1 Barnard’s star is a near neighbor of the Sun whose properties we know quite well. It is a type M4V with absolute magnitude 13.22. Suppose that another star of spectral type M4V is observed to have apparent magnitude 8.22. How far away is it?
   a. 100 parsecs.
   b. 1000 parsecs.
   c. 1 parsec.
   d. 5 parsecs.
   e. 10 parsecs.

2 A full cycle of day and night on Mars is called a ‘sol.’ In terms of 24 hour Earth days, a Martian sol is
   a. slightly shorter than one Earth day.
   b. about 11 hours.
   c. about 687 Earth days.
   d. about 27 Earth days.
   e. slightly longer than one Earth day.

3 Underneath the Atlantic Ocean is an undersea mountain range called the MidAtlantic Ridge. That ridge is caused by
   a. A continuing collision between the North American Plate and the Eurasian Plate.
   b. The remains of an ancient asteroid impact.
   c. An upward current in the Earth’s Mantel.
   d. The remains of an ancient collision between the North American Plate and the Eurasian Plate.
   e. The pressure exerted by the water in the Atlantic Ocean

4 Water ice can be found on all but one of these planets. Which one has no ice?
   a. Venus
   b. Earth
   c. Mars
   d. Mercury

5 The stars of the Milky Way are found
   a. only near the ecliptic.
   b. only near the celestial equator.
   c. in a band of stars stretching across the sky.
   d. in all parts of the celestial sphere.
   e. only near the celestial poles.

6 Venus retains a dense carbon dioxide atmosphere because
   a. there is no life there.
   b. there is no liquid water there.
   c. there is no plate tectonic activity in its crust.

7 There are 365.242199 solar days in a year. From this fact, you can conclude that, relative to the distant stars, earth rotates closest to
   a. 366.242199 times in a year.
   b. 365.242199 times in a year.
   c. a number of times in a year that cannot be determined from the information given.
   d. 364.242199 times in a year.
8. As the two foci of an ellipse are brought together, the shape of the ellipse becomes
   a. more like a triangle drawn around the foci.
   b. more like a sphere around the foci.
   c. more like a line between the foci.
   d. more like a circle around the foci.

9. During the Tau Tauri phase of a protostar’s evolution,
   a. the brightness increases.
   b. the brightness decreases.
   c. the photosphere has yet to form.
   d. nuclear burning starts.
   e. the surface area stops decreasing

10. The force of gravity explains
    a. how the tides work but not how lightning works.
    b. how objects fall on Earth but not how the tides work.
    c. how the Sun shines but not how planets move.
    d. how objects fall on Earth but not how planets move.
    e. how planets move but not how objects fall on Earth.

11. You would expect to see a waxing crescent Moon
    b. Rising in the West just before the Sun.
    c. Setting in the East right after the Sun.
    d. In the North at around midnight.
    e. Setting in the West right after the Sun.

12. Current computer models of planet formation suggest that the Alpha Centauri system
    a. could have planets within the habitable zone of Alpha Centauri A but not Alpha Centauri B.
    b. could have planets within the habitable zones of both Alpha Centauri A and Alpha Centauri B.
    c. probably does not have planets because of the shifting gravitational fields in that system.

13. What total force will cause an object with a mass of 1kg to gain 10 meters per second every second?
    a. 9.8 Newtons.
    b. 1 Newton.
    c. 10 Newtons.
    d. 2.5 Newtons.
    e. 5 Newtons.

14. It is expected that a normal Jovian planet, with no accidental encounters that could add or subtract moons, should have
    a. a family of moons, all orbiting in the plane of the planets equator.
    b. no moon.
    c. just one moon.
15 Which of the following planets does the moon Ganymede orbit?
   a. Jupiter
   b. Mars
   c. Neptune
   d. Saturn
   e. Uranus

16 Which of the following objects is the most likely to be considered a scientific model?
   a. A test-tube.
   b. An oil painting of a person.
   c. An accurate map of Richmond.
   d. A blackboard.
   e. A computer program.

17 Suppose that the color and behavior of a star identify it as a type that we know has absolute magnitude $M_0 = 4.8$. If the star's apparent magnitude is found to be $m = 14.8$, how far away is it?
   a. 10 parsecs.
   b. 5 parsecs.
   c. 1000 parsecs.
   d. 50 parsecs.
   e. 100 parsecs.

18 The photosphere of a protostar
   a. is where light is last scattered.
   b. is where the pressure drops to zero.
   c. does not exist since only stars have photospheres.
   d. is the outer boundary of the collapsing cloud.
   e. is where the temperature is a maximum.

19 In the ancient Greek theory of gravity, everything was attracted to the center of the universe. In Newton's theory of gravity, everything was attracted
   a. only to the Sun.
   b. only to massive heavenly objects such as the Sun, Moon, planets, and the Earth.
   c. to every other object in the universe.
   d. only to the center of the Earth.

20 The Ptolemaic System was replaced when
   a. Copernicus produced a system with the Sun at the center.
   b. it came into conflict with reproducible observations.
   c. Astronomers realized that Aristarchus had been right when he said it was unreasonable for the giant Sun to orbit the tiny Earth.
21 An ion rocket engine produces 10 Newtons of thrust. What acceleration can it give to a space probe with a mass of 1000 kg?
   a. 0.001 m/s²
   b. 0.01 m/s²
   c. 0.1 m/s²
   d. 1000 m/s²
   e. 1 m/s²

22 The star 61-Cygni is 3.3 parsecs from our Sun. The light from this star in the “serpent holder” constellation has been traveling for approximately
   a. 0.3 years
   b. 11 years
   c. 20 years
   d. 0.55 years
   e. 3.3 years

23 On a world with liquid water but no life, carbon dioxide in the atmosphere would
   a. increase as the water releases it from surface rocks.
   b. decrease as the water dissolves it to form an acid that combines with surface rocks.
   c. be stable because dissolved carbon dioxide comes out of solution whenever the carbon dioxide pressure drops.

