ASTRONOMY 301
EXAMPLES OF TEST QUESTIONS FOR PARTS 1 AND 2
Instructor: John Kormendy

The first page of exams will look like this:

1 – Fill in the information requested at the top of the answer sheet, including your name and signature. DO NOT LIST YOUR SSN. In the area marked IDENTIFICATION, put your UT EID. You do not need the course's unique number.

Please encode your name and UT EID in the bubble code section.

2 – This is a closed-book exam. Work on your own and do not communicate with other students during the exam.

3 – Answer all 50 questions. Each correct answer scores 2 points. Wrong answers score 0 points. The maximum score is 100 points.

4 – There is only one correct answer to each question. Do not select more than one response to any question. Pick the most complete or the most correct answer.

5 – It is OK to write anything you like on the exam. You do not need to write your name on the exam question pages.

6 – Please do not use a calculator or cell phone or any other digital device.

7 – You will have 1 hour 10 min to do the test.

8 – **At the end, please turn in both the exam and your scantron.**

Newton's law of universal gravitation

Two bodies of mass M and m that are separated by a distance r attract each other with a force

$$F = \frac{GMm}{r^2} \ ,$$

where $G = 0.667 \times 10^{-10}$ m^3 kg^{-1} s^{-2} is a universal constant.

Wien's law

The wavelength of maximum brightness in the spectrum of an object is proportional to 1/T, where T is its temperature.

Stefan-Boltzmann law

The total energy per unit surface area radiated by a body is proportional to T^4. Therefore the total energy emitted by the body is proportional to $4\pi r^2 T^4$, where r is its radius and $4\pi r^2$ is its surface area.

In these examples, questions that refer to Part 1 are written in blue font and questions that refer to Part 2 are written in black font.

1. The most fundamental discovery in astronomy is that
   (A) the Sun and not the Earth is at the center of the Universe.
   (B) the Universe can be understood using physical laws that apply on Earth.
   (C) gravity works the same way in space as it does on Earth.
   (D) there are many planets outside our Solar System revolving around other stars.

2. How can we recognize that a theory is not scientific?
   (A) It is not correct.
   (B) It does not agree with the theories of previous generations of scientists.
   (C) It is not testable.
   (D) It is not agreed upon by a majority of scientists.

3. The capital of Greenland, Nuuk, is far north, at 64° latitude, almost on the Arctic Circle. Almost directly south of Nuuk is Rio de Janeiro, Brazil, which is in the tropics, 23° south of the equator. When it is noon in Nuuk, what time is it in Rio?
   (A) noon
   (B) 2 PM
   (C) 10 AM
   (D) midnight

4. When it is 10 PM on Monday in California, what day is it in Australia?
   (A) Sunday
   (B) Monday
   (C) Tuesday
   (D) None of the above

5. The Earth would not have seasons if
   (A) its orbit were exactly circular.
   (B) the observer's zenith were perpendicular to the Earth's orbit plane.
   (C) its axis of rotation were perpendicular to its equatorial plane.
   (D) its equatorial plane were in its orbit plane around the Sun.

6. What causes precession of the rotation axis of the Earth?
   (A) The Earth is a spinning sphere and its spin axis is tipped with respect to the orbital planes of the Moon around the Earth and the Earth around the Sun.
   (B) The Earth is slightly flattened – its equatorial diameter is bigger than its north-south diameter. And this equatorial bulge is tipped out of the plane of the Moon's orbit around the Earth and the Earth's orbit around the Sun.
   (C) The Sun and Moon pull on the Earth from different directions.
   (D) None of the above are correct

7. If the phase of the Moon is full, when is it highest in the sky?
   (A) 12 midnight
   (B) 6 PM
   (C) 12 noon
   (D) 6 AM

8. A new Moon is on the horizon at about
   (A) sunrise or sunset.
   (B) midnight.
   (C) noon.
   (D) A new Moon can never be on the horizon.

