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NZQA

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Level 2 Earth and Space Science 2022

91192 Demonstrate understanding of stars and planetary systems

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of stars and planetary systems.	Demonstrate in-depth understanding of stars and planetary systems.	Demonstrate comprehensive understanding of stars and planetary systems.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–15 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Merit

TOTAL 15

RESOURCE

Hertzsprung-Russell (HR) diagram

Adapted from: http://www.atnf.csiro.au/outreach/education/senior/cosmicengine/stars_hrdiagram.html

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The examination continues on the following page.

QUESTION ONE: VEGA AND RIGEL

Prominent in the winter night sky are the stars Rigel and Vega. Rigel is 20 times the mass of the Sun, whereas Vega is approximately twice the mass of the Sun.

(a) Using the HR diagram on page 2, complete the table below to list the properties of Vega and Rigel.

Star	Luminosity	Temperature	Colour
Rigel	10^5	10,000 K	Light Blue
Vega	10^2	10,000 K	Light Blue

(b) Explain the difference in fuel use of Rigel and Vega, by relating it to luminosity and mass.
In your answer, you should consider the rate at which the fuel is being used.

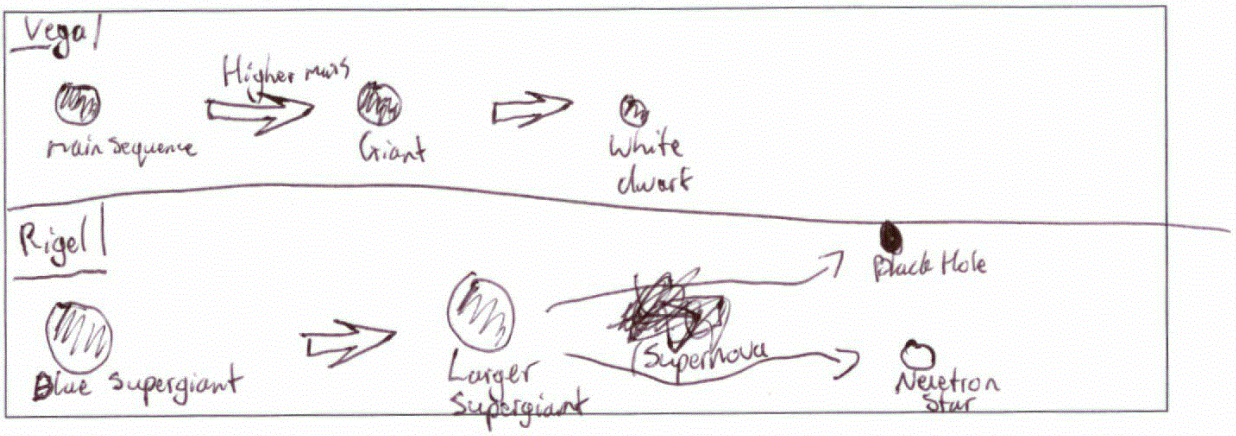
Rigel is a blue supergiant star that has a very high luminosity. With this in mind it is easy to tell that Rigel has a very high mass and surface area. Rigel is most likely fusing Helium into Carbon as fuel, this is because when stars run out of Hydrogen to fuse into Helium the star expands it's outer layers to become more massive, this is how Rigel became a Supergiant star. Because Rigel is so massive, Nuclear fusion occurs at a very fast rate, this is due to the imense pressure ~~gravity from~~ gravity is putting on the core. Vega is a blue main sequence star that has high luminosity of 10^2 but is not as high as Rigel's 10^5 luminosity. Vega Since Vega is only twice the mass of our sun and is still in the main sequence it is fusing Hydrogen to Helium as fuel. Vega is burning it's fuel at a much slower rate compared to Rigel because of the difference in surface area meaning there isn't as much pressure on Vega's core. ~~It is still fusing Hydrogen Helium~~

(c) Compare the likely outcome of BOTH stars as they end their life cycle. (Note: you do not need to explain the various stages of each star's life cycle.)

In your answer, you should consider:

- the mass of the stars
- the role of gravity.

An annotated diagram may assist your answer.



