Introductory Astronomy

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

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024 qmult 00020 2 4 3 moderate deducto-memory: Venus rotation

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.

   SUGGESTED ANSWER: (c) Pure deduction works here if one is really clever, but impure deduction plus a bit of memory should make this question not too hard.

   Wrong answers:
   a) Now a small impactor wouldn't do very much now would it.
   b) The answer clearly contradicts itself in that the revolution period is not equal to the rotation period.
   d) Well the 243.0187/224.695 is not 2/3. Of course, since answer (b) was a wrong answer, then one doesn't have to believe 224.695 days is the Venusian year really: but actually it is. Still one can deduce this answer is wrong because if it were right the Venusian year would have to be about 365 days which is the about Earth's year and we know Venus can't have a year like that since it is much closer to the Sun than the Earth.
   e) Now Jupiter's gravity does a lot of things, but why would it cause Venus to act funnily and not Earth and Mars in respect to rotation.

   Redaction: Jeffery, 2001jan01

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024 qmult 00100 1 1 5 easy memory: Venus is hot

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

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

   SUGGESTED ANSWER: (e)

   Wrong answers:
   b) "Unbelievably" doesn't sound like a scientific adjective.
   d) Lukewarm doesn't do it for temperatures that can melt lead. See Se-467.

   Redaction: Jeffery, 2001jan01

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024 qmult 00220 2 1 2 moderate memory: Venus seasons

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.

SUGGESTED ANSWER: (b)

Wrong answers:
a) The atmospheric circulation is very stable and efficient.
c) Irrelevant.
d) Eccentricity and axis inclination are small: the converse leads to season.
e) Irrelevant and wrong.

Redaction: Jeffery, 2001jan01

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024 qmult 00300 1 1 2 easy memory: Venus atmosphere

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.

SUGGESTED ANSWER: (b)

Wrong answers:
a) Carbon dioxide is a strong greenhouse gas.
c) Venus atmosphere is 96 per cent CO_2 and is 90 Earth pressures.
d) See (a) and (c) .
e) I suppose an atmosphere that resisted radiation flowing in more than flowing out would be cause a reverse greenhouse effect. I don't know if any such atmosphere has been seen in nature. A perfectly reflecting atmosphere, would mean the surface would be absolute zero aside from internal heating.

Redaction: Jeffery, 2001jan01

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024 qmult 00305 2 4 4 moderate deducto-memory: Venus' atmosphere history

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

SUGGESTED ANSWER: (d)

Wrong answers:

e) Liquid water can cause carbon from atmospheric CO_2 to be locked up in carbonate rock. Thus liquid water provides a CO_2 sink.

Redaction: Jeffery, 2001jan01

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024 qmult 00310 2 4 5 moderate deducto-memory: Venus illumination

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

SUGGESTED ANSWER: (e) See FMW-194 and Se-475. FMW-194 is specific about the absorption. But neither says it is the CO_2 that does the absorbing, but the right answer doesn't imply that CO_2 that does necessarily.

Wrong answers:

c) There is some water vapor in the Venusian atmosphere, but not a lot (Se-467).

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024 qmult 00500 2 4 1 moderate deducto-memory: Venus geological processes

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.

SUGGESTED ANSWER: (a)

Wrong answers:

b) Since Venus is nearly the same size and density as the Earth internal-heat-driven geology should occur.

c) There is no liquid water on Venus (except maybe for drops high in the atmosphere): the lower atmosphere is very dry. The thick atmosphere burns up most small meteors, and so no significant micrometeoritic erosion is expected.

d) See (c)

e) There are. Because of the low level of erosion compared to the Earth, there are many more large impact craters on Venus than on Earth.

Redaction: Jeffery, 2001jan01

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024 qmult 00600 2 4 2 moderate deducto-memory: Venus and Earth similar?

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).

   SUGGESTED ANSWER: (b)

   Wrong answers:
   a) Well they arn't all that close together.
   c) A red herring.
   d) No they don't and if they did it wouldn't necessarily mean anything.
   e) No they don't and if they did it wouldn't necessarily mean anything.

   Redaction: Jeffery, 2001jan01

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024 qmult 00610 2 4 1 moderate deducto-memory: terras of Venus

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.

   SUGGESTED ANSWER: (a)

   Wrong answers:
   e) Terra is Earth or earth in Latin and Italian. I sort of imagined a picture of little bitty Earths embedded like raisins in a big Venus muffin.

   Redaction: Jeffery, 2001jan01

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024 qmult 00620 2 4 2 moderate deducto-memory: Ishtar and Aphrodite

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.

   SUGGESTED ANSWER: (b)

   Wrong answers:
   e) I'm sure that Santa is very fond of the two love goddesses—even if they have been naughty.

   Redaction: Jeffery, 2001jan01

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024 qmult 00700 2 4 5 moderate deducto-memory: Venus' craters

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.

SUGGESTED ANSWER: (e)

Wrong answers:

a) But Venus lacks water erosion and plate tectonics. and small impactors due go closer to the Sun than the Earth's orbit: why shouldn't they?

b) Small impactors due go closer to the Sun than the Earth's orbit: why shouldn't they? But it is possible that relatively fewer go closer to the Sun than the Earth's orbit: just a logical possibility: I have no information on that point: "I know nothing, nothing" (Sergeant Schultz).

c) If size mattered most, Earth would have more craters than the Moon because it has a bigger impact cross section. There is no liquid water and precious little water vapor on Venus.

d) We've no reason to believe Venus formed so much later than the other planets. There is no liquid water and precious little water vapor on Venus.

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024 qmult 01000 2 4 4 moderate deducto-memory: Venusian magnetic field

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.

SUGGESTED ANSWER: (d) The dynamo effect that is believed to produce global dipole magnetic fields probably relies on rotation (Se-476). Venus' rotation period is 243.01 days (Se-467) which is very long compared to those of the Earth, Jupiter, and even Mercury all of which have global dipole magnetic fields although Mercury's is comparatively weak.

Wrong answers:

a) Well Venus is the only planet with clear coronas, but I don't think they could stop a global magnetic field

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024 qmult 01100 1 4 3 easy deducto-memory: fate of Venus

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.

SUGGESTED ANSWER: (c)

Wrong answers:

e) If the Sun doesn't evaporate Venus, something like this may happen to it.

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