

Astronomy 201
Test 2 – 3 April 2018

Use the Answer Sheet for the Multiple Choice Question and the bluebook for the Short Answer. Put your name and University Network ID (initials + number) on each. Be sure to indicate which Short Answer question you are doing. If I cannot read your Short Answers then I cannot grade it!
Multiple Choice

Indicate the answer choice that best completes the statement or answers the question.

1. According to solar nebula theory, what is the first step in planetesimal formation?
 - a. heating
 - b. flattening
 - c. accretion
 - d. condensation
 - e. gravitational collapse

2. How does Venus release its interior heat?
 - a. Through solar wind
 - b. Through active plate tectonics
 - c. Through large convective currents of hot magma that rise beneath its crust
 - d. Through periodic outgassing of the atmosphere
 - e. Through CO₂ outgassing

3. Which is a characteristic of Jovian planets when compared to Terrestrial planets?
 - a. Jovian planets are much larger than Terrestrial planets
 - b. Jovian planets have rocky surfaces
 - c. Jovian planets have no differentiation like Terrestrial planets
 - d. Jovian planets have moons, unlike the Terrestrial planets
 - e. Jovian planets have warmer atmospheres than Terrestrial planets.

4. The Earth's surface has very few craters relative to the Moon. This is because
 - a. The Moon intercepts most incoming objects.
 - b. There are no asteroids or meteoroids larger than 1 meter in the vicinity of Earth's orbit.
 - c. Plate Tectonics
 - d. Wind erosion fills in craters quickly.
 - e. Agricultural land usage.

5. Tides on the Earth are caused by
 - a. the Sun and Moon
 - b. the Moon
 - c. the Sun
 - d. the Earth's revolution about the Sun
 - e. precession

6. What are the two primary constituents of the Earth's atmosphere?
 - a. N₂ and H₂O
 - b. CO₂ and O₂
 - c. N₂ and O₂
 - d. Ne and Ar
 - e. H₂ and He

7. Which is a characteristic Venus shares with Earth?
- Both planets have an ozone layer within their atmospheres.
 - Both planets rotate clockwise on their axes.
 - Both planets have a uniform circulation within their atmospheres.
 - Both planets have similar crustal materials with the notable exception of water
 - Both planets have heavily cratered surfaces.
8. Even though Mercury has been recognized as a planet since antiquity, few people have seen it because
- it is always within 28° of the Sun and thus can only be seen near the horizon at dusk or dawn
 - it is too faint for most people's vision to detect
 - the glare of the Sun always hides it
 - it is always between the Earth and the Sun as it moves on its epicycle
 - it moves too fast to be seen except by stop action cameras
9. The inner planets are composed of ____.
- | | | |
|-----------------|------------------|-------------------|
| a. rock and ice | c. rock and gas | e. rock and metal |
| b. ice and gas | d. metal and ice | |
10. Which is a distinguishing characteristic of the Jovian planets?
- Jovian planets are rocky.
 - Jovian planets are less massive than terrestrial planets.
 - Jovian planets have rings.
 - Jovian planets have only one or two moons.
 - Jovian planets have high albedos.
11. What are sinuous rilles found on the lunar surface?
- ancient lava flows
 - channels cut by flowing lava on the edge of the maria
 - large basins once filled with water
 - light-colored rock found in the lunar highlands
 - fault lines found within the crust
12. What solid evidence do we have of the Moon's age?
- deep core samples of the Moon
 - igneous rock samples brought back by Apollo astronauts
 - meteorites that have impacted Earth
 - laser altimetry readings from the LCROSS mission
 - sedimentary rock samples brought back by Apollo astronauts
13. Large, smooth, dark plains on the moon are called ____.
- | | | |
|-------------------|----------------------|-------------------|
| a. ejecta blanket | c. maria | e. Sinuous rilles |
| b. central peak | d. multiringed basin | |