Rigel is a Supergiant Star and is ~~fusing~~ using it's fuel at an increasingly fast rate. This means that it is likely to expand is size and surface area. With this new mass it will have a higher gravity and faster fusion rate. Eventually, Rigel will attempt to fuse Iron in it's core, since iron can't fuse into other elements the Star will collapse and explode in supernova. Depending on how massive Rigel is when this happens it will either turn into a Neutron Star or Black hole.

Vega on the other hand is way less massive than Rigel which means it will never be able to expand into a Supergiant Star. Instead it will run out of Hydrogen to fuse into Helium and expand into a giant star, from then it won't have enough mass to expand further and will collapse under it's own gravity and turn into a White dwarf.

QUESTION TWO: NEPTUNE'S SATELLITES

Neptune is the outermost planet of our solar system. It is a giant planet with 14 natural satellites.

The largest of the satellites is Triton. Its orbit is retrograde (rotates in the opposite direction to the planet), and it contains 99% of the total mass of all the satellites.

Adapted from: https://upload.wikimedia.org/wikipedia/commons/1/16/Orbits_of_inner_moons_of_Neptune_including_S_2004_N_1.jpg

(a) Describe what is meant by the term natural 'satellite'.

A natural satelite is an object of noticeable size that orbits a planet, these objects are much smaller than the planet they orbit. ~~Sate~~ Natural satellites is are another term for moon.

There are a number of different theories about how satellites are formed.

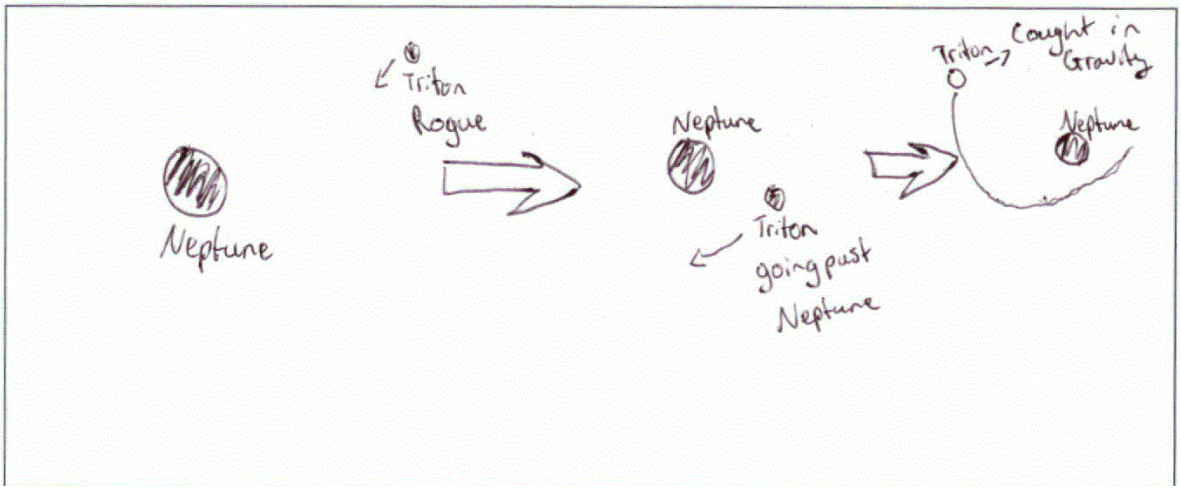
(b) Scientists think Triton may have been captured.

With reference to the diagram above and the information provided, explain why scientists may think this.

In your answer, you should consider:

- the capture theory of moon formation
- the mass of Triton
- the position of Triton's orbit and its motion around Neptune.

An annotated diagram may assist your answer.



The Majority of Neptune's moons are much smaller than Triton and they all go in a circular orbit in the same direction. These moons likely formed at the same time Neptune formed. Triton is an abnormally large moon compared to the others and it has an oval orbit going the opposite direction compared to every other Neptune moon. Triton is also orbiting the furtherest away from Neptune, while the other moons are much closer in ~~there~~ their orbiting patterns.

