

Crash Course Astronomy—All Questions

Lessons 31-32-33: Massive Stars/Neutron Stars/Black Holes

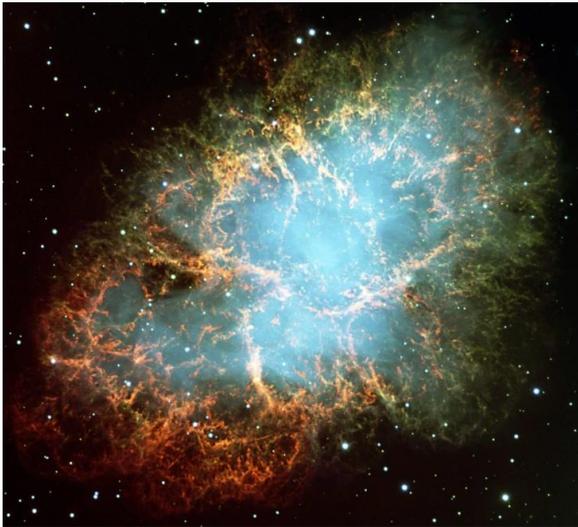
Canvas Instructions: This Quest is in the form of multiple-choice questions and a few fill in the blanks. Written responses must be spelled correctly. After reading each question carefully, select your answer or answers. **If the question calls for multiple answers, two or more, you must provide all 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. **MUCH SUCCESS!!!**

1. 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.
2. 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 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.
3. The Proton-Proton cycle (hydrogen fusion) makes helium. "Triple-alpha" helium fusion makes _____.
 - a. lithium.
 - b. boron.
 - c. carbon.
 - d. sulfur.
 - e. oxygen.

4. Carbon will begin to fuse in the cores of _____. Choose the most appropriate general answer that is correct.
- stars that have an approximate mass greater than about four to five times the sun's mass.
 - low mass stars residing in the middle to the lower right of the H-R diagram.
 - stars which have masses greater than about eight to nine times the sun's mass.
 - high mass stars residing on the upper left of the H-R diagram.
 - stars about 18-20 times the sun's mass.
 - stars about 40-50 times the sun's mass.
5. 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 _____.
- calcium.
 - cadmium.
 - iron.
 - lead.
 - uranium.
6. When helium fusion begins, a massive, main sequence star near the upper left of the Hertzsprung-Russell diagram will move upwards and to the right, or if supermassive, along a horizontal line to the right to become _____.
- a red dwarf.
 - a blue dwarf.
 - a blue giant.
 - a red subdwarf.
 - a blue supergiant.
 - a supergiant star.
7. Which two luminous, bright, red 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.
- Rigel.
 - Betelgeuse.
 - Spica.
 - Hind's Crimson Star.
 - Bellatrix.
 - Saiph.
 - Proxima Centauri A.
 - Antares.
8. 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?
- Mercury.
 - Venus.
 - Earth.
 - Mars.
 - Jupiter.
 - Saturn.

9. 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.
- where different types of thermonuclear fusion are occurring.
 - which are essentially unrelated to each other.
 - which in total are nearly the same diameter as the star.
 - where at the very end stage of the star's energy production, silicon may be collecting in the stars center.
 - in the core of the star which is very small compared to the diameter of the star that it is supporting.
10. The sun can fuse hydrogen for over ten or eleven billion years, while a star twice as massive as the sun runs out of hydrogen _____ .
- in a shorter period of time because fuel consumption in the core happens at a much faster pace than inside of a solar mass star.
 - 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.
 - 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.
11. 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 occurs at a _____ rate. Hint: Think duration here.
12. 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.
13. 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 white dwarf.
 - a neutron star.
 - a supernova.
 - a black hole.
 - a red dwarf.
 - a planetary nebula.
14. 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 planetary nebula.
 - a widget star.
 - a black hole.
 - a neutron star.
 - a supernova.
 - a red dwarf.

15. 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.
16. 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, lowering densities to allow its vast amounts of energy to be released. Spelling counts in Canvas tests, so make sure you've got the word spelled correctly or it will not be recognized.
17. The expanding Crab Nebula, M1, is an excellent example of a _____ which can be observed from our Northern Hemispheric winter sky.



