Astronomy—All Questions

White Dwarfs/Planetary Nebulae/Massive Stars/Neutron Stars/Black Holes

<u>Instructions</u>: This Quest is in the form of multiple-choice questions and a few fill in the blanks. Written responses must be spelled correctly. After reading each question carefully, select your answer or answers. **If the question calls for multiple answers, two or more, you must provide all correct answers.** Because of this, I will give you two attempts to take the test. Consider this open book. All answers can be found in Crash Course Astronomy, the lecture materials created for class which includes vocabulary, the assigned exercises, and the PowerPoint presentations; but if you feel the need to consult online sources, books, or magazines, please feel free to do so. Keep in mind that astronomy is an exact science, but there are many theories in competition. This Quest has a total value of 30 points. **<u>MUCH SUCCESS</u>!!!**

1. When astronomers talk about a star "burning" hydrogen into helium, they are referring to _______________.
   a. a process where the oxygen of the star goes into a chemical reaction with the hydrogen to produce energy and water vapor which then dissociates to form hydrogen and oxygen for more combustion. It's called the Hydrogen-Oxygen-Hydrogen cycle.
   b. a contractive, compressional process where the star's hydrogen supply gets pulled closer to its core by the star's tremendous gravity releasing copious amounts of energy.
   c. a thermonuclear process similar to, but not exactly like, the events that make a hydrogen bomb so deadly.
   d. Einstein's general field equations governing most of the operating mechanisms in the universe, such as the forces creating inertial motions are indistinguishable from the force of gravity.

2. A star is a balancing act. What are the two opposing forces that keep stars from collapsing or exploding when they are in hydrostatic equilibrium?
   a. centripetal force and the electron degeneracy force.
   b. hydrostatic force and gravity.
   c. centripetal force and the pressure of hot gasses.
   d. gravity and the electron degeneracy force.
   e. gravity and the pressure of the energy being created.

3. What is the total life span of the Sun expected to be?
   a. about 2-3 million years
   b. about 12 million years
   c. about 5-6 billion years
   d. about 10-11 billion years.
   e. about a half-trillion years.

4. As the sun ages, more and more helium will become compressed into the sun's core. It will settle to the center of the core causing it to become _______________. On the H-R diagram the sun moves to the right and up.
   a. less dense and much hotter.
   b. less dense and much cooler.
   c. The helium is transported to the star's surface where it radiates its energy into space.
   d. denser and therefore much hotter.
   e. denser and definitely cooler.

5. Currently, the Sun is fusing _______________ into ________________ in its core. After the core becomes inert (nonreacting) but much hotter, ________________ burning will initiate in a shell surrounding the core.
   Possible answers… Answers can be used more than once or not at all.
   A. energy; **B.** gravity; **C.** carbon; **D.** lithium; **E.** helium; **F.** hydrogen; **G.** oxygen
   a. E, F, E
   b. F, F, E
   c. E, E, F
   d. F, E, F

6. Eventually, if the interior of the sun reaches 100,000,000 K the sun will begin fusing ________________ into ________________ (principal element here). A star like the sun, or any star for that matter, is really a balancing act between the outward pressure of the ________________ being produced and its ________________ which results from its mass trying to collapse the star. A star that is balanced is in hydrostatic equilibrium.
   Possible answers… Answers can be used more than once or not at all.
   A. energy; **B.** gravity; **C.** carbon; **D.** lithium; **F.** helium; **G.** hydrogen; **H.** oxygen
   a. F, C, F, G
   b. C, F, A, G
   c. F, C, A, B
   d. G, C, A, B

7. When the sun runs out of hydrogen in its core ________________.
   a. it will begin to fuse helium into carbon in its core.
   b. it will begin to fuse helium into oxygen in its core.
   c. it will begin to fuse helium into neon in its core.
   d. it will begin to fuse hydrogen outside of the core in a thin shell.

8. As the Sun grows many times its current size, it will be classified as _______________.
   a. a subgiant.
   b. a giant.
   c. a solar giant.
   d. a supergiant.
   e. a hypergiant.

9. If helium fusion begins in the sun's core, our daystar will bloat up to 10 to 150 times its present size, and it will be classified as _______________.
   a. a red subgiant.
   b. a red giant.
   c. a red solar giant.
   d. a red supergiant.
   e. a red hypergiant

10. At some point, after becoming a red giant, the sun's core may become hot enough, 100 million K, to begin fusing helium into ______________.
    a. carbon.
    b. silicon.
    c. sodium.
    d. iron.