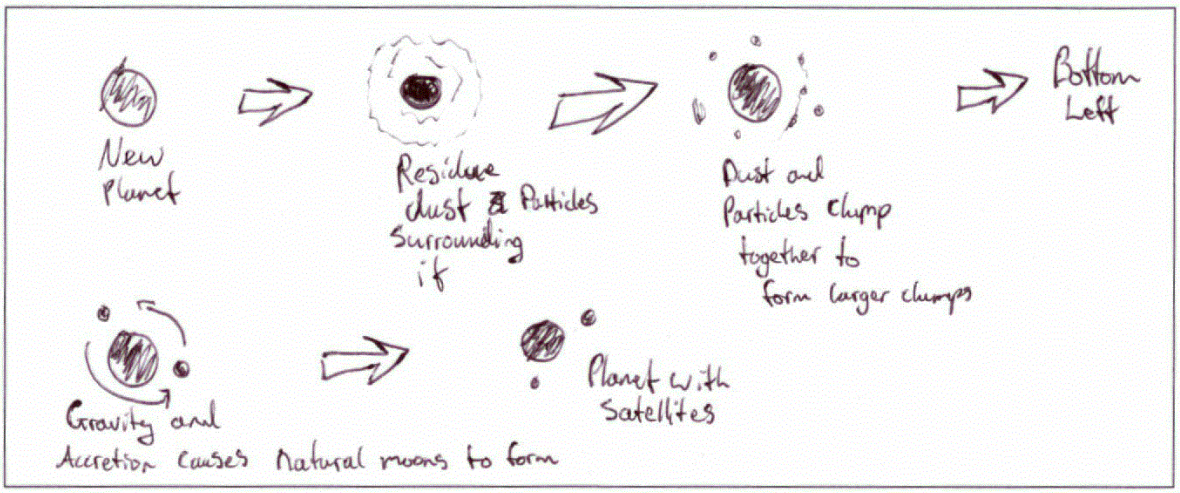
Before Triton was a moon of Neptune it was likely to be a rogue Asteroid in space. At some point it Went past Neptune and was close enough to be caught by Neptunes gravity Well. This explains why Triton is orbiting at such a distance from Neptune and why it has an oval shaped orbit. Triton ~~came~~ Went past Neptune at an opposite direction to the other moons and was going at a fast speed which caused it's orbit to be elongated when gravity from Neptune pulled Triton back towards it.

(c) Explain, in detail, ONE theory of satellite formation, other than the capture theory, that may explain the formation of Neptune's other satellites.

In your answer, you should consider:

- the influence of gravity
- the mass of the satellites
- the orbits of the satellites.

An annotated diagram may assist your answer.



Neptunes other ~~S~~ moons could have been formed at a similar time to when the planet formed. When a new planet is formed there can be some residue material left over on the ~~other~~ outside, which is comprised of the same material that ~~the~~ planet is made out of. Overtime these ~~pat~~ particles and materials ~~clump~~ clump together to form larger clumps due to gravity. This process of Accretion continues until the clumps of material become large enough to have their own gravity which causes it to attract more material and get larger. Eventually these new satellites have collected the remaing clumps of material and are orbiting in the same direction ~~as the new planet~~ around the New planet.

QUESTION THREE: NEUTRON STAR OR BLACK HOLE

Astronomers estimate that the Milky Way has anywhere from 10 million to one billion black holes, and around one billion neutron stars.

(a) With reference to the HR diagram on page 2, state where you would expect to find stars in the main sequence that will become neutron stars or black holes, and explain why they are found there.

