ESCI 1010 Lab 4
Stability

<u>Before Lab</u>: Review pages 125-138 in your Weather and Climate textbook. Pay special attention to the sections entitled “Adiabatic Temperature Changes” and “Processes that Lift Air”.

<u>Summary</u>: This lab exercise will introduce you to atmospheric stability. You will see how air parcels behave as they move vertically in the atmosphere. You will also be introduced to a couple of key stability indices used in severe thunderstorm forecasting.

LAB EXERCISE

1. A rising, unsaturated air parcel will cool at a dry adiabatic lapse rate of 10°C per 1000 meters. Assuming this lapse rate and an air parcel starting with a surface temperature of 22°C, what would be the temperature of the air parcel at 1000, 2000, and 3000 meters? Place your answers in the table below.

Height (meters)	Temperature (°C)
3000	
2000	
1000	
Surface	22

2. A rising, saturated air parcel will cool at a variable wet adiabatic lapse rate. Assume a lapse rate of 5°C per 1000 meters and an air parcel starting with a surface temperature of 22°C, what would be the temperature of the air parcel at 1000, 2000, and 3000 meters?

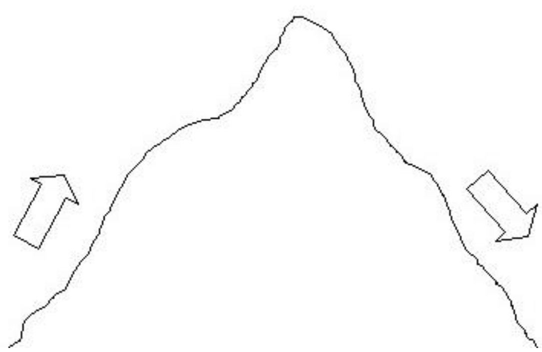
Height (meters)	Temperature (°C)
3000	
2000	
1000	
Surface	22

3. Both air parcels in question numbers 1 and 2 start out at the same temperature, but differ in adiabatic lapse rates. Why do the dry and wet adiabatic lapse rates differ (hint: remember a phase change takes place when air becomes saturated; see page 126 of the textbook)?

4. A rising, unsaturated air parcel starts out cooling at the dry adiabatic lapse rate of 10°C per 1000 meters. Once the lifted condensation level is reached, cooling continues at the wet adiabatic lapse rate (5°C per 1000 meters). Assuming these lapse rates and given data for the lifted condensation level at 2000 meters, what would be the temperature of the air parcel at the surface, 1000, 3000, and 4000 meters? Place your answers in the table below.

Height (meters)	Parcel Air Temperature (°C)	Parcel Dew Point (°C)
4000		-1
3000		4
2000	9	9
1000		11
Surface		13

5. As air moves up the windward side of the mountain, it cools at the dry adiabatic lapse rate of 10°C per 1000 meters until the lifted condensation level is reached. Once the lifted condensation level is reached, cooling continues at the wet adiabatic lapse rate (5°C per 1000 meters). In the table below, the values to the right of the "/" are dew points. As in question number 4, the lifted condensation level is the lowest altitude where the temperature and dew point equal one another. Assuming the lapse rates above and the temperature data for the surface below (25°C), fill in the temperatures to the left of each "/" in the table below. Values on the left are rising and values on the right are sinking.

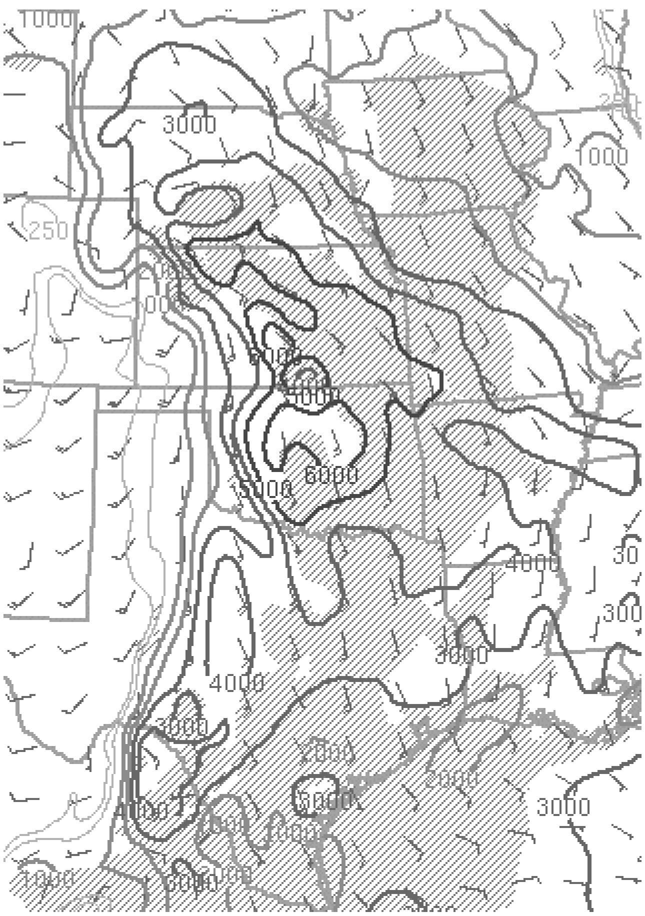
<table>
<tr><td>4000</td><td>/ -5</td><td rowspan="5"></td><td>/ -5</td></tr>
<tr><td>3000</td><td>/ 0</td><td>/ -3</td></tr>
<tr><td>2000</td><td>/ 5</td><td>/ -1</td></tr>
<tr><td>1000</td><td>/ 7</td><td>/ 1</td></tr>
<tr><td>Surface</td><td>25 / 9</td><td>/ 3</td></tr>
</table>

6. What is the altitude of the lifted condensation level in question 5 above?

7. Compare the surface temperature and the surface dew point on the windward and leeward sides of the mountain in question number 5. What happens to the air as it is forced to move over a mountain and then descend (i.e., how is the air different on the windward side vs. the leeward side)?

8. This effect you answered in question 7 has a special name. What is the name (hint: see page 127 in your textbook)?

9. The map below plots two key variables of instability used often in severe thunderstorm forecasting. The lines represent a variable called convectively available potential energy (CAPE), which quantifies the buoyancy (instability) of an air parcel. Bold lines represent strong instability. The shaded areas represent a variable called convective inhibition (CIN) or how much the air parcel is inhibited from rising. Areas that are shaded have strong inhibition (i.e., thunderstorms are unlikely to develop). On the map below what areas have the strongest instability (i.e., where are the values for CAPE the highest)?



10. There are the localized areas in the Plains with large amounts of CAPE and little CIN (i.e., bold lines with no shading). Where are they?

11. The map below shows station model data for the same time as the CAPE/CIN plot in question 9. In the areas you identified in question 10 above, is there any temperature or dew point gradient nearby? If so, circle the area. Remember the temperature is the value in the upper-left and the dew point is the value in the lower-left of the station model plot, respectively.