Name: _____Section/TA Name: _____

Atmospheric Science 101, Spring 2003
Midterm 2 Thursday 22 May 2003
Version A

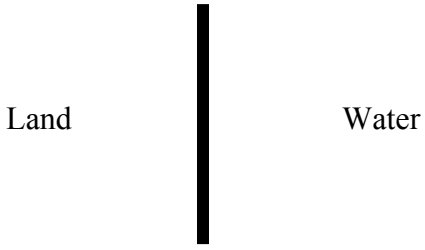
Multiple Choice (2 points each) Choose the best answer and mark it on a Scantron sheet.

1. Choose the words which best complete the following sentence describing the signature characteristics of an El Niño event?

A change in the surface pressure over the Equatorial Pacific is associated with a _____ of the trade winds which _____ the depth of the warm water layer in the eastern tropical Pacific thereby _____ upwelling.

a. strengthening, decreases, inhibiting
b weakening, decreasing, inhibiting
c. strengthening, increases, enhancing
d. weakening, increases, inhibiting

2.



Consider the above situation in the **Northern Hemisphere**. The coastline, represented by the thick black line, runs from North to South (North is up). From which direction must the wind blow over the water in order to produce coastal upwelling.

a. Easterly
b. Southerly
c. Westerly
d. Northerly

Match the following cloud types with their appropriate characteristics.

3. Stratus	**d**	a. Rain clouds
4. Cumulus	**e**	b. Wispy clouds
5. Cirrus	**b**	c. Lens shaped
6. Nimbus	**a**	d. Sheet like
		e. Puffy clouds

Use the following chart to answer questions 7-9

City	Air Temperature (ºC)	Dew Point Temperature(ºC)
City A	5	5
City B	30	3
City C	20	18
City D	18	2

7. Which city has the least water vapor in the air? **City D**

Dew point temperature is a direct reflection of the water vapor content of the air. The city with the lowest dew point temperature is the one with the lowest amount of water vapor in the air.

8. Which city has the highest relative humidity? **City A**

In the case of city A the temperature and the dew point temperature are equal. This occurs when the relative humidity is 100%.

9. Which city has the highest saturation vapor pressure? **City B**

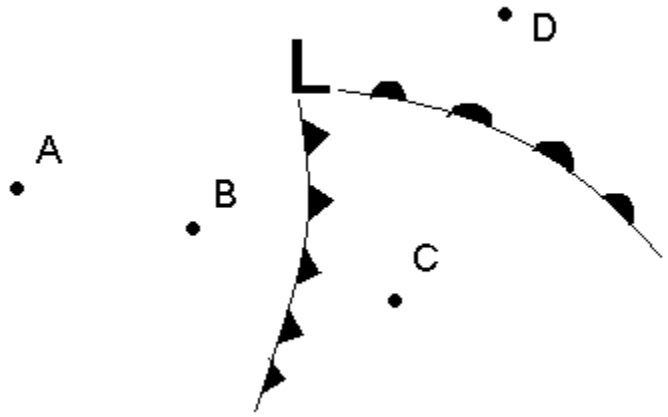
Saturation Vapor Pressure is dependent directly on temperature. The city with the highest temperature has the highest SVP.

10. As a storm moves over the Rockies it decreases in intensity while above the mountains and strengthens as it descends into the lee of the mountains. This strengthening is associated with an increase in _____?

a. Relative humidity
b. Coriolis force
c. Relative vorticity
d. Cloud cover

11. The formation of graupel and hail relies on the existence of _____ within the cumulonimbus clouds in which they form.

    a. Vigorous updrafts
    b. Temperature inversions
    c. Calm upper-level winds
    d. Lightning



Refer to the picture above to answer questions 12 – 14.

12. Which of the following ranks the sites A-C in order of temperature (warmest to coldest)?

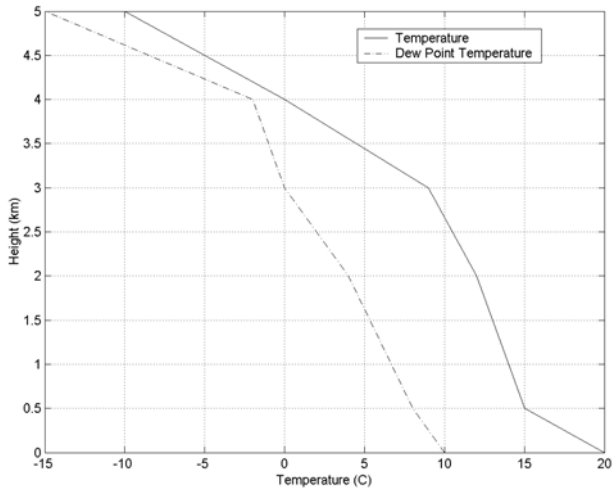
    a. B,A,C
    b. A,B,C
    c. C,B,A
    d. C,A,B