- a. a cometary nucleus.
 - b. a planetary nebula.
 - c. a supernova remnant.
 - d. a filament cluster.
18. 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.
19. The creation of heavy elements during a supernova explosion is called a _____.
- a. nucleoamalgamation.
 - b. fusion amalgamation.
 - c. nucleosynthesis.
 - d. shitstormaexplosion.
 - e. nuclear coalescence.

20. 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.
21. In the beginning after the big bang (big pop), the universe was composed of just _____ 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.
22. The two main 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. pulsars and magnetars.
 - e. magnetars and black holes.
 - f. white dwarfs and black holes.
23. 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.
24. In solar type stars and stars of even lower masses, the end result after thermonuclear fusion has stopped may be an inert (nonreacting) helium or carbon core which supports itself through a process called electron degeneracy pressure. In other words, matter is squeezed so closely together that the electrons actually hold up the star from further collapse. Why is this true and what kind of star remains? Provide two correct answers or get it wrong.
- a. similar charges repel.
 - b. neutron star.
 - c. black hole.
 - d. energy pushes outward.
 - e. photon pressure.
 - f. white dwarf.
25. 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.
26. 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.

27. 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. nucleosynthesides.
 - d. protons.
 - e. neutrons.
 - f. quarks.
28. Which one of the following particles produces no outward pressure or charge to help sustain, slow, or reverse the collapse of matter?
- a. nucleosynthesides.
 - b. neutrinos.
 - c. photons (electromagnetic energy).
 - d. electrons.
 - e. neutrons.
 - f. protons.
29. What is the name of the effect 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.
30. 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. nucleosynthesides.
 - b. neutrinos.
 - c. photons (light).
 - d. nonneutral matter.
 - e. neutrons.
 - f. protons.
31. Which subatomic particle is most responsible for blasting the layers of a star into space, aided by the shock wave that a supernova produces?
- a. nucleosynthesides.
 - b. neutrinos.
 - c. photons (light).
 - d. radicals (nonneutral molecules).
 - e. neutrons.
 - f. protons.
32. 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.
33. 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.

34. Compared to Earth's surface gravity, how much stronger is the surface gravity of a typical neutron star?
- 1 million times stronger.
 - 100 million times stronger.
 - 1 billion times stronger.
 - 100 billion times stronger.
35. Why do neutron stars that **have just been formed** complete several to hundreds of spins per second?
- Planets revolving around newly formed neutron stars help to accelerate them as well as the gases in their vicinity.
 - Strong magnetic fields tend to transport energy into the slowly spinning neutron star causing it to rotate faster.
 - As the core collapses and its radius decreases (angular), momentum is conserved and the star must spin faster.
 - 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.
 - Stars in binary systems, where one star will eventually become a red giant and (or the companion star) 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.
36. 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.
- Neil deGrasse Tyson.
 - Antony Hewish.
 - Carl Sagan.
 - Jocelyn Bell.
 - Stephen Hawking.
 - Diane Husic.
37. Rapidly rotating neutron stars almost always have a very strong magnetic field associated with them. If the magnetic field of the neutron star is not positioned along the rotational axis of the star, but is located in a different position; then it will sweep around the rotating star like a beam of light coming from a lighthouse. If that beam sweeps past the Earth and is detected, astronomers generally call that object a
- black hole.
 - magnetars.
 - white dwarf.
 - pulsar.
 - white hole.
38. A rapidly rotating neutron star of let's say 3.2 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.
- planetary nebula.
 - black hole.
 - millisecond pulsar.
 - high-rate pulsar.
 - white dwarf.
 - white hole.
39. A neutron star with an extremely small rotational period is called a _____.
- planetary nebula.
 - black hole.
 - millisecond pulsars.
 - high-rate pulsar.
 - white dwarf.
 - white hole.

40. Why are most pulsars never identified by astronomers?
- They lose their strong magnetic field as they spin more slowly.
 - 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 direction to sweep past the Earth.
 - Pulsars cool rapidly making any radiation which they are emitting less intense.
 - Pulsars are a relatively rare end product to stellar evolution.
 - Seriously all of these ideas are correct! I'm tired. It's time for bed.
 - None of the above are valid answer except for e.
41. 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.
42. 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.
43. If a dying star's core is greater than 2.8 times the sun's mass, it should become a _____ . Your spelling must be correct.
44. 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.
- one solar mass.
 - eight or nine solar masses.
 - 12 solar masses.
 - 20 solar masses.
 - 40 solar masses.
45. **Ripped Apart by Gravity**—Gary Gene Linney, 2015

