

**AT350**  
EXAM #2  
October 16, 2003

Name and ID: \_\_\_\_\_

Enter your name and student ID number on the answer sheet and on this exam. Record your answers to the questions by using a No. 2 pencil to completely fill the appropriate circle on the answer sheet. The exam will be computer graded, so be sure to follow the marking instructions provided on the answer sheet. The exam is closed book, closed notes. When you are finished, turn in both the exam and the answer sheet to the teaching assistants. Good luck!

**NOTE THE USEFUL INFORMATION FOUND ON THE LAST SHEET OF THE EXAM.**

- 1) If the air temperature remains constant, condensing water vapor into liquid will \_\_\_\_ the dew point and \_\_\_\_ the relative humidity.
  - a) increase, increase
  - b) increase, decrease
  - c) decrease, increase
  - d) decrease, decrease
  
- 2) Suppose a parcel of saturated air has an air temperature and dew point of 5° C, and a parcel of unsaturated air has an air temperature of 30° C and a dew point of 3° C. The saturated air contains \_\_\_\_ water vapor and has a \_\_\_\_ relative humidity than the unsaturated air.
  - a) more, lower
  - b) more, higher
  - c) less, lower
  - d) less, higher
  
- 3) Which of the following is the best indicator of the actual amount of water vapor in the air?
  - a) air temperature
  - b) saturation vapor pressure
  - c) relative humidity
  - d) dew point temperature

- 4) Suppose it is a winter night and at about 8 pm the air cools to the dew-point temperature and a thick radiation fog develops. Assume the mass of the fog does not change. If the air starts to warm during the night, the dew point temperature will probably:
- a) decrease as the air becomes drier
  - b) decrease as the air becomes moister
  - c) increase as the air becomes drier
  - d) increase as the air becomes moister
  - e) stay the same
- 5) Under what circumstances could the relative humidity exceed 100 percent without producing fog?
- a) the dew point is higher than the air temperature
  - b) the air is perfectly dry
  - c) there are no condensation nuclei present
  - d) there are too many electrically-charged ions in the air
- 6) Which clouds produce precipitation that reaches the ground?
- a) cirrostratus
  - b) nimbostratus
  - c) cumulonimbus
  - d) a, b, and c
  - e) b and c
- 7) In middle latitudes, which cloud will have the lowest base?
- a) cirrostratus
  - b) stratocumulus
  - c) altocumulus
  - d) cirrus
- 8) Which fog are you most likely to observed over a lake in Minnesota during fall in the early morning?
- a) Advection fog
  - b) Radiation fog
  - c) Evaporation (mixing) fog
  - d) Upslope fog
- 9) The cold feeling that you experience after leaving a swimming pool on a hot, dry, summer day is due to:
- a) conduction
  - b) convection
  - c) radiation
  - d) latent heat

- 10) A cloud cools the surface through \_\_\_\_ but warms the surface through \_\_\_\_.
- absorption and reemission of longwave radiation; reflection of solar radiation
  - precipitation; reflecting the earth's heat
  - reflection of the earth's radiation; reflection of solar radiation
  - reflection of solar radiation; absorption and reemission of longwave radiation
- 11) Heat transferred outward from the surface of the moon can take place via (hint: assume the moon has no atmosphere):
- convection
  - conduction
  - latent heat
  - radiation
- 12) If the air temperature increased, with no addition or removal of water vapor, the vapor pressure would:
- increase
  - decrease
  - stay the same
  - become greater than the saturation vapor pressure
- 13) In terms of the water vapor pressure, the least amount of moisture is likely found:
- in central Canada during summer
  - in central Canada during winter
  - in the southeastern US during spring
  - in southern Arizona and New Mexico during summer
- 14) Just above fair weather cumulus clouds you would expect to find
- A stable layer
  - An unstable layer
  - A conditionally unstable layer
  - Swimming garden gnomes.
- 15) Which of the following is not a way of producing clouds?
- Lifting air along a topographic barrier
  - Lifting air along a front
  - Warming the surface of the earth
  - Air motions caused by subsidence
- 16) If you were to take a trip during the summer from Ohio to Colorado, you would most likely observe that afternoon cumulus clouds \_\_\_\_ as you travel west
- Have higher cloud bases
  - Are larger
  - Form earlier in the day
  - Are darker in appearance