11. When fusion has stopped in the sun's core and the sun has "blown off" its outer layers, it will be classified as a ______________.
    a. white dwarf.
    b. red dwarf.
    c. white subgiant.
    d. red subdwarf.
    e. planetary nebula.

12. Near the end of the life of a low mass star, possibly even the sun, the shell burning around the core will become more and more unstable. The star will begin to pulsate, losing even larger quantities of matter than in the earlier red giant phase of its existence. Eventually, these pulsations will become so great that shells of gas will be pumped into space causing a (an) _______________.
    a. exoplanet to be formed.
    b. dwarf nebula to be created.
    c. supernova to initiate.
    d. event horizon.
    e. planetary nebula to form.
    f. cumulonimbus cloud to form around the star.
    g. instability cloud.
    h. supernova remnant.

13. Referring to the last question, the gases surrounding the dead star's hot core are made to glow because ultraviolet radiation emitted from the core _______________.
    a. reflects its light back into space allowing us to see it.
    b. causes the gases surrounding the star to fluoresce or glow.
    c. disperses the light energy of this star back into space, causing the gases to glow in different spectral colors, such as reds, blues, and greens.
    d. forward scatters the light similar to small ice particles in orbit around the planet Saturn.

14. As the sun expands, it will lose a great deal of its mass, causing the Earth to
    a. move towards the sun into a smaller, tighter orbit.
    b. move away from the sun, into a larger orbit.
    c. one hemisphere towards sun as it rotates and orbits in the same period.
    d. move away from the sun because of the decrease in the sun's gravity. Earth's motions will rapidly become tidally locked with the sun.

15. Once helium fusion stops in a low mass star, and shell burning is initiated around the core, the dominate force supporting the inert, nonreacting core from collapsing any farther will be ______________.
    a. neutron degradation pressure.
    b. photon depravity pressure.
    c. electron degeneracy pressure.
    d. positive proton pressure
    e. the pressure exerted by neutrinos.

16. When the sun's core has contracted to about the size of the Earth (about 10,000 miles in diameter) it will be classified as _______________.
    a. a white dwarf.
    b. a blue dwarf.
    c. a white subgiant.
    d. a blue subdwarf.

17. Referring to the last question, the location of this star on the Hertzsprung-Russell diagram would be (Two answers here)
    a. above
    b. below
    c. in the center
    d. right
    e. left

18. A single cubic centimeter of a white dwarf, about the size of a six-sided die, has a mass of _______________ Hint: There are 1000 grams/kilogram and 1000 kilograms/metric ton.
    a. a thousand grams — ten metric tons.
    b. a million grams — ten metric tons.
    c. a thousand grams — one metric ton.
    d. a million grams — one metric ton.

19. If you have a mass of 60 kg (132 pounds), and you stood on the surface of a white dwarf, you'd weigh _______________
    a. 132 pounds.
    b. 1320 pounds.
    c. 13,200 pounds.
    d. 132,000,000 pounds.
    e. Who cares! You'd be an ionized glob of slime gas in a New York second.

20. Because white dwarfs are incredibly hot, but are very small, color wise and brightness wise they are actually _______________. **Two answers are correct** and both must be provided for full credit.
    a. not always white.
    b. quite cool.
    c. bright
    d. quite faint.
    e. quite luminous.

21. Some planetary nebulae look like soap bubbles, which is what you'd expect when you look at _______________.
    a. a contracting shell of glowing gas if the gravitational source is much greater than expected.
    b. an expanding shell of glowing gas not under the influence of any additional gravitational forces.
    c. an expanding shell of dust reflecting the light from the dead star.
    d. an expanding shell of dust scattering the light from the dead star.
    e. a contracting shell of dust if the dead star becomes a black hole.

22. The structure of planetary nebulae come in all shapes that can be seen by amateur astronomers with relatively small telescopes and in more detail when imaged in different wavelengths of light. These different shapes tell us something about the region of space around these dying stars. Which one is **NOT** acceptable as a reason?
    a. Black holes swallow the dying star.
    b. Planets in orbit around the dying star are engulfed by the expanding shells of gases.
    c. The nonsymmetrical shape of some planetary nebulae speaks to the fact that the formation of the cloud results from differing amounts of outward force or the additional influence of external gravitational forces.
    d. The dying star was part of a double or multiple star system which churned up the gases.
    e. Magnetic fields sculpt (shape) the way material is ejected into jets.