14. The magnetic field of the Earth protects us from
- a. marauding Martians led by H.G. Wells
 - b. high energy photons from the Sun
 - c. iron-nickel asteroids
 - d. Cupians from Venus
 - e. high energy particles such as cosmic rays
15. During which stage of planetary development did the lunar maria form?
- a. cratering
 - b. differentiation
 - c. flooding
 - d. tectonic plate movement
 - e. slow surface evolution
16. What is the correct order of planetary development?
- a. differentiation, cratering, flooding, slow surface evolution
 - b. cratering, flooding, differentiation, slow surface evolution
 - c. slow surface evolution, differentiation, flooding, cratering
 - d. differentiation, flooding, cratering, slow surface evolution
 - e. flooding, slow surface evolution, cratering, differentiation
17. From meteorite and lunar rock samples, astronomers have determined the age of the Solar System to be ____.
- a. 4.6 million years
 - b. 10 million years
 - c. 2.4 billion years
 - d. 4.6 billion years
 - e. 8.4 billion years
18. How did Mars get its two moons?
- a. Mars captured asteroids from the asteroid belt.
 - b. Mars suffered a catastrophic meteor impact, breaking a piece off the planet.
 - c. Mars had planetary bodies near it when the solar wind blew out the nebula.
 - d. Mars collided and fused with another planet leaving two remnants behind.
 - e. Mars captured comets from the Kuiper belt.
19. The collision of plates can produce ____.
- a. craters
 - b. rift zone
 - c. erosion
 - d. midocean rise
 - e. folded mountain ranges
20. If plate tectonics is what builds up Earth's mountains and continents, then what process tears them down?
- a. convection
 - b. volcanism
 - c. cratering
 - d. erosion
 - e. accretion

21. Comparing and contrasting the characteristics of planets is known as ____.
- | | |
|----------------------|--------------------------------------|
| a. geology | d. comparative planetology |
| b. plate tectonics | e. Terrestrial planet classification |
| c. greenhouse effect | |
22. What evidence is there to prove that there has been no tectonic movement on Mars?
- The meteorites that have landed on Earth
 - The “blueberries” found by rover Opportunity
 - The huge size of the Martian volcanoes
 - The presence of ice beneath the surface
 - The large number of polygonal cracks on the surface
23. Who determines nomenclature for features on planets, finalizes names of minor planets and the satellites of planets?
- The United Nations Educational, Scientific, and Cultural Organization
 - Science Europe
 - The discoverer gets to name the object
 - The International Astronomical Union
 - National Academy of Sciences for US based discoveries.
24. What is the largest impact crater on Mercury?
- | | |
|------------------|-------------------------|
| a. Caloris Basin | d. Mare Imbrium |
| b. Aitken Basin | e. Mare Tranquillitatis |
| c. Mare Crisium | |
25. The radioactive age of a rock is actually the length of time since the material in that rock was last ____.
- | | | |
|------------|-----------------|--------------|
| a. formed | c. concentrated | e. condensed |
| b. erupted | d. melted | |
26. Which is the correct order of planetary object class during their formation?
- planetesimals, protoplanets, and planets
 - planets, planetesimals, and protoplanets
 - planetesimals, planets, and planetettes
 - protoplanets, planetesimals, and planets
 - planetesimals, planetettes, and planets
27. Which element/molecule would not have been found in Earth’s early atmosphere?
- | | |
|--------------------------------------|-----------------------------|
| a. nitrogen (N ₂) | d. hydrogen (H) |
| b. carbon dioxide (CO ₂) | e. oxygen (O ₂) |
| c. helium (He) | |

28. Why are there no small craters on the surface of Venus?
- The thick atmosphere protects the surface from small meteorites.
 - Old surfaces have been subducted by convection currents.
 - Venus formed after the heavy bombardment period.
 - Weathering and erosion removed all craters.
 - Shield volcanoes prevent small craters to remain on exist on the surface.
29. Why is the very center of Earth's core a solid and not a liquid?
- There is less metal in the central core.
 - The central core has a combination of gases with the metals.
 - Accretion "seeded" Earth with a solid central core.
 - The pressure at the central core raises the melting point of the metals higher than its temperature.
 - The central core is a frozen block of water ice.
30. With the understanding of differentiation, which layer of Earth would be the densest?
- lithosphere
 - core
 - crust
 - hydrosphere
 - mantle
31. What does "maria" mean?
- plateaus
 - ponds
 - rivers
 - rivulets
 - seas
32. The ____ couples convection in the liquid core with Earth's rotation to produce electric currents that are believed to be responsible for Earth's magnetic field.
- albedo
 - bow shock
 - axis rotation
 - convection currents
 - dynamo effect
33. Which statement best describes an extrasolar planet?
- A planet that orbits closely to the Sun in our Solar System.
 - A new planet not previously accounted for within our Solar System.
 - A planet smaller and icier than the other planets in our Solar System.
 - A planet discovered orbiting another star outside of our Solar System.
 - A planetary body that orbits just beyond Neptune.
34. Which is a unique geological feature found on Mercury's surface?
- craters
 - lobate scarps
 - shield volcanoes
 - sinuous rilles
 - basins