24 Mars retains a carbon dioxide atmosphere because
   a. the pressure is very close to the triple point of water.
   b. there is no liquid water there.
   c. it has plate tectonic activity like Earth.
   d. there is no life there.

25 Within our own Milky Way Galaxy, our Sun is a typical member of
   a. Population I.
   b. either Population I or II.
   c. Population II.

26 A large vortex or hurricane on Jupiter has been named
   a. The Great Red Spot.
   b. Jove’s Eye.
   c. The Great Dark Spot.
   d. The Red Storm.

27 Which of the following statements describes the relation between what we observe and the predictions of the nebular model of the formation of the Solar System?
   a. The model predicts icy planets throughout the Solar System and we observe icy planets everywhere.
   b. The model predicts icy planets farthest from the Sun and we observe icy planets there.
   c. The model predicts icy planets throughout the Solar System and we observe icy planets only far from the Sun.
   d. The model predicts icy planets throughout the Solar System and we observe icy planets only nearest to the Sun.
   e. The model predicts icy planets nearest to the Sun and we observe icy planets there.
28 The density of water is $1000\text{kg/m}^3$, the density of rock is about $3000\text{kg/m}^3$, and the density of iron is $7800\text{kg/m}^3$. Which of the following densities would indicate an object that consists mostly of substances much less dense than rock or iron?
  a. $20,000\text{kg/m}^3$
  b. $3000\text{kg/m}^3$
  c. $8000\text{kg/m}^3$
  d. $4000\text{kg/m}^3$
  e. $1000\text{kg/m}^3$

29 Planets that are in orbit around stars other than our own Sun are *most often* found by observing
  a. telescope images of the planets.
  b. the microlensing of light from background stars.
  c. small wobbles in our own Sun.
  d. small changes in starlight due to planetary transits.

30 Which of these planets is the farthest from the Sun?
  a. Neptune
  b. Uranus
  c. Jupiter
  d. Mars
  e. Saturn

31 You are having central air conditioning installed in your two-story house and you have a choice between putting the vents on the second floor and putting them on the first floor. Of course, it would be best to put them in both places but you can’t do that. Which of the options that you have is best?
  a. Put the vents on the first floor so that the cooled air will rise to the second floor.
  b. Both options are equally good (or equally bad) because the cooled air will neither rise nor fall.
  c. Put the vents on the second floor so that the cooled air will descend to the first floor.

32 The angle between the rotation axis of a planet and the perpendicular to the plane of its orbit is called its “axial tilt.” Which of these planets has an axial tilt that is less than one degree?
  a. Earth.
  b. Saturn.
  c. Uranus.
  d. Mars.
  e. Mercury.

33 The property of electron-degenerate matter that is important in the evolution of a star is that this type of matter
  a. is easily compressed and heated.
  b. triggers nuclear fusion reactions.
  c. cannot be compressed and heated.
  d. conducts electricity without resistance.
  e. is the densest possible state of matter.
34 The time from one Full Moon to the next is 29.5 days. The length of a sidereal month is
   a. 27 days.
   b. 29.3 days.
   c. 29.7 days.
   d. 32 days.
   e. 29.5 days.

35 The term ‘greenhouse effect’ refers to
   a. the absorption of infrared light by gases in the atmosphere.
   b. the absorption of ultraviolet light by gases in the atmosphere.
   c. the destruction of the ozone layer.
   d. a theory proposed by Charles T. Greenhouse.
   e. the fact that the atmosphere is transparent.

36 The first spacecraft to put a lander on Titan was
   a. Mariner 9
   b. Galileo
   c. Cassini-Huygens
   d. Ulysses
   e. Pioneer 11

37 In the picture that we used in class, with the Sun above the top of the picture and the Earth shown with its
   North Pole facing you, the part of the Earth that is experiencing sunset would be
   a. below the North Pole in the picture.
   b. above the North Pole in the picture.
   c. to the left of the North Pole in the picture.
   d. to the right of the North Pole in the picture.

38 Most plants here on Earth are green because the process of converting carbon dioxide and water into organic
   matter uses only
   a. green light.
   b. red, blue, green, and violet light.
   c. blue and violet light.
   d. red, blue, and violet light.
   e. red light.

39 A star is seen to move by 0.2 seconds of arc between February 1, 1999 and August 1, 1999 and then back to its
   starting point on February 1, 2000. What is the parallax angle for this star?
   a. 0.1 seconds of arc.
   b. 0.3 seconds of arc.
   c. 0.4 seconds of arc.
   d. 0.5 seconds of arc.
   e. 0.2 seconds of arc.
40 The second most common element in the universe is
   a. water.
   b. silicon.
   c. helium.
   d. hydrogen.
   e. carbon.

41 In the Hertzsprung-Russell Diagram shown, which point represents a star of type B with absolute magnitude +10?

42 At which of these times of day would you expect to find the Sun in the East?
   a. 6:00am
   b. Midnight.
   c. Noon.
   d. 6:00pm.

43 Which of the following magnitudes corresponds to the brightest star?
   a. +2
   b. +1
   c. 0
   d. +3
   e. +4

44 Which of the following planets has just two moons?
   a. Jupiter
   b. Mars
   c. Neptune
   d. Venus
   e. Earth

45 The magnetic field of Jupiter is
   a. about 10 times the intensity of the Earth’s magnetic field.
   b. essentially zero.
   c. about 1% of the Earth’s magnetic field.
   d. about 100 times the intensity of the Earth’s magnetic field.
   e. Similar in intensity to the Earth’s magnetic field.
46 The first space probes to land on another planet were from the
   b. The Voyager series.
   c. The Viking series.
   d. The European Venus Express series.
   e. Russian Venera series.

