

Name: _____

NATS 101 Introduction to Weather and Climate, Section 54, Fall 2005
Quiz #1: Thursday, 22 September 2005.

Earth's Energy Budget [10]

- ___ **c** ___ 1. The earth's energy peaks in which region of the electromagnetic spectrum? [5]
- Visible.
 - Ultraviolet (UV).
 - Infrared (IR).**
 - Microwave.

2. What is the distinction between the "atmospheric greenhouse effect" and the "enhanced greenhouse effect"? Use the terms "selective absorbers" and "atmospheric window" in your answer. [5]

The greenhouse effect is the warming of the earth by the atmosphere, which is in addition to the warming it receives by the sun. Thus, the earth is warmer than it would be without the atmosphere present. Gases in the atmosphere that absorb the earth's IR radiation and emit it back to the surface are called greenhouse gases. These gases are "selective absorbers" because they only absorb and emit radiation within a particular region of the electromagnetic spectrum - the IR region. The portion of the IR spectrum where the atmosphere does not absorb is called the "atmospheric window".

The enhanced greenhouse effect is the increased warming of the earth by enhanced levels of greenhouse gases in the atmosphere. Greenhouse gases added to the "atmospheric window" are particularly effective, since IR from the earth, normally escaping to space through this "window", is trapped by these gases.

Seasons [15+6]

- ___ **b** ___ 3. Which day is the longest day in Tucson?
- December 23.
 - June 21.**
 - March 20.
 - May 22.

- ___ **a** ___ 4. The time of year in the previous question is called,
- Summer solstice.**
 - Winter solstice.
 - Indian Summer.
 - Vernal equinox.

- ___ **d** ___ 5. Despite the 24-hour sunlight, which of the following help explain why the North Pole is colder than locations farther south in June.
- Solar energy is spread over a larger area in the northern latitudes.
 - Some of the sun's energy is used to melt frozen soil in the northern latitudes.
 - Some of the sun's energy is reflected by snow and ice in the northern latitudes.
 - All of the above.**

E.C.. The Tropics are located between what two latitudes? This is due to what? [6]

Tropic of Cancer (23.5°N) and Tropic of Capricorn (23.5°S) [Actual degrees latitude or names were acceptable.] Regardless of the earth's tilt, the sun's rays are the most overhead (least oblique) between these two latitudes, providing more direct sunlight than at higher latitudes. Thus, this region has a small annual cycle and high annual average temperatures.

Daily, Monthly, and Annual Temperature Variability [45]

___ **a** ___ 6. The largest annual range of temperatures are found

- a. **at polar latitudes over land.**
- b. at polar latitudes over water.
- c. at middle latitudes near large bodies of water.
- d. at the equator.

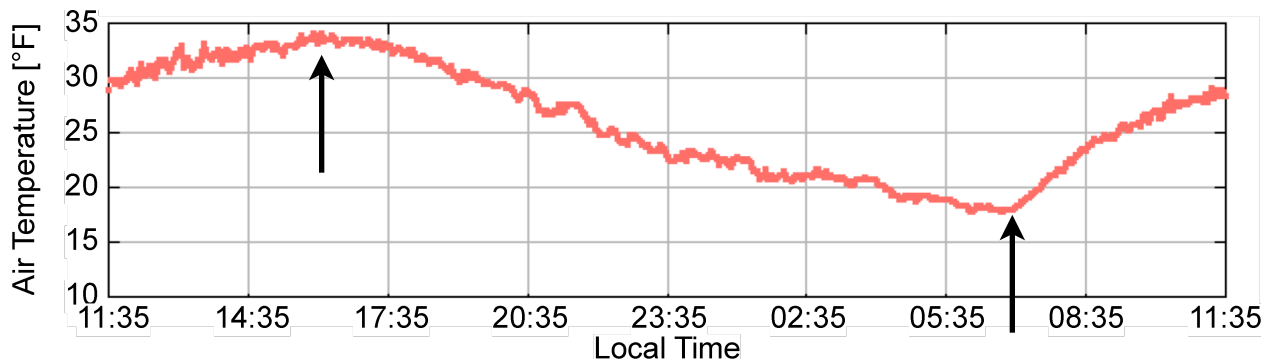
___ **b** ___ 7. Thermal belts are,

- a. pockets of warm air resting on a valley floor during the afternoon.
- b. **warmer hillsides that are less likely to experience freezing conditions.**
- c. pockets of cold air resting on a valley floor at night.
- d. cold, below-freezing air found at the top of a mountain.

