45° angle towards the upper right of the chart. Temperature decreases as you go to the left and towards the top and the temperature increases as you go to the right and towards the bottom. The pressure coordinate is plotted on the vertical axis and decreases with height. The spacing between pressure lines increases as you go towards the top of the chart because the spacing of the lines is determined by the natural logarithm of the pressure. Both the temperature and pressure lines are printed in black.

There are three other sets of lines on the Skew T-ln p and they are printed in different colors in order to keep them separate.

1. **Dry-Adiabat** - The dry adiabat is printed in red and represents the rate at which a dry parcel of air would cool as it is lifted. Dry adiabats are labeled in °C and their label corresponds to the temperature labels at 1000 mb.
2. **Moist-Adiabat** - The moist adiabat is printed in blue and represents the rate at which a moist parcel of air would cool as it is lifted. Moist adiabats are labeled in °C and their label corresponds to the temperature labels at 1000 mb.

3. **Saturation Mixing Ratio** - The saturation mixing ratio is printed in green and represents the maximum water content a parcel of air can have at a particular temperature and pressure. Saturation mixing ratios are labeled in g/kg and are listed across the bottom of the chart in green.

II. Reading the Skew T-ln p.

Two sets of data are included with this lab. The first is for Topeka, Kansas 00Z May 1, 1998. The second is for Charleston, South Carolina 00Z May 1, 1998. You will use this data to determine different properties of the atmosphere at these locations.

1. **Saturation mixing ratio (w_s)**. Locate the specified pressure and air temperature on the chart. Compare that location with the green lines on the chart. Follow the appropriate green line to the bottom of the chart and read off the label. If the point falls between lines, interpolate between lines to determine the saturation mixing ratio. Fill in the appropriate blanks on the data sheet for this lab.

2. **Actual mixing ratio (w)**. Repeat the procedure as specified with the saturation mixing ratio except use the dew-point temperature instead of the air temperature.

3. **Relative humidity (RH)**. The ratio of mixing ratio to saturation mixing ratio multiplied by 100% is the relative humidity. Use the results from parts 1 and 2 to complete this calculation.

$$RH = \frac{w}{w_s} \times 100\%$$

4. **Temperature of a lifted dry parcel**. Locate the pressure and air temperature for the specified parcel of air on the chart. Travel a path parallel to the red lines (dry adiabats) on the chart until you reach the destination pressure. Record the value of the new temperature.

5. **Temperature of a lifted wet parcel**. Repeat the procedure as specified with the lifted dry parcel except follow the blue lines (wet adiabats).

6. **Lifting condensation level (LCL)**. Locate the dew point temperature at the surface and determine the mixing ratio. Locate the air temperature at the surface and determine the temperature of the dry adiabat. Find the intersection point between your determined mixing ratio and dry adiabat. Read off the air pressure for this location. The air pressure can then be converted to a height using a geopotential height table.

III. Plotting Atmospheric Sounding.

Two sets of data are included with this lab. The first is for Topeka, Kansas 00Z May 1, 1998. The second is for Charleston, South Carolina 00Z May 1, 1998. You will use this data to plot the sounding on the Skew T-ln p.

1. **Temperature plot**. Using only pressure and air temperature plot all of the data points from the sounding. Connect the points with solid lines.

2. **Dew-point plot**. Using only pressure and dew-point temperature plot all of the data points from the sounding. Connect the points with dashed lines.

3. **Locate the LCL**. As described above use the surface air temperature and dew point temperature to determine the location of the LCL. On the chart write LCL and draw an arrow pointing at the location of the LCL.

4. **Locate the tropopause**. The tropopause is where the air temperature remains constant with height. It will be located at the top of the chart where the temperature line is running at a 45° angle.

5. **Locate cloud layers**. In air which is above freezing a cloud is present when the dew-point depression is decreasing and lies between 0 and 2 °C. In air below freezing a cloud is present when the dew-point depression is decreasing and lies between 0 and 6 °C. The top of the cloud will be where the dew-point depression increases.

6. **Locate inversions**. Circle any regions where the air temperature increases with height.

