1 pt Which equation is the Roche limit for the case where the moon and planet have the same density? [Use these equations as a reminder.]

1. **A**◯R=2.5R_{planet}.
   B◯KE=1/2 m v^2, where v is the speed
   C◯v^2>2GM_{planet}/R_{planet}, where v is the speed.
   D◯KE=3/2kT, where T is temperature.

Answer for Part: 0
true
false
false
false

1 pt The specific purpose of the 4.1-meter primary mirror of the SOAR Telescope is to

2. **A**◯refract light.
   B◯analyze light into its colors.
   C◯collect light.
   D◯take pictures.

Answer for Part: 0
false
false
true
false

1 pt To achieve the same angular resolution, a radio telescopes is much larger than an optical telescope because

3. **A**◯radio telescopes must be more precise.
   B◯the wavelength of radio waves is much longer.
   C◯optical telescopes must be more precise.
   D◯radio waves are weaker.

Answer for Part: 0
false
true
false
false

1 pt [*] Consider this hypothetical discovery, which consists of three statements. S1: A planet is discovered beyond the orbit of Pluto. S2: Its density is 5 times the density of water. S3: It has many craters.would be very surprising.

4. **A**◯S2 & S3
   B◯None of the statements
   C◯S3
   D◯S2
   E◯S1, S2, & S3

Answer for Part: 0
false
false
false
true
false

1 pt Which is not a moon of Jupiter?

5. **A**◯Io
   B◯Titan
   C◯Europa
   D◯Ganymede
   E◯Callisto

Answer for Part: 0
false
true
false
false
false

1 pt You are equiped with a suit that supplies air to breathe and keeps you warm or cool. On which of these moons or planets could you not land?

6. **A**◯Pluto
   B◯Mars
   C◯Callisto
   D◯Saturn

Answer for Part: 0
false
false
false
true

1 pt The planet that is fourth closest to the sun is

7. **A**◯Venus.
B◯Mars.
C◯Jupiter.
D◯Earth.
E◯Saturn.

Answer for Part: 0
false
true
false
false
false

1 pt Potassium 40, which decays into argon 40, is used to figure out the age of meteorites. Why is there no argon 40 in the meteor when it formed?

8. **A**◯No argon 40 had been produced in the solar system when the meteor formed.
B◯Argon condenses at an extremely low temperature.
C◯Argon collected in the massive asteroids.
D◯All the argon collected in the jovian planets.

Answer for Part: 0
false
true
false
false

1 pt The age of the solar system is ___ years.

9. **A**◯65 Million
B◯13 Billion
C◯1 Billion
D◯4.5 Billion

Answer for Part: 0
false
false
false
true

1 pt Whattriggered the collapse of the gas cloud that became the solar system.

10. **A**◯The Big Bang
B◯A supernova, an exploding star
C◯The pressure of a massive star
D◯Gravity

Answer for Part: 0
false
true
false
false

1 pt Which one of these statements is true for the nucleus of Halley's comet?

11. **A**◯Its shape is roughly spherical.
B◯It is about the size of Michigan.
C◯It is made mostly of carbon.
D◯Its surface is uniform.
E◯It is very black.

Answer for Part: 0
false
false
false
false
true

1 pt Why does the tail of a comet point away from the sun?

12. **A**◯The magnetic field of the sun keeps the tail pointing away.
B◯Gas from the comet, heated by the sun, pushes the tail away from the sun.
C◯The solar wind blows gas and dust away from the sun.
D◯Conservation of angular momentum keeps the tail pointing away.

Answer for Part: 0
false
false
true
false

1 pt Which of the following statements comparing the jovian interiors is not thought to be true?

13. **A**◯They all have cores of roughly the same mass.
B◯They all have the same exact set of internal layers, though these layers differ in size.
C◯They all have cores that contain at least some rock and metal.
D◯Deep inside them, they all have pressures far higher than that found on the bottom of the ocean on Earth.

Answer for Part: 0
false
true
false
false

1 pt The clouds on the surface of Jupiter are not made of condensed

14. **A**◯hydrogen.
B◯ammonium hydrosulfide.
C◯ammonia.
D◯water.

Answer for Part: 0
true
false
false
false

1 pt Why can the material in the rings of Jovian planets not collect to form moons?

15. **A**◯The rings are not made of sticky material
B◯There is not enough material
C◯The rings are inside the Roche limit
D◯The rings are too thin

Answer for Part: 0
false
false
true
false

1 pt Which of the following best explains what we think happened to outgassed water on Venus?

16. **A**◯It turned into carbon dioxide by reacting with nitrogen in Venus's atmosphere.
B◯Ultraviolet light split the water molecules, and the hydrogen then escaped to space.
C◯It is frozen in craters near the poles.
D◯Water was removed from the atmosphere by chemical reactions with surface rock.

Answer for Part: 0
false
true
false
false

1 pt Astronomers believe that Mars had liquid water in the past because

17. **A**◯photographs show smooth rocks
B◯the space probe Odyssey found water ice.
C◯microscopic fossils were found.
D◯photographs show dry riverbeds.

Answer for Part: 0
false
false
false
true

1 pt Why does Venus have so much more atmospheric gas than Earth?

18. **A**◯Because of its lack of magnetic field, Venus has been able to gain gas through the process of bombardment, while Earth has not gained gas in this way.
B◯Earth has lost much more gas to thermal escape than has Venus.
C◯Earth has lost much more atmospheric gas than Venus, primarily to condensation of water vapor into liquid water and to chemical reactions that make carbonate rock.
D◯Venus has gained much more gas through outgassing than has Earth.

Answer for Part: 0
false
false
true
false

3 pt [*] Uranus was able attract helium (mass=4) and molecular hydrogen (mass=2) to the core, which formed first. Assume that Uranus cannot keep a gas with mass=1. Imagine a hypothetical planet core formed at the same location with the same size and 1/10 as much mass. What is the minimum mass of the gas that this hypothetical planet can attract and keep?

19. **A**◯4
B◯10
C◯40
D◯2
E◯20

Answer for Part: 0
false
true
false
false
false

1 pt Which is evidence that Io, one of Jupiter's moons, has a hot interior.