47 The range of signal frequencies between absorption bands caused by hydrogen and hydroxyl molecules
   a. has no particular significance for SETI programs.
   b. is always avoided by SETI programs because signals there are strongly absorbed.
   c. is referred to as the "water hole" and is the frequency band that SETI programs usually choose.
   d. is referred to as the "hydrogen band" and is usually avoided by SETI programs.

48 A large asteroid impact can affect the Earth’s climate primarily by
   a. producing strong winds from its passage.
   b. heating the air with the heat of impact.
   c. poisoning the air with its fumes.
   d. blocking the sunlight with its smoke and dust.

49 Which of these moons has landmarks that are not rotating with the rest of the moon, indicating a subsurface
   ocean?
   a. Europa.
   b. Enceladus.
   c. Ganymede.
   d. Titan.

50 Eratosthenes of Cyrene is generally credited with using the angle of the noon Sun at Alexandria and Syene to
determine the
   a. size of the Sun.
   b. distance from the Earth to the Sun.
   c. size of the Earth.
   d. time of the summer solstice.
   e. length of a solar year.

51 In a Hertzsprung-Russell diagram, the absolute brightness of stars increases going
   a. upward.
   b. to the left.
   c. downward.
   d. to the right.
52 A horse is pulling a cart along a road. Which of the following pairs of forces is an action-reaction pair?
   a. The force of the horse on the cart and the force of the horse on the road.
   b. The force of the cart on the horse and the force of the horse on the road.
   c. The force of the cart on the horse and the force of the road on the horse.
   d. The force of horse on the road and the force of the road on the horse.
   e. The force of the horse on the cart and the force of the road on the horse.

53 Aristotle said that the spherical shape of the Earth was
   a. the natural result of gravity pulling everything toward a center.
   b. due to air pressure pushing everything inward.
   c. unstable since small deviations from it would grow larger.
   d. something that could not be explained or understood.

54 The first human landing on the Moon was
   b. Surveyor 1 in 1969.
   c. Apollo 10 in 1969.
   e. Apollo 10 in 1974.

55 The focal point of a lens is
   a. the center of the lens.
   b. the place where it sends rays that are off-axis.
   c. the center of curvature of the lens.
   d. the place where it sends all light rays.
   e. the place where it sends rays that are parallel to the axis.

56 The radiant of a meteor shower is the point in the sky that the
   a. Earth is moving towards during the shower.
   b. original comet was moving towards when it broke up.
   c. meteors are all equidistant from.
   d. meteors seem to be going toward.
   e. Sun is moving towards during the shower.

57 Ancient lava flows on the Moon are called Lunar
   a. maria.
   b. planitia.
   c. craters.
   d. valleys.
   e. terrae.
58 From the way that lunar eclipses happen, the Ancient Greeks were able to
   a. conclude that the Sun is farther from the Earth than the Moon.
   b. calculate the distance from the Earth to the Sun.
   c. calculate the distance from the Earth to the Moon.

59 Which of the following spacecraft is the only one to have flown past Uranus?
   a. Cassini-Huygens
   b. Pioneer 11
   c. Voyager 1
   d. Voyager 2
   e. Galileo

60 The strongest evidence that Earth life is all descended from a single self-copying molecule is that all Earth life
   a. uses the same 4 nitrogenous bases to code for the same 20 amino acids.
   b. is powered directly or indirectly by sunlight.
   c. is mostly made of iron, magnesium, calcium and phosphorus.
   d. uses the same 6 nitrogenous bases to code for the same 30 amino acids.
   e. is mostly made of carbon, hydrogen, and oxygen.

61 An annual meteor shower occurs when
   a. the Earth passes through comet debris.
   b. the Solar Wind hits the Earth’s atmosphere.
   c. a nearby star explodes.
   d. our Sun passes through a spiral arm.
   e. asteroids hit the Earth.

62 Which of the following temperatures is closest to what you might expect on the planet Uranus?
   a. -250°F
   b. 50°F
   c. 100°F
   d. -350°F
   e. -150°F

63 Joseph Weber designed a series of devices to detect ripples in space-time, called gravitational waves. After
   several years of effort, Joe announced that he had detected gravitational waves. He built several versions of his
   devices and they all detected the waves. When other people tried to build similar devices, none of them detected
   anything at all. Joe’s evidence was ignored by the scientific community because
   a. Joe’s observations were sloppily done and not convincing.
   b. Joe’s observations were not reproduced by others.
   c. Joe was an Electrical Engineer and did not belong to the physicist club.
   d. Scientists would not believe there was a possible source for gravitational waves strong enough to register
   on Joe’s detectors.
64 The Greek philosopher who guessed that the Earth is a sphere because that is the most elegant and simple shape was
   a. Pythagoras.
   b. Aristotle.
   c. Plato.
   d. Eratosthenes.
   e. Aristarchus.

65 A star whose apparent brightness is $\frac{1}{100}$ that of a sixth magnitude star would have magnitude
   a. 16.
   b. 21.
   c. 11.
   d. 6.
   e. 1.

66 The mass of a carbon atom is 12.00amu while the mass of a deuterium atom is 2.014amu. If a gamma ray photon splits a carbon atom into six deuterium atoms, how much energy is converted into mass?
   a. 0.168amu
   b. 0.056amu
   c. 0.084amu
   d. 0.009amu
   e. 0.014amu

67 In comparison to the Copernican Theory, the Ptolemaic Theory made predictions that were of
   a. about the same accuracy.
   b. much less accuracy.
   c. much higher accuracy.

68 Spectroscopic Parallax refers to
   a. a method for finding distances to stars.
   b. the shifting of spectral lines due to star motion.
   c. the pressure broadening of spectral lines.
   d. the use of stellar parallax.

