University of Massachusetts Lowell

Environmental, Earth & Atmospheric Sciences

84.141.201 Weather & Climate Spring 2002 Dr. Leo McNamara

Chapter 1

1. Meteorologists use 6 “elements” to describe the atmosphere. Name the missing one
   - Pressure
   - Amount & type of precipitation
   - Type & amount of cloudiness
   - Speed & direction of the wind
   - Humidity of the air
   - **& what?**
2. Name the missing sphere in the following list
   - Atmosphere
   - Lithosphere
   - Biosphere
   - ????
3. List the 4 gases that make up most of the atmosphere, in **de**creasing order of abundance:

4. Name the 2 sources of the heat that affect the atmosphere:

5. True or False: The temperature decreases as you go higher into the stratosphere

6. What gas is converted to what other gas in photosynthesis by plants & trees?
   is converted to . (fill in the spaces)
7. What is the gas that protects us from the extreme ultra-violet radiation from the Sun?

8. How high up do you have to go in the atmosphere for the pressure to drop to one half of its value at the ground?

9. What is the normal atmospheric pressure at the ground, in mb?

10. What is the value of the “normal lapse rate”?

Chapter 2

1. Why do we have seasons?

2. At what latitude is the Sun overhead at noon on September 22?

3. What is the noon Sun angle at Sydney (latitude 34^{O}S) on June 22?

4. The temperature of the solar photosphere is 6000 K, and the temperature of the Earth is 300 K. Use Stefan's Law ($W = \sigma T^4$) to calculate the ratio of the energy emitted by the Sun to the energy emitted by the Earth. What is this ratio? (You do not need to know the value of the Stefan-Boltzmann constant)

5. Wien's Law says that the wavelength of the most intense electromagnetic radiation from a body at temperature T is given by $\lambda_{max} = 2898/T$, if the wavelength is measured in μm. What is the wavelength at which the Sun radiates most of its energy?

6. Mark each of the following as True or False:

   - The albedo of the Earth varies from place to place and from time to time. On average, it is 80% (reflections - 20% by clouds; 55% by land/sea; 5% back-scatter)
   - Fresh snow has a very high albedo
   - Scattering by the atmosphere depends on $1/\lambda^4$ (true). Red light is scattered more than blue.
   - Blue sky is caused by scattering of the blue part of the Sun's white light.
   - Red sunsets are caused by red dust in the atmosphere.

7. Which mechanism of heat transfer is LEAST important in the atmosphere?

8. True or False: The Sun heats the atmosphere, which then heats the Earth's surface.

9. In what latitude range is the heat surplus in June?

10. Mark each of the following as True or False:

    - Clear nights in Winter at Lowell are colder than cloudy nights.
    - The greenhouse effect is caused mainly by water vapor
    - All electromagnetic radiation travels at $3x10^8$ km/hour
    - Without the greenhouse effect, the Earth would be about 30^{O}C cooler.

Chapter 3

1. Which of the six controls of temperature has most effect on the temperature at a location?

2. What are the lines joining places on a map that have the same temperature called?

3. True or False? Water in lakes is always colder in Winter than the surrounding land because water can freeze, and land cannot.

4. Which transfers more heat from the tropics to the poles - ocean currents or winds?

5. True or False: Land shows more extremes in temperature than water does.

6. When does the maximum temperature occur during a day (mark the correct answer):

   1. At noon
   2. Middle of the afternoon
   3. Just after the Sun goes down

7. True or False? The temperature range for a windward coast is usually small because the air is warmed by the sea, which experiences only a small temperature change during the day

8. Give two reasons why cities are warmer than the surrounding countryside:

   -
   -

9. On the Celsius temperature scale, what is the boiling point of water?

10. What is the temperature in degrees Celsius corresponding to 100^{O} Fahrenheit?

Chapter 4

1. True or False - Latent heat is the heat needed to raise a substance's temperature so that it will change its state.

2. The water vapor content of the atmosphere is expressed in five ways:

   Absolute Humidity, Mixing Ratio, Vapor Pressure, Relative Humidity, Dew Point

   Circle the two that are most useful to meteorologists. DO NOT CIRCLE MORE THAN 2!!

3. True or false? Air with a high relative humidity contains more water vapor than air with a lower relative humidity.

4. True or false? The relative humidity at a location is usually lowest at sunrise.

5. True or false? An adiabatic temperature change is the change in temperature that causes the air to lose all of its water vapor.

6. What is it that makes the wet adiabatic rate lower than the dry adiabatic rate?

7. True or false? (3 questions)

   Oragraphic lifting occurs when air flows over the warm sea, and therefore gets warmer?

   Frontal wedging occurs when cold air rides up over the top of warm air.

   Convergence occurs when a pileup of horizontal air flow results in an upwards movement

8. If an air parcel is cooler than the surrounding air, is the parcel stable or unstable?

9. Mark the wrong one. Instability is enhanced by
   :
   Intense solar heating warming the lower-most layer of the atmosphere
   The heating of an air mass from below as it passes over a warm surface
   Oragraphic lifting
   Radiation warming of the cloud tops

10. If an unsaturated air parcel is forced up from the ground which is at a temperature of 25^{O}C, what will the temperature of the air parcel at 2 km? (The environmental lapse rate is 6.5^{O}C/km. The wet adiabatic rate is 5^{O}C/km. The dry adiabatic rate is 10^{O}C/km.)