ATMO 336 -- Exam 1 (110 possible points) **Name: _____**

<u>Multiple Choice Questions</u> (Answer All 30 Questions) -- 3 Points Each.

1. The two gases that are mainly responsible for the atmospheric greenhouse effect are _____.
   (a) nitrogen and oxygen (c) oxygen and ozone
   (b) carbon dioxide and ozone (d) carbon dioxide and water vapor

2. Which two gases are most abundant in the Earth's atmospheric?
   (a) nitrogen and oxygen (c) oxygen and ozone
   (b) carbon dioxide and ozone (d) carbon dioxide and water vapor

3. Which two molecules prevent harmful UV radiation from penetrating to the surface?
   (a) nitrogen and oxygen (c) oxygen and ozone
   (b) carbon dioxide and ozone (d) carbon dioxide and water vapor

4. Which heat transfer mechanism propagates energy from the sun to reach Earth?
   (a) advection (b) convection (c) conduction (d) radiation

5. Without an atmosphere, Earth's daytime temperatures would be much hotter and its nighttime lows would be much colder. (True / False)

6. If the temperature of an object doubles, then the wavelength of maximum radiation that is emitted by the object would _____?
   (a) increase by a factor of 2 (b) decrease by a factor of 2 (c) increase by a factor of 16 (d) decrease by a factor of 16

7. If the temperature of an object doubles, then the total radiation that is emitted by the object would _____?
   (a) increase by a factor of 2 (b) decrease by a factor of 2 (c) increase by a factor of 16 (d) decrease by a factor of 16

8. If an air parcel's temperature remains constant but its density doubles, then its pressure would _____?
   (a) increase by a factor of 2 (b) decrease by a factor of 2 (c) increase by a factor of 16 (d) decrease by a factor of 16

9. Which process cools the surrounding environment?
   (a) condensation (Gas → Liquid) (b) evaporation (Liquid → Gas) (c) deposition (Gas → Vapor)

10. Raindrops falling from clouds can evaporate before hitting the ground. (True / False)

11. If the air temperature is 60° F and the dew point temperature is 30° F, what percentage of the air is composed of water vapor?
   (a) 50% (b) 30% (c) less than 4 %

12. When you can "see your breath" on a cold morning, you are seeing an air parcel that contains _____.
    (a) a high concentration of water vapor coming from your mouth
    (b) a low concentration of O_2 coming from your mouth
    (c) a high concentration of CO_2 coming from your mouth
    (d) tiny droplets of liquid water

13. Albuquerque NM is 1631 m (5352 ft) above sea level. Las Vegas NV is 663 m (2174 ft) above sea level. Which city will have the lowest station air pressure measured with a barometer?
    (a) Albuquerque (b) Las Vegas (c) sometimes Albuquerque, sometimes Las Vegas.

14. Sea level pressure that is plotted on a surface weather map for Las Vegas is _____ than the station pressure measured with a barometer.
    (a) always lower (b) always higher (c) sometimes lower, sometimes higher

15. Higher than about 20,000 ft above sea level, people have trouble breathing. The main reason is that the _____.
    (a) air pressure and density are too low to get enough oxygen
    (b) air temperature is too cold to breathe
    (c) percentage of oxygen molecules in the air drops below 21%
    (d) ozone levels are too high

16. The geostrophic wind results from a balance between which two forces?
    (a) Coriolis-friction (b) Coriolis-pressure gradient (c) Friction-pressure gradient (d) Coriolis-centripetal

17. Consider a glass of ice water. If no water condenses onto the outside of the glass, the dew point temperature of the air would most likely be?
    (a) Below 0° C (b) Exactly 0° C (c) Above 0° C

18. Why does a metal object at room temperature (70° F) often feel colder to the touch than a wooden object at a same temperature?
    (a) Metal is a better heat conductor than wood
    (b) Wood is a better heat conductor than metal
    (c) Metal is a better radiator than wood
    (d) Wood is a better heat convector than metal

19. On a given day, the wind chill equivalent temperature in Chicago IL is lower than it is in Boston MA. Which of the following MUST be true?
    (a) The air temperature in Chicago is lower than it is in Boston
    (b) The wind speed in Chicago is faster than it is in Boston
    (c) The rate of heat loss from the human body is slower in Chicago than it is in Boston
    (d) The rate of heat loss from the human body is faster in Chicago than it is in Boston

20. On a given day, the heat index in Atlanta is higher than it is in Tucson. Which of the following MUST be true?
    (a) The air temperature in Atlanta is higher than it is in Tucson
    (b) The dew point in Atlanta is higher than it is in Tucson
    (c) The rate of heat loss from the human body is slower in Atlanta than it is in Tucson
    (d) The rate of heat loss from the human body is faster in Atlanta than it is in Tucson

Use the table of saturation mixing ratios to answer questions the next three questions. This is the same table you used in homework #3.