13. At a later time the cold front catches up to the warm front. What is the term for the new boundary that is formed?

    a. Warm front
    b. Occluded front
    c. Cold front
    d. Stationary front

14. At point D from what direction is the wind blowing from?

    a. North
    b. East
    c. West
    d. South



Based on the above sounding showing temperature and dew point temperature, answer questions 16-17.

15. If we lift an air parcel from the surface, initially the parcel will be cooling at the _____ adiabatic lapse rate

    a. dry
    b. moist
    c. occluded
    d. ambient

16. The air parcel reaches its saturation point at an elevation of ___ km at which point it will cool at the _____ adiabatic lapse rate.

    a. 2,ambient
    b. 1,occluded
    c. 2,dry
    d. 1,moist

17. Winds around a surface low pressure in the Northern Hemisphere are best described as:

    a. Frictionless flow towards the low pressure
    b. Anticyclonic (clockwise) flow diverging away from the low pressure
    c. Cyclonic (counter-clockwise) flow converging in towards the low pressure
    d. Frictionless flow away from the low pressure

18. Pick the option that best evaluates the following statement: "The flow down a bathtub drain swirls clockwise or counterclockwise depending on which hemisphere it is in."

    a. True, the Coriolis force acts significantly on the motion of water flowing down the drain and the Coriolis force changes direction as one crosses the equator.
    b. False, the Coriolis force does act on the moving water but it is weak compared to other forces acting on the water. The direction of circulation in the drain primarily depends on the shape of the drain and other random swirls in the water.
    c. False, the Coriolis force cannot possibly act on the water flowing down the drain. The direction of circulation in the drain primarily depends on the shape of the drain and other random swirls in the water.
    d. False, the Coriolis force does act on water flowing down the drain, but it always deflects moving objects to the right, so the drain should always drain counterclockwise.

19. On a cold winter morning in Charlottesville, Virginia, Carl and his fishing buddies notice fog above their favorite lake, in which the water is warm relative to the surrounding air. Given the situation, what type of fog would Carl claim is occurring?

    a. Steam fog
    b. Advection fog
    c. Upslope fog
    d. Radiation fog

20. Increased fogginess or cloud cover in polluted regions due to emissions from industrial processes can be attributed to _____ amounts of _____ available upon which water vapor may condense.

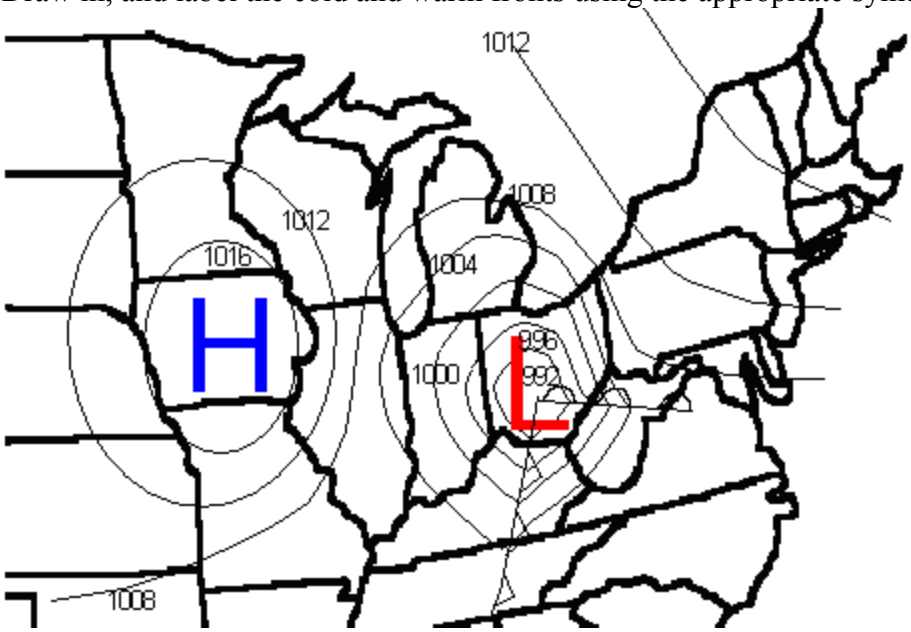
    a. Decreased, condensation nuclei
    b. Increased, condensation nuclei
    c. Increased, graupel
    d. Decreased, graupel