23. The different colors of planetary nebulae that can be seen in long exposures result from the different ________________ of the gases which make up the nebula. Composition

24. The human eye is most sensitive in the region of the visible spectrum which the sun most commonly produces. This area is in the ________________ part of the visible spectrum.
    a. red.
    b. orange.
    c. yellow.
    d. green.
    e. blue.
    f. violet.

25. When viewing a bright planetary nebula through a telescope, it most often has a _____________ hue. Green

26. How long can the glowing gases of a planetary nebula be seen, before they fade?
    a. several centuries.
    b. a few thousand years.
    c. a few million year.
    d. a few billion years.

27. The Proton-Proton cycle (hydrogen fusion) makes helium plus energy. The "Triple-alpha" helium fusion creates _______________ plus energy.
    a. lithium.
    b. boron.
    c. carbon.
    d. sulfur.
    e. oxygen.

28. Carbon will begin to fuse in the cores of _______________. Choose the most appropriate general answer that is correct.
    a. stars that have an approximate mass greater than about four to five times the sun's mass.
    b. low mass stars residing in the middle to the lower right of the H-R diagram.
    c. stars which have masses greater than about nine times the sun's mass.
    d. high mass stars residing on the upper left of the H-R diagram.
    e. stars about 18-20 times the sun's mass.
    f. stars about 40-50 times the sun's mass.

29. A very massive star continues to change hydrogen into helium, helium into carbon, and carbon into heavier and more complex elements until the central core is fusing silicon into _______________.
    a. calcium.
    b. cadmium.
    c. iron.
    d. lead.
    e. uranium.

30. Use the Hertzsprung-Russell diagram as a basis for your answer. When a massive, main sequence star nears the end of its life and moves upwards and to the right, or if supermassive, along a horizontal line to the right, it becomes a _______________ star.
    a. red dwarf.
    b. blue dwarf.
    c. blue giant.
    d. red subdwarf.
    e. blue supergiant.
    f. red supergiant.

31. Which two luminous, bright, reddish stars that we can easily see from mid-latitudes are very near the end of their lives? They are both red supergiants. A little research may have to be done here. Both answers must be provided to receive credit.
    a. Rigel.
    b. Betelgeuse.
    c. Spica.
    d. Hind's Crimson Star.
    e. Bellatrix.
    f. Saiph.
    g. Proxima Centauri A.
    h Antares.

32. VY Canis Majoris, one of the largest known hypergiant stars, is about two billion km in diameter. If placed in the middle of the solar system, this star would extend just past the planet _______________. Hint: There are 1.6095 kilometers (km)/mile. How many miles or kilometers does an AU have?
    a. Mercury.
    b. Venus.
    c. Earth.
    d. Mars.
    e. Jupiter.
    f. Saturn.

33. The core of a supergiant star looks like an onion, a series of shells or layers _______________. This question has **TWO** answers which must both be correct to receive credit.
    a. where different types of thermonuclear fusion are occurring.
    b. of thermonuclear fusion which are essentially unrelated to each other.
    c. which in total are nearly the same diameter as the star.
    d. where at the very last stage of the star's energy production, silicon may be collecting in the stars center.
    e. in the core of the star which is very small compared to the diameter of the star that it is supporting.

34. The sun can fuse hydrogen into helium for a long, long time, while a star twice as massive as the sun runs out of hydrogen _______________.
    a. in a shorter period of time because fuel consumption in the core happens at a much faster pace than in the core of a solar mass star.
    b. in the same amount of time since core fuel consumption occurs at double the rate of the sun. Double the mass and the star doubles the rate of hydrogen fusion in its core.
    c. in a longer period of time, since the mixing of hydrogen with the core is more efficient than in the sun, and almost all of the hydrogen in the star is consumed, allowing the star to maintain its energy production for a longer period of time.

35. In high mass stars that are near the very end of their lives, the fuel burning that occurs in each successive layer deeper into the star's core occurs at a ________________ rate producing less energy. Hint: Think duration here.

36. In its creation, which element, will eventually remove energy from a star's core in order to fuse its material into heavier elements? In other words, this element ________________ requires energy to be imputed into the core in order for heavier elements to be formed. What is the name of that element?