9. If, during the course of a night, you saw that every star moves around a circular arc that is tipped about half-way between horizontal to the horizon and vertical to the horizon, where would you be?
   (A) The South Pole
   (B) The North Pole
   (C) The Equator
   (D) Texas

10. Suppose that the Earth is experiencing a total solar eclipse. You are standing on the Moon, and for you, the Sun just set. Where do you see the Earth?
    (A) It is nearly on the horizon as you look around you.
    (B) It is high in the sky.
    (C) You cannot see the Earth – it is far below your horizon.
    (D) The Earth is above your horizon and therefore – in principle – visible to you, but it is too dark to see, because the Moon blocks all sunlight as seen from the Earth.

11. Suppose that the Moon is experiencing a total solar eclipse. You are standing on the Earth, looking at the Moon. What do you see?
    (A) The Moon would look completely dark.
    (B) The Moon's disk would be black, but it would be surrounded by a thin ring of light that is the red color of a sunset as seen on Earth.
    (C) The Moon's disk would be dark, coppery red.
    (D) The shadow of the Earth on the Moon would be a dark spot moving over the Moon.

12. The Moon and the Sun look almost exactly the same size as seen from Earth. Why?

    (A) The Sun is about 400 times bigger than the Moon, but it is about 400 times farther away. So they look the same size. This is an accident.

    (B) The above statement is true, but this is not an accident. It was engineered by the mutual tidal forces between the Earth and the Moon, which move the Moon farther from the Earth until the above condition is exactly achieved.

    (C) The question is wrong. The Moon is much closer than the Sun, so it looks much bigger than the Sun.

    (D) None of the above answers is correct.

13. The Moon always keeps the same face pointed towards Earth. It orbits the Earth in 28 days. How long does one day last on the Moon (that is, how long is it between sunrise and sunset)?

    (A) One year

    (B) One month

    (C) Two weeks

    (D) The Moon does not rotate, so it is either always daytime or always nighttime, depending on whether you are on the near side (to the Earth) or on the far side.

14. It is warmer in Hawaii than at the north pole because

    (A) the Sun is closer to the Earth's equator than to its north pole.

    (B) the Sun's rays hit the ground nearly vertically in Hawaii; in contrast, sunlight hits the ground at a shallow angle at the north pole.

    (C) the Earth's atmosphere has fewer clouds near the equator.

    (D) This is an accident of the present time. When the precession of the Earth's axis carries the north pole far from where it is now, it will no longer necessarily be warm in Hawaii and cold where the north pole is now.

15. If the plane of the Moon's orbit around the Earth were the same as the plane of the Earth's orbit around the Sun, there would be a total solar eclipse

    (A) twice per month.

    (B) every day.

    (C) once per month.

    (D) twice per year.

16. The radius of Venus's orbit around the Sun is 0.7 astronomical units. Which of the following statements is true?

    (A) Venus always shows a thin crescent phase.

    (B) Venus shows all phases, from new to full, some time during several orbits around the Sun.

    (C) Venus always shows a nearly full phase.

    (D) None of the above is correct.

17. The radius of Mars's orbit around the Sun is 1.5 astronomical units. Which of the following statements is true?

    (A) Mars always shows a thin crescent phase.
    (B) Mars shows all phases, from new to full, some time during several orbits around the Sun.
    (C) Mars always shows a nearly full phase.
    (D) None of the above is correct.

18. Which of these did Aristotle believe?

    (A) The stars and planets move around the Earth.
    (B) If you drop a heavy object and a light one, the heavy object falls faster.
    (C) If an object moves in a straight line at a constant speed, then something is pushing on it.
    (D) all of the above
    (E) none of the above

19. Who was the first astronomer to discover a mathematical law of nature?

    (A) Johannes Kepler
    (B) Galileo Galilei
    (C) Tycho Brahe
    (D) Isaac Newton

20. Who was the first to measure the distance to the Moon?

    (A) Ptolemy
    (B) Aristarchus
    (C) Eratosthenes
    (D) Aristotle

21. Which of the following of Galileo's discoveries provides the strongest proof that the Sun is at the center of the Solar System?

    (A) Sunspots
    (B) Moons of Jupiter
    (C) Mountains, valleys, and craters on the Moon
    (D) Phases of Venus

22. A drop of water that is released into the air inside the International Space Station quickly settles into a spherical shape in the microgravity there. What holds it together?