35. How is it that Earth has less CO₂ in its atmosphere than Venus, even though both planets likely outgassed the about the same amount of CO₂ during their development?
- Earth absorbed most of the CO₂ into its oceans.
 - Venus absorbed most of the CO₂ into its oceans.
 - Earth lost most of its CO₂ because of weak gravity.
 - Venus rotates too slowly to lose any of its CO₂.
 - Venus retained much of its CO₂ in polar ice.
36. Which of the following is the oldest geological feature of the Moon?
- maria
 - lowlands
 - highlands
 - regolith
 - rilles
37. What makes up the bulk of the atmosphere of Venus?
- hydrogen
 - carbon dioxide
 - argon
 - water vapor
 - sulfuric acid
38. What does a high albedo indicate with regard to a planetary object?
- The surface is cratered and old.
 - The planetary object is still developing.
 - The planet is highly active.
 - The surface is highly reflective and therefore most likely young.
 - The planetary object has a strong magnetic field.
39. What is the current dominant geological process on Mars?
- plate tectonics
 - volcanism
 - wind erosion
 - water erosion
 - cratering
40. How often does Venus rotate on its axis?
- 24 h
 - 182 Earth days
 - 243 Earth days
 - 1 Earth year
 - 3 Earth years
41. Planetesimals beyond the orbit of _____ failed to accumulate into a protoplanet because the gravitational field of _____ continuously disturbed their motion.
- Neptune; Uranus
 - Jupiter; Mars
 - Earth; Saturn
 - Mars; Earth
 - Mars; Jupiter
42. Which element represented most of the atoms in the early Universe?
- helium
 - hydrogen
 - oxygen
 - carbon
 - nitrogen

43. What formed the lunar maria?
- a. ancient lava flows
 - b. Earth-moon collision
 - c. volcanic eruptions
 - d. erosion
 - e. tectonic plate movement
44. Why is Venus's atmosphere hotter than Mercury even though it is farther from the Sun?
- a. Venus has a thin atmosphere thus allowing more of Sun's radiation to enter.
 - b. Venus contains water vapor in its atmosphere, which absorbs more heat.
 - c. Venus contains 96 percent CO₂ resulting in very hot temperatures.
 - d. Mars contains more CO₂, which has a cooling effect on its atmosphere.
 - e. Mercury has a hotter atmosphere because it is closer to the Sun than Venus.
45. Which is a unique characteristic of Venus not shared by the other Terrestrial planets?
- a. The planet has an atmosphere.
 - b. The planet has volcanoes on its surface.
 - c. The planet experiences retrograde rotation.
 - d. The planet has a strong magnetic field.
 - e. The planet once had water on its surface.
46. The rocks that form the Earth's crust are mostly formed from compounds of
- a. calcium and phosphorous
 - b. carbon and oxygen
 - c. aluminum and silicon
 - d. iron and silicon
 - e. manganese and titanium
47. What was the key physical property in determining the two categories of planets during solar system formation?
- a. pressure
 - b. gravity
 - c. density
 - d. momentum
 - e. temperature
48. What theory explains the movement of the continents on Earth's surface?
- a. continental spreading
 - b. continental drift
 - c. continental tectonics
 - d. continental rifting
 - e. continental rise
49. Why do scientists refer to Earth's mantle as a plastic?
- a. The mantle has many properties of a solid, but can flow under pressure.
 - b. The mantle has the mixed properties of a solid and a liquid.
 - c. The mantle frequently shifts between its states of matter.
 - d. The mantle is a softer solid as it approaches the core.
 - e. The mantle has the properties of a liquid, but is limited in its movement.

50. What is significant about Olympus Mons?
- It is the only impact crater remaining on Mars.
 - It is the largest crater in the Solar System.
 - It is the largest volcano on Venus.
 - It is the only composite volcano on Mars.
 - It is the largest volcano in the Solar System.