37. In the death throes of a star that has less than 20 times the sun's mass, the final object that is created is _______________.
    a. a white dwarf.
    b. a neutron star.
    c. a supernova.
    d. a black hole.
    e. a red dwarf.
    f. a planetary nebula.

38. As the core collapses, a star that has a mass approximately 20 or more times greater than the sun's mass has a good chance of finally ending up as _______________.
    a. a planetary nebula.
    b. a widget star.
    c. a black hole.
    d. a neutron star.
    e. a supernova.
    f. a red dwarf.

39. In general terms, when a massive star dies, the event that brings an end to a star's fusion life is ________________.
    a. the collapse of the core.
    b. a sudden release of neutrinos.
    c. a supernova.
    d. the release of visible light.
    e. electrons being forced into extreme bondage with their proton brothers.

40. The collapse of a star's core generates vast numbers of elusive subatomic particles called _______________ which have almost no possibility of interacting with matter at normal densities. During core collapse, matter is squeezed to such high densities that these subatomic particles play a major role in lifting and accelerating the star's inner layers. This lowers the density of the material to allow these particles which possess vast amounts of energy to be released. Before a star's explosion can been detected from Earth, a large number of ________________ are detected. Spelling counts in Canvas tests, so make sure you've got the word spelled correctly or it will not be recognized.

41. The expanding Crab Nebula, M1, seen below is an excellent example of a ________________ which can be observed from our Northern Hemispheric winter sky. It is found in the constellation of Taurus the Bull (TWO words).

a. a cometary nucleus.
b. a planetary nebula.
c. blue giant.
d. a supernova remnant.
e. a filament cluster.

42. Exploding stars within the distance of ________________ light years could damage the Earth's environment, but not cause life to cease as we know it. Write your answer as a number (numeral) in magnitudes of 10, i.e. 1, 10, 100, 1000, etc.

43. The creation of heavier elements during a supernova explosion or for that matter during the life of a star on the main sequence is called _______________.
a. nucleoamalgamation.
b. fusion amalgamation.
c. nucleosynthesis.
d. shitstormexplosion.
e. nuclear coalescence.

44. We owe our very existence to the heavier elements that were created in the "bellies" of stars when they went ________________ in the past. In fact, our sun is considered to be a second or third generation star.

45. In the beginning after the big bang (big pop), the universe was basically composed of just two elements _______________ and _______________. There are **TWO** answers that will be acceptable, and both must be given to receive credit.
    a. lithium.
    b. carbon.
    c. hydrogen.
    d. nitrogen.
    e. helium.

46. The two general types of objects created by supernovae are ______________.
    a. neutron stars and pulsars.
    b. neutron stars and black holes.
    c. white dwarfs and neutron stars.
    d. remnants and pulsars.
    e. reflection nebulae
    f. pulsars and magnetars.
    g. magnetars and black holes.
    h. white dwarfs and black holes.
    i. fluorescing nebulae.

47. Current theory proposes that a supernova resulting from the core collapse of an 30-40 solar mass star results in the formation of a ______________.
    a. white dwarf.
    b. plasma star.
    c. dark core star.
    d. black hole.
    e. neutron star.

48. In solar type stars and stars of even lower masses, the end result after thermonuclear fusion has stopped may be an inert (nonreacting) helium core called a _______________ which supports itself through a process called electron degeneracy pressure. In other words, matter is squeezed so tightly that the electrons actually hold up the star from further collapse because _______________. Provide **TWO** correct answers or you do not get full credit.
    a. similar charges repel.
    b. neutron star.
    c. black hole.
    d. energy pushes outward.
    e. photon pressure.
    f. white dwarf.

49. Pulsars were first detected in the 1960's by astronomers using a (an) _______________ telescopes.
    a. optical telescope.
    b. radio telescope.
    c. gamma ray satellite.
    d. X-ray satellite.
    e. infrared satellite.

50. White dwarf stars have limiting masses of about 1.44 times the amount of matter that the sun contains before electron degeneracy pressure fails. They then evolve into something else. Based upon the information provided in the last problem, pick the core mass which you believe would produce the white dwarf of the smallest diameter.
    a. 0.79 times the mass of the sun.
    b. 0.99 times the mass of the sun.
    c. 1.05 times the mass of the sun.
    d. 1.25 times the mass of the sun.
    e. 1.40 times the mass of the sun.
    f. 1.65 times the mass of the sun.

