

ASTRONOMY 101, SECTION 004
Spring, 2017
First Hour Examination

Print Your Name: _____ SID _____

Please legibly write your name and student ID on this answer sheet and print your name on your test.

Now you are ready to begin the test. For each question, select the one *best* answer and write it on your answer sheet. Ensure that the number of your answer corresponds to the number of the question.

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Feel free to mark your test, including eliminating answers, doing calculations or estimates, and especially making drawings. You must hand in your test and answer sheet before leaving the test site.

The first 19 questions are T/F. Mark 'T' if the answer is true (T). Mark 'F' if the answer is false (F).

The remainder of the questions is multiple choice. Mark the best answer A - D.

A proctor will be available to answer questions. You are on your honor as a lady or gentleman not to cheat on this test.

Numbers you should know but perhaps forgot:

There are 360 degrees in a full circle.

There are 365 days in a year.

There are 24 hours in a day.

True/False questions. Mark T for true (T). Mark F for false (F).

1. The light we see when we look at the moon actually is coming from the sun.
2. The North Star (Polaris) can be seen from any place on Earth.
3. Newton showed that a body remains at rest or moves in a straight line with a constant speed, unless it is acted upon by an outside force.
4. If there is a force acting on a body, the body is being accelerated.
5. If a body is being accelerated, there is a force acting on it.
6. The reason for seasons is that the Earth's rotation axis is tilted relative to its orbital plane about the sun.
7. The distance between two successive wave crests is called the *wavelength*.

8. According to Kepler's Second Law, planets move faster when farthest from the sun and slowest when closest to the sun.
9. Planets have elliptical orbits about the sun, just as the Moon has an elliptical orbit about the Earth.
10. The Millennium Falcon can make the Kessel Run in an interval of time less than 12 parsecs.
11. The basic structure of an atom is positively charged protons surrounding a nucleus made of positively charged protons and charge-neutral neutrons.
12. One property of light is that it can act either as a wave or as a particle, depending upon how you measure it (the wave-particle duality).
13. The current generation of giant (and larger) telescopes being built are all refracting telescopes.
14. The principal reason for building larger telescopes is to capture more energy, transmitted as electromagnetic radiation from faint objects.
15. The International Space Station (ISS), currently orbiting the Earth at an altitude of about 400 km, no longer experiences a gravitational force relative to the Earth.
16. Astronomy and astrophysics are the most exciting topics one can ever imagine.
17. A spectrum of the galaxy Messier 31 (M 31, the Great Nebula in Andromeda) exhibits spectral lines, all of which are shifted to the blue compared to measurements of the same lines made in the laboratory. This indicates M 31 is moving towards us!
18. A "neon" sign is a glass tube filled with neon (or other gas) at low pressure and excited by an electric current. The characteristic color of a neon sign is red. By doubling the current, one can make the neon emit green (higher energy) light.
19. An electron in a hydrogen atom makes a transition from a higher energy state, $E(h)$, to a lower energy state, $E(l)$, by *absorbing* a photon of light with energy equal to $E(h) - E(l)$.

Multiple choice questions. Mark the one **best** answer A - D.

20. Before the invention of the telescope, the known (“naked-eye”) planets were
 - A) Mercury, Venus, Mars, Jupiter, and Saturn.
 - B) Mercury, Venus, Mars, Jupiter, and Uranus.
 - C) Jupiter, Venus, Pluto, Mars, and Saturn.
 - D) Mars, Neptune, Jupiter, Mercury, and Venus.

21. With respect to the stars, the rotation of the Earth carries you toward the
 - A) south. B) east. C) west. D) north.

22. According to the scientific method, a hypothesis that is proposed to explain a particular physical phenomenon is considered to be wrong if
 - A) leading scientists in the world believe that it is wrong.
 - B) it is in conflict with the results of just one reliable and repeatable observation.
 - C) it appears to defy logic and logical reasoning.
 - D) it disagrees with the accepted theory at the time of the proposal.

23. If you were standing on the Moon in darkness on the opposite side from the Earth at a particular time, which of the following conditions would be true?
 - A) You would never see the Sun from that position.
 - B) You would see the Earth in about 7 days.
 - C) It would take about $\frac{1}{4}$ year (3 months) before you would see the Earth from that position.
 - D) You would never see the Earth from that position.