21. If the air at a temperature of 100° F and a dew point temperature of 60° F, then the relative humidity would be closest to?
    (a) 16% (b) 26% (c) 36% (d) 46%

22. If the air temperature is 70° F and the relative humidity is 85%, then the dew point temperature would be closest to?
    (a) 35° F (b) 45° F (c) 55° F (d) 65° F

23. If the air temperature is 80° F and the wet-bulb temperature is 59° F, then the actual mixing ratio would be?
    (a) 5.28 g/kg (b) 7.74 g/kg (c) 11.10 g/kg (d) 22.43 g/kg

24. If the wet-bulb temperature is 65° F and the saturation mixing ratio is 13.38g/kg, then the dew point temperature would be?
    (a) below 65° F (b) above 65° F (c) exactly 65° F

Temperature (ºF)	Saturation Mixing Ratio (g/kg)	Temperature (ºF)	Saturation Mixing Ratio (g/kg)
5	1.21	55	9.32
10	1.52	60	11.19
15	1.89	65	13.38
20	2.34	70	15.95
25	2.88	75	18.94
30	3.54	80	22.43
35	4.33	85	26.48
40	5.28	90	31.16
45	6.40	95	36.56
50	7.74	100	42.78

Locate the five points labeled A, B, C, D and E on the 84 hour, 500 mb forecast map (left); use that map and the February climatology map (right) to answer the following six questions.

25. Which point is located under a trough? **C** (By far, the best choice. It is located in the largest negative height anomaly.)

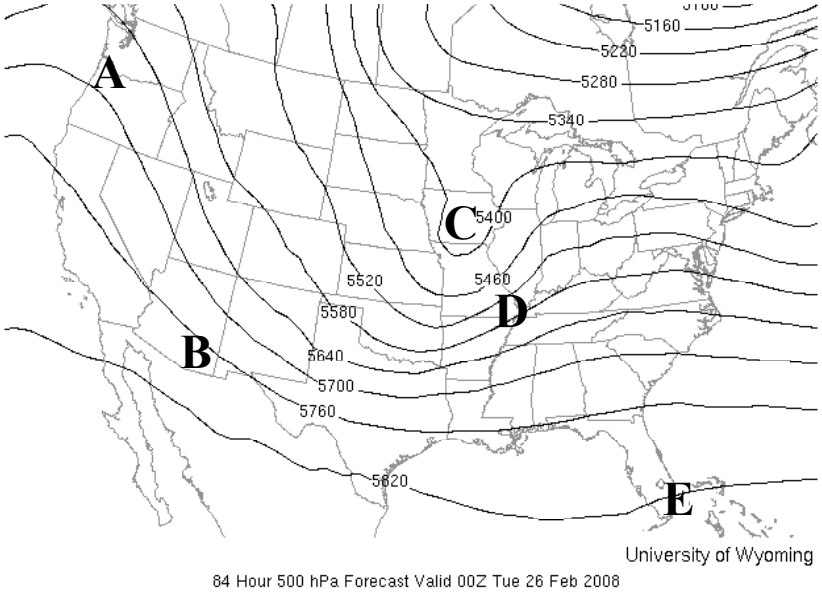
26. At which point would you expect temperatures to be the *most above average*? **A** (Location of the largest positive height anomaly)

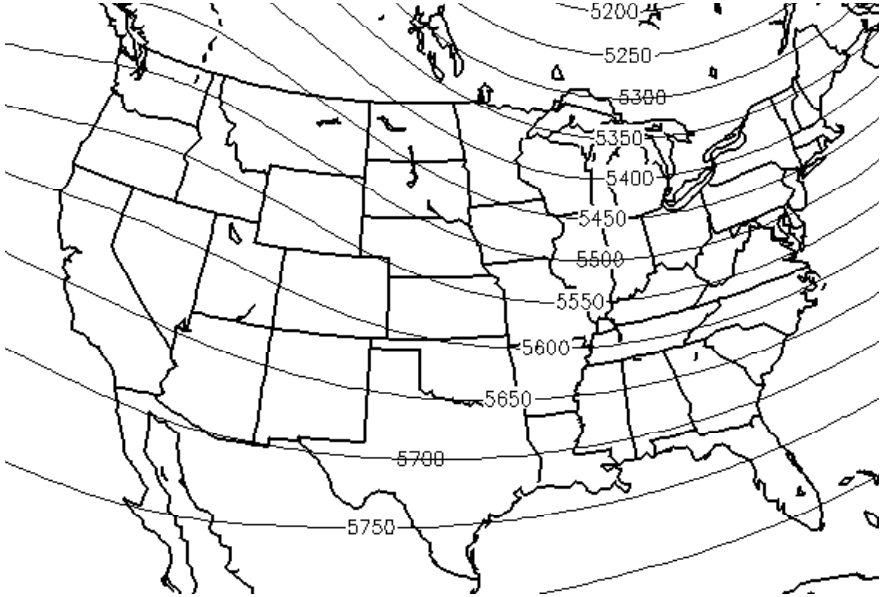
27. At which point would you expect the best chance for precipitation? **D** (Downwind of the trough)