20. **A**◯Jupiter radiates a lot of infrared light.
B◯Io is close to Jupiter.
C◯Io has high radioactivity.
D◯Io has volcanoes.

Answer for Part: 0
false
false
false
true

1 pt What is the source of the energy that heats Io?

21. **A**◯Radioactivity.
B◯Infrared radiation from Jupiter.
C◯Motion of the moons.
D◯Solar energy.

Answer for Part: 0
false
false
true
false

1 pt [*] Hydrogen and helium make up more than 98% of the mass of the proto solar system. Carbon, nitrogen, and oxygen make up 1%. Metals and other elements make up 0.6%. Why did the hydrogen and helium that was in the vicinity of the formingEarth not end up on the present Earth? R1: It was too hot for these to condense. R2: The solid earth was notmassive enough to hold on to these gases. R3: The solar wind blew these gasses away. The main reasons are.[Hint: Test your reasons with the case of Jupiter.]

22. **A**◯R1 & R2.
B◯R2 & R3.
C◯R1, R2, & R3.
D◯R1 & R3.

Answer for Part: 0
true
false
false
false

1 pt What happened to the metals that were in the vicinity of the forming Earth?

23. **A**◯They were driven off by the solar wind.
B◯The Jovian planets accreted them.
C◯They became asteroids.
D◯They are primarily in the core of the earth.

Answer for Part: 0
false
false
false
true

1 pt A giant hand suddenly moves the earth farther from the Sun. The temperature of the Earth cools. Which processwould certainly happen and cause the temperature to rise.

24. **A**◯Volcanoes are more active.
B◯Plate tectonics become more active.
C◯There is less rain.
D◯There is more plant matter.

Answer for Part: 0
false
false
true
false

1 pt The space probe Odyssey found that the in regions north and south of 60 degrees latitude the surface is 50%water ice by volume. How is it that Odyssey was able to detect this water?

25. **A**◯The Odyssey sent a surface probe down to collect samples.
B◯Odyssey detected the differences in the energy of the neutrons coming off the surface of the planet.
C◯The density of the surface was greater where there is no water.
D◯The color of the surface is different where there is water.
E◯The temperature of the surface is cooler where there was so much ice.

Answer for Part: 0
false
true
false
false
false

1 pt Which of the following best explains what we think happened to outgassed water on Venus?

26. **A**◯Ultraviolet light split the water molecules, and the hyrdrogen then escaped to space.
B◯Water was removed from the atmosphere by chemical reactions with surface rock.
C◯It is frozen in craters near the poles.
D◯It turned into carbon dioxide by reacting with nitrogen in Venus's atmosphere.

Answer for Part: 0
false
false
false
true

1 pt Which of the following is not a general characteristic of the four jovian planets in our solar system?

27. **A**◯They lack solid surfaces.
B◯They are much more massive then any of the terrestrial planets.
C◯They are higher in average density than are the terrestrial planets.
D◯They are composed of mainly hydrogen, helium, and hydrogen compounds.

Answer for Part: 0
false
true
false
false

1 pt The planets near the sun have a high density because

28. **A**◯The lighter materials could not condense because the proto planet fell too far and became too hot.
B◯The sun evaporated the lighter materials
C◯The lighter materials escaped the planets gravity
D◯The sun prevented the lighter materials from condensing.

Answer for Part: 0
true
false
false
false

1 pt The Hubble Space Telescope orbits the Earth, even though it is far inside the Roche limit. The Hubble Space telescope is not broken apart because

29. **A**◯The Roche limit will cause the Space Telescope to break up after some time.
B◯The density of the Space Telescope is too high.
C◯Gravity does not apply to weightless conditions.
D◯the Roche limit does not apply to something held together by atomic bonds.

Answer for Part: 0
false
false
false
true

1 pt [*] The energy levels 1-4 of Hydrogen are 0, 10.2, 12.1, and 12.8 electron volts (eV), repectively. The Hydrogen is so cool that the electrons are all in level 1. The Hydrogen gas absorbs photons of energy 12.1 eV. When the electrons lose energy, light of ___ different energies will be emitted.

30. **A**◯1
B◯3
C◯2
D◯more than 3

Answer for Part: 0
false
true
false
false

1 pt [*] Do the lamps L & R at the front of the room emit thermal (black body) radiation?

31. **A**◯Yes for both.
B◯No for L; yes for R.
C◯No for both.
D◯Yes for L; no for R.

Answer for Part: 0
true
false
false
false

1 pt [*] While walking home around 9 pm, you see the moon rising. ___ of the moon is lit.

32. **A**◯Almost all
B◯Less than half
C◯Little
D◯More than half
E◯Half

Answer for Part: 0
false
false
false
true
false

1 pt [*] A giant hand suddenly doubled the mass of the sun and adjusted the motion of the earth to keep it in the same path. The giant hand would have had to make the earth___.

33. **A**◯move the same
B◯move faster
C◯move slower

Answer for Part: 0
false
true
false

1 pt

[*] Suppose a new comet is discovered with a period of 29.5 years, which is the same as that of Saturn. The orbit of the comet is highly elliptical. Saturn is 9.5 AU from the sun. Draw the orbits of the comet and Saturn. Be certain to include the sun. Your drawing must show accurate relative sizes.

34. *Leave blank on scoring form*

1 pt Which equation is the Roche limit for the case where the moon and planet have the same density? [Use these equations as a reminder.]

1. **A**◯$v^2 > 2GM_{planet}/R_{planet}$, where v is the speed.
B◯KE=3/2kT, where T is temperature.
C◯KE=1/2 m v^2, where v is the speed
D◯$R=2.5R_{planet}$.

Answer for Part: 0
false
false
false
true

1 pt The specific purpose of the 4.1-meter primary mirror of the SOAR Telescope is to

2. **A**◯take pictures.
B◯collect light.
C◯analyze light into its colors.
D◯refract light.

Answer for Part: 0
false
true
false
false

1 pt To achieve the same angular resolution, a radio telescopes is much larger than an optical telescope because

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C◯radio telescopes must be more precise.
D◯the wavelength of radio waves is much longer.

Answer for Part: 0
false
false
false
true

1 pt [*] Consider this hypothetical discovery, which consists of three statements. S1: A planet is discovered beyond the orbit of Pluto. S2: Its density is 5 times the density of water. S3: It has many craters.would be very surprising.