24. During a solar eclipse, the
 - A) Sun comes between the Earth and the Moon.
 - B) Moon comes between the Earth and the Sun.
 - C) Sun goes below the horizon.
 - D) Earth comes between the Sun and the Moon.

25. In a radio wave transmitter (such as that used by a radio or TV station), when the frequency of the signals is increased, the
 - A) wavelength is decreased.
 - B) speed of transmission of the waves is increased.
 - C) wavelength and speed of transmission both increase.
 - D) wavelength remains constant.

26. What is the phase of the Moon during a total solar eclipse?
 - A) full B) new C) crescent D) first quarter

27. The chemical makeup of a star's surface is obtained by
 - A) measuring the chemical elements present in the stellar wind.
 - B) theoretical methods, considering the evolution of the star.
 - C) taking a sample of the surface with a space probe.
 - D) spectroscopy of the light emitted by the star, which contains absorption lines.

28. The basic makeup of an atom is
- A) small, negatively charged particles orbiting around a central positive charge.
 - B) negative and positive charges mixed uniformly over the volume of the atom.
 - C) small, positively charged particles orbiting around a central negative charge.
 - D) miniature planets, possibly with miniature people, gravitationally bound in orbits around a miniature star.
29. An electrical spark, such as lightning, generates electromagnetic radiation over a wide range of wavelengths. How much longer does a pulse of radio energy take to travel between two detector stations 100 m apart than a pulse of ultraviolet radiation from the same spark?
- A) much longer, since radio waves have much longer wavelengths and therefore travel slower
 - B) much shorter, since long-wavelength radiations travel faster
 - C) just a little longer, since the high-frequency UV radiation travels faster than the low-frequency radio waves
 - D) The time is identical, since both pulses travel at the speed of light.
30. What is the phase of the Moon during a total lunar eclipse?
- A) new
 - B) gibbous
 - C) full
 - D) first quarter
31. Which of the following statements correctly states the significance of Galileo's observation that Jupiter has satellites (moons)?
- A) It was interesting but had no particular significance.
 - B) It showed that bodies can orbit an object other than Earth.
 - C) It showed that Jupiter must be four times the size of Earth (since Jupiter has four moons and Earth has one).
 - D) It showed that Jupiter must orbit around the Sun, not around Earth.
32. A full moon always occurs
- A) on the first of every month.
 - B) when the Moon is at right angles to the direction of the Sun.
 - C) when the Moon is closer to Sun than is the Earth.
 - D) when the Moon is farther from the Sun than is the Earth.
33. In single-telescope astronomical systems, either optical or radio, the
- A) longer the focal length of the primary mirror, the sharper the image.
 - B) longer the wavelength, the sharper the image.
 - C) smaller the main-mirror aperture in general, the sharper the image.
 - D) larger the main mirror aperture in general, the sharper the image.
34. Which way are you moving with respect to the background stars because of the revolution of the Earth *in its orbit around the Sun*?
- A) westward
 - B) northeastward
 - C) northwestward
 - D) eastward