- 17) A cloud of little vertical development at 5000 meters altitude might be called a:
- a) Stratocumulus
  - b) Altocumulus
  - c) Altostratus
  - d) Cirrostratus
- 18) The proper name of a thunderstorm cloud is
- a) Cumulus humilis
  - b) Cumulonimbus
  - c) Stratocumulus
  - d) Nimbostratus
- 19) Which of the following clouds likely consist of *exclusively* ice particles?
- a) Cirrus
  - b) Cirrocumulus
  - c) Altocumulus
  - d) a, b, and c
  - e) a and b only
- 20) Suppose incident solar radiation (with a wavelength of approximately 0.5 microns) encounters a cloud droplet (with a diameter of approximately 20 microns) and scatters. Which scattering regime best describes this situation?
- a) Rayleigh scattering
  - b) Mie scattering
  - c) Geometric scattering
  - d) Water vapor scattering
- 21) Scattering in the Rayleigh regime preferentially scatters
- a) All wavelengths equally
  - b) Red light predominantly
  - c) Blue light predominantly
  - d) Infrared light predominantly
- 22) A red sunset is caused by \_\_\_\_\_; the blue sky is caused by \_\_\_\_\_
- a) Rayleigh scattering, Mie scattering
  - b) Geometric scattering, Geometric scattering
  - c) Rayleigh scattering, Geometric scattering
  - d) Rayleigh scattering, Rayleigh scattering
- 23) The reason that rising saturated air cools at a lesser rate than rising unsaturated air is:
- a) rising saturated air is heavier
  - b) rising saturated air is lighter
  - c) unsaturated air expands more rapidly
  - d) saturated air has a higher heat capacity
  - e) latent heat is released by rising saturated air

- 24) Which set of conditions, working together, will make the atmosphere the most stable?
- a) cool the surface and warm the air aloft
  - b) cool the surface and cool the air aloft
  - c) warm the surface and cool the air aloft
  - d) warm the surface and warm the air aloft
- 25) Which of the following set of surface conditions would produce a convective cumulus cloud with the highest base?
- a) air temperature 30 °C, dew point 10 °C
  - b) air temperature 25 °C, dew point 15 °C
  - c) air temperature 35 °C, dew point 10 °C
  - d) air temperature 10 °C, dew point 5 °C
  - e) air temperature 25 °C, dew point 5 °C
- 26) What would the air temperature inside a conventional jet airliner be, if outside air at an altitude of 5 km, pressure of 500 mb and a temperature of -40 °C, is brought inside and compressed to a pressure of 1000 mb? (Hint: you may assume that 1000 mb pressure is equivalent to 0 m altitude)
- a) -40 °C
  - b) 10 °C
  - c) -90 °C
  - d) -35 °C
  - e) 40 °C

*For the following questions, use the information provided in the table at the end of the exam:*

- 27) Given a dew point temperature of 13 degrees C and a temperature of 27 degrees C, what is the actual water vapor pressure in the air (rounded to the nearest number)?
- a) 10 mb
  - b) 15 mb
  - c) 25 mb
  - d) 35 mb
- 28) Given a dew point temperature of 13 degrees C and a temperature of 27 degrees C, what is the saturation water vapor pressure of the air (rounded to the nearest number)?
- a) 10 mb
  - b) 15 mb
  - c) 25 mb
  - d) 35 mb

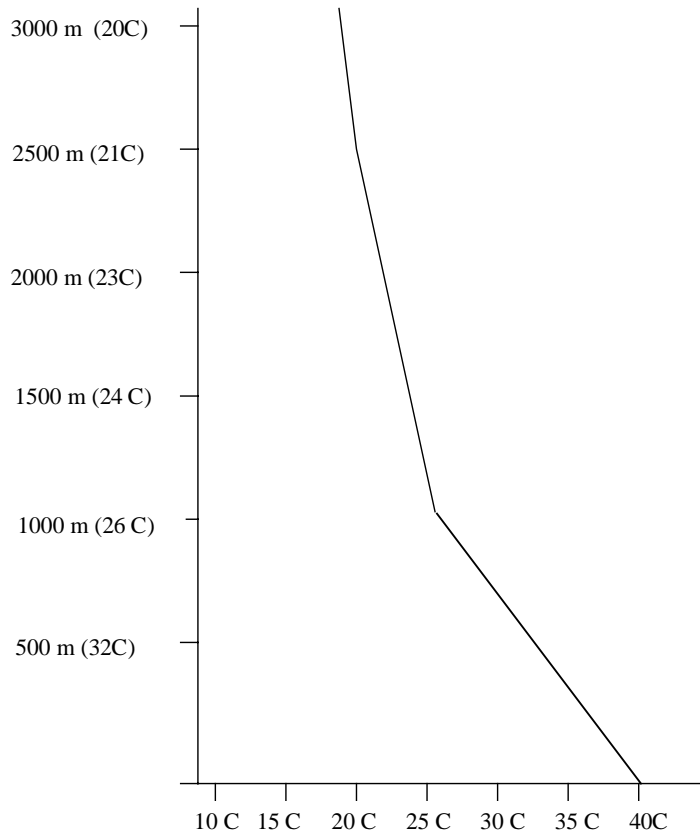
- 29) Given a relative humidity of 80% and actual water vapor pressure of 40 mb, what is the saturation water vapor pressure of the air (rounded to the nearest number)?
- a) 12 mb
  - b) 50 mb
  - c) 25 mb
  - d) 30 mb
- 30) Given a relative humidity of 25% and actual water vapor pressure of 10mb, what is the temperature of the air (rounded to the nearest number)?
- a) 7° C
  - b) 21° C
  - c) 29° C
  - d) 33° C
- 31) Given a relative humidity of 50% and actual water vapor pressure of 10mb, what is the dew point temperature of the air (rounded to the nearest number)?
- a) 18° C
  - b) 7° C
  - c) 21° C
  - d) 15° C

