## Introductory Astronomy

**Homework 13: Venus** Not to be handed in. Homework solutions are posted already.

1. The period for Venus' axial rotation relative to fixed stars is unusually long for planet (243.0187 days) and the rotation is retrograde (i.e., clockwise as viewed from the north ecliptic pole) which is unlike most of the other planets. These unusual rotation characteristics may be due to:

   c) a **SMALL** impactor that randomly altered the rotation characteristic imposed at formation. Those formation characteristics may have been more like those of Earth and Mars.
   b) **SYNCHRONOUS TIDAL LOCKING** to the Sun. Recall the Venusian year (i.e., revolution period) relative to the fixed stars is 224.695 days.
   c) a **GIANT** impactor that randomly altered the rotation characteristic imposed at formation. Those formation characteristics may have been more like those of Earth and Mars.
   d) **NON-SYNCHRONOUS TIDAL LOCKING** to the Sun exactly like the tidal locking of Mercury to the Sun. Recall that the ratio of the Mercurian rotation period to Mercurian revolution period is 2/3 nearly exactly.
   e) a gravitational perturbation by Jupiter.

2. Compared to Earth's surface, the surface of Venus is:

   a) cold. b) unbelievably cold. c) middling cold. d) lukewarm e) hot.

3. Venus has virtually no seasons because:

   a) of **SMALL** eccentricity and axis inclination, and **HIGHLY VARIABLE,** heat-transport-**INEFFICIENT** global atmospheric circulation.
   b) of **SMALL** eccentricity and axis inclination, and **HIGHLY STABLE,** heat-transport-**EFFICIENT** global atmospheric circulation.
   c) Venus is **CLOSER TO** the Sun than Earth.
   d) of **LARGE** eccentricity and axis inclination, and **HIGHLY STABLE,** heat-transport-**EFFICIENT** global atmospheric circulation.
   e) Venus is **FARTHER FROM** the Sun than Earth.

4. Venus has a:

   a) **THICK**, carbon-dioxide-**RICH** atmosphere, and so has virtually **NO** greenhouse effect.
   b) **THICK**, carbon-dioxide-**RICH** atmosphere, and so has an **EXTREME** greenhouse effect.
   c) **THIN**, carbon-dioxide-**POOR** atmosphere, and so has an **EXTREME** greenhouse effect.
   d) **THIN**, carbon-dioxide-**POOR** atmosphere, and so has virtually **NO** greenhouse effect.
   e) **THICK** carbon-dioxide-**POOR** atmosphere, and so has a **REVERSE** greenhouse effect: i.e., the surface is cooled far below what it would be if there were no atmosphere at all.

5. The super-dense, $CO_2$-dominated atmosphere of Venus (and consequently Venus' extreme greenhouse effect) developed because of continuing _____ outgassing by volcanic activity and the _____ of liquid water.

   a) $O_2$; abundance b)$N_2$; abundance c) $N_2$; absence d) $CO_2$; absence e) $CO_2$; abundance

6. The daytime illumination on the surface of Venus is: _____, because the _____ light is strongly absorbed by the thick _____-dominated atmosphere.

a) bluish; reddish; $CO_2$ b) bluish; reddish; $N_2$ c) orangy; bluish; water-vapor d) orangy; bluish; $N_2$ e) orangy; bluish; $CO_2$

7. Venus has:

   a) **NO** liquid water erosion, **NO** micrometeoritic erosion, and **NO** evidence of full plate tectonics. Geological activity is mainly volcanic and tectonic due to **INTERNAL HEAT** with some wind erosion. But large-scale impactor geology (i.e., impactor cratering) is more important on Venus than on Earth because of the low level of erosion compared to the Earth and, perhaps, because of a lower level of internal-heat-driven geology.
   b) **NO** liquid water erosion, **NO** micrometeoritic erosion, and **NO** evidence of full plate tectonics. There is **NO INTERNAL-HEAT-DRIVEN** geological activity at all. There is probably some solar tidal force geological activity and large impactors occasionally hit. Like the Moon and Mercury, Venus is nearly a dead world.
   c) liquid water erosion, micrometeoritic erosion, and full plate tectonics. There is also **INTERNAL-HEAT-DRIVEN** geological activity. Except for the micrometeoritic erosion, Venus geology is **MUCH** like the Earth's.
   d) liquid water erosion, micrometeoritic erosion, and full plate tectonics. There is also **INTERNAL-HEAT-DRIVEN** geological activity. Venus geology is **EXACTLY** like the Earth's.
   e) no impact craters.