35. The occasional retrograde motion of Mars against the background stars is the result of the
- observation of a moving Mars from Earth, whose orbital motion is faster than that of Mars.
 - observation of a rapidly moving Mars from a more slowly moving Earth.
 - variable speed of Mars because its orbit is elliptical.
 - observation of Mars from the rapidly rotating Earth.
36. Choose the correct sequence of electromagnetic radiations, in order of increasing wavelengths.
- radio, IR, visible, UV
 - UV, visible, radio, IR
 - UV, visible, IR, radio
 - visible, UV, IR, radio
37. The "color" or wavelength of maximum emission of radiation for a hot, solid body (or a dense gas such as a star) when the body cools from a temperature of several thousand degrees
- remains fixed, as the light fades and eventually becomes invisible to the eye.
 - moves toward the red end of the spectrum.
 - moves toward the blue end of the spectrum.
 - remains absolutely constant, depending only on the original color of the body.
38. In the northern hemisphere, summertime occurs when
- the Earth is closest to the Sun in its elliptical orbit.
 - sunlight falls more directly on this hemisphere, heating it more than at other times of the year.
 - the Earth's equator is parallel to the plane of its orbit.
 - sunlight falls less directly on this hemisphere, spreading the heat out over a greater area.
39. Why do we see different phases of the Moon?
- The motion of the Moon in its orbit around the Earth causes us to see different amounts of the Earth's shadow falling on the Moon.
 - The motion of the Moon in its orbit around the Earth causes us to see different amounts of the sunlit side of the Moon.
 - The distance of the Moon from the Earth changes because of the elliptical orbit of the Moon, causing the sunlit side of the Moon to move relative to the Earth.
 - The rotation of the Moon around its own axis causes us to see different amounts of the sunlit side of the Moon.
40. We can occasionally see a total eclipse of the Sun on Earth because
- the Moon is cooler than the Sun.
 - the angular sizes of Sun and Moon, when viewed from Earth, are almost the same.
 - the physical sizes of Sun and Moon are almost the same.
 - both the Moon and Sun move precisely along the ecliptic plane.
41. The main reason for building large optical telescopes on Earth's surface is
- for national prestige with no scientific reason.
 - to collect more light from faint objects.
 - to bring astronomical objects closer for more detailed examination by scientists.
 - to magnify images of objects and produce higher resolution photographs.

42. How much of the total surface of the Moon is illuminated by the Sun when it is at quarter phase?
A) one quarter B) very little C) all of it D) one half
43. An astronomer finds an object at a distance of 6.8 AU from Earth. Based on the distance, which of the following is this object most likely to be?
A) a star in our galaxy C) a distant galaxy
B) an artificial satellite orbiting the Earth D) a comet in our solar system
44. The spectrum of a star shows a set of dark absorption lines equivalent to those of the Sun, but with one exception: Every line appears at a slightly longer wavelength, shifted toward the red end of the spectrum. What conclusion can be drawn from this observation?
A) The star is moving rapidly toward Earth.
B) A cloud of dust surrounds the star and absorbs the light.
C) The star is moving rapidly away from Earth.
D) The temperature of the star's surface is higher than that of the Sun.
45. The reason the Moon always keeps one face toward Earth is that
A) the impact of asteroids on the Moon early in its history slowed its rotation rate.
B) gravitational forces from the Sun act on the tidal bulge of the Moon.
C) the Moon was spinning this way when it was formed and has maintained this rotation.
D) gravitational forces from Earth act on the tidal bulge of the Moon.
46. Violet light differs from red light in that violet light
A) has a longer wavelength than red light.
B) travels more slowly (through a vacuum) than red light.
C) travels more quickly (through a vacuum) than red light.
D) has a shorter wavelength than red light.
47. What happens when a beam of white light (containing all colors) is passed through a prism of glass?
A) Different colors are refracted at different angles to produce a spectrum.
B) Selected colors are absorbed so that the remaining light that leaves the prism is colored.
C) The speed of the red light that leaves the prism is higher than that of the blue light, leading to a colored beam.
D) Selected colors are reflected from the outer faces of the prism, and the light that passes through is colored.
48. The ecliptic crosses the celestial equator at
A) two points, known as solstices.
B) one point only, known as the vernal equinox.
C) the meridian.
D) two points, known as equinoxes.

