Introductory Astronomy

Homework 12: The Moon and Mercury Not to be handed in. Homework solutions are posted already.

1. The lunar month is:

    a) the same length as the lunar day due to tidal locking (i.e., tidal coupling or tidal force effects).
    b) the same length as the lunar day due to radioactivity.
    c) the same length as the lunar day due to the solar wind (i.e., solar wind interactions with the Moon's magnetic field).
    d) the same length as the lunar day due to light reflected from Earth.
    e) twice the length of the lunar day.

2. You are standing on the near side of the Moon. How does the Earth's position in the sky change relative to your local horizon?

    a) The Earth moves across sky from eastern to western horizon for a 12 hour period on average and then is below the horizon for another 12 hour period on average. The Earth does show phases that depend on the time of the lunar month.
    b) The Earth circles the zenith position every 24 hours.
    c) The Earth circles the zenith position every 29.53059 days on average.
    d) The Earth zigzags randomly all across the sky.
    e) The Earth stays more or less fixed in the sky relative to the local horizon because of the synchronous tidal locking of the Moon to the Earth. The Earth jiggles about a little because of some wobbling of the Moon. The Earth does show phases that depend on the time of the lunar month.

3. Two immediately striking facts about the Moon in comparison to the Earth are (1) the Moon's radius is about ________ times the Earth's radius and (2) the Moon's mean density is about ________ times the Earth mean density.

    a) 1/4; 2   b) 1/4; 3/5   c) 1/2; 2   d) 2; 2   e) 1/10; 1/20

4. The mean lunar density relative to the mean Earth density is:

    a) high.   b) negligible.   c) low.   d) identical.   e) practically the same.

5. The Moon's mass is about 1/80 of the Earth's mass. But the Moon's surface gravity is about 1/6 of the Earth's surface gravity. Why isn't the Moon's surface gravity about 1/80 of the Earth's surface gravity?

    a) The gavitational force of the Earth increases the downward gravitational force on the Moon.
    b) The gravitational force law has mass **TIMES** radius squared. The Moon has a small mass relative to Earth, but also a small radius relative to Earth. The two differences cancel somewhat, and so the Moon's surface gravity is not as small as just considering the Moon mass only suggests.
    c) The gravitational force law has mass **DIVIDED** by radius squared. The Moon has a small mass relative to Earth, but also a small radius relative to Earth. The two differences cancel somewhat, and so the Moon's surface gravity is not as small as just considering the Moon mass only suggests.
    d) Magnetic fields on the Moon increase the effect of gravity.
    e) The astronauts were too full of turkey.

6. The far side of the Moon is:

    a) seen from Earth once per month.   b) seen from Earth only at new moon.   c) never seen from Earth.   d) seen from Earth only during solar eclipses.   e) constantly visible from

Earth.

7. The sky on the Moon is always:

   a) black. b) blue. c) red. d) red and white. e) red, white, and blue.

8. A mare (Latin for "sea": the last "e" is not silent but the pronunciation seems various and who knows how the Romans really said it: plural "maria") is:

   a) a region of the light colored lunar highlands.
   b) a dark lava plain on the Moon that is **LIGHTLY** cratered compared to the lighter colored lunar highlands.
   c) a dark lava plain on the Moon that is **HEAVILY** cratered compared to the lighter colored lunar highlands.
   d) a sea bed of a dried up lunar sea.
   e) the mother of a colt.

9. The lunar mountains seem to be

   a) fold- and fault-mountains, impact crater rims or parts thereof, and hotspot volcanoes.
   b) fold- and fault-mountains and hotspot volcanoes.
   c) fold- and fault-mountains.
   d) impact crater rims or parts thereof and hotspot volcanoes.
   e) entirely impact crater rims or parts thereof.

10. A moonquake is:

    a) a wobble of the Moon in its orbit. b) a lunar mare. c) a fluctuation in the Moon's reflected brightness caused by a strong gust of the solar wind. d) the Moon's equivalent of an earthquake. e) a contradiction in terms.

11. Most significant moonquakes (in the present epoch) are thought to be caused primarily by:

    a) plate tectonic activity. b) volcanism. c) impacts and volcanism. d) impacts and solar tidal force effects. e) the solar wind.