8. Why might one expect Venus and Earth to be similar?

   a) They are nearly at the same distance from the Sun.
   b) They have nearly the same mass and mean density, and the difference in their distances from the Sun isn't huge.
   c) Because Venus is closer to the Sun than Earth.
   d) They have nearly the same color.
   e) They have nearly the same rotation period relative to the Sun (i.e., day period).

9. The terras of Venus are:

   a) uplands: they are perhaps similar to Earth's continents. b) lowlands: they are perhaps similar to Earth's continents. c) lowlands: they are perhaps similar to Earth's ocean basins. d) lowlands: they are perhaps similar to Earth's mid-ocean ridges. e) little Earths embedded in Venus' surface.

10. The Ishtar and Aphrodite are:

    a) Venusian impact craters. b) Venusian terras. c) Martian impact craters. d) Martian volcanoes. e) dear friends of Santa.

11. So far about 900 impact craters have been found on Venus by radar mapping. This is far more than on Earth, but far fewer than on the Moon. None of the discovered craters is smaller than about 3 km in diameter. Explain these facts.

    a) The Venus surface is renewed more slowly than the Earth surface. This is perhaps because Venus **HAS** plate tectonics and water erosion. On the other hand, the Venus surface is renewed more quickly than the Moon surface since on the Moon geological activity is very slow and mostly due to impacts themselves. Thus Venus craters last longer than Earth craters, but not as long as Moon craters. This explains Venus' intermediate crater population. The lack of small impact craters is due to Venus' **LOCATION IN THE SOLAR SYSTEM**. Smaller impactors do not get closer to the Sun than the orbit of Earth.

b) The Venus surface is renewed more slowly than the Earth surface. This is perhaps because Venus **LACKS** full plate tectonics (as far as we know circa 2004) and water erosion. On the other hand, the Venus surface is renewed more quickly than the Moon surface since on the Moon geological activity is very slow and mostly due to impacts themselves. Thus Venus craters last longer than Earth craters, but not as long as Moon craters. This explains Venus' intermediate crater population. The lack of small impact craters is due to Venus' **LOCATION IN THE SOLAR SYSTEM**. Smaller impactors do not get closer to the Sun than the orbit of Earth.

c) Venus has fewer craters than the Moon and more than the Earth mainly because its intermediate size between Moon and Earth sizes. The small craters on Venus are mainly **FULLY FLOODED BY LIQUID WATER,** and so are not seen.

d) Venus formed **AFTER THE HEAVY BOMBARDMENT PHASE** of the solar system ($\sim$ 4.6–3.8 billion years ago), and so missed most of the early cratering that the Moon and Mercury received. On the other hand, Venus has slower geological activity than the Earth, and so it has more craters than the Earth: the Earth's craters from the heavy bombardment have all been destroyed since then. The lack of small craters is caused by rapid **LIQUID WATER EROSION** on Venus that removes the small features first.

e) The Venus surface is renewed more slowly than the Earth surface. This is perhaps because Venus **LACKS** full plate tectonics (as far as we know circa 2004) and water erosion. On the other hand, the Venus surface is renewed more quickly than the Moon surface since on the Moon geological activity is very slow and mostly due to impacts themselves. Thus Venus craters last longer than Earth craters, but not as long as Moon craters. This explains Venus' intermediate crater population. The lack of small impact craters is probably due to Venus' **THICK ATMOSPHERE**. Smaller impactors tend to burn up in the Venus atmosphere more than in the Earth atmosphere.

12. Venus has no significant magnetic field. Although somewhat puzzling this lack is probably at least partially due to Venus':

    a) abundant coronas. b) lack of coronas. c) very fast rotation rate. d) very slow rotation rate. e) very variable rotation rate.

13. The final fate of Venus is probably to:

    a) collide with the Earth.
    b) collide with Mars.
    c) be evaporated in the Sun during a red giant phase in 5 or 6 Gyr.
    d) be evaporated in the Sun during a red giant phase in 5 or 6 million years.
    e) be left as cold rocky world with a cold $CO_2$ atmosphere and no internal heat. A layer of $CO_2$ ice might condence out on the surface. This will happen billions of years from now after the Sun has become a white dwarf star.