28. At which point would you expect to find the fastest winds at 500 mb? **D** (Tightest spacing between height contours)

29. This map is forecast for 00Z on Tuesday, Feb 26. What is the local time in Tucson?
    (a) 12 AM, Feb 26 (b) 12 PM, Feb 26 (c) 5 AM, Feb 26 (d) 5 PM, Feb 25

30. What type of weather would you predict for Tucson AZ, point **B**?
    (a) Sunny, cool (b) Sunny, warm (c) Rainy, cool (d) Rainy, warm





<u>Short Answer Questions</u> (Select 4 of the 7 Questions) -- 5 Points Each

Write your answers on the attached blank sheet(s). Let us know if you need more paper. Your answers should be concise and to the point. No more than a few sentences (2 or 3) should be needed. Make sure you answer all parts of each question. **Points will be deducted for incorrect or unnecessary statements in your answer, even if the correct answer is found somewhere**. Use legible penmanship; if the graders can't read it, then they can't (and won't) award credit. Be sure to clearly indicate which 4 questions you would like graded.

1. Explain why winds only 10 m above the ground tend to blow from higher to lower pressure, but they do not more than 1 km above the ground.

   Winds are geostrophic above 1 km elevation, and the geostrophic wind blows perpendicular to the pressure gradient force (PGF). At 10 m above ground level, friction slows the wind speed to below the geostrophic value, which in turn makes the Coriolis force smaller than the PGF; the imbalance between the PGF and Coriolis forces would accelerate the air to lower pressure.

2. Cyclones can deepen only underneath regions of upper-level divergence. Explain why divergence is necessary for a cyclone to develop.

   Deepening, or decreasing surface pressure, can occur only if the total mass in the air column directly over the cyclone decreases with time. Only net divergence in the column can evacuate air from the column.

3. The color of an electric coil on a stove top changes colors from red, to orange, then yellow as it is warms up to the full setting. Explain why.

   Wien's Law states that the wavelength of maximum radiation emission becomes shorter as the temperature increases. Red light corresponds to a longer wavelength than orange light, which in turn corresponds to a longer wavelength than yellow light.

4. A thermos contains a "dead" air space (i.e. still air) between its reflective inner liner and its outer case. Explain the two main ways that its construction serves to impede heat transfer from the hot contents that are inside the liner to the colder air that is outside the thermos' shell.

   Air has a very low specific heat capacity, which means conductive heat transfer between the liner and outer shell would be small. Still air implies that convective heat transfer, which requires fluid motion for mass exchange, would be close to zero.

5. People who move to the desert southwest from much more humid and much colder regions of the United States often say things like "40° (Fahrenheit) sure feels a lot colder here than it did back home." There is actually some truth to this statement. Keeping in mind that even when you are not obviously sweating, water is constantly moving from tissues beneath the skin to the skin surface, explain the above perception. (NOTE: I am not looking for answers like "their blood thins" or "those folks just aren't used to cold anymore.")

   The evaporation of water from your flesh occurs at a faster rate in dry air (all other factors being equal). Evaporation requires heat from the surrounding environment, which is supplied by your flesh. You would feel this as a colder temperature.

6. In sauna rooms, people can spend several minutes in conditions of air temperature over 90° C (194° F) with a relative humidity near 10%. However, if you stick your arm into liquid water that is at a temperature of 90° C (194° F), you would be severely burned in much less than one minute. Give two reasons why people are able to spend time in a sauna, but they are severely burned by water at the same temperature.

   1) Sweating would be a very effective cooling mechanism in hot arid air, but it cannot exist if your arm is submerged in water. 2) Water has a much higher heat capacity than air. Thus, water would cool at a very slow rate in response to heat transfer from to your arm compared to the air next to your arm.

7. List the two main ways that the human body responds to heat stress (body core temperature getting too high) and briefly describe how they work. List the two main ways the human body responds to cold stress (core temperature getting too low) and briefly describe how they work.

   Fighting hyperthermia: 1) Increased sweating would increase evaporative cooling. 2) Vasodilation would increase blood flow and heat transport from the body core to the extremities, and thus it would cool the body core.

   Fighting hypothermia: 1) Involuntary shivering increases metabolism, which generates internal heat. 2) Vasoconstriction would reduce blood flood and heat transport from the body core to the extremities, and thus it would slow the rate of cooling.