51. A star of 15 solar masses that goes supernova has a remaining core of about 6.5 miles (10 km) in diameter. That remaining mass is basically composed of ________________.
    a. plasma.
    b. neutrinos.
    c. nucleosynthetides.
    d. protons.
    e. neutrons.
    f. quarks.

52. Which one of the following particles (real or imagined) produces no outward pressure or charge to help sustain, slow, or reverse the collapse of matter?
    a. nucleosynthetides.
    b. neutrinos.
    c. photons (electromagnetic energy).
    d. electrons.
    e. neutrons.
    f. protons.

53. What is the name of the force when neutrons strongly resist being squeezed tightly together?
    a. electron degeneracy pressure.
    b. neutron degeneracy pressure.
    c. proton scattering.
    d. neutron degradation pressure.
    e. atomic abasement pressure.

54. Which one of the following subatomic particles has the least chance of interacting with or passing through matter which has a high density (mass/unit volume)?
    a. nucleosynthetides.
    b. neutrinos.
    c. photons (light).
    d. nonneutral matter.
    e. neutrons.
    f. protons.

55. Which subatomic particle is most responsible for blasting the layers of a supernova into space, aided by the shock wave that the dying produces?
    a. nucleosynthesides.
    b. neutrinos.
    c. photons (light).
    d. radicals (nonneutral molecules).
    e. neutrons.
    f. protons.

56. Any neutron star about 6.5 km in diameter would have more mass than _______________. There are definitely multiple answers to this question, but no clue as to how many.
    a. the Earth.
    b. Mercury.
    c. Jupiter.
    d. the sun.
    e. the entire solar system.
    f. a white dwarf.

57. A single cubic centimeter of a neutron star has a mass equivalent to _______________.
    a. the total mass of every taxi and uber in New York City.
    b. the total mass of every car in California.
    c. the total mass of every human in California, Wyoming, Colorado, West Virginia, and New York.
    d. the total mass of every car and truck in the US.
    e. the total mass of every vehicle in the US, Canada, and Mexico.

58. Compared to Earth's surface gravity, how much stronger is the surface gravity of a typical neutron star?
    a. 1 million times stronger.
    b. 100 million times stronger.
    c. 1 billion times stronger.
    d. 100 billion times stronger.

59. Why do newly formed neutron stars complete several to hundreds of spins per second?
    a. The gravity from planets revolving around newly formed neutron stars help to accelerate them as well as the gases in their vicinity.
    b. Strong magnetic fields tend to transport energy into the slowly spinning neutron star causing it to rotate faster.
    c. As the core collapses and its radius decreases (angular), momentum is conserved and the star must spin faster. It is the same principal as an ice skater going into a pirouette (spin).
    d. It's all about $E = mc^2$. As the core collapses and vast amounts of energy are created, some of this energy goes into causing the star to spin faster.
    e. Stars in binary systems, where one star will eventually become a red giant and is close enough to the neutron star so that it can lose matter to the neutron star's gravitational pull, will cause the neutron star to spin faster over time.

60. Which astrophysicist noted below received the Nobel Prize for the discovery of rotating neutron stars in 1967? The answer may surprise you. Research this one.
    a. Neil deGrasse Tyson.
    b. Antony Hewish.
    c. Carl Sagan.
    d. Jocelyn Bell.
    e. Stephen Hawking.
    f. Diane Husic.

61. Rapidly rotating neutron stars almost always have very strong magnetic fields associated with them. If the magnetic field of the neutron star is not positioned parallel to the rotational axis of the star, then it will sweep around the rotating star like a beam of electromagnetic radiation coming from a lighthouse. If that beam sweeps past the Earth and is detected, astronomers generally call that object a
    a. black hole.
    b. magnetars.
    c. white dwarf.
    d. pulsar.
    e. white hole.
    f. supernova.

62. A rapidly rotating neutron star of let's say 3.6 solar masses is affected by centrifugal force which is outwardly directed. Over time as other forces cause the neutron star to spin more slowly, it could possibly turn into a _______________. Hint: Think of how spin could affect the force of gravity.
    a. planetary nebula.
    b. black hole.
    c. millisecond pulsar.
    d. high-rate pulsar.
    e. white dwarf.
    f. white hole.