    (A) the strong nuclear force
    (B) the weak nuclear force
    (C) the electromagnetic force
    (D) gravity: "Migrogravity" is very weak gravity, but it is not <u>no</u> gravity.

23. If the Sun's mass were suddenly to become zero, then all the planets would
    (A) move away in epicycles.
    (B) move away in straight lines.
    (C) fall into the Sun.
    (D) continue in their orbits.

24. If one star in a binary system exploded, leaving no remnant, then the other star would
    (A) move away in epicycles.
    (B) move away in a straight line.
    (C) also explode.
    (D) continue in its orbit.

25. Who first developed a theory of gravity that explains Kepler's laws?
    (A) Albert Einstein
    (B) Galileo Galilei
    (C) Isaac Newton
    (D) Tycho Brahe

26. Which of the following statements is correct?
    (A) An astronout in orbit around the Earth is falling toward the Earth.
    (B) The astronaut is not falling toward the Earth if she is in an exactly circular orbit around the Earth.
    (C) The astronaut's orbit is very slowly shrinking, because she is using up some of her orbital energy to make tides on Earth.
    (D) The astronaut's orbit is unchanging, because she is beyond the reach of Earth's gravity.

27. Kepler's second law (equal areas in equal times)
    (A) explains why planets like Mars move in elliptical orbits.
    (B) explains why Halley's comet moves so quickly near the Sun while it but spends a long time in its outer orbit.
    (C) can be used to determine the masses of planets.
    (D) none of the above.

28. Kepler's third law says that the cube of the radius of an orbit (a^3) is proportional to the square of the orbital period (P^2). In other words, a^3/P^2 is the same constant for everything that orbits the Sun. If a new object is discovered that has a circular orbit with an orbital period of 3 years, how big is the orbit?
    (A) about 2 astronomical units.
    (B) about 3 astronomical units
    (C) about 16 astronomical units.
    (D) about 64 astronomical units.

29. Which of the following statements about light is true?

(A) Blue light has a shorter wavelength than red light.
(B) Blue light travels faster than red light.
(C) Radio waves are not a kind of light.
(D) None of the above

30. The light-gathering power of a large telescope depends on

(A) the size of its mirror.
(B) the magnification of its optical elements.
(C) the focal length of its eyepiece.
(D) the effect of atmospheric seeing.

31. Which of these <u>most strongly</u> motivate astronomers to put a telescope in space?

(A) the desire to magnify images more than we can from ground-based telescopes
(B) the desire to observe X-rays from hot gas near black holes
(C) the desire to observe the dark matter that holds clusters of galaxies together – it is too dark to be seen from the surface of the Earth.
(D) the desire to observe radio jets emitted by black holes in orbit around other stars
(E) none of the above

32. Suppose that your eyes were sensitive only to X-ray radiation. Which of the following statements would be true?

(A) We would see completely different kinds of objects when we look at the night sky.
(B) We would see only the most energetic objects – for example, supernovae – in the night sky.
(C) We would see more or less the same objects that we see now, but hotter objects would be easier to see and colder objects would be harder to see than they are now.
(D) None of the above

33. Suppose that your eyes were sensitive only to the infrared light given off by normal furniture at room temperature. Which of the following statements would be wrong?

(A) If you dove into a swimming pool full of water and opened your eyes under water, you would see the Sun as a brilliant light above the water.
(B) The inside of a refrigerator would look black, but people would glow.
(C) A roaring campfire would look bright.
(D) Steam would be a bright cloud compared to your surroundings on a pleasant summer day.

34. Stellar parallax is

(A) the apparent motion of a star in the sky when you cover up one eye to look at it.
(B) the apparent backward motion of a star in the sky when you look at it near midnight; that is, at the time when the Earth is "catching up and passing" the star as seen from the Sun.
(C) the apparent backward motion of all the stars in the sky parallel to the Sun's motion around the Galactic center.
(D) the apparent motion of a nearby star with respect to the background stars as you look at it from different points along the Earth's orbit around the Sun.