4. **A**◯S3
B◯S2
C◯None of the statements
D◯S1, S2, & S3
E◯S2 & S3

Answer for Part: 0
false
true
false
false
false

1 pt Which is not a moon of Jupiter?

5. **A**◯Ganymede
B◯Io
C◯Callisto
D◯Europa
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Answer for Part: 0
false
false
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6. **A**◯Callisto
B◯Saturn
C◯Pluto
D◯Mars

Answer for Part: 0
false
true
false
false

1 pt The planet that is fourth closest to the sun is

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B◯Venus.
C◯Earth.
D◯Mars.
E◯Jupiter.

Answer for Part: 0
false
false
false
true
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1 pt Potassium 40, which decays into argon 40, is used to figure out the age of meteorites. Why is there no argon 40 in the meteor when it formed?

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D◯All the argon collected in the jovian planets.

Answer for Part: 0
true
false
false
false

1 pt The age of the solar system is ___ years.

9. **A**◯4.5 Billion
B◯1 Billion
C◯65 Million
D◯13 Billion

Answer for Part: 0
true
false
false
false

1 pt Whattriggered the collapse of the gas cloud that became the solar system.

10. **A**◯The pressure of a massive star
B◯The Big Bang
C◯A supernova, an exploding star
D◯Gravity

Answer for Part: 0
false
false
true
false

1 pt Which one of these statements is true for the nucleus of Halley's comet?

11. **A**◯Its surface is uniform.
B◯It is very black.
C◯It is made mostly of carbon.
D◯It is about the size of Michigan.
E◯Its shape is roughly spherical.

Answer for Part: 0
false
true
false
false
false

1 pt Why does the tail of a comet point away from the sun?

12. **A**◯The magnetic field of the sun keeps the tail pointing away.
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Answer for Part: 0
false
false
false
true

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C◯They all have the same exact set of internal layers, though these layers differ in size.
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Answer for Part: 0
false
false
true
false

1 pt The clouds on the surface of Jupiter are not made of condensed

14. **A**◯ammonia.
B◯hydrogen.
C◯water.
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Answer for Part: 0
false
true
false
false

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15. **A**◯There is not enough material
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Answer for Part: 0
false
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1 pt Which of the following best explains what we think happened to outgassed water on Venus?

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Answer for Part: 0
false
false
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1 pt Astronomers believe that Mars had liquid water in the past because

17. **A**◯photographs show dry riverbeds.
B◯the space probe Odyssey found water ice.
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Answer for Part: 0
true
false
false
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18. **A**◯Because of its lack of magnetic field, Venus has been able to gain gas through the process of bombardment, while Earth has not gained gas in this way.
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3 pt [*] Uranus was able attract helium (mass=4) and molecular hydrogen (mass=2) to the core, which formed first. Assume that Uranus cannot keep a gas with mass=1. Imagine a hypothetical planet core formed at the same location with the same size and 1/10 as much mass. What is the minimum mass of the gas that this hypothetical planet can attract and keep?

19. **A**◯2
B◯20
C◯10
D◯40
E◯4

Answer for Part: 0
false
false
true
false
false

1 pt Which is evidence that Io, one of Jupiter's moons, has a hot interior.

20. **A**◯Io has volcanoes.
B◯Jupiter radiates a lot of infrared light.
C◯Io has high radioactivity.
D◯Io is close to Jupiter.

Answer for Part: 0
true
false
false
false

1 pt What is the source of the energy that heats Io?

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Answer for Part: 0
false
false
false
true

1 pt [*] Hydrogen and helium make up more than 98% of the mass of the proto solar system. Carbon, nitrogen, and oxygen make up 1%. Metals and other elements make up 0.6%. Why did the hydrogen and helium that was in the vicinity of the formingEarth not end up on the present Earth? R1: It was too hot for these to condense. R2: The solid earth was notmassive enough to hold on to these gases. R3: The solar wind blew these gasses away. The main reasons are.[Hint: Test your reasons with the case of Jupiter.]

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D◯R2 & R3.

Answer for Part: 0
false
true
false
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B◯1
C◯3
D◯2

Answer for Part: 0
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31. **A**◯No for both.
B◯Yes for both.
C◯No for L; yes for R.
D◯Yes for L; no for R.

Answer for Part: 0
false
true
false
false

1 pt [*] While walking home around 9 pm, you see the moon rising. ___ of the moon is lit.

32. **A**◯More than half
B◯Half
C◯Little
D◯Less than half
E◯Almost all

Answer for Part: 0
true
false
false
false
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1 pt
[*] Suppose a new comet is discovered with a period of 29.5 years, which is the same as that of Saturn. The orbit of the comet is highly elliptical. Saturn is 9.5 AU from the sun. Draw the orbits of the comet and Saturn. Be certain to include the sun. Your drawing must show accurate relative sizes.

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false

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Answer for Part: 0
false
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false
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4. **A**◯S3
   B◯S1, S2, & S3
   C◯S2 & S3
   D◯None of the statements
   E◯S2

Answer for Part: 0
false
false
false
false
true

1 pt Which is not a moon of Jupiter?

5. **A**◯Ganymede
   B◯Callisto
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Answer for Part: 0
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false
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B◯Mars.
C◯Earth.
D◯Venus.
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B◯Argon condenses at an extremely low temperature.
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true
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1 pt The age of the solar system is ___ years.

9. **A**◯1 Billion
B◯13 Billion
C◯4.5 Billion
D◯65 Million

Answer for Part: 0
false
false
true
false

1 pt Whattriggered the collapse of the gas cloud that became the solar system.

10. **A**◯A supernova, an exploding star
B◯The pressure of a massive star
C◯Gravity
D◯The Big Bang

Answer for Part: 0
true
false
false
false

1 pt Which one of these statements is true for the nucleus of Halley's comet?

11. **A**◯Its surface is uniform.
B◯Its shape is roughly spherical.
C◯It is made mostly of carbon.
D◯It is about the size of Michigan.
E◯It is very black.

Answer for Part: 0
false
false
false
false
true

1 pt Why does the tail of a comet point away from the sun?