63. A neutron star with an extremely small rotational period is called a _______________.
    a. planetary nebula.
    b. black hole.
    c. millisecond pulsars.
    d. high-rate pulsar.
    e. white dwarf.
    f. white hole.

64. Why are most pulsars never identified by astronomers?
    a. They lose their strong magnetic field as they spin more slowly.
    b. The neutron star is spinning in such a manner that the narrow jets of energy which are being giving off by the star are not in the proper orientation to sweep past the Earth.
    c. Pulsars are a relatively rare end product in the stellar evolution "game."
    d. Seriously all of these ideas are correct! I'm tired. It's time for bed.
    e. None of the above are valid answer except for e.

65. If a dying star's core is less than 1.4 times the mass of the sun, it becomes a _______________. Your spelling must be correct.

66. If a dying star's core is between 1.4 and 2.8 times the sun's mass, it becomes a _______________. Your spelling must be correct.

67. If a dying star's core is greater than 3.5 times the sun's mass, it should become a _______________. Your spelling must be correct.

68. The minimum mass of a star that will supernova and become a black hole is about ________________. Please understand that there is still some disagreement with this datum, but there is only one correct answer in the group.
    a. one solar mass.
    b. eight or nine solar masses.
    c. 12 solar masses.
    d. 20-60 solar masses.
    e. 100 solar masses

69 **Ripped Apart by Gravity**—Gary Gene Linney, 2015

I am holding nothing now,
it weighs me down like a spoonful of ________________ star.
Degeneracy Pressure holds me still,
holds me close….
…subdued by [the] Pauli Exclusion Principle.
the electrons of emotional collapse.
This Pressure holds me up
and I shine on alone.
I envy event horizons.

The type of star that Linney is describing in his poem of a lost love based upon the descriptors is a _________________. I could go for **TWO** correct answers here if you want full credit.

a. white dwarf.
b. black hole.
c. a subdwarf
d. white hole.
e. neutron star.

70. Linney envisions the event horizons as a means of ______________.
    a. offering a new beginning on the other side.
    b. making events in his life go backwards.
    c. ending his pain and suffering.
    d. being held in a prison of timelessness from his perspective.
    e. saying that black holes are still brighter than Linney's future.

71. If space mobsters threw me into a black hole to get rid of me, from the mobsters' perspective in their spaceship far away as they watched me move towards the hole, they would observe me ______________.
    a. die, ha-ha.
    b. approach the black hole forever.
    c. falling into the "rabbit hole," i.e., the black hole.
    d. finding God.
    e. turning blue as my oxygen tanks were depleted of air.
    f. smoking weed and having the best time of my life.
    g. turning bluer and bluer as the wavelengths of light reflecting from my body are collapsed by the huge gravitational pull of the black hole.

72. In order to escape the Earth's gravitational field, a rocket must be propelled to a velocity of about 11.2 km/s or 6.95 mi/s., but a black hole is different. There is no escape, because the escape velocity is ______________.
    a. greater than the speed of sound.
    b. greater than the speed of any conventional or future rocket that humans could design.
    c. greater than the speed of light.

73. The position around a black hole, where the escape velocity equals the speed of light, is called the ______________.
    a. observable boundary.
    b. event horizon.
    c. point of no return.
    d. progenitor's surface.
    e. Chandrasekhar limit.
    f. final countdown.

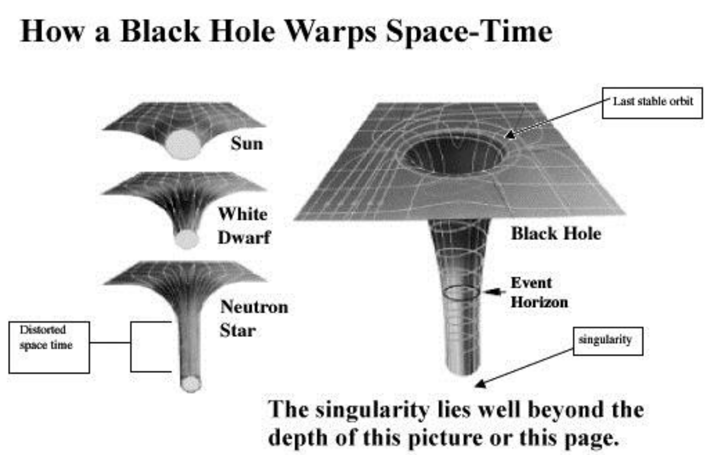
74. When the gravitational force between two objects is calculated, the mass of each object is ______________.
    a. assumed to be uniformly distributed throughout both objects.
    b. concentrated in the center of each object.
    c. assumed to be on the surface.
    d. assumed to be at the location which is determined to be the midpoint of that body's mass from center to surface.