49. Which of the following statements correctly states the significance of Galileo's observation that Venus shows phases?
- A) Because the phases were NOT correlated with angular size, they actually provided more support for the geocentric theory than for the heliocentric theory.
 - B) The phases were interesting but did not have any particular significance.
 - C) The phases showed that, like the Moon, Venus is always much closer to Earth than the Sun.
 - D) The phases were correlated with angular size in a way that supported the heliocentric theory.
50. The Earth's shadow falling on the Moon is the reason we see
- A) solar eclipses.
 - B) The Earth's shadow cannot fall on the Moon.
 - C) lunar eclipses.
 - D) the phases of the Moon.
51. Suppose that at the same time on the same night we observe one supernova (a star exploding) in the Andromeda galaxy, 2 million light-years away from us, and another in the galaxy M82, 6 million light-years away from us. Which of the following statements is correct?
- A) Both stars exploded at the same time, because we saw the explosions at the same time.
 - B) We cannot tell which star actually exploded first, because they are so far away.
 - C) The supernova in the Andromeda galaxy actually occurred after the one in M82.
 - D) The supernova in the Andromeda galaxy actually occurred before the one in M82.
52. Atoms in a thin, hot gas (such as a neon advertising sign) emit light at
- A) specific wavelengths, depending on the element.
 - B) all wavelengths, with the shape of the continuum distribution depending on the temperature of the gas.
 - C) only visible wavelengths.
 - D) only a specific single wavelength.
53. The gas in interstellar space between the stars is very tenuous ("thin"). Near a hot star, this gas is heated to a high temperature. Any such hot, tenuous gas emits light
- A) at all wavelengths, peaking at a certain wavelength or color.
 - B) at no wavelength, since hot thin gases do not emit light.
 - C) only at specific wavelengths ("spectral lines"), and these spectral lines do not change in wavelength as the temperature changes.
 - D) only of specific colors ("spectral lines") whose wavelengths change as the temperature changes.
54. Which of the following factors makes it far more likely that a person will have seen a total lunar eclipse than a total solar eclipse?
- A) The Moon appears brighter during a total lunar eclipse than does the Sun during a total solar eclipse.
 - B) A total lunar eclipse occurs at full Moon when the Moon is bright and high in the sky, while a total solar eclipse occurs at new Moon when the Moon is dark and low in the sky.
 - C) A total lunar eclipse can be seen by people on most of the nighttime side of Earth, while a specific total solar eclipse can be seen only by people within a narrow strip of the Earth's surface.
 - D) Total solar eclipses occur much less frequently than total lunar eclipses.

55. The specific colors of light emitted by an atom in a hot, thin gas (e.g., in a tube in a laboratory or a gas cloud in space) are caused by
- A) the vibrations of the electrons within the atom.
 - B) an electron dropping into the nucleus and causing changes in the energy of the nucleus.
 - C) electrons jumping to lower energy levels, losing energy as they do so.
 - D) protons jumping from level to level.
56. Twice per year, when day and night are equal in length, the Sun is at one of two positions in the sky known as equinoxes. These points are the intersections of which two planes in the sky?
- A) ecliptic and celestial meridian
 - B) ecliptic and arctic circle
 - C) celestial meridian and celestial equator
 - D) celestial equator and ecliptic
57. When we watch the nighttime sky, we find that
- A) the stars and constellations remain fixed in our sky, not rising or setting in a time as short as one night because they are so far away.
 - B) stars and constellations slowly rise in the west, pass overhead, and set in the east.
 - C) all stars and constellations reach their highest point in the sky at midnight.
 - D) stars and constellations slowly rise in the east, pass overhead, and set in the west.
58. Which of the following objects cannot transit (pass in front of) the Sun when viewed from Earth?
- A) Mars
 - B) Venus
 - C) the Moon
 - D) Mercury
59. A light-year is a measure of
- A) arc length along an orbit.
 - B) expansion rate of the universe.
 - C) time.
 - D) distance.
60. The celestial equator is defined as the
- A) line in the sky that is perpendicular to the Earth's spin axis.
 - B) line traced in our sky by the Moon each month against the background stars.
 - C) line traced in our sky by the Sun over one year against the background stars.
 - D) band of constellations through which the Sun and Moon move in our sky.
61. The Doppler effect is the change in the wavelength of light caused by the source
- A) being within a high gravitational field.
 - B) being in an intense magnetic field.
 - C) being embedded in a cloud of dust and gas.
 - D) moving with respect to the observer.
62. The phenomenon of parallax is the
- A) change in the position of an object in the sky as a consequence of its motion.
 - B) change in apparent position of a nearby object as the observer moves.
 - C) apparent change in angular size of an object as it moves directly away from an observer.
 - D) change in direction of motion of a planet from retrograde to direct motion.