21. The windward side of the Olympic Mountains experiences very large amounts of annual precipitation due to westerly flow that results in adiabatic _____ of air on the _____ side of the barrier. (windward = upwind, west side of the Olympics, leeward = downwind, east side of Olympics)

    a. Warming, Windward
    b. Cooling, Windward
    c. Warming, Leeward **(Also accepted)**
    d. Cooling, Leeward

SHORT ANSWER(6 points each): Answer **ONLY 3** of 4 questions. If all four questions are answered, only questions 1-3 will be graded.

1. a. Draw in, and label the cold and warm fronts using the appropriate symbols.

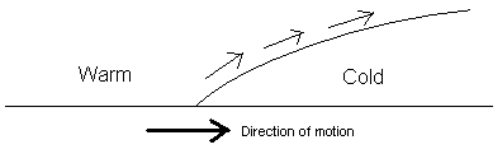


b. List 3 features used to determine the position of surface fronts:

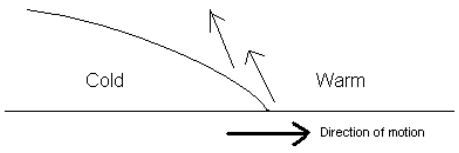
a. A kink in the isobars
b. A sharp temperature gradient
c. A shift in winds
d. Increased cloud cover and precipitation

c. Draw the vertical cross-section of a cold front and warm front. Indicate the direction of motion, the warm and cold air masses, and regions of rising air.

