

Earth 351, Forming a Habitable Planet Name: _____

Problem Set #3 – Comets and Meteorites Due: Mon, April 17, 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 0°C is about 2500 kJ/kg.

c) Estimate the mass and radius of an impacting body that would have the required kinetic energy.

4. View the 2011 Whipple Lecture, Fall 2011 AGU meeting by Joseph Veverka, The complex evolution of comet nuclei: Evidence from Deep Impact and Stardust-NexT: <https://www.youtube.com/watch?v=hf4irGb8QLE> . What did these missions discover about the surface of comet Tempel -1? About its interior?

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?

7. We watched a video about the HI-SEAS (Hawaii Space Exploration Analog and Simulation) program, whose fifth “mission” to simulate Mars is now ongoing. To learn more, read (and watch any embedded video in)

<http://www.space.com/25352-nasa-long-duration-spaceflight-ethical-risks.html>

<https://www.theatlantic.com/technology/archive/2014/04/will-living-on-mars-drive-us-crazy/360034/>

Based on these and any other information:

a) What do you consider the three most crucial issues that need to be considered in deciding whether to send humans to Mars?

b) If you were in charge of crew selection for a Mars mission, what do you consider the most crucial things to look for and why?