35. How do astronomers measure distances to stars?

(A) doppler effect
(B) precession of the Earth's axis
(C) parallax
(D) apparent brightness of the star

36. One of the most important ways of learning about a celestial object is to study its spectrum. A spectrum is

(A) the amount of energy coming from an object measured at various wavelengths.
(B) white light spread into its component colors.
(C) radio waves, infrared and blue light, ultraviolet radiation, and X-rays.
(D) all of the above.

37. Which of these kinds of light has the most energy per photon?

(A) Radio waves from quasars
(B) Yellow light from the Sun
(C) Infrared light from your campfire
(D) X-rays from a solar flare

38. Your campfire is dying down. It contains glowing coals, all the same size. Cooler coals are

(A) brighter and redder.
(B) fainter and redder.
(C) fainter and bluer.
(D) none of the above

39. Suppose the we point our telescope and spectrograph at a cloud of gas that is surrounded on three sides by hot, young stars. We would observe

(A) that the spectrum of the gas cloud consists of many emission lines.
(B) that the spectrum of the gas cloud consists of many absorption lines.
(C) that the gas cloud has a black body continuous spectrum that is characteristic of the average temperature of the stars that shine on it.
(D) None of the above answers is correct.

40. The spectrum of a perfect 6000° K black body seen through a cloud of cool gas would show

(A) emission lines.
(B) absorption lines.
(C) both emission and absorption lines.
(D) neither emission nor absorption lines.

41. Binary stars are extraordinarily useful to astronomers. Why?
    - (A) They allow us reliably to find black holes.
    - (B) They allow us to determine stellar radii.
    - (C) They are responsible for some kinds of supernova explosions.
    - (D) All of the above.

42. When the outermost electron in an excited atom drops to a lower energy level, what happens?
    - (A) A photon is emitted whose wavelength is such that the photon energy is exactly equal to the difference in the energy levels of the electron before and after its transition.
    - (B) A photon is absorbed whose wavelength is such that the photon energy is exactly equal to the difference in the energy levels of the electron before and after its transition.
    - (C) By Newton's third law, the nucleus of the atom recoils and the atom ends up moving in a different direction.
    - (D) Answer C is correct but incomplete: In addition, the atom moves more slowly, and this (slightly) decreases the temperature of the gas.

43. The spectrum of a nebula that contains lots of dust and that is illuminated from far away by red supergiant stars shows mainly
    - (A) emission lines.
    - (B) absorption lines.
    - (C) blue reflected light from the illuminating stars.
    - (D) none of the above.

44. A protostar – a star that is still forming – is
    - (A) not yet emitting light.
    - (B) moving up the main sequence in the Hertzsprung-Russell diagram as its mass increases.
    - (C) shrinking in size and, in general, increasing in temperature.
    - (D) not yet powered by nuclear reactions, becuase it does not yet contain the proper fuel (that is, hydrogen).

45. How far away is the nearest star, not counting the Sun?
    - (A) 8 light minutes
    - (B) hundreds of light hours
    - (C) 4.2 light years
    - (D) about 500 light years, in the Orion Nebula

46. Near the Sun, the most common stars are
    - (A) spectral type K giants.
    - (B) A-type white dwarfs.
    - (C) M-type red dwarfs.
    - (D) stars just like the Sun.

47. Near the Sun, which of these kinds of stars are the least common?

(A) red giants
(B) O-type main sequence stars
(C) M-type main sequence stars
(D) white dwarfs

48. What will be the most common kind of star in the Orion Nebula cluster immediately after its gas cloud has finished making stars?

(A) main-sequence G stars just like our Sun
(B) main-sequence M stars much tinier than our Sun
(C) red giant and red supergiant stars
(D) white dwarf stars

49. What will be the least common kind of star in the Orion Nebula cluster immediately after its gas cloud has finished making stars?

(A) main-sequence G stars just like our Sun
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(C) red giant and red supergiant stars
(D) white dwarf stars

50. Our Sun is mostly made of

(A) carbon.
(B) hydrogen.
(C) oxygen.
(D) helium.