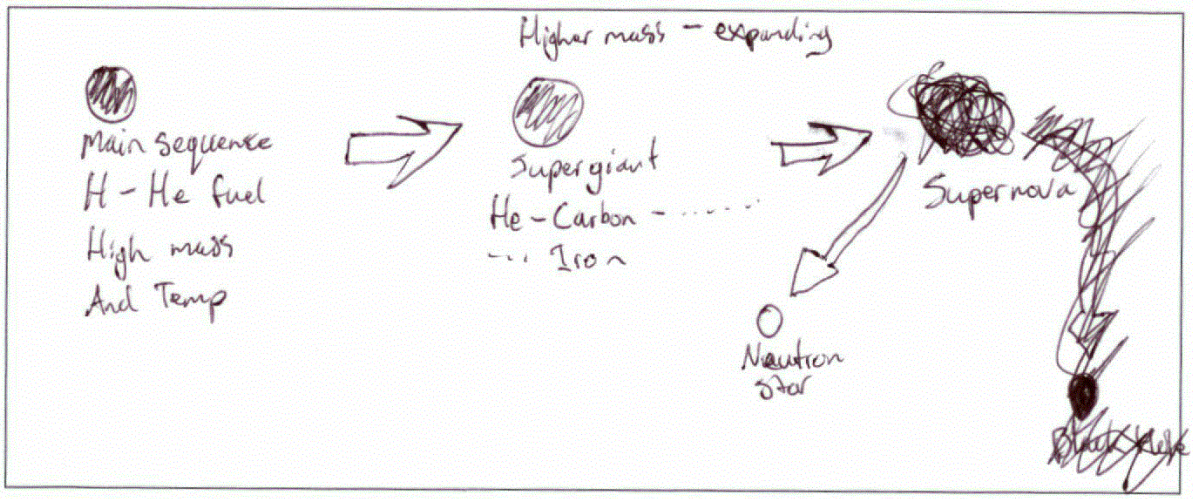
The ~~main sequence~~ stars ~~of~~ near the top of the main Sequence are ~~most~~ likely to become Neutron Stars or Black Holes because ~~of~~ their large mass and surface area.

(b) Explain, in detail, the life cycle of stars that lead to the formation of neutron stars from the main sequence.

In your answer, you should explain:

- energy changes during the different life stages
- fuel use during the different life stages.

An annotated diagram may assist your answer.



Main Sequence stars with a very high mass will ~~have~~ fuse Hydrogen to Helium as fuel at a very fast rate due to the high pressure ~~caused~~ caused by gravity from the massive star. Eventually the star will run out of Hydrogen to ~~have~~ fuse with Helium, this causes it to expand it's outer layers causing more pressure on

the stars core, which then creates enough heat for the stars core to begin to fuse Helium into carbon. This star is now a supergiant that fuses elements at an increasingly fast rate. Eventually, it runs out of Helium to fuse Carbon and expands further creating enough pressure into it's core to fuse carbon into more elements like Neon and Oxygen. At some point the star will try to create Iron in it's core and because Iron can't fuse to create more elements the Iron atoms instead repel the pressure put on them by the supergiant star's inense gravity. This causes a Supernova explosion leaving only the extremely dense and Hot core of the once supergiant star. This is called a Neutron star.

Question Three continues on the following page.

(c) Explain why some dying stars form neutron stars, while others form black holes.
In your answer, you should consider the effects of mass and gravity.

When stars go Supernova they will either become a Neutron Star or a black hole. The reason for this is ~~because~~ that Supergiant Stars with less than 100 times the mass of our sun will not have enough gravity to collapse into a Singularity after it goes Supernova. Instead a lower mass Supergiant will explode and leave it's core behind because it didn't have enough gravitational energy to collapse further.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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QUESTION NUMBER

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Standard	91192	Display ID	Response 62126665. NSN 138613083	**Total score**	15 = M
Q	**Grade score**	**Annotation**			
1	M6	The candidate has explained the rate of fuel use in relation to the respective star's masses and luminosity values. The luminosity is linked to the energy being released with star size and surface area. Star outcomes are explained in terms of mass, however an important part of the process involving Vega has not been included.			
2	M5	The candidate has provided an explanation for why Triton is a captured moon in terms of size (mass) and orbit with reference to Neptune's inner moons. The role gravity played in the capture and orbital characteristics is commented on. The inner moon formation is linked to the accretion of residue after the planets' formation with a reference to their orbit and the planets rotation. No comment is made about properties.			
3	A4	Whereas the candidate as adequately explained the how large stars form, the process during their life span and eventual demise, no reference has been made to the quantitative values of star mass and star core mass after the supernova explosion. Lacking this evidence or linking star mass to outcome in this was reduces the quality of the explanation.			