75. Because the gravitational effects between two objects including a black hole vary directly as the mass of the objects divided by the inverse square of their distances; $F = m_1 \times m_2/d^2$; but $F = m_1 \times$ acceleration or ($a = m_{2\ \text{black hole}}/d^2$). This simply means that _______________.
    a. the distance from the black hole is the most important factor governing capture.
    b. the mass of the black hole is supreme.
    c. there is no escaping the deadly influence of a black hole.
    d. acceleration is paramount to escaping the influence of a black hole once the object is beyond the event horizon.
    e. acceleration is dependent upon m_1.
    f. no matter what happens, a black hole is like a vacuum cleaner, sucking in everything that comes near to it.
    g. the universe can be considered to be a black hole because there is no escaping it.

76. If you could instantaneously turn the sun into a black hole, then the Earth would _______________.
    a. get quickly pulled into the black hole.
    b. orbit it slower than it does now.
    c. orbit the black hole pretty much exactly as it does now.
    d. orbit the solar mass black hole faster than it does now since it was drawn closer towards the black hole by its inescapable gravity.

77. If the Earth got very close to a small black hole, let us say the mass of the sun,
    a. the Earth would be very rapidly pulled into the black hole.
    b. the Earth would be repelled by the radiation emitted by the black hole.
    c. the Earth would be repelled by the black hole's magnetic field.
    d. the Earth would get torn apart by the intense tidal forces acting on the planet.
    e. the Earth would get vaporized in the plasma jets of the black hole.

78. Space and time are intimately connected. They affect one another. Think of space and time as a huge elastic sheet of rubber that can easily be stretched, and the black hole with its mass squeezed into a volume of nothingness, putting a huge and deep dimple into the sheet, something like the following picture.



Find the **INCORRECT** statement from the perspective of a what a person would see in orbit around the black hole as he/she watched you drop into the hole.
a. you would simply drop through—all information lost forever.
b. your watch, digital or analog, would be ticking slower and slower.
c. your image would become redder and redder (color), then disappearing at the event horizon. Gravity stretches the wavelengths of light trying to escape causing them to redden.
d. you would be moving towards the black hole slower and slower.
e. you would follow the curvature of space-time which would bend towards the black hole.

79. Falling head first into a small black hole without having any orbital motion, you would feel the tidal forces of gravity pulling more strongly on your head than your feet. This would cause you to become stretched in the direction of the black hole and compressed in width in a painful and deadly process called _______________.
a. fettuccination.
b. the linguine effect.
c. drawn and quartered.
d. spaghettification.
e. googling.
f. drooling.

80. Black holes with masses ranging from about 3.5 to a few dozen solar masses are called _______________.
a. white dwarf black holes.
b. mini black holes.
c. event horizon black holes.
d. stellar-mass black holes.
e. dark matter black holes.

81. The black hole at the center of our own Milky Way galaxy _______________.
a. can be seen directly with instrumentation from Earth.
b. has a mass of 4 million times the sun's mass.
c. is actively ingesting large amounts of matter.
d. can be considered to be a large, massive black hole as galaxies go.
e. was recently formed.

82. At the event horizon of a black hole, time _______________.
a. slows to a crawl.
b. stops.
c. speeds up.
d. reverses itself and goes backwards.

83. When you're at the event horizon of a black hole, an outside observer would see the light coming from you infinitely stretched and you would _______________.
a. be blue-shifted.
b. be slightly blue-shifted.
c. disappear.
d. be slightly red-shifted.
e. be moderately red-shifted.

84. What is **INCORRECT** about the following pictorial representation of this black hole.

a. The matter falling into the black hole along the accretion disk is redder nearest to it.
b. The matter of the accretion disk is swirling around the black hole in a counter clockwise direction.
c. Matter is escaping from near the black hole in the form of a jet (white area).
d. Space-time dips into the hole and would not be present as part bubble type structure above the accretion disk.
e. Matter is not being googled as it enters the hole from its tidal forces.