Short Answer: Answer 10 of the following 12 questions (5 points each)

Use the bluebook for the Short Answer Questions. Put your name and University Network ID (initials + number) on it. Be sure to indicate which Short Answer question you are doing. If I cannot read your Short Answers, then I cannot grade it!

- The Moon is often thought of as a dead sphere. Yes or No or Maybe and why.
- Outline a simple model of planet building.
- What are the shared common characteristics of the Moon and Mercury?
- What is odd about the magnetic field of Venus?
- What are the four stages of Terrestrial planet development?
- Why can't scientists put a rover on Venus like the ones on Mars?
- Why are volcanoes so large on Venus and on Mars?
- Why do scientists believe Venus lacks plate tectonics?
- Describe the surface features of Venus. If the atmosphere is so thick and the planet is so hot, how do we know about these surface features on Venus?
- Describe those surface features that indicate water once flowed on Mars.
- Explain the three different hypotheses for the origin of the Moon and how evidence from the Apollo lunar rocks persuaded scientists to develop a new hypothesis.
- Your instructor wants a feature named after him on Venus. What is the probability of this happening?

Bonus (10 Points):

How are poles (the North and South poles of the Earth are an example) determined for solar system planets and minor planets? Minor planets are objects such as Pluto and asteroids?

Answer Key

- | | | | |
|-----|---|-----|---|
| 1. | d | 26. | a |
| 2. | c | 27. | e |
| 3. | a | 28. | a |
| 4. | c | 29. | d |
| 5. | a | 30. | b |
| 6. | c | 31. | e |
| 7. | d | 32. | e |
| 8. | a | 33. | d |
| 9. | e | 34. | b |
| 10. | c | 35. | a |
| 11. | b | 36. | c |
| 12. | b | 37. | b |
| 13. | c | 38. | d |
| 14. | e | 39. | c |
| 15. | c | 40. | c |
| 16. | a | 41. | e |
| 17. | d | 42. | b |
| 18. | a | 43. | a |
| 19. | e | 44. | c |
| 20. | d | 45. | c |
| 21. | d | 46. | c |
| 22. | c | 47. | e |
| 23. | d | 48. | b |
| 24. | a | 49. | a |
| 25. | d | 50. | e |

51. The Moon has been geologically inactive for 3+ billion years – that is dead. However, cratering still occurs regularly on the Moon. LRO has found hundreds of new craters in the continuing 10+ years of its mission. High energy particles and photons continually break up rock and form an ever deepening regolith layer. Thus the surface does change. There are reports yet unconfirmed that the volcanic regions are active. That would be really odd if true.

52. Planetary development in the solar nebula began with the formation of dust grains by condensation. A particle grows by condensation when it adds matter one atom or one molecule at a time, producing a larger body called a planetesimal that contains both rock and metal. A planet grows from accretion and collision of the uniform planetesimals, resulting planet is of homogenous composition. Heat from radioactive decay and planetesimal in-fall causes differentiation, resulting planet has a metal core and low-density crust.

53. Earth's Moon and Mercury are good subjects for comparative planetology. They are similar in a number of ways. Most important, they are small worlds; the Moon is only a fourth of Earth's diameter, and Mercury is just over a third of Earth's diameter. They have negligible atmospheres, their rotation has been altered by tides, their surfaces are heavily cratered, their lowlands are flooded in places by ancient lava flows, and both now have ancient, inactive surfaces.

54. The interior structure of Venus is thought to be similar to the Earth and therefore should have a dynamo that produces a magnetic field. However, there is no magnetic field. That is odd.

55. Differentiation produced a dense core, thick mantle, and low-density crust. The young Earth was heavily bombarded in the debris-filled early Solar System. Flooding by molten rock and later by water filled lowlands. Slow surface evolution continues due to geological processes, including erosion.

56. Temperatures on the surface of Venus are over 470°C, hot enough to melt lead. Robotics would melt as well.

57. Volcanoes have grown very large, which shows that after repeated eruptions the crust is not moving over hot spots.

58. True plate tectonics are apparently not important on Venus. Although measurements by lander probes show that the surface rock on Venus is the same kind of dark-gray basalt found in Earth ocean crust, they also reveal that the crust is very dry and therefore about 12 percent less dense than Earth's crust. Venus's low-density crust is more buoyant than Earth's crust and would resist being pushed into the interior. Also, model calculations indicate that water embedded in rocks is needed to lubricate plate motion, so Venus's dry crustal rocks would not slide past each other easily. Finally, Venus's crust is so hot that it is halfway to its melting point. Such hot rock is not very stiff, so it cannot form the rigid plates typical of plate tectonics on Earth. Planetary scientists hypothesize that the low density, dryness, and pliability of Venus's crustal rocks are the reasons that planet lacks plate tectonics.

