SUPERVISOR'S USE ONLY

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91192

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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Earth and Space Science 2025

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 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area will 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

HR (Hertzsprung-Russell) diagram

Effective temperature, K

Absolute magnitude, M

Luminosity compared to Sun

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

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The assessment begins on the following page.

QUESTION ONE: LEPUS

The constellation Lepus sits near the Orion constellation in the southern sky.

The constellation's brightest star is Arneb. The star has a mass of 14 Msun, and is approximately 1250 light years from the Sun. In the same constellation is the Gliese 229 system. The star Gliese, has a mass of 0.6 Msun, and is 19 light years from the Sun.

(a) Using the HR diagram on page 2, complete the table comparing the properties of Arneb with Gliese 229.

Star	Colour	Temperature	Luminosity
Arneb	yellowish white	6,800 K	10^{4}
Gliese 229	Red	3,900 K	10^{-2}

(b) Explain, in detail, using the information from the HR diagram and the star properties, the differences in luminosity between Arneb and Gliese 229.

In your answer you should consider:

- what luminosity refers to
- the mass of each star
- the temperature of each star
- the current fusion process.

the star Gliese 229 is a main sequence star with similar mass to that of our own sun and a similar Luminosity while the star Arneb is a ~~[illegible]~~ supergiant and it's mass and Luminosity is much higher than that of our sun Luminosity referes to the energy out put of which a star produces (Lsun) our sun is making (1Lsun) the mass of Gliese 229 is around 9msun and Arneb being around ~4msun the ~ is more while the positive is less so Arneb is much larger in mass than Gliese 229 M sun is measured

using our own suns mass our sun being (1 msun) both stars burn at diffrent temperatures Arneb being at around 6,800K and gliese229 being only around 3,900 K the current fussion process for gliese 229 since it's a main sequnce star in it's main sequnce stage the star fuses hydrogen and helium while Arneb which is in it's supergiant faso would be fusing helium to carbon.

(c) There are two brown dwarfs orbiting Gliese.

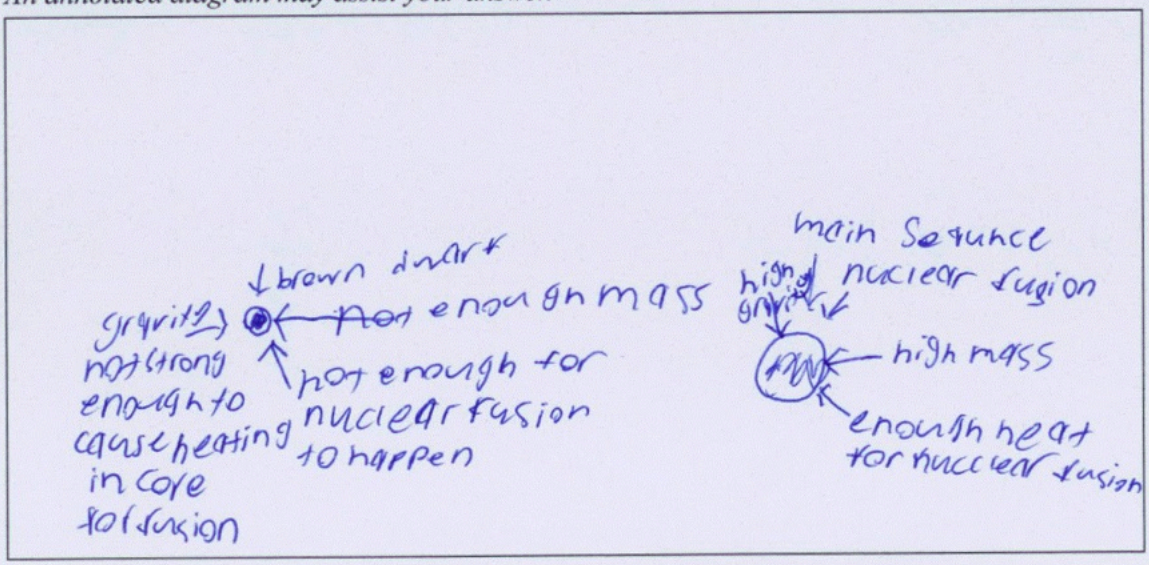
Adapted from: https://hubblesite.org/contents/media/images/1995/48/372-Image.html?news=true

Explain, in detail, why these brown dwarfs would not be found on the HR diagram.

In your answer you should consider:

- the process of star formation
- temperature and energy source in main sequence stars
- the role of mass in star formation.

An annotated diagram may assist your answer.



for a star to form it needs to be able to be Hot enough, Have enough mass, and to be able to fuse Hydrogen and Helium a star forms from a stellar nebula which is a hot dense cloud of gas and in that gas is a Protostar which is

Pulling in that gas with it's gravity and making the particles colide and cause friction to heat up the protostar to around 20,000,000k for nuclear fission to start eventually that happens particles colide heat then the star becomes a main sequnce the star rotates causing the gas disk to flatten for a star to form it needs a mass of around 0.08 mSun gliese229 has 2 brown dwarfs orbiting it which are failed stars they never gained enough mass or gravity in the core to be able to heat up and become a star. and were not able to fuse hydrogen to helium causing the star to become a failed star known as a brown dwarf

QUESTION TWO: MOONS

(a) All planets and moons within our solar system originated from material within the protoplanetary disk.