7. **Record winds**. Along the right side of the chart record the wind direction and speed at the mandatory levels. The mandatory levels are 100, 150, 200, 300, 400, 500, 700, 850, and 1000 mb. Use a wind pointer with flags just like you would in a station model. Also label the level at which the maximum wind occurs.

8. **Record heights**. Along the left side of the chart record the height of the mandatory pressure levels.

Question.
On either of the soundings were there any layers of air which were absolutely unstable or conditionally unstable? If so, which sounding and which layers were unstable. Why do you feel these layers were unstable?

DATA SHEET

Mixing Ratios and Relative Humidity

Local	P (mb)	T (°C)	T_d (°C)	w (g/kg)	w_s (g/kg)	RH (%)
CHS	500					
CHS	850					
CHS	1000					
TOP	400					
TOP	700					
TOP	850					

Lifted Parcels

Local	P_0 (mb)	P_f (mb)	T_0 (°C)	$T_{f\text{-}dry}$ (°C)	$T_{f\text{-}wet}$ (°C)
CHS	1000	700			
CHS	700	500			
CHS	500	300			
TOP	850	700			
TOP	700	500			
TOP	500	300			

Lifting Condensation Level

P_0 (mb)	h_0 (m)	T (°C)	T_d (°C)	P_f (mb)	h_f (m)
1000		20	15		
950		20	15		
850		20	15		
1000		30	5		
950		30	5		
850		30	5		

Date:0000Z 1 MAY 98
Station: CHS
WMO ident: 72208
Latitude: 32.90
Longitude: -80.03
Elevation: 14.00