12. The giant impactor theory of the Moon's formation explains:

    a) the heavy cratering of the Moon, the lunar maria, and the inclination of the Earth's axis.
    b) the relatively low uncompressed mean density of the Moon compared to that of the Earth and the existence of the lunar maria.
    c) the relatively low uncompressed mean density of the Moon compared to that of the Earth and the similar composition of the Earth and lunar crusts and mantles.
    d) the relatively low uncompressed mean density of the Moon compared to that of the Earth and the length of the lunar month.
    e) the heavy cratering of the Moon, the lunar maria, and the chemical differentiation of the lunar material.

13. How can one tell if a large lunar crater is comparatively old or young?

    a) An old crater has dry water channels flowing from the rim both outward to the surroundings and inward toward the crater center. Young craters formed after all the lunar water was gone and so have no dry water channels.

b) The older the crater, the more ice has accumulated in the crater center. The ice comes from water vapor that is released by comet impacts. The ice condenses in the cold crater centers. There have probably been hundreds of comet impacts since geological activity stopped on the Moon. The ice is **EASILY SEEN** from the Earth because of its high reflectivity.
c) The older the crater, the more ice has accumulated in the crater center. The ice comes from water vapor that is released by comet impacts. The ice condenses in the cold crater centers. There have probably been hundreds of comet impacts since geological activity stopped on the Moon. The ice is covered by regolith and is **NOT EASILY SEEN** from the Earth. The ice was detected in the 1990's by radar techniques and by studying the speed of neutron emission from the lunar surface. (Energetic solar wind particles cause the lunar surface to emit neutrons.)
d) The older the crater, the greener it looks.
e) The older the crater, the more heavily it itself tends to be cratered.

14. Lunar regolith is:

a) lunar rock ground down to fragments and dust by volcanic action.
b) lunar rock ground down to fragments and dust by strong winds present on the early Moon.
c) lunar rock ground down to fragments and dust by the solar wind.
d) lunar rock ground down to fragments by meteoritic impacts, and on the surface few meters to dust. The dust is due mainly to the sandblasting effects of micrometeorites.
e) lightly cratered lunar terrain.

15. Until about the middle of the 20th century most geologists thought the lunar craters were mostly volcanic. This was so because it was thought that impact craters:

a) could not be mostly so round as almost all lunar craters appeared to be.
b) had to be mostly so round as almost all lunar craters appeared to be.
c) could not be on top of mountains as almost all lunar craters appeared to be.
d) had to be on top of mountains as almost all lunar craters appeared to be.
e) had to be squarish unlike lunar craters.

16. Astronauts first landed on the Moon in:

a) 1962. b) 1984. c) 1958. d) 1969. e) 1948.

17. The time period of the crewed lunar landings was:

a) 1962–1972. b) 1984–1992. c) 1958–1962. d) 1969–1972. e) 1948–1958.

18. In future gigayears, the Moon:

a) will have an eventful history with volcanism and outgassing. It will develop a dense CO_2 atmosphere and become like Venus is today.
b) will split into tiny fragments and become a ring around the Earth. The ring will be rocky, and so less bright than Saturn's icy ring.
c) will crash into the Earth. This will probably end life on Earth.
d) will continue to suffer slow meteoritic erosion and occasionally large impacts. It's appearance will probably change only slowly and it might look roughly much the same as it does now when the Sun in one of its red giant phases, perhaps, swallows and evaporates it along with the Earth.
e) will turn into green cheese finally and become Santa's new home after the north polar cap melts.

19. Mercury is:

a) the largest rocky (or terrestrial) planet. b) the least cratered rocky (or terrestrial) planet. c) the closest planet to the Sun. d) always the brightest planet visible from the Earth. e) the red planet.

20. Among the rocky (or terrestrial) planets, Mercury is:

    a) largest. b) smallest. c) most massive. d) farthest from the Sun. e) reddest.

21. The only spacecraft through year 2004 to obtain close-up images of Mercury is:

    a) Apollo 11. b) Apollo 13. c) Mariner 10. d) Venus. e) Mars.

22. "Let's play *Jeopardy*! For $100, the answer is: This solar system body is nonsynchronously tidally locked to the parent body it orbits."

    What is ____________, Alex?

    a) Mercury b) the Moon c) Io d) Charon e) Lead

23. The ratio of Mercury's rotation period (period for one axis rotation) to its revolution period (period for one orbit around the Sun) is 2/3. Both these periods are relative to the fixed stars and both are counterclockwise when view from the north ecliptic pole. How long is Mercury's day (i.e., noon to noon period) in units of its revolution period? **HINT:** An orbital diagram with artifical mountain on Mercury might help.

    a) 1 revolution period. b) 2 revolution periods. c) 3 revolution periods. d) 1/2 revolution period. e) 1/3 revolution period.

