ASTRONOMY 150 – MIDTERM Name: _____

Feb 08, 2007 – Winter 2007 TA's Name & Section (2 pts): _____

Answer all questions in the space provided. If you have any questions, raise your hand. 100 points possible. No calculators.

The table below shows the properties of two planets orbiting a star that is identical to our Sun. Assume these planets are made of the same materials as the planets in our solar system. You will need to refer to these data for the rest of the exam.

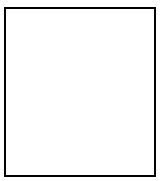
Planet	Mass [Earth = 1]	Size [Earth = 1]	Uncompressed Density [g/cm^3]	Distance to Star [AU]	Atmospheric Pressure [ATM]	Ave Surface Temp [C]
ARRAKIS	1/2	1	3.2	0.5	—	50
HOTH	2	2	3.5	1.5	0.5	50

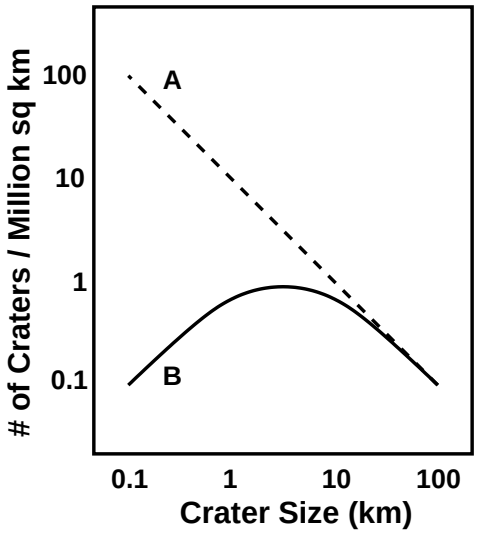
1 (8 pts) Show that the gravity on the two worlds are the same.

2 (6 pts) Explain why only one of the worlds has a substantial atmosphere even though they have the same escape velocity (gravity).

3 (8 pts) Explain why the atmosphere of HOTH is unlikely to be rich in hydrogen (H_2) or helium (He), but is probably rich in carbon dioxide (CO_2).

4 (10 pts) Both worlds have the same average surface temperature, but are at very different distances from the central star. Explain how this can be.



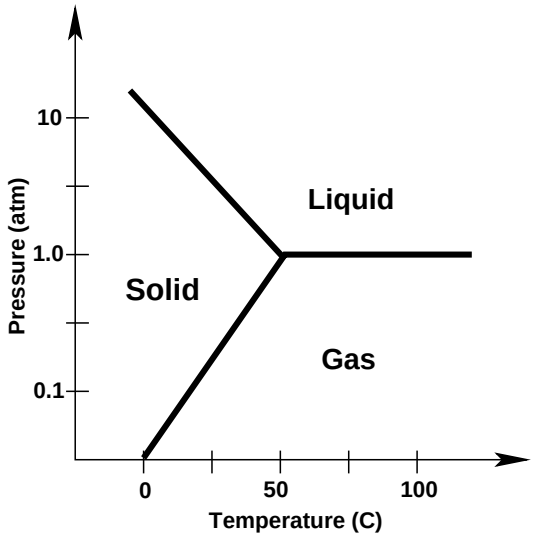


On the left is a plot of the crater density of the two worlds. The data for world ARRAKIS, is indicated by the dashed line (labeled **A**) and data for the world HOTH is the solid line (labeled **B**).

5 (3 pts) According to the data, how does the number of 0.1 km craters on B compare to the number of 0.1 craters on A. Be quantitative!

6 (6 pts) According to this data, the **relative** ages of the surfaces of ARRAKIS and HOTH are about the same. Explain how you can conclude this, even though the plots look very different.

7 (8 pts) Explain why you **cannot** use the data above to determine the **absolute** age of these worlds. Do not tell me how we do determine the absolute age, just why we cannot use crater counting.

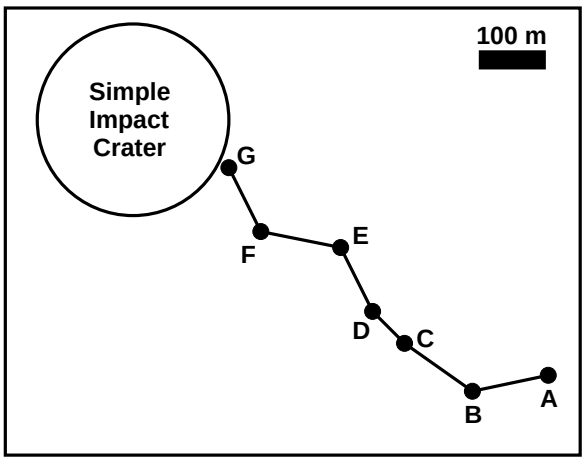


Scientists on the Earth have proposed that a substance called *Soylent Green* may be found in small quantities on the surface HOTH. On the left is a phase diagram for *Soylent Green*.

8 (4 pts) If the temperature on the surface of HOTH ranges from 25 to 75 C, what phase(es) would you expect to find *Soylent Green* in?

9 (8 pts) Explain why you would expect to find **liquid** *Soylent Green* in the subsurface of HOTH, but not in the atmosphere.

10 (6 pts) Explain why you would expect the level of geological activity on ARRAKIS and HOTH to be roughly comparable to the level of geological activity on the Earth.



After landing on the surface of ARRAKIS, your first journey is to the rim of a simple impact crater (see the map on the left). Along the way you collect samples at the locations labeled by the letters **A** – **G**.

11 (2 pts) Based on this map, how deep below the surface (in meters) did the sample at location **G** originate?

12 (6 pts) Explain why it would be **very** surprising if the samples collected at sites **A** or **B** were similar to the *Pristine Highland* rocks (Anorthosite) on the Moon.

13 (8 pts) Taking the samples back to our lab, you determine that samples **A** – **D** are all basalts with the same age of 100 million years and samples **E** – **G**, are all basalts that are 300 million years old. Describe a geological history for this site that could account for these results.

14 (10 pts) Scientists have suggested that the world Arrakis has suffered a giant impact event that melted the whole planet very early in its history. Analyzing all the samples you collected, you find that they are very rich in volatile elements compared to the Earth. Explain why this result does **not** support the giant impact idea.

15 (5 pts) The Moment-of-Inertia Factor for Arrakis (0.33) suggests that it has differentiated. However, all of the samples collected around the impact crater are rich in the very dense element Iridium. Explain how this can be.