Name: _____

Homework 5 – Ast 281 – Spring 2009
Due Thursday 02/26/09– 12:00pm, Wat 420 – 100 points

Note: Homework is due at the beginning of the period. Feel free to work with others on the homework.

1. This question relates to the change in the sun's energy production as a function of time, and the different conditions early in Earth's history.

   (a) Describe what the faint young sun paradox is. Why was the sun fainter in the past? [10]

   (b) What are zircons and how do they relate to the issue of the sun's luminosity early in Earth's history? [5]

   (c) When did Earth's continents start to form, and what remote chemical evidence might we look for to see if a similar continent building process occurred on Venus? [5]

2. Suppose we visit an extrasolar planetary system which is in the equivalent of the Hadean epoch. Assume that the young star is similar to our sun 4.5 Gy ago. One of the planets is just barely inside the zone of habitability (the distance from the sun where temperatures are such that liquid water can exist on the planetary surface) – the surface temperatures on the planet is just barely warm enough to sustain life. Suppose, further that there are only 2 forms of life on this planet, one which has a low albedo (species A) and one which has a high albedo (species B).

   - What besides distance from the sun might affect the size of the zone of habitability? (Hint, consider properties of the planet itself) [10]

- At this time, which species might survive better and why? [5]

- What effect might your choice of species have on global temperatures? [please ignore for the moment the organism's means of energy production, *i.e.* photosynthesis, or production of methane etc.] [5]

- Eventually, the star's energy output will be much greater than that of our present sun. At this point which species will survive better? [5]

3. **Terraforming** or geoengineering, is the process of changing the conditions on a world. For each of the following, state the effect on a global scale that this might have on the climate and environment:

   - Fossil fuels are the remnants of decayed plant material. Although there has been some chemical alteration, many of the original elements are still present. What is the effect of burning fossil fuels (climatologically)? [5]

   - Addition of Fe to oceans, which supply nutrients to phytoplankton, causing rapid growth. [5]

   - *Major* addition of $CFCl_3$, a chloroflurocarbon to a planetary atmosphere. This compound absorbs strongly in the 10-100 μm region. The following reaction will occur in sunlight, [5]

$$CFCl_3 + hf \longrightarrow CFCl_2 + Cl \tag{1}$$

- The addition of large-scale solar arrays in orbit which not only collect and process solar energy, but also block the average energy input to the planet by 20%. [5]

- Addition of a large amount of dust to the atmosphere. [5]

4. This question deals with the exploration of the rise of a specific type of life and how we know it.

   (a) Describe the process of banded iron deposits. What is this a record of and what era in geologic history did this occur? [5]

   (b) When did photosynthetic bacteria first make an appearance on Earth? How do you reconcile this date with the BIF formations? [5]

5. For each of the following, please provide a brief definition. [20]

   (a) **gene** –

   (b) **eukaryote** –

   (c) **archaea** –

(d) **bacteria** –

(e) **prokaryote** –

(f) **chirality** –

(g) **metabolism** –

(h) **heterotroph** –

(i) **autotroph** –

(j) **ATP** –