51. When our Sun evolves off of the main sequence, it will be mostly made of

(A) carbon.
(B) hydrogen.
(C) oxygen.
(D) helium.

52. The most abundant element in the Universe is

(A) carbon.
(B) hydrogen.
(C) oxygen.
(D) helium.

53. What fuels our Sun's enormous energy output?

(A) conversion of hydrogen to helium via the "proton-proton cycle" of nuclear reactions
(B) conversion of hydrogen to helium via the "carbon cycle" of nuclear reactions
(C) nuclear reactions that convert helium to carbon in its core.
(D) nuclear fission of unstable heavy elements such as uranium.

54. Sunspots

(A) are dark.
(B) are hotter than the rest of the surface of the Sun and make aurorae (e. g., northern lights) on Earth when they emit energetic particles.
(C) are only slightly fainter than the rest of the Sun's surface, because they are slightly cooler than the rest of the surface.
(D) vary periodically with time, rising and falling in numbers on a 30-day cycle.

55. Energy produced in the core of the Sun escapes from the core

(A) by radiation.
(B) by convection.
(C) both of the above
(D) neither of the above

56. Near the surface of the Sun, energy produced in the core escapes <u>mainly</u> by

(A) by radiation.
(B) by convection.
(C) both of the above
(D) neither of the above

57. When the least luminous M stars die, what will they turn into?

(A) white dwarf
(B) neutron star
(C) black hole
(D) supernova

58. Our Sun is 4.5 billion years old. When and how will it die?

(A) The answer is not known.
(B) In 4 – 5 billion years, it will swell enormously and become a giant star; then it will puff off its outer envelope as a planetary nebula.
(C) It will explode as a supernova in about 5 billion years.
(D) It will fade gradually, moving down the main sequence toward lower temperatures as its fuel runs out.

59. As it evolves, how big will the Sun get?
    (A) no bigger than it is now
    (B) about as big as the radius of Earth's orbit
    (C) about as big as the radius of Jupiter's orbit
    (D) infinitely big – it will blow up

60. Solar flares emit lots of high-energy charged particles. When they get to the Earth,
    (A) they do nothing noticeable or important.
    (B) they cause aurorae – the northern and southern lights.
    (C) they can kill people who are too near the north or south poles, where the Earth's magnetic field does not deflect the particles and thereby protect the people.
    (D) both B and C

61. Are the physical properties of the Sun (mass, age, temperature, etc.) unusual?
    (A) Yes.
    (B) No.

62. I observe two star clusters. Each contains one Cepheid variable, and the two Cepheids have the same measured pulsation period. I conclude that
    (A) the two clusters must be at the same distance.
    (B) the apparent magnitudes of the two Cepheids must be the same.
    (C) the absolute magnitudes of the two Cepheids must be the same.
    (D) the parallaxes of the two clusters must be the same.

63. Which of these reactions produces the **most** energy per unit mass of fuel?
    (A) burning of hydrogen in oxygen to make water
    (B) fusion of silicon to make iron
    (C) fission of uranium in an atomic bomb
    (D) fusion of hydrogen to make helium

64. Which of these reactions produces the **least** energy per unit mass of fuel?
    (A) burning of hydrogen in oxygen to make water
    (B) fission of iron to make aluminum
    (C) fission of uranium in an atomic bomb
    (D) fusion of hydrogen to make helium

65. What properties of stars decrease from M stars to O stars along the main sequence?
    (A) their size
    (B) their mass
    (C) their lifetime
    (D) their temperature
    (E) all of the above

66. The star Rigel has a spectral type of B8. The Sun is a G2 star. You can conclude that

    (A) Rigel is hotter than the Sun.
    (B) Rigel is the same temperature as the Sun, but it is more luminous.
    (C) Rigel is cooler than the Sun.
    (D) Rigel is older than the Sun.

67. A red giant star is

    (A) a post–main-sequence star that is burning hydrogen in a shell around a helium core.
    (B) a distant bright star that is reddened by dust.
    (C) a star that is forming and therefore still reddened by dust.
    (D) at the low-mass (cool) end of the main sequence.