12. **A**◯The magnetic field of the sun keeps the tail pointing away.
B◯Gas from the comet, heated by the sun, pushes the tail away from the sun.
C◯The solar wind blows gas and dust away from the sun.
D◯Conservation of angular momentum keeps the tail pointing away.

Answer for Part: 0
false
false
true
false

1 pt Which of the following statements comparing the jovian interiors is not thought to be true?

13. **A**◯Deep inside them, they all have pressures far higher than that found on the bottom of the ocean on Earth.
B◯They all have the same exact set of internal layers, though these layers differ in size.
C◯They all have cores that contain at least some rock and metal.
D◯They all have cores of roughly the same mass.

Answer for Part: 0
false
true
false
false

1 pt The clouds on the surface of Jupiter are not made of condensed

14. **A**◯ammonia.
B◯ammonium hydrosulfide.
C◯water.
D◯hydrogen.

Answer for Part: 0
false
false
false
true

1 pt Why can the material in the rings of Jovian planets not collect to form moons?

15. **A**◯There is not enough material
B◯The rings are too thin
C◯The rings are inside the Roche limit
D◯The rings are not made of sticky material

Answer for Part: 0
false
false
true
false

1 pt Which of the following best explains what we think happened to outgassed water on Venus?

16. **A**◯It turned into carbon dioxide by reacting with nitrogen in Venus's atmosphere.
B◯Ultraviolet light split the water molecules, and the hydrogen then escaped to space.
C◯Water was removed from the atmosphere by chemical reactions with surface rock.
D◯It is frozen in craters near the poles.

Answer for Part: 0
false
true
false
false

1 pt Astronomers believe that Mars had liquid water in the past because

17. **A**◯the space probe Odyssey found water ice.
B◯photographs show smooth rocks
C◯microscopic fossils were found.
D◯photographs show dry riverbeds.

Answer for Part: 0
false
false
false
true

1 pt Why does Venus have so much more atmospheric gas than Earth?

18. **A**◯Because of its lack of magnetic field, Venus has been able to gain gas through the process of bombardment, while Earth has not gained gas in this way.
B◯Earth has lost much more gas to thermal escape than has Venus.
C◯Earth has lost much more atmospheric gas than Venus, primarily to condensation of water vapor into liquid water and to chemical reactions that make carbonate rock.
D◯Venus has gained much more gas through outgassing than has Earth.

Answer for Part: 0
false
false
true
false

3 pt [*] Uranus was able attract helium (mass=4) and molecular hydrogen (mass=2) to the core, which formed first. Assume that Uranus cannot keep a gas with mass=1. Imagine a hypothetical planet core formed at the same location with the same size and 1/10 as much mass. What is the minimum mass of the gas that this hypothetical planet can attract and keep?

19. **A**◯2
B◯10
C◯4
D◯40
E◯20

Answer for Part: 0
false
true
false
false
false

1 pt Which is evidence that Io, one of Jupiter's moons, has a hot interior.

20. **A**◯Jupiter radiates a lot of infrared light.
B◯Io is close to Jupiter.
C◯Io has high radioactivity.
D◯Io has volcanoes.

Answer for Part: 0
false
false
false
true

1 pt What is the source of the energy that heats Io?

21. **A**◯Infrared radiation from Jupiter.
B◯Motion of the moons.
C◯Radioactivity.
D◯Solar energy.

Answer for Part: 0
false
true
false
false

1 pt [*] Hydrogen and helium make up more than 98% of the mass of the proto solar system. Carbon, nitrogen, and oxygen make up 1%. Metals and other elements make up 0.6%. Why did the hydrogen and helium that was in the vicinity of the formingEarth not end up on the present Earth? R1: It was too hot for these to condense. R2: The solid earth was notmassive enough to hold on to these gases. R3: The solar wind blew these gasses away. The main reasons are.[Hint: Test your reasons with the case of Jupiter.]

22. **A**◯R1 & R2.
B◯R1 & R3.
C◯R2 & R3.
D◯R1, R2, & R3.

Answer for Part: 0
true
false
false
false

1 pt What happened to the metals that were in the vicinity of the forming Earth?

23. **A**◯The Jovian planets accreted them.
B◯They became asteroids.
C◯They were driven off by the solar wind.
D◯They are primarily in the core of the earth.

Answer for Part: 0
false
false
false
true

1 pt A giant hand suddenly moves the earth farther from the Sun. The temperature of the Earth cools. Which processwould certainly happen and cause the temperature to rise.

24. **A**◯Volcanoes are more active.
B◯Plate tectonics become more active.
C◯There is less rain.
D◯There is more plant matter.

Answer for Part: 0
false
false
true
false

1 pt The space probe Odyssey found that the in regions north and south of 60 degrees latitude the surface is 50%water ice by volume. How is it that Odyssey was able to detect this water?

25. **A**◯The color of the surface is different where there is water.
B◯Odyssey detected the differences in the energy of the neutrons coming off the surface of the planet.
C◯The temperature of the surface is cooler where there was so much ice.
D◯The density of the surface was greater where there is no water.
E◯The Odyssey sent a surface probe down to collect samples.

Answer for Part: 0
false
true
false
false
false

1 pt Which of the following best explains what we think happened to outgassed water on Venus?

26. **A**◯It is frozen in craters near the poles.
B◯Ultraviolet light split the water molecules, and the hyrdrogen then escaped to space.
C◯Water was removed from the atmosphere by chemical reactions with surface rock.
D◯It turned into carbon dioxide by reacting with nitrogen in Venus's atmosphere.

Answer for Part: 0
false
false
false
true

1 pt Which of the following is not a general characteristic of the four jovian planets in our solar system?

27. **A**◯They are composed of mainly hydrogen, helium, and hydrogen compounds.
B◯They are much more massive then any of the terrestrial planets.
C◯They are higher in average density than are the terrestrial planets.
D◯They lack solid surfaces.