63. Newton's law of universal gravitation is so named because it
- A) defines the forces between all the planets and the Sun and no other objects.
 - B) was first printed by Universal Press Ltd. of Cambridge, England.
 - C) holds for all objects on Earth, and nowhere else.
 - D) holds for all objects in the universe.
64. Which scientific discipline can be considered to be truly universal?
- A) astronomy
 - B) social studies
 - C) geology
 - D) biological science
65. When astronomers look for evidence of hydrogen gas in the spectra of the Sun, the planets, and nearby stars, the positions of the spectral features or "lines" due to hydrogen
- A) are in a very different pattern, depending on the location of the planet or star, and are reproduced only with difficulty in the laboratory.
 - B) are always in the same pattern, characteristic of hydrogen gas, as seen in the laboratory.
 - C) change systematically, depending on the distance from the source, starting with a laboratory pattern.
 - D) are in the same pattern for solar and planetary sources but are very different for stars at larger distances because of absorption of light by the interstellar matter.
66. The Moon is seen to keep one face toward Earth at all times. If viewed from a point directly above the plane of the planetary system, how does it have to rotate to maintain this alignment?
- A) It must rotate once per year as Earth and Moon orbit the Sun together.
 - B) It must rotate once per day.
 - C) It must not rotate at all, since we always see the same face from Earth.
 - D) It must rotate once per month, or once per orbit around Earth.
67. The water on the side of Earth that faces away from the Moon experiences
- A) a high tide because the Moon in effect pulls the solid Earth out from under the water on the far side.
 - B) a low tide because all Earth's water is pulled toward the side of Earth that faces the Moon.
 - C) no tidal force.
 - D) either a high tide or a low tide, depending on the angle to Jupiter.
68. The early workers in spectroscopy (Fraunhofer with the solar spectrum, Bunsen and Kirchhoff with laboratory spectra) discovered which very significant fact about the spectra produced by hot gases, such as elements heated in a flame?
- A) The higher the temperature, the greater the red shift of the emitted spectral lines.
 - B) They produce their own characteristic pattern of spectral lines, which remain fixed as the temperature increases.
 - C) They emit spectral lines that move continuously toward the blue end of the spectrum as the gas temperature increases.
 - D) They produce the same set of spectral lines and are hence indistinguishable.
69. The star grouping Leo (the lion) extends for about 30° along and close to the celestial equator. At low to mid-latitudes, roughly how long does it take Leo to rise above the horizon?
- A) 5 hours
 - B) 30 seconds
 - C) 30 minutes
 - D) 2 hours

70. What is the one major difference between the Sun and the Moon in our sky?
- Their apparent motion across the sky with respect to the horizon in one day is very different.
 - Their diameters subtend very different angles.
 - The spectrum of their light is very different.
 - The Sun emits light while the Moon merely reflects it.
71. Electromagnetic radiation moving through space with the speed of light consists of oscillating
- electric and magnetic fields, always inseparable, always having the same frequency and wavelength, and traveling in the same direction.
 - electric fields, with magnetic fields occasionally accompanying them, moving in the same direction.
 - electric and magnetic fields moving in opposite directions along the same line in space.
 - magnetic fields that over time and distance change to oscillating electric fields and back again.
72. The nightly motion of objects across the sky is caused by the
- revolution of Earth around the Sun.
 - rotation of the whole celestial sphere of stars around the fixed Earth.
 - rotation of the Earth on its axis.
 - motion of the solar system around the galaxy.
73. A person orbiting Earth in the International Space Station (ISS) feels weightless because
- only one significant force (Earth's gravity) acts on her, but the same gravitational acceleration operates on the ISS so that the ISS does not push up on her to create the feeling of weight within it.
 - two forces are acting on her in opposite directions, so they cancel and produce the same effect as if no force at all were acting.
 - her mass is zero in space, and weight requires mass.
 - no forces act on her.
74. One astronomical unit, or one AU is defined as the
- distance traveled by light in one year.
 - mean distance between the Sun and the Earth.
 - distance from which Earth-Sun distance will subtend an angle of one arcsecond.
 - distance traveled by light in one second.
75. Kepler's second law states that a planet moves fastest when it
- | | |
|-----------------------------------|---------------------------|
| A) passes through the minor axis. | C) is closest to the Sun. |
| B) is furthest from the Sun. | D) is at conjunction. |
76. The physical force that holds the components of an atom together is the
- uclear force from protons and neutrons.
 - centrifugal force on the electrons, caused by their orbital motion.
 - gravitational force between the nucleus and the electrons.
 - electromagnetic attraction between the nucleus and the electrons.