68. Which answer lists main sequence stars that die, respectively, as white dwarfs, neutron stars, and stellar-mass black holes?

    (A) 1 solar mass stars, 15 solar mass stars, 50 solar mass stars
    (B) the Sun, either star in a typical binary star system, a red giant star
    (C) an old star, a typical star that we see in our night sky, a young star
    (D) the brightest stars in the Orion nebula, a typical star that is forming now, a typical star that we now see in a globular cluster

69. Two white dwarf stars both have masses less than one solar mass. How does the more massive white dwarf compare to the less massive one?

    (A) It is bigger, because mass is proportional to volume, and volume is proportional to $(\text{radius})^3$.
    (B) It is the same size. White dwarf size does not depend on mass.
    (C) It is smaller, because more mass results in stronger gravitational forces and these compress the star more.
    (D) Not enough information if given to answer the question.

70. What property is similar for all red giant stars?

    (A) their size
    (B) their mass
    (C) they have exhausted their fuel supply of hydrogen near their centers
    (D) all of the above

71. The best wavelength at which to look for stars that are forming now from dust and gas is

    (A) X-rays – at the end of their collapse phase, protostars are very hot.
    (B) ultraviolet light – the most massive protostars give off a lot of UV photons.
    (C) visible light – protostars form very bright clusters.
    (D) infrared light – protostars are shrouded by dust that heats up and emits infrared radiation. Also, at these wavelengths we can see through the surrounding dust.

72. Two stars have the same spectral type. One star has much stronger absorption lines than the other star. Therefore

(A) it is cooler than the other star.
(B) it is younger than the other star.
(C) it has a higher abundace of heavy elements than the other star.
(D) Not enough information is given to answer the question.

73. Sirius, the apparently brightest star in the sky after our Sun, has a surface temperature of about 10,000 °K – it is white hot – and it is 22.5 times more luminous than our Sun. Its compantion star has almost the same surface temperature, but it is only 0.25 % as luminous as our Sun. How can it be so faint?

(A) It is on the far side of its orbit around Sirius as seen from the Earth.
(B) It is much younger – stars get more luminous as they form, and it is not finished forming.
(C) It is much smaller in size.
(D) none of the above

74. The hottest stars do not contain spectral lines from molecules like carbon dioxide. Why?

(A) They are too hot: carbon dioxide is broken up into carbon and oxygen.
(B) They are too hot, so they can't make spectral lines at all. They have continuous spectra, like incandescent light bulbs.
(C) They are the most massive stars, and these have burned carbon and oxygen into heavier elements.
(D) The question is wrong: such stars do show spectral lines from CO_2.

75. Which of these sequences of spectral classes lists stars in order from **coolest** to **hottest**?

(A) ABFGKMO
(B) OBAFGKM
(C) OMKGFBA
(D) MKGFABO

76. The Hertzsprung-Russell or HR diagram is a plot of

(A) stellar luminosity versus stellar surface temperature.
(B) stellar mass versus surface temperature.
(C) stellar luminosity versus mass.
(D) stellar age versus luminosity.

77. The Hertzsprung-Russell diagram is very useful to astronomers. Why?

(A) It illustrates how the lifetime of a star depends on its mass and composition.
(B) It is a convenient way to show how a star's temperature and absolute magnitude evolve through the star's life.
(C) It provides an explanation of how binary stars are used to measure the properties of stars.
(D) It tells us which stars die by becoming white dwarfs or neutron stars or black holes.

78. Which of these statements about a main sequence star is true?

(A) The lifetime of a star on the main sequence is very long – about 10 billion years.

(B) The main sequence phase of a star's life lasts until all of the hydrogen in its core has been converted into helium.

(C) Stars' masses, luminosities, lifetimes, temperatures, and radii all decrease along the main sequence from O to M.

(D) None of the above

79. Hydrogen "burning" over the main sequence lifetime of the Sun lasts for about

(A) one million years.

(B) ten million years.

(C) one billion years.

(D) ten billion years.

80. The rate at which a star evolves in any portion of the HR diagram is determined by its

(A) rate of rotation.

(B) magnetic field strength.