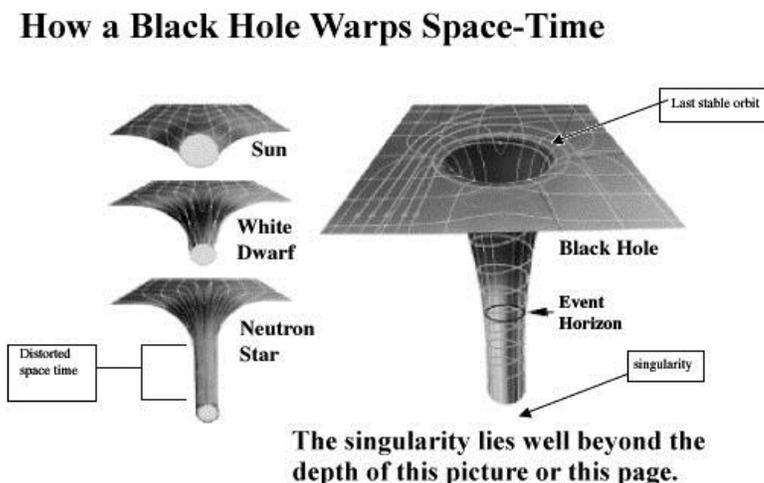
I am holding nothing now,
it weighs me down like a spoonful of _____ star.
Degeneracy Pressure holds me still,
holds me close....
...subdued by [the] Pauli Exclusion Principle.
the electrons of emotional collapse.
This Pressure holds me up
and I shine on alone.
I envy event horizons.

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.

- white dwarf.
- black hole.
- a subdwarf
- white hole.
- neutron star.

46. Linney envisions the event horizons as a means of _____.
- offering a new beginning on the other side.
 - making events in his life go backwards.
 - ending his pain and suffering.
 - being held in a prison of timelessness from his perspective.
 - saying that black holes are still brighter than Linney's future.
47. 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 _____.
- die, ha-ha.
 - approaching the black hole forever.
 - falling into the "rabbit hole," i.e., the black hole.
 - finding God.
 - turning blue as my oxygen tanks ran out of air.
 - smoking weed and having the best time of my life.
 - turning bluer and bluer as the wavelengths of light reflecting from my body are collapsed by the gravitational pull of the black hole.
48. 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 _____.
- greater than the speed of sound.
 - greater than the speed of any conventional or future rocket that humans could design.
 - greater than the speed of light.
49. The position around a black hole, where the escape velocity equals the speed of light, is called the _____.
- observable boundary.
 - event horizon.
 - point of no return.
 - progenitor's surface.
 - Chandrasekhar limit.
 - final countdown.
50. When the gravitational force between two objects is calculated, the mass of each object is _____.
- assumed to be uniformly distributed throughout both objects.
 - concentrated in the center of both objects.
 - assumed to be on the surface.
 - assumed to be at the location which is determined to be the midpoint of that body's mass from center to surface.

51. 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 $F = m_1 \times \text{acceleration}$ 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.
52. If you could 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.
53. 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.
54. 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.
- you would simply drop through—all information lost forever.
 - your watch, digital or analog, would be ticking slower and slower.
 - your image would become redder and redder (color), then disappearing at the event horizon.
 - you would be moving towards the black hole slower and slower.
 - you would follow the curvature of space-time which would bend towards the black hole.
55. 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 _____.
- fettuccination.
 - the linguine effect.
 - spaghettification.
 - googling.
56. Black holes with masses ranging from about 3 to a few dozen solar masses are called _____.
- white dwarf black holes.
 - mini black holes.
 - event horizon black holes.
 - stellar-mass black holes.
 - dark matter black holes.
57. The black hole at the center of our own Milky Way galaxy _____.
- can be seen directly with instrumentation from Earth.
 - has a mass of 2-4 billion times the sun's mass.
 - is actively ingesting large amounts of matter.
 - can be considered to be a large, massive black hole as galaxies go.
 - was recently formed.
58. At the event horizon of a black hole, time _____.
- slows to a crawl.
 - stops.
 - speeds up.
 - reverses itself and goes backwards.
59. 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 _____.
- be blue-shifted.
 - be slightly blue-shifted.
 - disappear.
 - be slightly red-shifted.
 - be moderately red-shifted.

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



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