MET 200: Atmospheric Processes and Phenomena Due: 19 September 2013
Fall Semester Name: _____
Businger **Homework Assignment #1**

1. (20 pts) The International Space Station has an interior pressure just about equal to that at sea level on Earth, 100 kPa. In building the ISS, the designers want to calculate how many bolts are needed to hold a small door to outer space in place. The door is rectangular with dimensions 2 m high x 1.5 m wide.

(a) What is the pressure on the inside of the door (i.e. the pressure wanting to push the door outwards)? What is the pressure on the outside of the door?
(b) What, then, is the force on the inside of the door? What is the force on the outside of the door?
(c) If each bolt can hold 30 kN of force before breaking, then what is the minimum number of bolts needed to make sure this door holds?
(d) Does the answer depend on the orientation of the ISS, i.e. if the door points at Earth, or away from Earth, or in any other direction? Why?

2. (20 pts) a. Calculate escape velocity for a satellite launched from Earth. Use the universal law of gravitation. $G=6.67\times10^{-11}$ Nm^2 kg^{-2} and mass of Earth = 5.98 x 1024 kg, radius = 6.37 x 10^6 m,
b. Give an example of an <u>active</u> remote sensing instrument carried on a satellite.
c. What type of satellite (e.g., orbit) would this type of instrument most likely be flown on? Why?

3. (20 pts) a. Calculate the height (in km) of a geostationary orbit given:
angular frequency of the Earth's rotation = 7.29 x 10^{-5} s^{-1},
mass of Earth = 5.98 x 1024 kg, radius = 6.37 x 10^6 m,
universal gravitational constant = 6.67 x 10^{-11} Nm^2 kg^{-2}
Show your work
b. What are two practical advantages of a geostationary orbit?
c. What are three disadvantages of a geostationary orbit?

4. (10 pts) Consider a pot of water that contains 7 L of water at 25°C.
(a) Calculate the amount of energy that is needed to bring this water just to a boil.
(b) Find the energy necessary to evaporate all of the liquid.
(c) From the time the pot is put on the burner until it is completely dry, find the amount of time required if the burner outputs 2500 W.

5. (10 pts) If the Earth's tilt were 30° rather than 23.5°, discuss whether or not the following would change, how they would change, and why. Draw diagrams for each.
(a) Summertime and wintertime temperatures
(b) Position of the sun during the equinoxes
(c) Length of day during the solstices
(d) Position of the arctic circle

6. (10 pts) As the Earth warms, the amount of permanent ice (such as glaciers and ice sheets) as well as seasonal ice (ground-level snow, much of the Arctic ice cap) decreases. If we instantly removed all of this ice and snow from the Earth's surface, the albedo of the Earth would decrease from 0.30 to 0.28. Estimate how much the Earth's average surface temperature would *increase* if this occurred. (ignore the atmosphere's greenhouse effect, just do a radiation balance without an atmosphere).

7. (10 pts) What type of radiation (e.g. x-rays, microwaves) is primarily associated with each of the following phenomena. Use Wien's Law to calculate the wavelength of peak radiation emission:
(a) Sunlight
(b) Earth's reflected radiation
(c) Earth's surface emitted radiation
(d) Emitted radiation by greenhouse gases in the troposphere (water vapor at ~ 400 mb).