LEV	PRES mb	HGHT m	TEMP C	DEWP C	RH %	DD C	WETB C	DIR deg	SPD knt	THETA K	THE-V K	THE-W K	THE-E K	W g/kg
SFC	1011	14	20.0	18.3	90	1.7	18.9	90	11	292.2	294.6	291.6	329.6	13.20
1	1009	32	20.2	16.9	81	3.3	18.0	90	11	292.6	294.8	290.8	326.9	12.09
2	1000	112	19.4	17.6	89	1.8	18.2	90	12	292.5	294.8	291.3	328.8	12.76
3	975	330	17.2	16.7	97	0.5	16.9	94	13	292.5	294.7	291.0	327.5	12.35
4	925	779	14.8	14.3	97	0.5	14.5	80	6	294.4	296.4	290.7	326.4	11.14
5	862	1375	12.6	12.1	97	0.5	12.3	256	11	298.1	300.0	291.2	328.3	10.34
6	850	1493	12.4	9.7	84	2.7	10.7	260	12	299.1	300.8	290.3	325.3	8.92
7	778	2232	9.2	3.2	66	6.0	5.9	260	15	303.4	304.5	289.4	322.0	6.20
8	700	3100	3.8	2.6	92	1.2	3.1	250	21	306.7	307.9	290.8	326.8	6.61
9	652	3673	0.6	-5.4	64	6.0	-2.1	250	26	309.4	310.1	289.3	321.7	3.92
10	604	4284	-1.5	-10.5	50	9.0	-5.2	250	30	313.8	314.3	289.6	323.0	2.84
11	517	5502	-10.1	-20.1	44	10.0	-13.1	215	32	317.7	318.0	289.6	322.7	1.50
12	508	5638	-9.7	-34.7	11	25.0	-14.9	215	33	319.8	319.8	289.1	321.2	0.40
13	500	5760	-10.1	-41.1	6	31.0	-15.6	215	34	320.7	320.8	289.2	321.5	0.21
14	419	7098	-20.3	-55.3	3	35.0	-23.7	232	34	324.3	324.3	290.1	324.5	0.05
15	400	7440	-23.3	-36.3	29	13.0	-25.4	235	33	324.7	324.8	290.6	326.3	0.43
16	378	7850	-27.1	-36.1	42	9.0	-28.4	234	32	325.0	325.1	290.7	326.7	0.46
17	362	8160	-27.9	-31.8	69	3.9	-28.6	232	37	328.0	328.1	291.9	330.6	0.74
18	348	8442	-29.5	-34.4	62	4.9	-30.2	230	41	329.5	329.6	292.2	331.7	0.60
19	325	8924	-33.7	-36.3	77	2.6	-34.0	227	49	330.2	330.3	292.3	332.2	0.53
20	300	9480	-37.3	-42.3	60	5.0	-37.8	225	55	332.8	332.9	292.8	334.0	0.31
21	250	10720	-46.5	-52.5	50	6.0	-46.8	225	71	336.9	337.0	293.7	337.4	0.12
22	200	12160	-57.9	-63.9	46	6.0	-58.0	230	99	341.1	341.1	294.6	341.2	0.04
23	195	12320	-59.0	-65.0	46	6.0	-59.1	235	104	341.8	341.8	294.8	341.9	0.03
24	181	12784	-62.3	-68.3	44	6.0	-62.4	238	102	343.8	343.8	295.3	343.9	0.02
25	170	13171	-63.5	-70.5	38	7.0	-63.6	240	100	348.0	348.0	296.2	348.1	0.02
26	150	13940	-63.9	-70.9	38	7.0	-64.0	240	85	360.0	360.0	298.7	360.1	0.02
27	103	16230	-66.1	-73.1	37	7.0	-66.2	245	57	396.6	396.7	304.8	396.7	0.02
28	100	16410	-64.5	-71.5	38	7.0	-64.6	245	54	403.1	403.1	305.6	403.2	0.02
29	97	16597	-64.5	-71.5	38	7.0	-64.6	246	50	406.6	406.6	306.1	406.8	0.03
30	87	17257	-68.7	-75.7	36	7.0	-68.8	253	34	411.0	411.0	306.6	411.1	0.02
31	72	18399	-66.7	-73.7	37	7.0	-66.8	246	18	438.1	438.2	309.7	438.3	0.02
32	70	18570	-65.9	-73.9	32	8.0	-66.0	240	19	443.4	443.4	310.2	443.5	0.02
33	61	19413	-61.1	-70.1	29	9.0	-61.4	272	14	471.9	471.9	312.8	472.2	0.05
34	50	20650	-59.9	-69.9	26	10.0	-60.3	280	13	502.3	502.3	315.1	502.7	0.06
35	45	21307	-59.9	-70.9	22	11.0	-60.4	284	14	517.7	517.7	316.2	518.1	0.06
36	39	22208	-55.7	-68.7	18	13.0	-56.6	323	10	549.9	550.0	318.1	550.6	0.09
37	30	23880	-54.9	-71.9	10	17.0	-56.3	35	2	595.0	595.0	320.4	595.5	0.08
38	26	24805	-51.7	-71.7	7	20.0	-54.0	342	3	628.9	629.0	321.9	629.6	0.09
39	20	26510	-52.3	-76.3	4	24.0	-55.1	245	6	676.1	676.1	323.6	676.6	0.06
40	19	26841	-52.5	-77.5	3	25.0	-55.4	248	9	685.5	685.5	324.0	685.9	0.05
41	16	27959	-49.1	-76.1	3	27.0	-53.4	270	16	731.1	731.1	325.4	731.8	0.08
42	13	29334	-44.5	-73.5	3	29.0	-51.2	303	21	791.7	791.8	327.1	793.1	0.14
43	10	31100	-41.7	-71.7	2	30.0	-50.8	265	6	863.9	864.0	328.7	866.4	0.24
44	7.3	33248	-38.5	-69.5	2	31.0	-50.8			958.3	958.6	330.6	963.7	0.45

Date:0000Z 1 MAY 98
Station: TOP
WMO ident: 72456
Latitude: 39.07
Longitude: -95.62
Elevation: 270.00