69 The star Kruger 60 shows a heliocentric stellar parallax of almost exactly 0.25 seconds of arc. The distance from our Sun to Kruger 60 is
   a. 4 parsecs.
   b. 2 parsecs.
   c. 0.75 parsecs.
   d. 0.25 parsecs.
   e. 8 parsecs.

70 For a planet that is following Kepler’s Laws, the magnitude of the planet’s acceleration is
   a. proportional to the square of the planet’s distance from the Sun.
   b. inversely proportional to the square of the planet’s distance from the Sun.
   c. inversely proportional to the planet’s distance from the Sun.
   d. a constant.
   e. proportional to the planet’s distance from the Sun.
71 The velocity of sound waves is roughly the same for all wavelengths. Suppose that a sound wave has a wavelength of one meter and a frequency of 1000Hz. The wavelength of a 250Hz sound wave would then be
   a. 1/4 m.
   b. 4 m.
   c. 1000 m.
   d. 1 m.
   e. 250 m.

72 The magnetic field of Saturn is
   a. about 10 times the intensity of the Earth’s magnetic field.
   b. about 100 times the intensity of the Earth’s magnetic field.
   c. essentially zero.
   d. about 1% of the Earth’s magnetic field.
   e. Similar in intensity to the Earth’s magnetic field.

73 Gerard Kuiper predicted that the region we now call the "Kuiper Belt" should be empty.
   a. He was incorrect because he assumed a mass for Pluto that is now known to be too small.
   b. He was incorrect because he assumed a mass for Pluto that is now known to be too large.
   c. He was incorrect because his calculations were wrong.
   d. He was correct, which is why the region was named after him.

74 The Viking Landers carried out several experiments on Martian surface soil. One of those experiments, the Pyrolytic Release Experiment gave a positive result for the presence of life forms. That result was interpreted to mean
   a. that life might exist in Martian surface soil.
   b. nothing because it contradicted the results of the other experiments.
   c. nothing because a sterilized control sample gave the same result.

75 Which of the following types of radiation has the highest frequency on this list?
   a. Radio waves.
   b. red light.
   c. infrared light.
   d. heat radiation.
   e. green light.

76 A time of 24 hours is
   a. slightly different from both a solar day and a sidereal day.
   b. exactly equal to a solar day.
   c. exactly equal to a sidereal day.

77 The dark side of the Moon, where the Sun never shines,
   a. is the side that always faces toward the Earth.
   b. does not exist.
   c. is the side that always faces away from Earth.
78 A planet with a thin, unstable surface floating on a hot liquid or semi-liquid interior would be a good place to look for life because
   a. things could live in the interior.
   b. it could have a carbon-return process similar to Earth’s.
   c. frequent quakes and volcanos would drive evolution by eliminating unfit life forms.

79 The layer of the Earth’s interior that flows like a liquid under gradual pressure but acts like a stiff solid under sudden pressure changes is the
   a. crust.
   b. mantle.
   c. mesosphere.
   d. inner core.
   e. outer core.

80 The iron core of an evolved massive star collapses because
   a. the weight of the rest of the star increases.
   b. its temperature rises faster when iron nuclei come apart.
   c. its temperature suddenly goes to zero.
   d. the weight of the rest of the star goes away.
   e. its temperature rise stops when iron nuclei come apart.

81 Saturn is about
   a. the same distance from the Sun as Jupiter
   b. five times as far from the Sun as Jupiter.
   c. 50% farther from the Sun than Jupiter.
   d. half as far from the Sun as Jupiter.
   e. twice as far from the Sun as Jupiter

82 The role of the DNA molecule in current Earth life is to
   a. store and release energy as needed.
   b. provide the patterns for the enzymes that carry out the chemical processes of life.
   c. carry out all of the chemical processes of life.
   d. use photons to split water into oxygen, electrons, and hydrogen ions.
   e. store and release oxygen as needed.

83 From his observations of the phases of Venus, Galileo concluded that
   a. Venus has moons.
   b. Tycho Brahe’s Model is wrong.
   c. Venus is rotating.
   d. The Ptolemaic Model is wrong.
   e. The Copernican Model is wrong.

84 The number of near-Earth asteroids that are more than one kilometer in diameter appears to be close to
   a. 30,000
   b. 1000.
   c. 300,000
   d. 10.
   e. 3,000,000
85 Which of the following spacecraft went into orbit around Mars only to find the surface totally obscured by a planet-wide dust storm?
   a. MESSENGER
   b. Mariner 10
   c. Pioneer 11
   d. Pioneer 10
   e. Mariner 9

86 Consider a light source whose absolute magnitude can be deduced from the properties of the light that reaches us from that source. Astronomers often refer to this sort of object as a
   a. brightness reference.
   b. reference object.
   c. standard candle.
   d. spectroscopic standard.
   e. distance marker.

87 The main reason to suspect that Enceladus has a subsurface ocean of water is
   a. geysers of water shooting out through cracks in the moon.
   b. patterns of cracks in the ice on its surface.
   c. landmarks that are not rotating with the rest of the moon.
   d. low fluxes of epithermal neutrons.

88 The Moon rotates on its axis relative to the distant stars
   a. not at all.
   b. once a year.
   c. once every sidereal month.
   d. once every sidereal day.

89 If an object is moving at constant speed in a straight line, its acceleration is
   a. zero.
   b. changing.
   c. positive in its direction of motion.
   d. negative in its direction of motion.

90 Black holes
   a. cannot be detected because they emit no radiation.
   b. have been detected as pulsing radio sources.
   c. have been detected because they block starlight.
   d. have been detected because infalling matter emits X-rays.

