Introductory Astronomy

Homework 15: Gas Giant Planets Not to be handed in. Homework solutions are posted already.

1. The gas giant planets in order of decreasing diameter are:

   a) Saturn, Jupiter, Uranus, and Neptune. b) Jupiter, Saturn, Uranus, and Neptune. c) Uranus, Neptune, Jupiter, and Saturn. d) Jupiter, Saturn, Earth, and Venus. e) Ganymede, Callisto, Io, and Europa.

2. The most abundant elements in the gas giants are

   a) hydrogen and helium. b) carbon and nitrogen. c) carbon and helium. d) silicon, oxygen, and iron. e) hydrogen and iron.

3. The moons of the gas giants probably mainly formed by two processes. One of these is formation from a miniature protoplanetary disk that formed around the gas giant. The other is:

   a) fission of material from the gas giant due to high rotation. The material then coalesced into moons.
   b) by giant impactors that knocked material off the gas giants. The material then coalesced into moons.
   c) gravitational capture of small bodies such as planetesimals, protoplanets, asteroids, icy bodies, and maybe comets.
   d) close encounters with passing stars that pulled material out of the planets. The material then coalesced into moons.
   e) ejection of material from giant volcanoes on the gas giants. The material then coalesced into moons.

4. This substance does **NOT** ordinarily exist on Earth, but likely is a major component of Jupiter and Saturn and perhaps all the gas giants.

   a) Molecular hydrogen gas. b) Helium gas. c) Liquid metallic hydrogen. d) Solid metallic hydrogen. e) Methane gas.

5. "Let's play *Jeopardy*! For $100, the answer is: These orbiting structures are maintained around planets because the planet tidal force is too strong to allow them to coalesce under their self gravity into moons."

   What are _____, Alex?

   a) planets b) comets c) rings d) toroids e) clumps

6. Why are the ring systems of the gas giants flat?

   a) There is a **COLLISIONAL PROCESS** that eventually causes the ring particles to orbit in a disk and the alignment of the disk favored by the gravity of the oblate planet is alignment with the planet's **EQUATORIAL PLANE**.
   b) There is a **COLLISIONAL PROCESS** that eventually causes the ring particles to orbit in a disk and the alignment of the disk favored by the gravity of the oblate planet is alignment with the planet's **POLAR PLANE**.
   c) There is a **MAGNETIC PROCESS** that eventually causes the ring particles to orbit in a disk and the alignment of the disk favored by the gravity of the oblate planet is alignment with the planet's **EQUATORIAL PLANE**.
   d) There is a **MAGNETIC PROCESS** that eventually causes the ring particles to orbit in a disk and the alignment of the disk favored by the gravity of the oblate planet is alignment with the

planet's **POLAR PLANE.**

e) The tenth planet from the Sun, Planet X, gravitationally perturbs the rings particles into disk in the planet's **POLAR PLANE.**

7. Jupiter is:

   a) the fifth planet from the Sun. b) the fourth planet from the Sun. c) the sixth planet from the Sun. d) a comet. e) the tenth planet from the Sun. It has often been called Planet X.

8. Jupiter's observable surface is:

   a) **uncratered** by impacts because of its extreme **volcanic activity**.
   b) **heavily impact cratered** because of its extreme **volcanic activity**.
   c) **uncratered** by impacts because it is a **gas**.
   d) **uncratered** by impacts because it is **solid**.
   e) bright green cheese due to impact cratering.

9. Jupiter's composition by mass is estimated to be dominated by:

   a) methane (**90** percent) and ammonia (**9** percent).
   b) carbon dioxide (**55** percent) and molecular nitrogen (**36** percent).
   c) hydrogen in liquid molecular and liquid metallic form (**78** percent) and helium (**19** percent).
   d) hydrogen in liquid molecular and metallic form (**19** percent) and helium (**78** percent).
   e) methane (**9** percent) and ammonia (**90** percent).

10. The source of Jupiter's colors (reds, browns, oranges, etc.):

    a) is various forms of hydrogen and helium. b) is iodine. c)'has not yet been determined. The source is probably trace chemicals of sort or another: perhaps organic molecules, sulfur, or phosphorus. d) is iron. e) is vegetation.

11. On Jupiter the rising and sinking convective flows at the surface are:

    a) organized into bright and dark bands that are **perpendicular** to the equator and meet at the poles.
    b) organized into bright and dark bands that are **parallel** to the equator.
    c) organized into **granules** and intergranule surroundings as on the Sun.
    d) completely undetectable. Their existence is known only from modeling.
    e) completely green in color.

12. On Jupiter the rising and sinking convective flows at the surface are:

    a) organized into bright and dark bands that are **PERPENDICULAR** to the equator and meet at the poles. The bright bands are the **HOT, HIGH-PRESSURE RISING GAS** and dark bands are **COOLER, LOW-PRESSURE SINKING GAS**. The dark bands are at lower elevation and receive less solar illumination.
    b) organized into bright and dark bands that are **PARALLEL** to the equator. The bright bands are the **HOT, HIGH-PRESSURE RISING GAS** and dark bands are **COOLER, LOW-PRESSURE SINKING GAS**. The dark bands are at lower elevation and receive less solar illumination.
    c) organized into bright and dark bands that are **PARALLEL** to the equator. The bright bands are the **COOLER, LOW-PRESSURE SINKING GAS** and dark bands are **HOT, HIGH-**

PRESSURE RISING GAS. The dark bands are at lower elevation and receive less solar illumination.

d) organized into bright and dark bands that are **PERPENDICULAR** to the equator. The bright bands are the **COOLER, LOW-PRESSURE SINKING GAS** and dark bands are **HOT, HIGH-PRESSURE RISING GAS**. The dark bands are at lower elevation and receive less solar illumination.

e) completely green in color.