Venus also lacks linear mountain chains, has very few folded mountain belts, and has widespread volcanic occurrences—all of which would provide evidence for plate tectonics.

59. Most of the surface of Venus consists of low, rolling plains and highland regions. Those rolling plains appear to be large-scale smooth lava flows; whereas the highlands are regions of deformed crust. Lava flows seem to have completely resurfaced Venus within approximately the past half-billion years. Signs of volcanism dominate the surface of Venus. Lava channels are common, and they appear similar to the sinuous rilles visible on Earth's Moon. Scientists have identified these features from radar imaging of the surface using instruments on satellites orbiting the planet.

60. Two kinds of formations hint at water flowing over the surface. Outflow channels appear to have been cut by massive floods carrying as much as 10,000 times the volume of water flowing down the Mississippi River. In a matter of hours or days, such floods swept away landscape features and left outflow channels. The number of craters formed on top of the outflow channels show that they are billions of years old. The valley networks look like meandering riverbeds that may have formed over long period. The valley networks are also located in the old, cratered southern hemisphere, so they must be very old as well. There are other signs that water has flowed on the Martian surface, some of which may be only a few years old

61. The *fission hypothesis* proposed that the Moon broke from a rapidly spinning young Earth. The *condensation hypothesis* suggested that Earth and the Moon condensed together from the same cloud of matter in the solar nebula. The *capture hypothesis* suggested that the Moon formed elsewhere in the solar nebula and was later captured by Earth. Each of these three hypotheses failed to compare with evidence. After Moon rocks were returned to Earth and examined did a new hypothesis form.

The *large-impact hypothesis* proposes that the Moon formed when a very large planetesimal, estimated to have been at least as massive as Mars (1/10 the mass of Earth), smashed into the proto-Earth. Model calculations indicate that this collision would have ejected a disk of debris into orbit around Earth that would have quickly formed the Moon

62. Features on Venus are named after females, mostly goddesses. That makes it very unlikely that a feature will be named after him, a mere mortal male.

Bonus:

Directly from the notes:

The International Astronomical Union (IAU) defines the geographic north pole of a planet or any of its satellites in the Solar System as the planetary pole that is in the same celestial hemisphere relative to the invariable plane of the Solar System as Earth's North pole. This definition means that an object's direction of rotation may be negative (retrograde rotation) — in other words, it rotates clockwise when viewed from above its north pole, rather than the "normal" counterclockwise direction exhibited by Earth's north pole. Venus rotates in the opposite direction to the other planets, and Uranus has been knocked on its side and rotates almost perpendicular to the rest of the Solar System. The ecliptic remains within 3° of the invariable plane over five million years, but is now inclined about 23.44° to Earth's celestial equator used for the coordinates of poles. This large inclination means that the declination of a pole relative to Earth's celestial equator could be negative even though a planet's north pole (such as Uranus) is north of the invariable plane.

The invariable plane of a planetary system, also called Laplace's invariable plane, is the plane passing through its barycenter (center of mass) perpendicular to its angular momentum vector. In the Solar System, about 98% of this effect is contributed by the orbital angular momenta of the four Jovian planets (Jupiter, Saturn, Uranus, and Neptune). The invariable plane is within 0.5° of the orbital plane of Jupiter, and may be regarded as the weighted average of all planetary orbital and rotational planes.

In 2009 the responsible IAU Working Group decided to define the poles of dwarf planets, minor planets, their satellites, and comets according to the right-hand rule. To avoid confusion with the "north" and "south" definitions relative to the invariable plane, the poles are called "positive" and "negative." The positive pole is the pole toward which the thumb points when the fingers of the right hand are curled in its direction of rotation. The negative pole is the pole toward which the thumb points when the fingers of the left hand are curled in its direction of rotation. This change was needed because the poles of some asteroids and comets precess rapidly enough for their north and south poles to swap within a few decades using the invariable plane definition.