Answer for Part: 0
false
true
false
false

1 pt The planets near the sun have a high density because

28. **A**◯The lighter materials could not condense because the proto planet fell too far and became too hot.
B◯The lighter materials escaped the planets gravity
C◯The sun prevented the lighter materials from condensing.
D◯The sun evaporated the lighter materials

Answer for Part: 0
true
false
false
false

1 pt The Hubble Space Telescope orbits the Earth, even though it is far inside the Roche limit. The Hubble Space telescope is not broken apart because

29. **A**◯Gravity does not apply to weightless conditions.
B◯The Roche limit will cause the Space Telescope to break up after some time.
C◯The density of the Space Telescope is too high.
D◯the Roche limit does not apply to something held together by atomic bonds.

Answer for Part: 0
false
false
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1 pt [*] The energy levels 1-4 of Hydrogen are 0, 10.2, 12.1, and 12.8 electron volts (eV), repectively. The Hydrogen is so cool that the electrons are all in level 1. The Hydrogen gas absorbs photons of energy 12.1 eV. When the electrons lose energy, light of ___ different energies will be emitted.

30. **A**◯more than 3
B◯3
C◯2
D◯1

Answer for Part: 0
false
true
false
false

1 pt [*] Do the lamps L & R at the front of the room emit thermal (black body) radiation?

31. **A**◯Yes for both.
B◯No for both.
C◯Yes for L; no for R.
D◯No for L; yes for R.

Answer for Part: 0
true
false
false
false

1 pt [*] While walking home around 9 pm, you see the moon rising. ___ of the moon is lit.

32. **A**◯Half
B◯Almost all
C◯Little
D◯More than half
E◯Less than half

Answer for Part: 0
false
false
false
true
false

1 pt [*] A giant hand suddenly doubled the mass of the sun and adjusted the motion of the earth to keep it in the same path. The giant hand would have had to make the earth___.

33. **A**◯move slower
B◯move faster
C◯move the same

Answer for Part: 0
false
true
false

1 pt

[*] Suppose a new comet is discovered with a period of 29.5 years, which is the same as that of Saturn. The orbit of the comet is highly elliptical. Saturn is 9.5 AU from the sun. Draw the orbits of the comet and Saturn. Be certain to include the sun. Your drawing must show accurate relative sizes.

34. *Leave blank on scoring form*

1 pt Which equation is the Roche limit for the case where the moon and planet have the same density? [Use these equations as a reminder.]

1. **A**◯KE=1/2 m v^2, where v is the speed
B◯KE=3/2kT, where T is temperature.
C◯v^2>2GM_{planet}/R_{planet}, where v is the speed.
D◯R=2.5R_{planet}.

Answer for Part: 0
false
false
false
true

1 pt The specific purpose of the 4.1-meter primary mirror of the SOAR Telescope is to

2. **A**◯refract light.
B◯collect light.
C◯take pictures.
D◯analyze light into its colors.

Answer for Part: 0
false
true
false
false

1 pt To achieve the same angular resolution, a radio telescopes is much larger than an optical telescope because

3. **A**◯the wavelength of radio waves is much longer.
B◯radio telescopes must be more precise.
C◯radio waves are weaker.
D◯optical telescopes must be more precise.

Answer for Part: 0
true
false
false
false

1 pt [*] Consider this hypothetical discovery, which consists of three statements. S1: A planet is discovered beyond the orbit of Pluto. S2: Its density is 5 times the density of water. S3: It has many craters.would be very surprising.

4. **A**◯S2 & S3
B◯S1, S2, & S3
C◯S2
D◯None of the statements
E◯S3

Answer for Part: 0
false
false
true
false
false

1 pt Which is not a moon of Jupiter?

5. **A**◯Titan
B◯Io
C◯Ganymede
D◯Callisto
E◯Europa

Answer for Part: 0
true
false
false
false
false

1 pt You are equiped with a suit that supplies air to breathe and keeps you warm or cool. On which of these moons or planets could you not land?

6. **A**◯Pluto
B◯Callisto
C◯Saturn
D◯Mars

Answer for Part: 0
false
false
true
false

1 pt The planet that is fourth closest to the sun is

7. **A**◯Earth.
B◯Mars.
C◯Jupiter.
D◯Saturn.
E◯Venus.

Answer for Part: 0
false
true
false
false
false

1 pt Potassium 40, which decays into argon 40, is used to figure out the age of meteorites. Why is there no argon 40 in the meteor when it formed?

8. **A**◯Argon condenses at an extremely low temperature.
B◯No argon 40 had been produced in the solar system when the meteor formed.
C◯Argon collected in the massive asteroids.
D◯All the argon collected in the jovian planets.

Answer for Part: 0
true
false
false
false

1 pt The age of the solar system is ___ years.

9. **A**◯65 Million
B◯1 Billion
C◯13 Billion
D◯4.5 Billion

Answer for Part: 0
false
false
false
true

1 pt Whattriggered the collapse of the gas cloud that became the solar system.

10. **A**◯Gravity
B◯A supernova, an exploding star
C◯The pressure of a massive star
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Answer for Part: 0
false
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C◯Its surface is uniform.
D◯It is made mostly of carbon.
E◯It is very black.

Answer for Part: 0
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false
false
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12. **A**◯Conservation of angular momentum keeps the tail pointing away.
B◯Gas from the comet, heated by the sun, pushes the tail away from the sun.
C◯The solar wind blows gas and dust away from the sun.
D◯The magnetic field of the sun keeps the tail pointing away.

Answer for Part: 0
false
false
true
false

1 pt Which of the following statements comparing the jovian interiors is not thought to be true?

13. **A**◯They all have cores that contain at least some rock and metal.
B◯They all have the same exact set of internal layers, though these layers differ in size.
C◯They all have cores of roughly the same mass.
D◯Deep inside them, they all have pressures far higher than that found on the bottom of the ocean on Earth.

Answer for Part: 0
false
true
false
false

1 pt The clouds on the surface of Jupiter are not made of condensed

14. **A**◯hydrogen.
B◯water.
C◯ammonia.
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Answer for Part: 0
true
false
false
false

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15. **A**◯The rings are not made of sticky material
B◯The rings are too thin
C◯The rings are inside the Roche limit
D◯There is not enough material

Answer for Part: 0
false
false
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1 pt Which of the following best explains what we think happened to outgassed water on Venus?