91 Suppose that a star has a spectrum that includes red, blue, and violet lines spaced in the pattern of the lines from hydrogen but the violet lines are at 444nm and 420nm instead of the usual 434nm and 410nm. From this evidence, you can conclude that the star is
   a. moving toward us.
   b. moving away from us.
   c. unusually cold.
   d. rotating.
   e. unusually hot.
92 The Earth’s motion around the Sun causes
   a. all stars to move away from a point in the constellation Hercules.
   b. nearby stars to shift steadily in the same direction.
   c. nearby stars to shift back and forth once a year.
   d. all stars to jump randomly around.

93 The second largest known dwarf planet in the Kuiper Belt is
   a. Sedna.
   b. Neptune.
   c. Eris.
   d. Pluto.
   e. Quaoar.

94 Which of the following statements is falsifiable?
   a. Dinosaurs taste good.
   b. Dinosaurs taste terrible.
   c. Dinosaurs are extinct.
   d. Dinosaurs are not extinct.
   e. Dinosaurs were extremely annoying.

95 Suppose that you drop two objects from the same height at the same time. Both objects are heavy enough to be
   unaffected by air resistance. If one object is twice as heavy as the other, Aristotle predicted that
   a. both objects would hit the ground at the same time.
   b. the heavier object would hit the ground long before the lighter one.
   c. the lighter object would hit the ground long before the heavier one.

96 A neutron star in orbit near a normal star is expected to emit
   a. bursts of X-rays but no constant signal.
   b. no X-rays at all.
   c. a constant X-ray signal with no bursts.
   d. both a constant X-ray signal and X-ray bursts.

97 To calculate the velocity of a wave, you need to know
   a. the number of crests that pass and the time taken.
   b. the time taken for a wave crest to pass.
   c. the wavelength and the distance traveled by a wave crest.
   d. the distance traveled by a wave crest and the time taken.
   e. the distance from one crest to the next.

98 Nuclear fusion requires high temperatures because nuclei
   a. have hard shells.
   b. repel each other.
   c. are extremely strong.
   d. have a lot of inertia.
99 Which of the following spectral types would you expect to look blue in color?
   a. F.
   b. G.
   c. A.
   d. M.

100 From the motions of nearby stars, the mass of the radio source Sgr A* is found to be spread
   a. over a region less than a few light days across.
   b. throughout the nearby stars.
   c. over a region a few light years across.

101 The stars that form the Big Dipper (in England it is called the Plough) are
   a. all at very different distances from the Earth.
   b. mostly at nearly the same distance from the Earth, but with exceptions.
   c. all at nearly the same distance from the Earth.

102 When the hydrogen fuel runs out at the center of a main sequence star, the star
   a. stops burning and becomes a brown dwarf.
   b. continues as a main sequence star.
   c. swells up and becomes a red giant.
   d. begins to collapse to a white dwarf star.
   e. explodes as a supernova.

103 A starship observes that a nearby star has apparent magnitude 4.0. The spectrum of the star indicates that it is
   a type that normally has absolute magnitude 4.0. From these observations, the starship knows that it is
   a. 10 parsecs from the star.
   b. 1 parsec from the star.
   c. 10,000 parsecs from the star.
   d. 100 parsecs from the star.
   e. 1000 parsecs from the star.

104 In comparison to Cepheid variables, RR Lyra variable stars are
   a. less luminous and less common.
   b. more luminous and less common.
   c. more luminous and more common.
   d. less luminous and more common.

105 Pathfinder was the first
   a. Mars orbiter.
   b. to use airbags to land on Mars.
   c. Mars lander.
   d. to use ion drive rockets for planetary exploration.

106 Apollo 8 made the first
   a. landing on the Moon by a spacecraft.
   b. test of docking procedures in lunar orbit.
   c. manned orbit of the Moon.
   d. manned landing on the Moon.
107 The space shuttle is in a roughly circular orbit near the surface of the Earth, moving at around 5 miles per second. Suppose that it is desired to lower it to a new circular orbit, slightly closer to the surface. The shuttle flips over and fires its main rocket engine in a short burst to slow its speed to 4.96 miles per second. What must it do next?

a. Boost its speed a bit when its distance from the Earth stops decreasing.
b. Slow its speed again by a bit when its distance from the Earth stops decreasing.
c. Nothing. It will drop to a new, lower circular orbit.
d. Rethink its plan because decreasing its speed will put it into an orbit that is farther from the surface.

108 Icy objects were ejected inward from the neighborhood of the Jovian planets to form

a. the oceans and atmosphere of Earth.
b. the asteroid belt.
c. the Oort Cloud.
d. the Moons of the Jovian planets.
e. the Kuiper belt.

109 Stellar Parallax is caused by

a. the motion of the Earth around the Sun.
b. the actual motion of stars relative to their neighbors.
c. turbulence in the Earth’s atmosphere.
d. the motion of our Sun relative to its neighbors.
e. the finite speed of light.

110 When you throw a baseball, the baseball keeps moving because

a. no force stops it.
b. the force of your hand keeps acting on it.
c. the displaced air pushes it from behind.
d. it is rotating.
e. the force of its inertia pushes it.

111 Most of the ancient Greek astronomers believed that the Earth was fixed at the center of the universe. There was one, however, who thought that the Sun was fixed and a rotating Earth moved around the Sun. That was

a. Aristarchus of Samos.
b. Ptolemy.
c. Aristotle
d. Plato.
e. Eristarchus of Cyrene.
112 One reason that the Copernican System failed to fit Tycho’s observations was that
   a. it placed the Earth at the center of the universe.
   b. it used circular orbits instead of ellipses.
   c. it placed the Sun at the center of the system.
   d. it used elliptical orbits instead of circles.

113 Convection currents in the Earth’s Mantle
   a. do not happen because solid rock does not move.
   b. cause mass extinctions.
   c. are responsible for moving the tectonic plates.
   d. happen but do not affect the crust.
   e. are responsible for land tides.