(C) mass.

(D) color.

81. Suppose that a main sequence star temporarily shrinks slightly and gets hotter inside. What would happen?

(A) Nuclear reactions in the core would speed up more and more until the star explodes.

(B) It would move up the main sequence toward higher temperatures.

(C) Nuclear reactions in the core would speed up and increase the energy output, thereby increasing the pressure. The star would expand, cool, and bring nuclear reactions back to their normal rate.

(D) The star would begin to pulsate in radius and luminosity and become a Cepheid variable.

82. A planetary nebula is

(A) a gas cloud pushed away from the atmosphere of a planet by the solar wind.

(B) a gas cloud about to make a planet.

(C) a gas cloud left over after a supernova explosion.

(D) a gas cloud emitted by a star while it is a red giant.

83. Astronomers discover a cluster of stars; they measure its stars and plot a Hertzsprung-Russell diagram. It shows that the cluster contains main sequence stars whose spectral types include K and M. What kind of stars does the cluster **not** contain?

(A) 25 $M_\odot$ main sequence stars

(B) stars like our Sun

(C) 0.6 $M_\odot$ white dwarfs

(D) The cluster contains all of the above types of stars.

84. Consider a 100-$M_\odot$ single star that formed at the same time as our Sun. What has that star evolved into now?

(A) an unusually massive white dwarf star

(B) a red giant star

(C) It is still a 100-$M_\odot$ main sequence star.

(D) a black hole

85. How long does a 10 $M_\odot$ star live?

(A) about 3000 years

(B) about 30 million years

(C) about 10 billion years

(D) about 1000 billion years

86. Now long does a white dwarf shine?

(A) It doesn't – it only reflects light that shines on it.

(B) It shines for about 10 billion years as it cools off.

(C) It shines almost forever as it cools slowly to the temperature of the background radiation that fills the Universe.

(D) Not enough information is given to answer the question.

87. What will happen to the Earth as the Sun ages over the next 4 – 5 billion years?

(A) Global temperatures will not change very much, because stars are "thermostatted" so nuclear reaction rates don't change very much.

(B) The Earth will get slowly cooler as the nuclear fuel that powers the Sun slowly runs out.

(C) The Earth will get hotter as the Sun evolves into a red giant star.

(D) The Earth will be toast when the Sun goes supernova.

88. After the main sequence life of a star is over, what is its most long-lasting remaining fuel source?

(A) fusion of hydrogen to helium

(B) fusion of helium to carbon

(C) fusion of silicon and similar elements to iron

(D) It no longer has any fuel that can power nuclear reactions.

89. What kind of star is held up by degeneracy pressure?

(A) Rock music star

(B) White dwarf

(C) Neutron star

(D) Both B and C

90. What is the Chandrasekhar limit?

(A) It is the limiting radius that a white dwarf can have – all white dwarfs must be smaller than a radius than roughly the Earth's radius.

(B) It is the limiting mass that a white dwarf can have – all white dwarfs must be less massive than about 1.4 times the mass of our Sun.

(C) It is the lowest mass of star that can become a white dwarf when it dies – about 8 times the mass of the Sun.

(D) It is the lowest mass that a star can have and be hot enough inside for nuclear fusion reactions.

91. Why are moderately massive atomic nuclei (like carbon) more stable than the lightest atomic nuclei (like helium)?

(A) They are small enough so that all (or almost all) of the particles are closer together than the strong nuclear force. If you add a particle to make the nucleus heavier, it attracts all the other particles via the strong nuclear force, and this attraction wins out more strongly over the electromagnetic repulsion between the positively charged protons.

(B) Adding more nuclear particles (either protons or neutrons) always makes the nucleus more tighly bound or "stable", because they attract each other via the strong nuclear force.

(C) More particles attract each other more strongly via gravity.

(D) A heavier nucleus has more protons in it, and therefore a heavier atom also has more electrons to keep the total charge neutral. More protons and more electrons attract each other more strongly via the electromagnetic force, so the result is more tightly bound or "stable" than a lighter atom or nucleus.

