

Name: Answer Key

Atmospheric Science 101, Spring 2003
Midterm 1 Thursday 24 April 2003

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

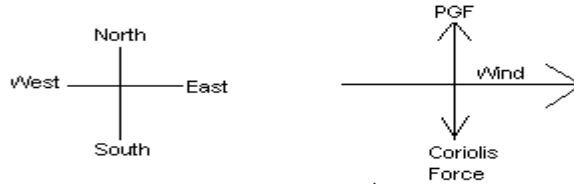
1. The general trend in the troposphere is for temperature to _____ and pressure to _____ with height.
 - a. increase, decrease
 - b. decrease, decrease**
 - c. increase, increase
 - d. decrease, increase

2. The temperature inversion in the stratosphere is caused by:
 - a. thermal updrafts due to convection
 - b. absorption of ultraviolet light by ozone**
 - c. subsiding warm air from the thermosphere
 - d. absorption of infrared light by clouds

3. The least effective form of heat transfer in the atmosphere is:
 - a. conduction**
 - b. convection
 - c. radiation
 - d. they are all equally effective

4. If the Earth's average surface temperature should decrease, the amount of radiation emitted from the Earth's surface will _____, and the wavelength of maximum emission will shift toward _____ wavelengths.
 - a. decrease, shorter
 - b. increase, shorter
 - c. decrease, longer**
 - d. increase, longer

5. Lying in the grass in Montana, you notice that upper-level clouds are moving rather quickly from the west towards the east. In which direction from your location is the upper-level low located?

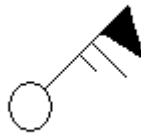


From the balance of forces in the diagram above, and using the fact that PGF points from High pressure to Low pressure...we see that the Low is to the left of the upper-level winds...or to the NORTH in this example.

- a. **north**
 - b. east
 - c. south
 - d. west
6. Which do you think is most likely to be in geostrophic balance?
- a. a sea breeze
 - b. flow around a low at the surface
 - c. **the jet stream**
 - d. flow around a tornado
7. Which of the processes below would act to cool the Earth's climate?
- a. increasing the water vapor content of the air
 - b. **increasing the snow cover around the Earth**
 - c. decreasing the Earth-Sun Distance
 - d. increasing the carbon dioxide content of the air

8. Why is the incoming solar radiation reaching the surface less intense at higher latitudes than at mid-latitudes?
- a. sunlight strikes the surface obliquely at higher latitudes
 - b. sunlight has to travel through a thicker atmosphere to reach the surface at higher latitudes
 - c. sunlight has to travel through increased amounts of pollution at higher latitudes
 - d. choices (a) and (b) are correct**
 - e. choices (a), (b), and (c) are correct
9. The air temperature at the surface is 10°C , and at 1 km it is 2.5°C . If an air parcel is lifted dry adiabatically from the surface to 1 km, and then released, it will:
- a. continue rising
 - b. remain at 1 km
 - c. begin sinking**

Use the following wind barb to answer questions 10 and 11:



10. What is the wind speed?
- a. 40 knots
 - b. 65 knots**
 - c. 25 knots
 - d. 115 knots
11. What direction is the wind coming from?
- a. northeast**
 - b. southwest
 - c. north
 - d. east