114 Suppose that an asteroid, about 1 kilometer in diameter, shows a 1 in 100 probability of an Earth impact fifty years in the future. Assume that an impact will trigger climate changes that would kill one billion (1,000,000,000) people. Also assume that each of these deaths represents $100,000 in lost production. Using the cold economic logic that we discussed in class, how much money should be budgeted to deflect the asteroid?
   a. one billion dollars ($1,000,000,000)
   b. one hundred trillion dollars ($100,000,000,000,000).
   c. one trillion dollars ($1,000,000,000,000).
   d. one hundred billion dollars ($100,000,000,000,000).

115 As seen from North America, the constellation Cassiopeia
   a. never sets.
   b. sets in the north.
   c. sets in the east.
   d. sets in the south.
   e. sets in the west.

116 When the light from a star is spread out into a rainbow of colors, the resulting picture is called
   a. an absorption diagram.
   b. a frequency diagram.
   c. an energy level diagram.
   d. a speculum.
   e. a spectrum.

117 A brown dwarf shines primarily with
   a. light reflected from nearby stars.
   b. energy left over from its formation.
   c. energy generated by nuclear fusion.
   d. energy generated by radioactive decay.

118 The intense magnetic field of the Crab pulsar causes its rate of spin to
   a. increase.
   b. decrease.
   c. vary up and down.
119 The Inner Oort Cloud is
   a. distributed along the rotation axis of the solar system.
   b. distributed in all directions.
   c. a belt of objects mostly in the plane of the solar system.
   d. a doughnut-shaped region with objects above and below the plane of the solar system.

120 An atom of ordinary hydrogen consists of a proton and
   a. a negatron.
   b. a neutrino.
   c. an electron.
   d. a neutron.
   e. a positron.
1. Choice c. (1 parsec.)
2. Choice e. (slightly longer than one Earth day.)
3. Choice c. (An upward current in the Earth’s Mantel.)
4. Choice a. (Venus)
5. Choice c. (in a band of stars stretching across the sky.)
6. Choice b. (there is no liquid water there.)
7. Choice a. (366.242199 times in a year.)
8. Choice d. (more like a circle around the foci.)
9. Choice b. (the brightness decreases.)
10. Choice a. (how the tides work but not how lightning works.)
11. Choice e. (Setting in the West right after the Sun.)
12. Choice b. (could have planets within the habitable zones of both Alpha Centauri A and Alpha Centauri B.)
13. Choice c. (10 Newtons.)
14. Choice a. (a family of moons, all orbiting in the plane of the planets equator.)
15. Choice a. (Jupiter)
16. Choice c. (An accurate map of Richmond.)
17. Choice c. (1000 parsecs.)
18. Choice a. (is where light is last scattered.)
19. Choice c. (to every other object in the universe.)
20. Choice b. (it came into conflict with reproducible observations.)
21. Choice b. (0.01 m/s^2.)
22. Choice b. (11 years.)
23. Choice b. (decrease as the water dissolves it to form an acid that combines with surface rocks.)
24. Choice a. (the pressure is very close to the triple point of water.)
27. Choice b. (The model predicts icy planets farthest from the Sun and we observe icy planets there.)
28. Choice e. (1000kg/m^3)
29. Choice d. (small changes in starlight due to planetary transits.)
30. Choice a. (Neptune)
31. Choice c. (Put the vents on the second floor so that the cooled air will descend to the first floor.)
32. Choice e. (Mercury.)
33. Choice c. (cannot be compressed and heated.)
34. Choice a. (27 days.)
35. Choice a. (the absorption of infrared light by gases in the atmosphere.)
36. Choice c. (Cassini-Huygens)
37 Choice c. (to the left of the North Pole in the picture.)
38 Choice d. (red, blue, and violet light.)
39 Choice a. (0.1 seconds of arc.)
40 Choice c. (helium.)
41 Choice d. (D)
42 Choice a. (6:00am)
43 Choice c. (0.)
44 Choice b. (Mars)
45 Choice a. (about 10 times the intensity of the Earth’s magnetic field.)
46 Choice e. (Russian Venera series.)
47 Choice c. (is referred to as the "water hole" and is the frequency band that SETI programs usually choose.)
48 Choice d. (blocking the sunlight with its smoke and dust.)
49 Choice d. (Titan.)
50 Choice c. (size of the Earth.)
51 Choice a. (upward.)
52 Choice d. (The force of horse on the road and the force of the road on the horse.)
53 Choice a. (the natural result of gravity pulling everything toward a center.)
54 Choice a. (Apollo 11 in 1969.)
55 Choice e. (the place where it sends rays that are parallel to the axis.)
56 Choice a. (Earth is moving towards during the shower.)
57 Choice a. (maria.)
58 Choice c. (calculate the distance from the Earth to the Moon.)
59 Choice d. (Voyager 2)
60 Choice a. (uses the same 4 nitrogenous bases to code for the same 20 amino acids.)
61 Choice a. (the Earth passes through comet debris.)
62 Choice d. (-350°F)
63 Choice b. (Joe’s observations were not reproduced by others.)
64 Choice a. (Pythagoras.)
65 Choice c. (11.)
66 Choice c. (0.084amu)
67 Choice a. (about the same accuracy.)
68 Choice a. (a method for finding distances to stars.)
69 Choice a. (4 parsecs.)
70 Choice b. (inversely proportional to the square of the planet’s distance from the Sun.)
71 Choice b. (4 m.)
72 Choice e. (Similar in intensity to the Earth’s magnetic field.)
73 Choice b. (He was incorrect because he assumed a mass for Pluto that is now known to be too large.)
74 Choice c. (nothing because a sterilized control sample gave the same result.)
75 Choice e. (green light.)
76 Choice b. (exactly equal to a solar day.)
77 Choice b. (does not exist.)
78 Choice b. (it could have a carbon-return process similar to Earth’s.)
79 Choice b. (mantle.)
80 Choice e. (its temperature rise stops when iron nuclei come apart.)
81 Choice e. (twice as far from the Sun as Jupiter)
82 Choice b. (provide the patterns for the enzymes that carry out the chemical processes of life.)
83 Choice d. (The Ptolemaic Model is wrong.)
84 Choice b. (1000.)
85 Choice e. (Mariner 9)
86 Choice c. (standard candle.)
87 Choice a. (geysers of water shooting out through cracks in the moon.)
88 Choice c. (once every sidereal month.)
89 Choice a. (zero.)
90 Choice d. (have been detected because infalling matter emits X-rays.)
91 Choice b. (moving away from us.)
92 Choice c. (nearby stars to shift back and forth once a year.)
93 Choice c. (Eris.)
94 Choice c. (Dinosaurs are extinct.)
95 Choice b. (the heavier object would hit the ground long before the lighter one.)
96 Choice d. (both a constant X-ray signal and X-ray bursts.)
97 Choice d. (the distance traveled by a wave crest and the time taken.)
98 Choice b. (repel each other.)
99 Choice c. (A.)
100 Choice a. (over a region less than a few light days across.)
101 Choice b. (mostly at nearly the same distance from the Earth, but with exceptions.)
102 Choice c. (swells up and becomes a red giant.)
103 Choice a. (10 parsecs from the star.)
104 Choice d. (less luminous and more common.)
105 Choice b. (to use airbags to land on Mars.)
106 Choice c. (manned orbit of the Moon.)
107 Choice b. (Slow its speed again by a bit when its distance from the Earth stops decreasing.)
108 Choice a. (the oceans and atmosphere of Earth.)
109 Choice a. (the motion of the Earth around the Sun.)
110 Choice a. (no force stops it.)
111 Choice a. (Aristarchus of Samos.)
112 Choice b. (it used circular orbits instead of ellipses.)
113 Choice c. (are responsible for moving the tectonic plates.)
114 Choice c. (one trillion dollars ($1,000,000,000,000).)
115 Choice a. (never sets.)
116 Choice e. (a spectrum.)
117 Choice b. (energy left over from its formation.)
118 Choice b. (decrease.)
119 Choice d. (a doughnut-shaped region with objects above and below the plane of the solar system.)
120 Choice c. (an electron.)
Where to find these questions in the lecture notes