16. **A**◯It is frozen in craters near the poles.
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Answer for Part: 0
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true
false
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17. **A**◯photographs show smooth rocks
B◯the space probe Odyssey found water ice.
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false
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19. **A**◯40
B◯10
C◯2
D◯20
E◯4

Answer for Part: 0
false
true
false
false
false

1 pt Which is evidence that Io, one of Jupiter's moons, has a hot interior.

20. **A**◯Io is close to Jupiter.
B◯Jupiter radiates a lot of infrared light.
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Answer for Part: 0
false
false
false
true

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22. **A**◯R1 & R2.
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C◯R1 & R3.
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Answer for Part: 0
true
false
false
false

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Answer for Part: 0
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false
true
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B◯S2
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Answer for Part: 0
false
true
false
false
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1 pt Which is not a moon of Jupiter?

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E◯Earth.

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B◯Venus has gained much more gas through outgassing than has Earth.
C◯Earth has lost much more gas to thermal escape than has Venus.
D◯Earth has lost much more atmospheric gas than Venus, primarily to condensation of water vapor into liquid water and to chemical reactions that make carbonate rock.

Answer for Part: 0
false
false
false
true

3 pt [*] Uranus was able attract helium (mass=4) and molecular hydrogen (mass=2) to the core, which formed first. Assume that Uranus cannot keep a gas with mass=1. Imagine a hypothetical planet core formed at the same location with the same size and 1/10 as much mass. What is the minimum mass of the gas that this hypothetical planet can attract and keep?

19. **A**◯4
B◯20
C◯10
D◯2
E◯40

Answer for Part: 0
false
false
true
false
false

1 pt Which is evidence that Io, one of Jupiter's moons, has a hot interior.

20. **A**◯Io has volcanoes.
B◯Jupiter radiates a lot of infrared light.
C◯Io has high radioactivity.
D◯Io is close to Jupiter.

Answer for Part: 0
true
false
false
false

1 pt What is the source of the energy that heats Io?

21. **A**◯Radioactivity.
B◯Solar energy.
C◯Motion of the moons.
D◯Infrared radiation from Jupiter.

Answer for Part: 0
false
false
true
false

1 pt [*] Hydrogen and helium make up more than 98% of the mass of the proto solar system. Carbon, nitrogen, and oxygen make up 1%. Metals and other elements make up 0.6%. Why did the hydrogen and helium that was in the vicinity of the formingEarth not end up on the present Earth? R1: It was too hot for these to condense. R2: The solid earth was notmassive enough to hold on to these gases. R3: The solar wind blew these gasses away. The main reasons are.[Hint: Test your reasons with the case of Jupiter.]

22. **A**◯R2 & R3.
B◯R1 & R2.
C◯R1 & R3.
D◯R1, R2, & R3.

Answer for Part: 0
false
true
false
false

1 pt What happened to the metals that were in the vicinity of the forming Earth?

23. **A**◯They are primarily in the core of the earth.
B◯The Jovian planets accreted them.
C◯They were driven off by the solar wind.
D◯They became asteroids.

Answer for Part: 0
true
false
false
false

1 pt A giant hand suddenly moves the earth farther from the Sun. The temperature of the Earth cools. Which processwould certainly happen and cause the temperature to rise.

24. **A**◯Volcanoes are more active.
B◯There is more plant matter.
C◯Plate tectonics become more active.
D◯There is less rain.

Answer for Part: 0
false
false
false
true

1 pt The space probe Odyssey found that the in regions north and south of 60 degrees latitude the surface is 50%water ice by volume. How is it that Odyssey was able to detect this water?

25. **A**◯The color of the surface is different where there is water.
B◯The Odyssey sent a surface probe down to collect samples.
C◯Odyssey detected the differences in the energy of the neutrons coming off the surface of the planet.
D◯The density of the surface was greater where there is no water.
E◯The temperature of the surface is cooler where there was so much ice.

Answer for Part: 0
false
false
true
false
false

1 pt Which of the following best explains what we think happened to outgassed water on Venus?

26. **A**◯It turned into carbon dioxide by reacting with nitrogen in Venus's atmosphere.
B◯Ultraviolet light split the water molecules, and the hyrdrogen then escaped to space.
C◯Water was removed from the atmosphere by chemical reactions with surface rock.
D◯It is frozen in craters near the poles.

Answer for Part: 0
true
false
false
false

1 pt Which of the following is not a general characteristic of the four jovian planets in our solar system?

27. **A**◯They lack solid surfaces.
B◯They are composed of mainly hydrogen, helium, and hydrogen compounds.
C◯They are much more massive then any of the terrestrial planets.
D◯They are higher in average density than are the terrestrial planets.

Answer for Part: 0
false
false
true
false

1 pt The planets near the sun have a high density because

28. **A**◯The sun evaporated the lighter materials
B◯The lighter materials could not condense because the proto planet fell too far and became too hot.
C◯The sun prevented the lighter materials from condensing.
D◯The lighter materials escaped the planets gravity

Answer for Part: 0
false
true
false
false

1 pt The Hubble Space Telescope orbits the Earth, even though it is far inside the Roche limit. The Hubble Space telescope is not broken apart because

29. **A**◯the Roche limit does not apply to something held together by atomic bonds.
B◯Gravity does not apply to weightless conditions.
C◯The density of the Space Telescope is too high.
D◯The Roche limit will cause the Space Telescope to break up after some time.

Answer for Part: 0
true
false
false
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1 pt [*] The energy levels 1-4 of Hydrogen are 0, 10.2, 12.1, and 12.8 electron volts (eV), repectively. The Hydrogen is so cool that the electrons are all in level 1. The Hydrogen gas absorbs photons of energy 12.1 eV. When the electrons lose energy, light of ___ different energies will be emitted.

30. **A**◯1
B◯more than 3
C◯3
D◯2

Answer for Part: 0
false
false
true
false

1 pt [*] Do the lamps L & R at the front of the room emit thermal (black body) radiation?

31. **A**◯Yes for both.
B◯No for both.
C◯Yes for L; no for R.
D◯No for L; yes for R.

Answer for Part: 0
true
false
false
false

1 pt [*] While walking home around 9 pm, you see the moon rising. ___ of the moon is lit.