24. Have you ever wondered how you calculate the length of a planet's day given its revolution (or orbital) period and axial rotation period (i.e., axial rotation period relative to the fixed stars)? "Yes!" This your lucky day.

    The easiest way to understand and set up the problem is take the origin on the planet and then the Sun revolves around the planet. Imagine line from the origin to the Sun and another line from the origin through a mountain on the planet. Take counterclockwise as the positive direction in the diagram you should have drawn by now. First, align the lines and then let time advance. When the lines come back into alignment, one planet day has passed. **HINT:** Draw a diagram.

    Mathematically, one can relate the planet and Sun rotation rates and the time of one day for cases where the axial tilt from the perpendicular to the orbital plane is not extreme by

    $$360^\circ = (\omega_{\rm pl} - \omega_\odot)t \ ,$$

    where $\omega_{\rm pl}$ is the planet angular rotation rate, $\omega_\odot$ is the Sun angular rotation rate, and

    $$t = \begin{cases} \text{planet day} & \text{if } \omega_{\rm pl} - \omega_\odot \geq 0; \\ -\text{planet day} & \text{if } \omega_{\rm pl} - \omega_\odot < 0. \end{cases}$$

    The peculiar definition of t allows a compact general expression. Now

    $$\omega_{\rm pl} = \frac{360^\circ}{P_{\rm pl}} \qquad \text{and} \qquad \omega_\odot = \frac{360^\circ}{P_\odot} \ ,$$

    where the P's are not periods, but periods multiplied by +1 for counterclockwise rotation and −1 for clockwise: this peculiar definition of the P's also allows a compact general expression.

    Find the general formula for t in terms of $P_{\rm pl}$ and $P_\odot$. What happens if $|P_{\rm pl}| << |P_\odot|$? What happens if $P_{\rm pl} = P_\odot$?

a) The general formula is

$$t = \frac{P_\odot - P_{\rm pl}}{P_\odot P_{\rm pl}} \ .$$

If $P_{\rm pl} << P_\odot$, then $t \approx 1/P_{\rm pl}$ and the day is the inverse of the rotational period. If $P_{\rm pl} = P_\odot$, the day is zero time in length.

b) The general formula is

$$t = P_{\rm pl} - P_\odot \ .$$

If $P_{\rm pl} << P_\odot$, then the day is negative and time flows backward. If $P_{\rm pl} = P_\odot$, the day is zero time in length.

c) The general formula is

$$t = \frac{P_\odot P_{\rm pl}}{P_\odot - P_{\rm pl}} \ .$$

If $P_{\rm pl} << P_\odot$, then $t \approx P_{\rm pl}$ and the day is almost the same length as the rotation period. If $P_{\rm pl} = P_\odot$, the day is infinitely long and the planet is synchronously tidally locked to the Sun.

d) The general formula is $t = P_{\rm pl}$ since the day always the same length as the planet rotation period. If $P_{\rm pl} << P_\odot$ or $P_{\rm pl} = P_\odot$, then still one has $t = P_{\rm pl}$.

e) The general formula is $t = P_\odot$ since the day always the same length as the Sun rotation period. If $P_{\rm pl} << P_\odot$ or $P_{\rm pl} = P_\odot$, then still one has $t = P_\odot$.

25. Mercury has:

a) a thick, dry, carbon dioxide atmosphere.
b) a water vapor atmosphere which is thick enough to to cause clouds that are sometimes seen from Earth.
c) a thin, but nearly breathable, oxygen-nitrogen atmosphere.
d) almost no atmosphere.
e) a thick atmosphere of nearly transparent molecular hydrogen gas.

26. Mercury has lava plains somewhat like the Moon's maria, but these Mercurian plains:

a) are not so dark and noticeable. b) cover all the Mercurian impact craters. c) are very much darker than the lunar maria. d) are green. e) are green because they are covered with vegetation.

27. "Let's play *Jeopardy*! For $100, the answer is: The focusing of siesmic waves at the antipodal point from Caloris Basin impactor impacted on Mercury is believed to have caused this geological feature at the antipodal point."

What is ____________, Alex?

a) an impact basin b) jumbled weird terrain, Alex? c) a lobate scarp d) a normal scarp e) a magnetic field