1. ****Module 024.504-g01 The Hertzsprung-Russelll Diagram, Spectroscopic Parallax (15%)
2. Module 011.507-g01 The Terrestrial Planets Mars Orbit and Rotation
3. EModule 016.102-g01 Earth’s Living Surface An Active Crust EC2
4. Module 011.204-g01 The Terrestrial Planets Venus Surface
5. Module 029.102 The Milky Way Galaxy, How We See it (052.12)
6. Module 016.501 Earth’s Living Surface Comparing Earth to Other Planets
7. ***Module 003.401-g01 The Sky: Celestial Sphere Apparent Motion of the Sun (25%)
8. Module 005.503 The Sky: Power of Observation Kepler’s First Law
9. Module 025.401 Evolution onto the Main Sequence (047.31)
10. Module 009.403 Science Models of Gravity Unifying Physical Law
11. Module 007.503 Science Model Building Phases of the Moon (47%)
12. Module 019.411-g01 The Search for Life Extrasolar Planets
13. Module 008.506 Science Models of Motion Force and Mass F=ma
14. Module 010.304-g01 Solar System Overview The Jovian Planets
15. Module 012.118 The Jovian Planets Jupiter Moons
16. Module 007.102-g01 Science Model Building Scientific Models
17. Module 022.401-g01 Stellar Magnitudes and Distance Luminosity, Finding the distance
18. Module 014.201 Formation of the Solar System The Protostar Stage
19. Module 009.301 Science Models of Gravity Universal Gravitation
20. Module 006.304 Science Scientific Statements The Search for Error
21. EModule 008.515-g01 Science Models of Motion Force and Mass a = F/m QR1
22. Module 020.408-g01 Stellar Parallax and Distance Parallax Angle and Distance
23. Module 016.303 Earth’s Living Surface The Carbon Cycle
24. **Module 016.503 Earth’s Living Surface Comparing Earth to Other Planets (30%)
25. Module 029.408 The Milky Way Galaxy, What is its Overall Shape? (053.31)
26. Module 012.106 The Jovian Planets Jupiter Surface
27. Module 014.302-g01 Formation of the Solar System Condensation of the Planets
28. Module 010.301-g01 Solar System Overview The Jovian Planets
29. Module 019.413 The Search for Life Extrasolar Planets
30. Module 010.103 Solar System Overview The Big Picture
31. Module 015.202-g01 Earth’s Atmosphere and Interior Convection
32. *Module 011.104-g01 The Terrestrial Planets Mercury Surface (38%)
33. Module 026.402-g01 The Quiet Deaths of Ordinary Stars, Game Over: Everybody leaves 048.42
34. Module 007.510 Science Model Building Phases of the Moon
35. EModule 015.401 Earth’s Atmosphere and Interior Greenhouse Effect (45%) EC5
36. Module 012.227 The Jovian Planets Saturn Space Probes
Module 007.403 Science Model Building Time and Compass Heading
Module 018.404-g01 Requirements for Life The Energy Sources of Life
Module 020.401 Stellar Parallax and Distance Parallax Angle and Distance (44%)
Module 018.201-g01 Requirements for Life The Chemical Basis of Life
Module 024.102A The Hertzsprung-Russell Diagram, A dot for each star
Module 001.101-g01 The Sky: As Certain as the Sunrise. Where?
Module 022.201-g01 Stellar Magnitudes and Distance Luminosity, The Magnitude Scale
Module 011.514 The Terrestrial Planets Mars Moons
Module 012.111 The Jovian Planets Jupiter Magnetic Field (44%)
Module 011.211 The Terrestrial Planets Venus Space Probes (49%)
Module 019.504 The Search for Life SETI: Search for ExtraTerrestrial Intelligence
Module 017.304 Earth Impacts Large Object Impacts EC4
*Module 019.302 The Search for Life The Jovian Moons (37%)
Module 002.401 The Sky: Spherical Earth. Circumference
EModule 024.203-g01 The Hertzsprung-Russell Diagram, Interpreting the diagram QR3
Module 008.602 Science Models of Motion Action and Reaction (46%)
Module 002.201 The Sky: Spherical Earth. Self-consistency
Module 011.422 The Terrestrial Planets Moon Space Probes
Module 020.102 Stellar Parallax and Distance Lenses and Mirrors
***Module 013.206-g01 Comets and the Outer Solar System Meteor Showers(26%)
Module 011.402 The Terrestrial Planets Moon Surface Features
**Module 007.204 Science Model Building Earth-Moon System (34%)
Module 012.317 The Jovian Planets Uranus Space Probes
Module 018.507 Requirements for Life Reproduction
Module 013.203 Comets and the Outer Solar System Meteor Showers
Module 012.304 The Jovian Planets Uranus Surface
EModule 001.202 The Sky: As Certain as the Sunrise. Reproducible CT1
**Module 002.102 The Sky: Spherical Earth. Elegance.(32%)
***Module 022.204-g02 Stellar Magnitudes and Distance Luminosity, The Magnitude Scale (26%)
Module 025.202-g01 Mass and Energy (042.22)
Module 004.602 The Sky: Wandering Planets Why Copernicus Lost
Module 024.502-g01 The Hertzsprung-Russell Diagram, Spectroscopic Parallax
EModule 020.405 Stellar Parallax and Distance Parallax Angle and Distance QR2
***Module 009.102-g01 Science Models of Gravity Explaining Kepler’s Laws (25%)
Module 021.109 Using the Doppler Shift Describing Waves
*Module 012.211 The Jovian Planets Saturn Magnetic Field (38%)
Module 014.505-g01 Formation of the Solar System The Fates of Dirty Snowballs
Module 019.207 The Search for Life Mars

