Problem Set #3 – Comets and Meteorites  Due: Tues, October 10, 2017

1. A meteorite collected in Antarctica, ALH84001, displays features interpreted as related to life on Mars (see: Search for Past Life on Mars, Science, McKay et al., 1996). Why was it attributed to Mars? Which characteristics suggest life? Find a publication arguing against the meteorite recording life. What reasons are cited?

2. What critical role do Ward and Brownlee (Chapter 4) postulate for Mars in getting life started on Earth?

3. It has been suggested that early in Earth's history, major impacts may have boiled off the oceans, causing the extinction of all life. To explore this possibility
   a) Estimate the volume and mass of the oceans, assuming they cover 71% of Earth's surface with an average depth of 4.3 km.

   b) Estimate the heat required to vaporize the oceans, using the fact that the heat required to vaporize water (latent heat) at 0oC is about 2500 kJ/kg.

   c) Estimate the mass and radius of an impacting body that would have the required kinetic energy.
4. Read [http://sci.esa.int/rosetta/55116-rosetta-fuels-debate-on-origin-of-earth's-oceans/](http://sci.esa.int/rosetta/55116-rosetta-fuels-debate-on-origin-of-earth's-oceans/) and summarize the argument about the origin of Earth's oceans. What are the Rosetta data and what do they imply for this question?

5. To explore the hypothesis that water was delivered to early Earth by comets:
   a) Estimate the volume of water in the nucleus of comet Tempel-1 shown in the handout, assuming its nucleus is 50% water.

   b) How many such comets of this size would be needed to supply the oceans?

   c) If this occurred over 10 m.y., how many comets per year would be required?

6. A recent paper (Wallner et al, 2016) reports new findings on the presence of the radioactive isotope iron 60 in deep sea sediments. Read the paper posted on the class website (and possibly other sources) to explain in one paragraph each:
   a) How is iron 60 produced?

   b) How did it arrive in the sediments?

   c) What is the significance of this discovery?