Name: _____

Astronomy 141
Winter Quarter 2012

Homework #2

Due Wednesday, February 1 in class

Instructions

This handout is your worksheet. Please write your answers in the spaces provided. In cases where a calculation is called for, please show your work including any sketches, so we can evaluate your answer and assign partial credit as appropriate. Answers given without showing at least some of the calculation will receive no credit. We will only accept homework turned in on this worksheet.

This homework assignment consists of the 4 problems below. Each question has equal weight.

1. The air pressure in the Earth's atmosphere drops by half (50%) for every 5600-meters you go up in altitude above sea-level. Answer the following:

   a. What is the outside air pressure seen by an intercontinental airplane flight cruising at an altitude of 11.2 km? Express your answer as a fraction of the sea-level pressure.

   b. At what altitude in kilometers is the air pressure 1/128 of the sea-level pressure?

   c. NASA defines an "astronaut" to be a person who has flown above an altitude of 80km. What is the outside air pressure seen by an astronaut flying at 84 km altitude? Express your answer as a fraction of the sea-level pressure.

2. For each of the following living organisms, tell me if they are chemoautotrophs, photoautotrophs, chemoheterotrophs, or photoheterotrophs and why (1 sentence each). Note that not all of these possibilities are necessarily represented by the organisms listed below.

   a. House Cat (*Felis catus*):

b. A hyperthermophile Bacterium (*Methanopyrus kandleri*) living near a deep-sea vent:

c. Portabella Mushroom (*Agaricus bisporus*):

d. Ohio Buckeye Tree (*Aesculus glabra*):

3. The mean surface temperature of the Earth today is about 290K (17°C). Astronomers estimate that during the Hadean and early Archaean Eons, the young Sun was only 70% as bright as it is today. A 30% decrease in the Sun's brightness would result in an 8.5% drop in the Earth's mean temperature.

   a. If the young Sun were only 70% as bright as it is today, what would the mean temperature of the young Earth be in Kelvins (K)?

   b. Compare your estimated temperature in part (a) to the freezing point of water (273K = 0°C). Express your answer quantitatively. Would you expect water on Earth to be liquid or frozen?

   c. Geological evidence shows that there has been liquid water on the Earth since at least the late Hadean (3.5 Gyr ago). The results in parts (a) and (b) present us with an apparent paradox. What other factors besides the amount of heating by sunlight might act to allow for conditions where liquid water could exist on the young Earth?
   [**Hint**: compare the composition of the Earth's atmosphere during the late Hadean Eon to its composition today?]

4. Impacts by asteroids and comets were a major factor in the early history of the Earth, and could still hit Earth today (it just happens much more rarely).

   Imperial College London has put a very nice set of Earth Impact Effects calculators on the web. The calculators estimate the damage (seismic, blast, crater, ejecta, etc.) of an asteroid or comet hitting the Earth.

   For this problem I am having you use the damage-map version of the calculator. The web address is impact.ese.ic.ac.uk/ImpactEffectsMap/. Your web browser will need to have the free Google Earth plug-in installed (www.google.com/earth/explore/products/plugin.html). Clicking this link will tell you if you already have the plug-in on your computer, or let you download it if you don't.

   The asteroid for this problem will hit the Earth at this location:
   Latitude **42.26584** degrees (north)
   Longitude **-83.74865** degrees (West) – note the minus (-) sign!

   To constrain the problem, setup the calculation for the following parameters:
   Projectile Density: **1500 kg/m^3** (porous rock)
   Impact Velocity: **17 km/sec** (average speed of an asteroid hitting the Earth)
   Impact Angle: **90 degrees** (direct hit)
   Target Type: **Sedimentary Rock** (rock type at the location above)

   You, however, will change the size of the body for doing calculations. Start with 100 meters for the Projectile Diameter and work up or down to answer each question. You may have to change the units of the Projectile Diameter from meters to km at some point just for convenience. You can round off your answers to the nearest convenient size in meters or km.

a. What diameter asteroid would have Columbus just at the outer edge of the Seismic shaking damage circle?

b. What diameter asteroid will have Columbus just at the edge of Air Blast damage circle?

c. What diameter asteroid would have Columbus just at the edge of the ejecta blanket formed (the outermost circle plotted is ejecta debris >1 cm thick)?