92. The Orion Nebula is currently forming new stars in a vigorous starburst. The first stars that die will leave behind what kind of remnant?

(A) a neutron star

(B) a black hole

(C) a white dwarf

(D) nothing

93. The Orion Nebula is currently forming new stars in a vigorous starburst. The last stars that die will leave behind what kind of remnant?

(A) a neutron star

(B) a black hole

(C) a white dwarf

(D) nothing

94. When a high-mass star dies as a supernova, what is its core made of?

(A) helium

(B) carbon

(C) iron

(D) uranium

95. When high-mass stars die as supernovae, most of the energy comes out as

(A) kinetic energy of the expanding gas cloud.
(B) gamma rays.
(C) x-rays.
(D) neutrinos.

96. The supernova explosion in 1054 AD which gave rise to the Crab Nebula also produced a stellar remnant from which we detect pulsations at optical and radio wavelengths. This is

(A) a rotating neutron star.
(B) a rotating white dwarf.
(C) a spinning black hole that is accreting matter.
(D) a bipolar outflow nebula.

97. Suppose that the surface temperature of Star A is 2 times the surface temperature of Star B. Meanwhile, Star B has 4 times the radius of Star A. Which star is more luminous and by how much?

(A) Star A is more luminous by a factor of 16.
(B) Star A is more luminous by a factor of 4.
(C) Star A and Star B have the same luminosity.
(D) Star B is more luminous by a factor of 4..

98. Stars C and Star D have the same luminosity. Star C has the same surface temperature as the Sun. Star D is hotter by a factor of 5. Therefore

(A) Star D looks blue.
(B) Star D looks similar in color to the Sun.
(C) Star D looks slightly redder than the Sun.
(D) Star D is so red that it is almost invisible.

99. Consider the two stars in the previous question. We can also conclude that

(A) Star D has 5 times the radius of Star C.
(B) Star D has the same radius as Star C.
(C) Star D has 1/5 the radius of Star C.
(D) Star D has 1/25 the radius of Star C.

100. What is the most abundant element in a star that has just formed?

(A) hydrogen
(B) helium
(C) iron
(D) It depends on the history of supernova explosions that enriched the gas that made the star with heavy elements.

101. Uranium

(A) was manufactured by nuclear reactions in the stable cores of high-mass stars.
(B) was manufactured via nuclear reactions in supernova explosions.
(C) was manufactured by the Big Bang – the explosive origin of the Universe.
(D) was already part of the Universe when the Universe was created.

102. Which of these processes can cause a supernova?

(A) Two stars collide in a dense star cluster.
(B) As the core temperature in a massive star rises, energy-producing nuclear reactions go faster and faster until the star explodes.
(C) Gas dumped onto a white dwarf by a companion star raises its mass above the Chandrasekhar limit of 1.4 $M_{\odot}$. The white dwarf collapses.
(D) If a star tries to form with a mass more than about 100 times the mass of our Sun, then the central temperature gets so high that the star blows up. That's why the main sequence stops at about 100 $M_{\odot}$.

103. What is left after a supernova explosion?

(A) Nothing. The star is always blown completely apart.
(B) A black hole, a neutron star, or a white dwarf, depending on the mass of the star
(C) Supernovae always make pulsars.
(D) A black hole, a neutron star, or a cloud of expanding hot gas, depending on the type of supernova explosion and on the mass of the star.

104. Why do neutron stars spin so rapidly?

(A) They are the smallest stars. Conservation of angular momentum makes the core of a star spin faster as it shrinks.
(B) Among stable stars, they have the highest surface gravity. This means that they can spin rapidly without flying apart.
(C) Their solid surfaces are stiff enough to support very rapid rotation.
(D) Only A and B but not C.

105. Which statement is **wrong**?

(A) The only properties of a black hole are mass, amount of spin, and electric charge.
(B) The most massive stars die as black holes with masses of $\sim 4-10$ times the mass of our Sun.
(C) If there is a black hole at the center of our Galaxy, it will eventually swallow the rest of our Galaxy. But this will take longer then the present age of the Universe.
(D) Astronomers believe that stellar-mass black holes are common in galaxies.