___ **d** ___ 8. Over the earth as a whole, one would expect to observe the smallest variation in temperature from day to day and month to month:

- a. at the North Pole.
- b. in the center of a large land mass.
- c. along the Pacific coast of North America.
- d. **on a small island near the equator.**

Use the following graph of the daily cycle of air temperature for Tucson to answer questions 9 and 10.



9. At approximately what time did the sun rise in Tucson on this day? [5]

~7:00 AM (arrow on the right)

10. Between approximately what **times** was the desert surface losing radiation at a greater rate than it was absorbing it? [5]

~4:00 PM - 7:00 AM (between the arrows)

11. Give two reasons why San Francisco has a smaller daily and annual range in temperature than Denver? (Why does San Francisco have a milder climate?) [8]

SF is a coastal city. Coastal climates are more mild, have less of a temperature range both diurnally as well as seasonally, than inland climates like Denver.

Denver ("Mile High" city) is at a higher elevation than SF, and therefore has more extreme temperature ranges than a city at sea level.

12. a. Explain why a temperature inversion forms near the earth's surface on calm, clear **nights**. Use radiation and conduction in your answer. [8]

At night, both the atmosphere and earth's surface are cooling radiatively. However, the earth cools at a faster rate than the atmosphere, causing its temperature to drop more rapidly and to a lower temperature than the air above it. The air in contact with the colder surface loses heat through conduction to the surface, making it colder than the air not in contact with the surface.

b. How would wind affect your answer to part a.? [4]

Wind mixes the air, reducing the amount of time any air mass is in contact with the cool surface, thus reducing the amount of heat loss to the ground. Since the air is mixed, any heat loss that does occur is going to be similar for all the air masses throughout the lowest few feet/meters of the atmosphere, so no temperature difference with height is observed.

Apparent Temperature [15+3]

a 13. The wind-chill index

a. relates body heat loss with wind to an equivalent temperature without wind.

b. indicates the temperature at which water freezes on exposed skin.

c. takes into account humidity and air temperature in expressing the current air temperature.

d. tells farmers when to protect crops from a freeze.

b 14. Hypothermia is most common in

a. hot, humid weather.

b. cold, humid weather.

c. hot, dry weather.

d. cold, dry weather.

c 15. The following factor(s) explain why the water off the coast of San Diego (~70°F) feels colder than 70°F air temperatures:

- a. air convects heat better than water.
- b. water radiates more effectively than air.
- c. water is a better conductor than air.**
- d. air is a better conductor than water.

E.C. A liquid-in-a-bulb thermometer in the thermosphere will not measure 300°C. Explain. [3]

A liquid-in-a-bulb thermometer measures temperature by having the bulb containing the liquid in contact with air molecules. This contact permits conduction of heat from the air to the liquid in the bulb. [Conduction is the transfer of heat through molecular interaction, where a hotter substance with more energetic molecules imparts energy to a colder substance with less energetic molecules, thereby warming the colder substance up.] As the liquid in the bulb warms, it expands. The amount of expansion indicates the liquid's temperature. Once in equilibrium with its surroundings, the temperature of the liquid is the same as that of the air.

In the thermosphere, even though the air molecules have a very high kinetic energy, and thus a high temperature, there are so few of them (air not very dense), that they do not come in contact with the bulb of the thermometer very often. Thus, air at this altitude cannot transfer heat to another substance very efficiently. It is a poor conductor.

Temperature Measurement [15+3]

 d 16. Which of the following is a liquid-in-a-bulb thermometer?

- a. thermister.
- b. radiometer.
- c. bimetallic thermometer.
- d. maximum thermometer.**

 b 17. An instrument that measures temperature by measuring emitted infrared radiation is called a,

- a. thermister.
- b. radiometer.**
- c. bimetallic thermometer.
- d. maximum thermometer.

 b 18. When a liquid thermometer is held in direct sunlight,

- a. it will accurately measure the air temperature.
- b. it will measure a much higher temperature than that of the air.**
- c. it will measure a much lower temperature than that of the air.
- d. it will measure the temperature of the sun.

E.C. What type of instrument of those mentioned in your book is used to measure sea surface temperature? [3]

radiometer