13. Jupiter radiates:

a) about **100 TIMES** the energy it absorbs from the Sun. This energy comes from a cold hydrogen fusion in its center.

b) about **100 TIMES** the energy it absorbs from the Sun. Most of this energy comes from residual formation and radioactive heat stored in its interior.

c) about **2 TIMES** the energy it absorbs from the Sun. Most of this energy comes from formation heat and radioactive heat stored in its interior. The emitted radiation heats **Io,** and thus causes Io's extensive **VOLCANIC ACTIVITY**.

d) about **2 TIMES** the energy it absorbs from the Sun. Most of this energy comes from residual formation and radioactive heat stored in its interior.

e) about **4 TIMES** the energy it absorbs from the Sun. Most of this energy comes from formation heat and radioactive stored in its interior. The emitted radiation heats **Io,** and thus causes Io's extensive **VOLCANIC ACTIVITY**.

14. The 4 Galilean moons of Jupiter are:

a) Callisto, Ganymede, Europa, and Io.
b) Callisto, Ares, Iolaus, and Pseudolus.
c) Callisto, Ganymede, Europa, and Phobos.
d) Callisto, Ganymede, Asia, and Io.
e) Callisto, Ganymede, Africa, and Io.

15. How many moons does Jupiter have?

a) 4 known moons circa 2004. There may be other undiscovered, small moons. The 4 moons are, of course, the Galilean satellites discovered by **Rembrandt**.

b) 4 known moons circa 2004. There may be other undiscovered, small moons. The 4 moons are, of course, the Galilean satellites discovered by **Galileo.**

c) 1001.

d) 16 known moons circa 2004. There may be other undiscovered, small moons.

e) 6 known moons circa 2004. These moons include the 4 Galilean satellites and the two small moons, **Phobos and Deimos**. There may be other undiscovered, small moons.

16. The Galilean moons of Jupiter orbit more or less in a single plane probably because:

a) the early solar nebular magnetic field forced them to form in a plane.

b) of pure luck.

c) of pure bad luck.

d) they formed out the disk of material that formed about the proto-Jupiter.

e) a passing giant protoplanet pulled them into a plane long after their formation.

17. The surfaces of the Jupiter's Galilean satellites can be summarized as follows:

a) Callisto (old dark icy), Ganymede (old dark icy in parts; newer icy in parts), Europa (sulfurous and volcanic), Io (**methane ice**).

b) **Triton** (methane ice), Ganymede (sulfurous icy), Europa (sulfurous and volcanic), Io (**methane ice**).
c) Callisto (old dark icy), Ganymede (old dark icy in parts; newer icy in parts), Europa (newer brighter icy), Io (**sulfurous and volcanic**).
d) **Triton** (old dark icy), Ganymede (old dark icy in parts; newer icy in parts), Europa (newer brighter icy), Io (**sulfurous and volcanic**).
e) Callisto (old dark icy), Ganymede (old dark icy in parts; newer icy in parts), Europa (newer brighter icy), Io (**iron oxide**).

18. The striking (garish?) colors of Io are caused by:

a) rainbows. b) molecular oxygen gas. c) volatile gases such as molecular hydrogen, helium, and water vapor. d) sulfur and sulfur compounds. e) orange-colored water ice.

19. The volcanoes on Io eject a lot of:

a) carbon in various forms. b) sulfur in various forms. c) helium gas. d) molecular oxygen. e) sulfur dioxide ice crystals.

20. The Saturnian rings (i.e., the bright rings of Saturn) consist mainly of:

a) carbon in various forms.
b) **WATER ICE** chunks in a range of sizes from billiard ball size to house size. Their icy content makes the rings highly **REFLECTIVE** and this is a main reason why the Saturnian rings are so much brighter than other gas giant rings.
c) **HELIUM ICE** chunks in a range of sizes from billiard ball size to house size. Their icy content makes the rings highly **REFLECTIVE** and this is a main reason why the Saturnian rings are so much brighter than other gas giant rings.
d) **WATER ICE** chunks in a range of sizes from billiard ball size to house size. Their icy content makes the rings highly **LIGHT-ABSORBING** and this is a main reason why the Saturnian rings are so much brighter than other gas giant rings.
e) **HELIUM ICE** chunks in a range of sizes from billiard ball size to house size. Their icy content makes the rings highly **LIGHT-ABSORBING** and this is a main reason why the Saturnian rings are so much brighter than other gas giant rings.

21. "Let's play *Jeopardy*! For $100, the answer is: It is an apparent gap in the rings of Saturn."

What is the _____, Alex?

a) Verdi vacancy b) Vivaldi separation c) Puccini gap d) Cassini division e) Salieri split