LEV	PRES mb	HGHT m	TEMP C	DEWP C	RH %	DD C	WETB C	DIR deg	SPD knt	THETA K	THE-V K	THE-W K	THE-E K	W g/kg
0	1000	91												
SFC	979	270	14.4	9.4	72	5.0	11.5	330	4	289.3	290.6	285.6	310.7	7.57
2	925	746	10.4	5.4	71	5.0	7.8	10	6	289.9	291.0	284.3	307.3	6.08
3	850	1443	5.0	1.4	78	3.6	3.2	20	11	291.4	292.3	283.7	305.8	4.98
4	707	2919	-4.9	-5.4	96	0.5	-5.1	15	18	296.2	296.9	284.2	307.0	3.62
5	700	2997	-4.7	-9.7	68	5.0	-6.5	15	19	297.3	297.8	283.5	305.2	2.61
6	678	3248	-4.1	-11.1	58	7.0	-6.7	15	21	300.7	301.1	284.6	308.1	2.41
7	603	4165	-8.1	-22.1	31	14.0	-11.9	6	20	306.3	306.5	285.2	309.9	1.08
8	500	5590	-18.5	-30.5	34	12.0	-20.7	10	23	310.5	310.6	286.2	312.6	0.60
9	435	6611	-26.3	-36.3	38	10.0	-27.6	10	35	313.2	313.3	286.9	314.6	0.39
10	421	6846	-28.7	-35.7	51	7.0	-29.6	8	37	313.1	313.2	286.9	314.6	0.43
11	400	7210	-31.7	-40.7	41	9.0	-32.6	5	41	313.8	313.8	287.0	314.8	0.27
12	367	7814	-36.3	-51.3	20	15.0	-37.2	4	45	315.5	315.5	287.3	315.8	0.09
13	333	8484	-40.9	-55.9	18	15.0	-41.5	2	51	318.1	318.1	288.2	318.3	0.06
14	300	9190	-44.1	-59.1	17	15.0	-44.6	355	52	323.2	323.2	289.8	323.4	0.04
15	250	10400	-50.3	-65.3	15	15.0	-50.6	350	50	331.3	331.3	292.1	331.4	0.02
16	220	11223	-54.5	-68.5	16	14.0	-54.7	340	35	337.1	337.1	293.6	337.2	0.02
17	200	11830	-54.9	-68.9	16	14.0	-55.1	335	45	345.8	345.8	295.7	345.9	0.02
18	181	12472	-53.1	-68.1	15	15.0	-53.4	335	26	358.8	358.8	298.5	358.9	0.02
19	150	13680	-55.3	-70.3	14	15.0	-55.6	295	22	374.8	374.8	301.4	374.9	0.02
20	140	14119	-56.1	-71.1	14	15.0	-56.4	290	23	380.9	380.9	302.4	380.9	0.02
21	125	14843	-53.9	-69.9	12	16.0	-54.4	281	26	397.4	397.4	304.9	397.5	0.02
22	100	16270	-55.7	-71.7	12	16.0	-56.1	285	23	420.1	420.1	307.7	420.2	0.02
23	98	16398	-55.3	-71.3	12	16.0	-55.8	285	23	423.3	423.3	308.1	423.5	0.03
24	70	18530	-56.7	-72.7	12	16.0	-57.2	270	20	463.1	463.1	312.1	463.3	0.03
25	53	20285	-57.1	-74.1	10	17.0	-57.8	266	13	500.5	500.5	315.0	500.7	0.03
26	50	20650	-59.9	-75.9	11	16.0	-60.4	270	14	502.3	502.3	315.1	502.5	0.03
27	42	21750	-56.3	-73.3	10	17.0	-57.2	295	13	536.9	536.9	317.3	537.2	0.04
28	37	22554	-57.9	-74.9	10	17.0	-58.8	303	14	552.6	552.6	318.2	552.9	0.04
29	30	23890	-53.9	-72.9	8	19.0	-55.5	300	10	597.7	597.7	320.5	598.2	0.07
30	23	25611	-49.3	-72.3	5	23.0	-52.5	306	14	658.4	658.5	323.0	659.2	0.10
31	20	26520	-52.3	-77.3	3	25.0	-55.1	305	14	676.1	676.1	323.6	676.5	0.05
32	17	27580	-48.1	-76.1	3	28.0	-52.5	290	21	721.7	721.8	325.1	722.4	0.07
33	11	30493	-41.1	-71.1	2	30.0	-50.1	280	28	842.8	843.0	328.3	845.3	0.24
34	10	31140	-41.3	-71.3	2	30.0	-50.6	280	28	865.4	865.5	328.8	868.1	0.25
35	9.6	31417	-42.1	-72.1	2	30.0	-51.2			872.5	872.6	328.9	875.1	0.23
36	8.5	32246	-38.9	-69.9	2	31.0	-50.3			915.9	916.1	329.8	920.1	0.36