Homework 7: Venus and Mars

Due: in your section on the week of March 11th. Be neat and concise, show your work, and remember units. An answer without the correct units is wrong.

Suggested reading: Lecture notes 16, 17, 18 and 19, and chapters 7.1, 9.4, 9.5, 9.6, 10.4, 10.5, and 10.6.

1. [1 Point] Why do we need radar to map the surface of Venus (why are optical telescopes not of much use)?

2. [4 Points] Below is a radar image of Venus’s surface from the Magellan mission.

   a) Explain why some regions are dark and others are bright. Is this how the surface would look to our eyes?
b) What kind of geologic structure is this? What are the features labeled A and B?

   a. Calculate the escape velocity from the top of Venus’s atmosphere (about 200 km above the surface).

   b. Calculate and compare the most probable thermal velocities of hydrogen and deuterium atoms at Venus’s exospheric temperature of 350 K [Hint: look at Mathematical Insight 10.2]. The mass of a hydrogen atom is $1.67 \times 10^{-27}$ kg, and the mass of a deuterium atom is about twice the mass of a hydrogen atom.

   c. Would you expect any of the atoms in Venus’s atmosphere to escape? What do these calculations tell us about whether Venus has lost large quantities of water? [Hint: the fraction of deuterium atoms to hydrogen atoms in Venus’s atmosphere today is about 100 times higher than on Earth]
4. [1 Point] Why is the surface of Mars red?

5. [2 Points] List 3 conditions necessary for a planet to have a magnetic field. Why does Venus not have a magnetic field?

6. [3 Points] The book mentions the Venus Express mission which reached Venus in 2006. What is the current status of the mission? Mention some aims of the mission, what it plans to study, and whether it has made any major discoveries. [Hint: You can search for news stories about Venus Express on the internet, but make sure to put your answer in your own words]
7. [3 Points] Below is a phase diagram for water (a plot that shows the temperature and pressure ranges where water is stable as a liquid, solid, and gas). Show where the range of Mars’s surface temperatures and pressures lies on this diagram. What can you conclude about the stability of liquid water on Mars today?