32. **A**◯Half
B◯Little
C◯Less than half
D◯Almost all
E◯More than half

Answer for Part: 0
false
false
false
false
true

1 pt [*] A giant hand suddenly doubled the mass of the sun and adjusted the motion of the earth to keep it in the same path. The giant hand would have had to make the earth___.

33. **A**◯move the same
B◯move faster
C◯move slower

Answer for Part: 0
false
true
false

1 pt

[*] Suppose a new comet is discovered with a period of 29.5 years, which is the same as that of Saturn. The orbit of the comet is highly elliptical. Saturn is 9.5 AU from the sun. Draw the orbits of the comet and Saturn. Be certain to include the sun. Your drawing must show accurate relative sizes.

34. *Leave blank on scoring form*

1 pt Which equation is the Roche limit for the case where the moon and planet have the same density? [Use these equations as a reminder.]

1. **A**◯KE=1/2 m v^2, where v is the speed
B◯KE=3/2kT, where T is temperature.
C◯v^2>2GM_{planet}/R_{planet}, where v is the speed.
D◯R=2.5R_{planet}.

Answer for Part: 0
false
false
false
true

1 pt The specific purpose of the 4.1-meter primary mirror of the SOAR Telescope is to

2. **A**◯refract light.
B◯collect light.
C◯take pictures.
D◯analyze light into its colors.

Answer for Part: 0
false
true
false
false

1 pt To achieve the same angular resolution, a radio telescopes is much larger than an optical telescope because

3. **A**◯radio telescopes must be more precise.
B◯radio waves are weaker.
C◯optical telescopes must be more precise.
D◯the wavelength of radio waves is much longer.

Answer for Part: 0
false
false
false
true

1 pt [*] Consider this hypothetical discovery, which consists of three statements. S1: A planet is discovered beyond the orbit of Pluto. S2: Its density is 5 times the density of water. S3: It has many craters.would be very surprising.

4. **A**◯S2 & S3
B◯S2
C◯S3
D◯None of the statements
E◯S1, S2, & S3

Answer for Part: 0
false
true
false
false
false

1 pt Which is not a moon of Jupiter?

5. **A**◯Io
B◯Callisto
C◯Europa
D◯Ganymede
E◯Titan

Answer for Part: 0
false
false
false
false
true

1 pt You are equiped with a suit that supplies air to breathe and keeps you warm or cool. On which of these moons or planets could you not land?

6. **A**◯Pluto
B◯Saturn
C◯Callisto
D◯Mars

Answer for Part: 0
false
true
false
false

1 pt The planet that is fourth closest to the sun is

7. **A**◯Venus.
B◯Earth.
C◯Saturn.
D◯Mars.
E◯Jupiter.

Answer for Part: 0
false
false
false
true
false

1 pt Potassium 40, which decays into argon 40, is used to figure out the age of meteorites. Why is there no argon 40 in the meteor when it formed?

8. **A**◯Argon condenses at an extremely low temperature.
B◯Argon collected in the massive asteroids.
C◯No argon 40 had been produced in the solar system when the meteor formed.
D◯All the argon collected in the jovian planets.

Answer for Part: 0
true
false
false
false

1 pt The age of the solar system is ___ years.

9. **A**◯4.5 Billion
B◯65 Million
C◯1 Billion
D◯13 Billion

Answer for Part: 0
true
false
false
false

1 pt Whattriggered the collapse of the gas cloud that became the solar system.

10. **A**◯The Big Bang
B◯Gravity
C◯A supernova, an exploding star
D◯The pressure of a massive star

Answer for Part: 0
false
false
true
false

1 pt Which one of these statements is true for the nucleus of Halley's comet?

11. **A**◯Its shape is roughly spherical.
B◯It is very black.
C◯Its surface is uniform.
D◯It is made mostly of carbon.
E◯It is about the size of Michigan.

Answer for Part: 0
false
true
false
false
false

1 pt Why does the tail of a comet point away from the sun?

12. **A**◯Conservation of angular momentum keeps the tail pointing away.
B◯The magnetic field of the sun keeps the tail pointing away.
C◯Gas from the comet, heated by the sun, pushes the tail away from the sun.
D◯The solar wind blows gas and dust away from the sun.

Answer for Part: 0
false
false
false
true

1 pt Which of the following statements comparing the jovian interiors is not thought to be true?

13. **A**◯They all have cores of roughly the same mass.
B◯Deep inside them, they all have pressures far higher than that found on the bottom of the ocean on Earth.
C◯They all have the same exact set of internal layers, though these layers differ in size.
D◯They all have cores that contain at least some rock and metal.

Answer for Part: 0
false
false
true
false

1 pt The clouds on the surface of Jupiter are not made of condensed

14. **A**◯ammonium hydrosulfide.
B◯hydrogen.
C◯water.
D◯ammonia.

Answer for Part: 0
false
true
false
false

1 pt Why can the material in the rings of Jovian planets not collect to form moons?

15. **A**◯The rings are not made of sticky material
B◯The rings are too thin
C◯There is not enough material
D◯The rings are inside the Roche limit

Answer for Part: 0
false
false
false
true

1 pt Which of the following best explains what we think happened to outgassed water on Venus?

16. **A**◯It is frozen in craters near the poles.
B◯It turned into carbon dioxide by reacting with nitrogen in Venus's atmosphere.
C◯Ultraviolet light split the water molecules, and the hydrogen then escaped to space.
D◯Water was removed from the atmosphere by chemical reactions with surface rock.

Answer for Part: 0
false
false
true
false

1 pt Astronomers believe that Mars had liquid water in the past because

17. **A**◯photographs show dry riverbeds.
B◯photographs show smooth rocks
C◯microscopic fossils were found.
D◯the space probe Odyssey found water ice.

Answer for Part: 0
true
false
false
false

1 pt Why does Venus have so much more atmospheric gas than Earth?

18. **A**◯Venus has gained much more gas through outgassing than has Earth.
B◯Earth has lost much more gas to thermal escape than has Venus.
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19. **A**◯4
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C◯10
D◯20
E◯40

Answer for Part: 0
false
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1 pt Which is evidence that Io, one of Jupiter's moons, has a hot interior.