***Module 018.101-g01 Requirements for Life Light (28%)

Module 003.404 The Sky: Celestial Sphere Apparent Motion of the Sun

***Module 011.408-g01 The Terrestrial Planets Moon Orbit and Rotation (26%)

Module 018.314 Requirements for Life The Requirements for a Carbon Cycle

Module 015.504-g01 Earth’s Atmosphere and Interior The Earth’s Interior

Module 027.201 Supernova Explosions, Payback Time 049.31

Module 012.203-g01 The Jovian Planets Saturn Surface

EModule 018.505 Requirements for Life Reproduction (F20113:89%) EC3

Module 007.601 Science Model Building Phases of Venus Variant

Module 017.104 Earth Impacts Near Earth Objects

*Module 011.517 The Terrestrial Planets Mars Space Probes (40%)

Module 022.502 Stellar Magnitudes and Distance Luminosity, Preview of the Distance Ladder

Module 019.303 The Search for Life The Jovian Moons

Module 011.408 The Terrestrial Planets Moon Orbit and Rotation

Module 008.302 Science Models of Motion Acceleration

Module 028.401 Collapsed Objects, Detecting Black Holes 051.21

Module 021.201 Using the Doppler Shift The Doppler Shift (41%)

Module 020.302 Stellar Parallax and Distance What Causes Parallax?

Module 010.604-g01 Solar System Overview The Kuiper Belt

EModule 006.103-g01 Science Scientific Statements How to test a statement CT2

Module 008.402 Science Models of Motion The Universality of Free Fall

Module 028.201 Collapsed Objects, X-Ray Sources 050.31

Module 021.107-g01 Using the Doppler Shift Describing Waves

Module 025.303-g01 Ignition (042.33)

Module 023.203-g01 Star Colors and Classes, Spectral Types

EModule 029.509 The Milky Way Galaxy, The Monster in the Core (055.33) (24%)

Module 003.204 The Sky: Celestial Sphere. Patterns

Module 026.102 The Quiet Deaths of Ordinary Stars, Out of Fuel 048.12

Module 022.301-g01 Stellar Magnitudes and Distance Luminosity, Apparent and Absolute Magnitudes

Module 029.203 The Milky Way Galaxy, How we Measure Distances Within It (052.33)

Module 011.524 The Terrestrial Planets Mars Space Probes

**Module 011.423-g01 The Terrestrial Planets Moon Space Probes (28%)

Module 009.602-g01 Science Models of Gravity Artificial Satellites

*Module 014.503 Formation of the Solar System The Fates of Dirty Snowballs (38%)

***Module 020.301 Stellar Parallax and Distance What Causes Parallax? (24%)

Module 008.504-g01 Science Models of Motion Force and Mass (F20113:60%,60%)
111 *Module 004.301 The Sky: Wandering Planets Aristarchus (40%)
112 Module 005.402 The Sky: Power of Observation Kepler’s War with Mars
113 Module 016.104 Earth’s Living Surface An Active Crust
114 **Module 017.406-g01 Earth Impacts Hunting Killer Asteroids (32%) RA1
115 Module 003.303 The Sky: Celestial Sphere Star Motions
116 Module 018.115-g01 Requirements for Life Light
117 Module 025.503 Stars of Extreme Mass (047.43)
118 **Module 028.106 Collapsed Objects, The Pulsar in the Crab Nebula 050.24 (26%)
119 Module 013.403 Comets and the Outer Solar System The Transition from Kuiper Belt to Oort Cloud
120 Module 025.101-g01 The Building Blocks of Matter (042.11)