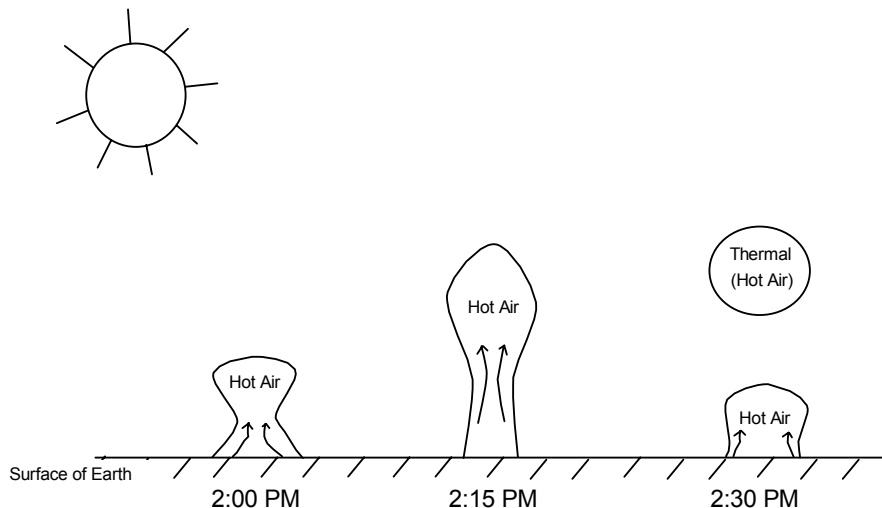
12. Surface winds are not in geostrophic balance due to the effects of:
- a. Gravity
 - b. Increased Coriolis force near the surface
 - c. **Friction at air surface interface**
 - d. Centripetal acceleration
13. What force initially sets air in motion
- a. Coriolis force
 - b. **Pressure gradient force**
 - c. Friction at air surface interface
 - d. Centripetal acceleration
14. As air flows off the Pacific it encounters the Cascade Mountains and is forced to rise. As a parcel of air rises up the western side of the Cascades from Seattle (sea level) to the crest of the Cascades, at 2000 meters, it _____ due to adiabatic _____.
- a. warms, expansion
 - b. **cools, expansion**
 - c. warms, compression
 - d. cools, compression
15. The Earth radiates energy predominantly in what range of wavelengths?
- a. Ultraviolet
 - b. Visible
 - c. **Infrared**
 - d. Microwave
16. An inversion in the troposphere is characterized by:
- a. **temperature increasing with increasing height**
 - b. temperature decreasing with increasing height
 - c. temperature constant with increasing height
 - d. none of the above, inversions only exist in the stratosphere

ANSWER 3 OF THE 4 Short Answer Questions (6 points each):

1. Climbers in Alaska complain that being at 20,000 feet on Denali (in central Alaska, 63°N, 151°W) feels like being at 23,000 feet on Mount Everest (in Nepal, 28°N, 87°E). It is, in fact, more difficult for our bodies to function at 20,000 feet on Denali than at 20,000 feet on Mount Everest because the air pressure at that height is lower on Denali than on Everest. Based on their locations, explain why this pressure difference exists.

Denali (in Alaska) is at a higher latitude than Mt. Everest, so the air around Denali is usually colder than the air around Everest. Since cold air is denser, the pressure decreases more quickly as you move up in cold air than in warm air, so by the time you reach 20,000 feet, the pressure has decreased more (and is therefore lower) at Denali than at Everest.

2.



The above figure is a pictorial description of the formation of a thermal. Describe the roles of conduction, convection and radiation in this process.

The initial step in the formation of a thermal is that the Earth's surface warms due to incoming solar *radiation*. The heated surface then warms a thin layer (depth of a few cm) of air that comes into contact with it through *conduction*, which is a molecule-molecule heat exchange process. Finally, once the air adjacent to the surface has been warmed, it becomes less dense than the surrounding air and begins to rise via *convection*, as it is buoyant. This rising pocket of warmed air is a thermal.

3. Would adding ice at 0°C cool a glass of water more efficiently than adding an equal amount of liquid water at 0°C? Explain your reasoning.

The Ice

Energy (latent heat) is required to undergo a phase change. (see figure 2.2 EOM). In order for the ice to melt (solid to liquid transition) energy is taken from the surrounding water. As a result the added ice more efficiently cools the water in the glass.

NOTE: Convection occurs only in the case of the added ice. As the cold water is poured into the glass of water it will sink (cold fluid is denser) and come to rest at the bottom. At this point the method of heat transfer acting is conduction. On the other hand, Ice floats. Therefore as the ice melts cold water will be released above warm water. This is an unstable configuration and convection will ensue.

4. If the Earth's rotation sped up such that a day lasted 12 hours instead of 24 hours, how would the daily cycle of temperature change? Name 2 other factors can influence the daily temperature range.

If the Earth's rotation sped up so that a day only lasted 12 hours instead of 24 hours, this would limit daytime heating to 6 hours and nighttime cooling to 6 hours. Since the daytime would not have as much time to heat up, the daytime high temperatures would decrease. During the nighttime, in which there would only be 6 hours to cool instead of 12 hours, the low temperatures would not be able to cool as much so they would be higher. Therefore, the daily range in temperature would decrease, as high temperatures would be lower, and low temperatures would be greater.

Other factors that can influence the daily temperature range include: clouds vs. clear skies, windy vs. calm, if the particular location is near a body of water... and many others were accepted.