*For the following questions, consider air being pushed up and over a mountain. Use the chart provided at the end of the exam as needed.*

- 32) At an elevation of 0 meters (before the air rises up the mountain), a parcel of air has a temperature of 35 C and dew point temperature of 19 C. What is the approximate relative humidity of the air at this level?
- a) 10%
  - b) 25%
  - c) 40%
  - d) 19%
- 33) As the air rises up the mountain, at what level would you expect to see clouds begin to form?
- a) 0 meters
  - b) 1000 meters
  - c) 2000 meters
  - d) 3000 meters
  - e) clouds would never begin to form
- 34) What is the dewpoint temperature at the level where clouds begin to form?
- a) 35° C
  - b) 19° C
  - c) 15° C
  - d) 25° C

- 35) As the air continues to rise (and water vapor continues to condense), the relative humidity of the air \_\_\_\_\_ while the dew point temperature \_\_\_\_\_.
- a) increases, decreases
  - b) decreases, stays the same
  - c) stays the same, decreases
  - d) stays the same, increases
- 36) Imagine that the top of the mountain is at a level of 3000 meters. What is the relative humidity at this level?
- a) 0%
  - b) 25%
  - c) 75%
  - d) 100%
- 37) What is the dew point temperature at 3000 meters?
- a) 7° C
  - b) 9° C
  - c) 5° C
  - d) 13° C
- 38) What is the temperature of the air at 3000 meters?
- a) 7° C
  - b) 9° C
  - c) 5° C
  - d) 13° C
- 39) Now imagine the air is forced back down the mountain on the other side. At 0 meters, what is the new dew point temperature?
- a) 9° C
  - b) 15° C
  - c) 35° C
  - d) 19° C
- 40) What is the new temperature at 0 meters after the air has descended?
- a) 35° C
  - b) 39° C
  - c) 19° C
  - d) 25° C
- 41) Compared to the air at 0 meters on the windward side of the mountain, the air at 0 meters on the leeward side of the mountain is:
- a) warmer and has a higher water vapor content
  - b) colder and has a lower water vapor content
  - c) warmer and has a lower water vapor content
  - d) at the same temperature and dew point temperature as the air at 0 meters on the windward side of the mountain.

The diagram below shows the vertical profile of the atmospheric temperature on a summer afternoon. The temperature is also indicated for each level at the left side of the figure.



- 42) Assume the air at the surface has a temperature of 40C and dewpoint temperature of 32C. What is the approximate relative humidity at the surface?
- a) 10%
  - b) 65%
  - c) 80%
  - d) 90%
- 43) If the air at the surface is lifted and begins to rise, at what level will clouds begin to form?
- a) 500 m
  - b) 1000 m
  - c) 1500 m
  - d) 2000 m
  - e) Clouds will not form



- 44) At what level will the air stop rising?
- a) 2500 m
  - b) 1000 m
  - c) 1500 m
  - d) 2000 m
  - e) 3000 m
- 45) What will the relative humidity be at 2000 meters?
- a) 10%
  - b) 65%
  - c) 0%
  - d) 100%
  - e) The air will not rise this high.
- 46) Now assume the air at the surface has a temperature of 42C and dewpoint temperature of 26C. What is the approximate relative humidity at the surface?
- a) 10%
  - b) 42%
  - c) 85%
  - d) 1000%
- 47) If the air at the surface is lifted and begins to rise, at what level will clouds begin to form?
- a) 500 m
  - b) 1000 m
  - c) 2000 m
  - d) 3000 m
  - e) Clouds will not form

***Useful information:***

Dry adiabatic lapse rate=10° C / 1000meters

Moist adiabatic lapse rate=6° C / 1000meters

Dew point temperature lapse rate= 2° C / 1000 meters

Tilt of the earth = 23.5 degrees from the axis of rotation

<b>Saturation vapor pressure as a function of air temperature</b>	
Air temperature (degrees C)	Saturation vapor pressure (mb)
2	6.9
4	8.4
7	10.2
10	12.3
13	14.8
16	17.7
18	21
21	25
24	29.6
27	35
29	41
32	48.1
35	56.2
38	65.2
41	76.2
43	87.8
46	101.4
49	116.8
52	134.2