ISP 205
Review Questions, Week 6

This is not required homework. It will not be graded. Answers will be supplied next week.

****

1. Our Moon is tidally locked to the Earth. What is meant by "tidal locking", and why does it happen? *"Tidal locking" means that the moon rotates (spins) on its axis exactly once for every time that it revolves around (orbits) its parent planet, in a way so that the same face of the moon is always pointed towards the parent planet. This can also happen for a planet orbiting a star, etc. It occurs because of the tidal forces that the planet exerts on the moon… the gravitational pull of the planet is stronger on the material on the side of the moon nearer the planet than it is on the material on the side of the moon that is farther away, so the moon gets stretched out along an axis that is pointed towards the planet. If the moon tries to spin at a rate that would cause this long axis to no longer point at the planet, then the tidal force from the planet tries to stretch the moon out into a new shape that would again have its long axis pointed towards the moon. Since the moon is made out of rock, it resists being constantly deformed, and instead just spins around so that its original long axis will stay pointed at the planet. This is a gradual effect that doesn't get completed in just one orbit,. But the Moon has orbited the Earth 45 billion times since it was formed, and it probably just required the first 100 or 1000 orbits for the tidal locking to have been set up.*

2. Why does Mercury spin on its axis exactly 1.5 times per orbit? *If Mercury was in a circular orbit and was fully tidally locked with the Sun, the planet's longest axis would always point towards the Sun. That would be accomplished by Mercury spinning on its axis exactly once per orbit. This almost happens, but not quite. Mercury is in a very elliptical orbit, so the Sun's tidal force is strong when Mercury is close to the Sun but is weaker when Mercury is farther away. So Mercury is free to spin at any rate it wants when it is far away from the Sun and in fact spins an extra ½ time per orbit. But the long axis must be in the correct alignment each time Mercury comes closest to the Sun. Spinning exactly 1.5 times per orbits is a way for this to happen… on each successive close pass by the Sun the particular end of the long axis that is pointed towards the Sun is switched, but that is OK.*

3. Why is the surface of Venus so hot? *Because of the Runaway Greenhouse Effect. The surfaces of planets heat up because they absorb sunlight, but this is at least partly counterbalanced by the cooling effect of re-radiating energy back out to space, as infrared light. Greenhouse gasses block some of that infrared radiation from escaping, so the surface winds up being hotter. Venus has an immensely dense atmosphere of CO_2, which has a very strong Greenhouse effect, hence the high temperature. Venus is closer to the Sun than the Earth is , so Venus absorbs more energy from sunlight. The "runaway" part of the effect is that even if the atmosphere of Venus started out similar to that of the Earth, in a situation where rain could absorb atmospheric CO_2 into a standing ocean, the oceans would start to evaporate because of the moderately higher solar heating. The evaporated water is another greenhouse gas so this would drive the temperature up higher and higher in a giant feedback loop. Eventually, ultraviolet radiation from the Sun will break apart the water-vapor molecules and then the resulting free hydrogen gas will escapes from venus, so there is no way to reform the water. The end result – a very dense CO_2 atmosphere and a very hot surface.*

4. What technique has told us the most about the general topography of the surface of Venus, and why do we need to use this technique? *Radar mapping. Venus is enshrouded in a dense cloud*

cover, so we cannot see the surface using visible light. But radio waves (radar) pass through the clouds.

5. Why is the surface of Mars so cold? *Mars has gradually lost most of its atmosphere, so even though the atmosphere is made of CO_2 (a greenhouse gas), there is not enough of it to block infrared radiation emitted by the surface from escaping out into space. This cools the surface.*

6. Are there oceans on Mars? Why or why not? *No oceans. There are former oceans, left over from when the atmosphere was thicker. But nowdays the air pressure is so low that H_2O cannot exist in its liquid form… it can only be either a solid (i.e. ice) or a vapor. The water has frozen out and is mostly underground in the form of permafrost.*