77. Astronomy from space vehicles is particularly useful because the telescope
- A) is in a clean, dust-free environment and scattered light is much reduced.
 - B) is above Earth's absorbing and distorting atmosphere and can measure radiation over a very wide wavelength range.
 - C) is in a gravity-free state, its mirror is not distorted by gravitational stress, and it can produce sharper images.
 - D) moves smoothly in a constant orbit and can produce sharp photographs.
78. The dark absorption lines in the solar spectrum are caused by absorption
- A) of sunlight in a layer of pure hydrogen gas overlying the solar surface.
 - B) of sunlight in a cooler layer of gas overlying the hot solar surface.
 - C) entirely by atoms and molecules in Earth's cool atmosphere.
 - D) of sunlight in a hotter layer of gas overlying the cooler solar surface.
79. Astronomers living north of the Arctic Circle around the time of summer solstice will enjoy which of the following?
- A) 24 hours of sunlight
 - B) continuous observation of the full Moon for several weeks
 - C) a period of several weeks during which the Moon does not appear, allowing uninterrupted views of faint objects in the background sky
 - D) 24 hours of continuous darkness
80. The speed of light in space is
- A) very large, but not infinite: 3×10^{1000} meters per second.
 - B) very large, 3×10^8 meters per second, independent of the speed of its source.
 - C) infinite, traveling through space instantaneously.
 - D) variable, depending on the speed of its source, but very large (on average, 3×10^8 meters per second).
81. Mars moves in an elliptical orbit around the Sun. The location of the Sun relative to this ellipse is at
- A) the focus that is closer to the point where Mars is moving the slowest.
 - B) one end of the major axis of the ellipse.
 - C) the exact center of the ellipse.
 - D) the focus that is closer to the point where Mars moves the fastest.
82. Which of the following planets will be seen from Earth as crescent shaped at certain times in its orbit?
- A) Jupiter
 - B) Uranus
 - C) Mars
 - D) Venus
83. During one complete year, an observer on the equator would be able to see what fraction of the overall sky?
- A) 50%
 - B) a variable amount, depending on the person's longitude
 - C) a variable amount, depending on which year
 - D) 100%

84. According to Newton's laws, a force must be acting whenever
- A) an object is moving with some speed.
 - B) an object's position changes.
 - C) time passes.
 - D) the direction of an object's motion changes.
85. Why is the sky blue?
- A) The air molecules absorb red light better than blue light, allowing more blue light to reach our eyes.
 - B) The air molecules scatter blue light better than red light, so more blue light reaches our eyes.
 - C) The air molecules scatter red light better than blue light, so less red light reaches our eyes.
 - D) The air molecules absorb blue light better than red light, making the sky appear bluer.

ASTRONOMY 101, SECTION 004
Spring, 2017
First Hour Examination

ANSWER SHEET

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| 1. <u> T </u> | 2. <u> F </u> | 3. <u> T </u> | 4. <u> T </u> | 5. <u> T </u> |
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| 21. <u> B </u> | 22. <u> B </u> | 23. <u> D </u> | 24. <u> B </u> | 25. <u> A </u> |
| 26. <u> B </u> | 27. <u> D </u> | 28. <u> A </u> | 29. <u> D </u> | 30. <u> C </u> |
| 31. <u> B </u> | 32. <u> D </u> | 33. <u> D </u> | 34. <u> D </u> | 35. <u> A </u> |
| 36. <u> C </u> | 37. <u> B </u> | 38. <u> B </u> | 39. <u> B </u> | 40. <u> B </u> |
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| 66. <u> D </u> | 67. <u> A </u> | 68. <u> B </u> | 69. <u> D </u> | 70. <u> D </u> |
| 71. <u> A </u> | 72. <u> C </u> | 73. <u> A </u> | 74. <u> B </u> | 75. <u> C </u> |
| 76. <u> D </u> | 77. <u> B </u> | 78. <u> B </u> | 79. <u> A </u> | 80. <u> B </u> |
| 81. <u> D </u> | 82. <u> D </u> | 83. <u> D </u> | 84. <u> D </u> | 85. <u> B </u> |
| 86. _____ | 87. _____ | 88. _____ | 89. _____ | 90. _____ |
| 91. _____ | 92. _____ | 93. _____ | 94. _____ | 95. _____ |
| 96. _____ | 97. _____ | 98. _____ | 99. _____ | 100. _____ |