20. **A**◯Io has volcanoes.
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1 pt [*] Hydrogen and helium make up more than 98% of the mass of the proto solar system. Carbon, nitrogen, and oxygen make up 1%. Metals and other elements make up 0.6%. Why did the hydrogen and helium that was in the vicinity of the formingEarth not end up on the present Earth? R1: It was too hot for these to condense. R2: The solid earth was notmassive enough to hold on to these gases. R3: The solar wind blew these gasses away. The main reasons are.[Hint: Test your reasons with the case of Jupiter.]

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[*] Suppose a new comet is discovered with a period of 29.5 years, which is the same as that of Saturn. The orbit of the comet is highly elliptical. Saturn is 9.5 AU from the sun. Draw the orbits of the comet and Saturn. Be certain to include the sun. Your drawing must show accurate relative sizes.

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false
true
false
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2. **A**◯refract light.
   B◯take pictures.
   C◯analyze light into its colors.
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Answer for Part: 0
false
false
false
true

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Answer for Part: 0
false
true
false
false

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4. **A**◯None of the statements
   B◯S1, S2, & S3
   C◯S2 & S3
   D◯S3
   E◯S2

Answer for Part: 0
false
false
false
false
true

1 pt Which is not a moon of Jupiter?

5. **A**◯Callisto
   B◯Ganymede
   C◯Titan
   D◯Io
   E◯Europa

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false
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1 pt The planet that is fourth closest to the sun is

7. **A**◯Mars.
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C◯Venus.
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Answer for Part: 0
true
false
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false
false

1 pt Potassium 40, which decays into argon 40, is used to figure out the age of meteorites. Why is there no argon 40 in the meteor when it formed?

8. **A**◯No argon 40 had been produced in the solar system when the meteor formed.
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Answer for Part: 0
false
true
false
false

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9. **A**◯13 Billion
B◯1 Billion
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D◯65 Million

Answer for Part: 0
false
false
true
false

1 pt Whattriggered the collapse of the gas cloud that became the solar system.

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Answer for Part: 0
true
false
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Answer for Part: 0
true
false
false
false

1 pt The clouds on the surface of Jupiter are not made of condensed

14. **A**◯water.
B◯ammonia.
C◯ammonium hydrosulfide.
D◯hydrogen.

Answer for Part: 0
false
false
false
true

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15. **A**◯The rings are too thin
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Answer for Part: 0
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19. **A**◯10
B◯20
C◯2
D◯40
E◯4

Answer for Part: 0
true
false
false
false
false

1 pt Which is evidence that Io, one of Jupiter's moons, has a hot interior.

20. **A**◯Io has high radioactivity.
B◯Jupiter radiates a lot of infrared light.
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Answer for Part: 0
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false
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false
false

1 pt The space probe Odyssey found that the in regions north and south of 60 degrees latitude the surface is 50%water ice by volume. How is it that Odyssey was able to detect this water?

25. **A**◯Odyssey detected the differences in the energy of the neutrons coming off the surface of the planet.
B◯The density of the surface was greater where there is no water.
C◯The Odyssey sent a surface probe down to collect samples.
D◯The color of the surface is different where there is water.
E◯The temperature of the surface is cooler where there was so much ice.

Answer for Part: 0
true
false
false
false
false

1 pt Which of the following best explains what we think happened to outgassed water on Venus?

26. **A**◯It is frozen in craters near the poles.
B◯Water was removed from the atmosphere by chemical reactions with surface rock.
C◯Ultraviolet light split the water molecules, and the hyrdrogen then escaped to space.
D◯It turned into carbon dioxide by reacting with nitrogen in Venus's atmosphere.

Answer for Part: 0
false
false
false
true

1 pt Which of the following is not a general characteristic of the four jovian planets in our solar system?

27. **A**◯They are composed of mainly hydrogen, helium, and hydrogen compounds.
B◯They are much more massive then any of the terrestrial planets.
C◯They lack solid surfaces.
D◯They are higher in average density than are the terrestrial planets.

Answer for Part: 0
false
true
false
false

1 pt The planets near the sun have a high density because

28. **A**◯The lighter materials escaped the planets gravity
B◯The sun evaporated the lighter materials
C◯The sun prevented the lighter materials from condensing.
D◯The lighter materials could not condense because the proto planet fell too far and became too hot.

Answer for Part: 0
false
false
false
true

1 pt The Hubble Space Telescope orbits the Earth, even though it is far inside the Roche limit. The Hubble Space telescope is not broken apart because

29. **A**◯The density of the Space Telescope is too high.
B◯The Roche limit will cause the Space Telescope to break up after some time.
C◯the Roche limit does not apply to something held together by atomic bonds.
D◯Gravity does not apply to weightless conditions.

Answer for Part: 0
false
false
true
false

1 pt [*] The energy levels 1-4 of Hydrogen are 0, 10.2, 12.1, and 12.8 electron volts (eV), repectively. The Hydrogen is so cool that the electrons are all in level 1. The Hydrogen gas absorbs photons of energy 12.1 eV. When the electrons lose energy, light of ___ different energies will be emitted.

30. **A**◯3
B◯more than 3
C◯1
D◯2

Answer for Part: 0
true
false
false
false

1 pt [*] Do the lamps L & R at the front of the room emit thermal (black body) radiation?

31. **A**◯Yes for L; no for R.
B◯No for both.
C◯No for L; yes for R.
D◯Yes for both.

Answer for Part: 0
false
false
false
true

1 pt [*] While walking home around 9 pm, you see the moon rising. ___ of the moon is lit.

32. **A**◯Little
B◯Less than half
C◯More than half
D◯Almost all
E◯Half

Answer for Part: 0
false
false
true
false
false

1 pt [*] A giant hand suddenly doubled the mass of the sun and adjusted the motion of the earth to keep it in the same path. The giant hand would have had to make the earth___.

33. **A**◯move faster
B◯move slower
C◯move the same

Answer for Part: 0
true
false
false

1 pt

[*] Suppose a new comet is discovered with a period of 29.5 years, which is the same as that of Saturn. The orbit of the comet is highly elliptical. Saturn is 9.5 AU from the sun. Draw the orbits of the comet and Saturn. Be certain to include the sun. Your drawing must show accurate relative sizes.

34. *Leave blank on scoring form*