Introductory Astronomy **NAME:**

Homework 15: Gas Giant Planets: Homeworks and solutions are posted on the course web site. Homeworks are **NOT** handed in and **NOT** marked. But many homework problems ($\sim$ 50–70 %) will turn up on tests.

Answer Table

	a	b	c	d	e
1.	O	O	O	O	O
2.	O	O	O	O	O
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4.	O	O	O	O	O
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Name:

	a	b	c	d	e
37.	O	O	O	O	O
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72.	O	O	O	O	O

1. Did you complete reading-homework-self-testing for the Introductory Astronomy Lecture (IAL) by the weekly due date?

   a) YYYessss! b) Jawohl! c) Da! d) Sí, sí. e) OMG no!

2. "Let's play *Jeopardy*! For $100, the answer is: These planets are:

   1) massive;
   2) powerful gravity sources;
   3) compartively low in density;
   4) in outer Solar System beyond 5 AU where it is generally pretty cold;
   5) have compositions dominated by hydrogen and helium;
   6) have extensive moon systems;
   7) have complex ring systems."

   What are the _____, Alex?

   a) rocky planets b) Bullwinkle and Rocky c) Kuiper Belt objects d) gas giant or **JOVIAN** planets e) gas giant or **JOVIAL** planets

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

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

4. 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.

5. 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.

6. What is a 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.

7. The gas giant planet atmospheres exhibit a band structure because of _____ from their _____ interiors combined with _____ rotation.

   a) convection; hot; rapid b) radiative transport of heat; hot; rapid c) convection; hot; slow
   d) radiative transport of heat; cold; slow e) radiative transport of heat; cold; slow

8. "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

9. 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**.

10. What is a major reason why the ring systems of the gas giants are so complex with knots and arcs, etc.?

a) The perfectly spherical shapes of the particles.
b) The cubical shapes of the particles.
c) Subtle gravitational perturbations by the gas giant moons.
d) Subtle magnetic perturbations by the gas giant moons.
e) The tenth planet from the Sun, Planet X, gravitationally perturbs the rings.

11. In our Solar System, Jupiter is:

a) the **MOST** massive planet and the **FIFTH** planet from the Sun.
b) the **MOST** massive planet and the **SIXTH** planet from the Sun.
c) the **SECOND MOST** massive planet and the **FOURTH** planet from the Sun.
d) the **FIFTH MOST** massive planet and the **THIRD** planet from the Sun.
e) a large asteroid that crosses both the orbits of Mars and Earth. It represents a perennial hazard to all life on Earth.

12. 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.

13. 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).

14. 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.

15. Jupiter's Great Red Spot is:

a) a long-lasting storm.
b) a remnant of the impacts of the cometary fragments of comet Shoemaker-Levy 9.
c) a red iceberg floating on molecular hydrogen gas.
d) a storm that has existed only a few years and will likely dissipate in another ten years or so.
e) actually on Saturn.

16. 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.

17. 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.

18. 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 primordial heat from time of formation and radiogenic heat both stored in its interior.
c) about **2 TIMES** the energy it absorbs from the Sun. Most of this energy comes from primordial heat from time of formation and radiogenic heat both 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 primordial heat from time of formation and radiogenic heat both stored in its interior.
e) about **4 TIMES** the energy it absorbs from the Sun. Most of this energy comes from primordial heat from time of formation and radiogenic heat both stored in its interior. The emitted radiation heats **Io,** and thus causes Io's extensive **VOLCANIC ACTIVITY**.

19. Jupiter probably has a strong magnetic field because of the dynamo effect. Why should Jupiter have a strong dynamo effect? It rotates _____ and probably has a deep convective layer of _____.

a) rapidly; hydrogen ice b) rapidly; liquid molecular hydrogen c) rapidly; liquid metallic hydrogen d) slowly; helium oxide e) rapidly; helium oxide

20. The 4 Galilean moons of Jupiter are:

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

21. 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 of the disk of material that formed about the early Jupiter.
e) a passing giant protoplanet pulled them into a plane long after their formation.

22. 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**).

23. Why has Io perhaps been especially heavily impacted for a Solar System body? Why is Io relatively uncratered by impacts compared to most Solar System moons?

a) It has perhaps been especially heavily impacted because of its **GREAT VOLCANIC ACTIVITY**. The closeness to Jupiter explains the lack of cratering.
b) It has perhaps been especially heavily impacted because **JUPITER'S STRONG GRAVITATIONAL FIELD** attracts impactors. Io's **LIQUID SURFACE** cannot, of course, be cratered.
c) It has perhaps been especially heavily impacted because **JUPITER'S STRONG GRAVITATIONAL FIELD** attracts impactors. Io's **ICE SURFACE** cannot, of course, be cratered.
d) It has perhaps been especially heavily impacted because **JUPITER'S FAST ROTATION RATE** attracts impactors. Io's **SNOW SURFACE** cannot, of course, be cratered.
e) It has perhaps been especially heavily impacted because **JUPITER'S STRONG GRAVITATIONAL FIELD** attracts impactors. Io's **GREAT VOLCANIC ACTIVITY** constantly renews its surface and relatively quickly eliminates any traces of impacts.

24. 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.

25. The cause of Io's great geological activity is:

a) Jupiter's tidal force. Because of its **CIRCULAR ORBIT,** the tidal force continually flexes Io's interior leading to internal heating. The heat causes volcanism.
b) Jupiter's tidal force. Because of its **ECCENTRIC ORBIT,** the tidal force continually flexes Io's interior leading to internal heating. The heat causes volcanism.
c) the great flux of impactors attracted by Jupiter. The impactors plunge deeply into Io and cause **INTENSE SHOCK FORCES** that cause heat. The heat causes volcanism.
d) the great flux of impactors attracted by Jupiter. The impactors plunge deeply into Io and release **RADIOACTIVE MATERIAL**. The radioactive material decays and so generates heat. The heat causes volcanism.
e) **LEFTOVER INTERNAL HEAT** from the time of formation. The heat causes volcanism.

26. 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.

27. 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.

28. "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