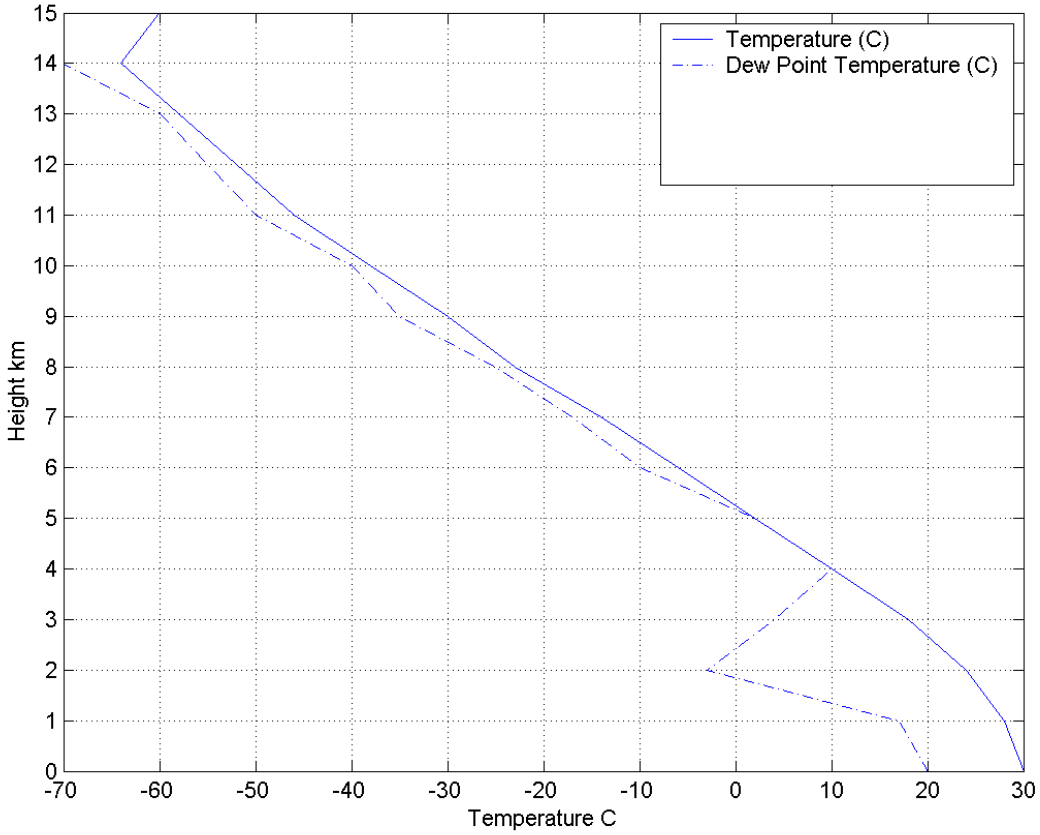
Warm Front



Cold Front



2. Based on the sounding below, fill in the missing values in the chart, by lifting an air parcel from the surface. For the stability column, use the abbreviations of (AU = absolutely unstable, CU = conditionally unstable, AS = absolutely stable). Note: there will only be one box checked in the last (condensation level) column.



Height (km)	Environmental Temperature (°C)	Parcel Temperature (°C)	Buoyant Yes/No	Environment Lapse Rate in kilometer below (°C/km)	Stability	Indicate the Condensation Level with a check-mark
0	**30**	**30**				
1	28	**20**	**No**	**2**	**AS**	√
2	24	**14**	**No**	*4*	AS	
3	18	8	**No**	6	AS	
4	**10**	2	**No**	8	**CU**	**Half credit**
5	2	-4	**No**	**8**	**CU**	**Half credit**
6	-6	-10	**No**	**8**	CU	
7	-14	-16	**No**	8	CU	
8	-23	-22	**Yes**	9	**CU**	
9	**-30**	-28	**Yes**	7	CU	
10	-38	**-34**	**Yes**	**8**	**CU**	
11	-46	-40	**Yes**	8	CU	
12	-52	-46	**Yes**	6	AS	
13	-58	-52	**Yes**	6	AS	

3. For the following pairs, discuss if and how the first term affects the second. Explain your reasoning.

a.) Temperature and Relative Humidity

Relative humidity is defined as actual vapor pressure divided by saturation vapor pressure. SVP is directly dependant on temperature—an increase in temperature leads to an increase in SVP. Since SVP is in the denominator an increase in SVP would lead to a decrease in RH. It follows that an increase in temperature would also lead to a decrease in RH.

b.) Dew Point Temperature and Saturation Vapor Pressure

Dew point temperature directly reflects the amount of water vapor *in the air* and is independent of air temperature. On the other hand, SVP is only dependant on the temperature of the air. Therefore dew point temperature does not affect SVP.

c.) Actual Vapor Pressure and Saturation Vapor Pressure

Actual vapor Pressure is a direct reflection of the amount of water vapor in the air and is independent of air temperature. On the other hand, SVP is only dependant on the temperature of the air. Therefore AVP does not affect SVP.

d.) Saturation Vapor Pressure and Relative Humidity

Relative humidity is defined as actual vapor pressure divided by saturation vapor pressure. An increase in SVP would lead to a decrease in relative humidity.

e.) Temperature and Saturation Vapor Pressure

Saturation vapor pressure is a measure of the maximum amount of water vapor an air parcel can possibly hold which is directly dependant on the temperature of the air parcel. Warmer air is capable of holding a larger amount of water vapor therefore an increase in temperature would result in an increase in SVP.

f.) Actual Vapor Pressure and Dew Point Temperature

The dew point temperature is the temperature to which you would have to cool the air to cause water to condense, or in other words, to reach 100% RH. The dew point depends only on the amount of water vapor in the air, or the AVP. So, increasing the AVP increases the dew point temperature.

4. Describe what is meant if a layer of the atmosphere is conditionally unstable. How would a saturated air parcel act if it were lifted into a conditionally unstable environment? How would the air parcel act if it were unsaturated? Describe the differences between clouds formed in an absolutely stable environment versus those formed in a conditionally unstable environment.

We determine atmospheric stability by comparing the environmental lapse rate to both the dry and the moist adiabatic lapse rates. A conditionally unstable environment is one in which the environmental lapse rate is greater than the moist adiabatic lapse rate (6°C/km) and less than the dry adiabatic lapse rate (10°C/km). The environment is cooling faster than a parcel lifted at the moist adiabatic lapse rate and not as fast as a parcel being lifted at the dry adiabatic lapse rate. A rising saturated parcel will be warmer than its surroundings and will continue to rise. On the other hand a rising dry parcel will end up cooler than its environment which will cause it to sink. Clouds formed in a stable environment are relatively thin and sheet-like (stratus), while in an unstable environment they are often deep and more localized (cumulus).