Exam 2 Nov. 6, 2017 Astronomy 131

Please answer the questions in your bluebooks. Answer each question as completely as you can. Partial credit will be given for partially correct answers. You must answer at least ***five*** questions in Section 1. If you answer more than the minimum number, then only your best answers in each section will be counted.

Section 1 (each question worth 20 points, and you must answer at least 5):

1) What is the difference between the flood channels and the valley networks on the surface of Mars? Discuss differences in their appearances, and how they are believed to have formed.

   *The **flood channels** are thought to have been carved out of the landscape on Mars very rapidly in geological terms, through the release of a large amount of pent up water over a short period of time. This sudden release would lead to very rapid flows and very rapid erosion. The features are narrow and steep walled, much like similar features on Earth called scablands.*
   *The **valley networks** are thought to be the result of a more gradual erosion like the kind seen on large rivers on Earth, with a large network of tributaries all feeding into bigger rivers. The features are not as steep sided.*

2) In terms of the solar nebula hypothesis, explain why Jupiter and Saturn ended up so much more massive than their fellow gas giants, Uranus and Neptune.

   The material in the solar nebula had increasing density closer to the Sun, and therefore was more highly concentrated near the locations of Jupiter and Saturn. Because the material was more spread out at the distances of Neptune and Uranus, it took longer for concentrations of matter to form within the solar nebula. By the time concentrations formed which could serve as the seeds for Neptune and Uranus, much of the gas within the solar nebula was dispersed, which limited the amount of matter they could accumulate. In addition, the closer planets Jupiter and Saturn were better positioned to accumulate the gas pushed out of the inner solar system by the heat of the still-forming Sun.

3) In the year 2525 NASA lands several robotic probes on a planet orbiting another star. This new planet (named Taylor) is the same size and mass as the Earth. Seismic measurements reveal that both P and S waves are able to travel freely through planet Taylor's core. Based on this, what can you say about the planet's interior and its magnetic field?

If both P waves and S waves can travel freely through planet Taylor's interior, then its core must be completely solid, because S waves cannot travel through liquids. Since the planet has the same size and same mass as the Earth, we assume it has the same chemical composition. The most obvious reasons why the planet would be completely solid is if 1) it had never differentiated, which means it was never molten to begin with and therefore has no metallic core, liquid or otherwise; or 2) planet Taylor formed the same way Earth did, and has the same internal structure, but the core is entirely solid because it has cooled off fully. This would suggest Taylor is older than dirt (Earth). Either way, lacking a liquid component to its core, the planet should have no magnetic field.

4) Astronomers have been discovering extrasolar planets (planets around other stars) for about 15 years now. Many of these newly discovered planets are gas giants like Jupiter or Saturn, only they orbit their stars very close in, with orbits of radius 1AU or even smaller. Would you expect such a very close in gas giant to have a strong magnetic field? Explain why or why *not.*

A Jupiter-like gas giant has a magnetic field due to the intense pressure occuring inside the planet, which forces the hydrogen gas into a metal-like state where it conducts electricity. As long as the proximity to the star doesn't significantly decrease the mass, or alter the rapid rotation, there is no reason why such a gas giant wouldn't have a strong magnetic field.

5) Explain why all the volcanoes observed on the surfaces of Venus and Mars are shield volcanoes.

Venus and Mars both lack plate tectonics, so there are no plates in their crusts. Without plates, there can be no continental drift, no sea floor spreading, and no subduction zones. With no subduction, there can be no composite volcanoes. Shield volcanoes do not need plate boundaries and subduction zones to form, they form when material from the mantle is able to push its way up through a weak spot in the crust of a planet. Shield volcanoes are then able to form in the absence of plate tectonics, just as they form that way here on Earth (think the big island of Hawaii, with 3 volcanoes on it).

6) It is possible (though probably quite rare) that a comet from another solar system might wander into our own from time to time. If this were to happen, how could we tell that it did not originally come from our Solar System?

Angle of the orbit will help – it is unlikely that an externally originated comet will come in along the plane of the ecliptic, so any comet close to the plane of the rest of the Solar System is likely from our own Solar System. However, our own Oort Cloud comets can approach at randomly oriented angles too, so the angle is not enough. Chemical composition will be helpful – all comets in the Solar System have similar chemical compositions, while comets from other star systems will have compositions reflecting that of their home stars.

7) Which gas giants emit more energy than they receive from the Sun? Describe how this energy is generated.

Jupiter, Saturn and Neptune all emit more energy than they receive from the Sun. They generate this energy through a process called the Kelvin-Helmholz contaction. Matter in these gaseous planets is attracted towards the center of mass, accelerating as it drops down. This essentially converts potential energy into kinetic energy of moving matter. This kinetic energy contributes to the heat of the planet, causing it to glow in the infra-red part of the spectrum. In the case of Saturn this process may not generate enough heat to explain the observed infra-red radiation and scientists have speculated that dense condensations of liquid helium may fall like raindrops down toward the planet's core to supplement the internal heat.