Describe what a protoplanetary disk is.

a Proto planetary disk is like the rings around saturn but instead this is around the sun when a star spins it flattens the gas out and makes a disk known as the protoplanetary disk which has planets form inside of it.

(b) Earth and Mars are similar in that both rocky planets have moons.

Mars has two moons, Phobos and Deimos. Both moons are small and irregular in shape.

The Martian moons: Deimos and Phobos
Source: https://www.skyatnightmagazine.com/space-science/the-moons-of-mars

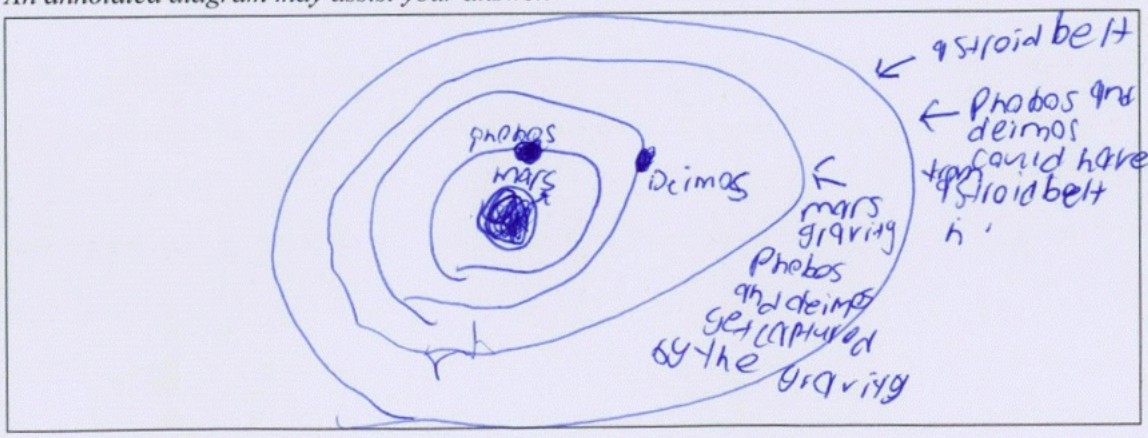
The orbits of Deimos and Phobos
Source: https://astronomynow.com/2018/07/30/find-martian-moons-phobos-and-deimos-at-the-red-planets-closest-approach/

Using evidence from the diagrams above, explain in detail, why the capture theory is the most likely origin of Deimos and Phobos.

In your answer you should consider:

- the position of the asteroid belt
- how the evidence fits the capture theory.

An annotated diagram may assist your answer.



mars moons deimos and Phobos are irregularly shapped and are supposed to be captured moons from mars gravity from the astroid belt why this is thought to be is because ~~mars~~ mars ~~moons~~ is the closest Planet to the astroid belt so any large irregular objects that come from their could have been captured by the gravity of mars therefore the 2 astroid looking moons are likely to have originated from the astroid belt. also the fact one of the moons of mars is slowy driving towards it and eventually in may be a billion or millions and millions of year will collide with mars and the is drifting away it's irreguler shape is what makes it seem like it was captured. ~~other info~~

(c) The Earth's Moon is thought to be about 4.46 billion years old. Earth is 4.55 billion years old.

The final Apollo mission in 1972 brought back rock samples from the Earth's Moon. These samples were chemically analysed and found to have a similar chemical composition to rocks on the Earth, but showed evidence of lower levels of iron and gaseous substances.

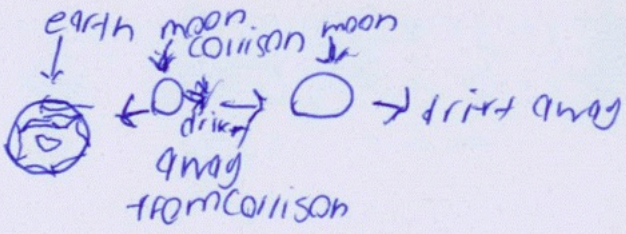
Source: https://en.wikipedia.org/wiki/Moon#/media/File:FullMoon2010.jpg

Using evidence explain, in detail, how the collision theory could explain the Moon's origin.

In your answer you should consider:

- the Moon's orbit
- evidence from rock samples
- how the evidence fits the collision theory
- how the evidence discounts other theories.

An annotated diagram may assist your answer.



the earths moon is thought to have been at one point another planet that was rogue ~~and~~ called then and colided with Earth making the moon our moons orbit used to be much much closer to earth in it's past as we know because of the moons very slow drift away from earth hence why we strongly think another planet colided with earth

When the last APOLLO mission happened in 1972 they bought back rock samples from the moon which showed similar composition to that of earth further backing the theory up how this fits into the ~~CONSPIRACY~~ collision theory is that they chemically analysed the rocks to find similar composition to earths and the dirt away of moon although it used to be much closer

QUESTION THREE: DEATH OF A STAR

Māori and Pacific astronomical traditions refer to Māhutonga, a bright star that became invisible. This was recorded in the southern sky around AD 185, and has been traced to the likely occurrence of a supernova in the constellation of Centauri.

Source: https://www.skyatnightmagazine.com/space-science/when-stars-collapse-what-is-a-supernova

(a) What is a supernova?

a supernova is when a stars life has ended and has fused all it's fuel hydrogen to carbon then carbon to an explosion the stars core loses against gravity and the outer layers expand till it explodes into a supernova

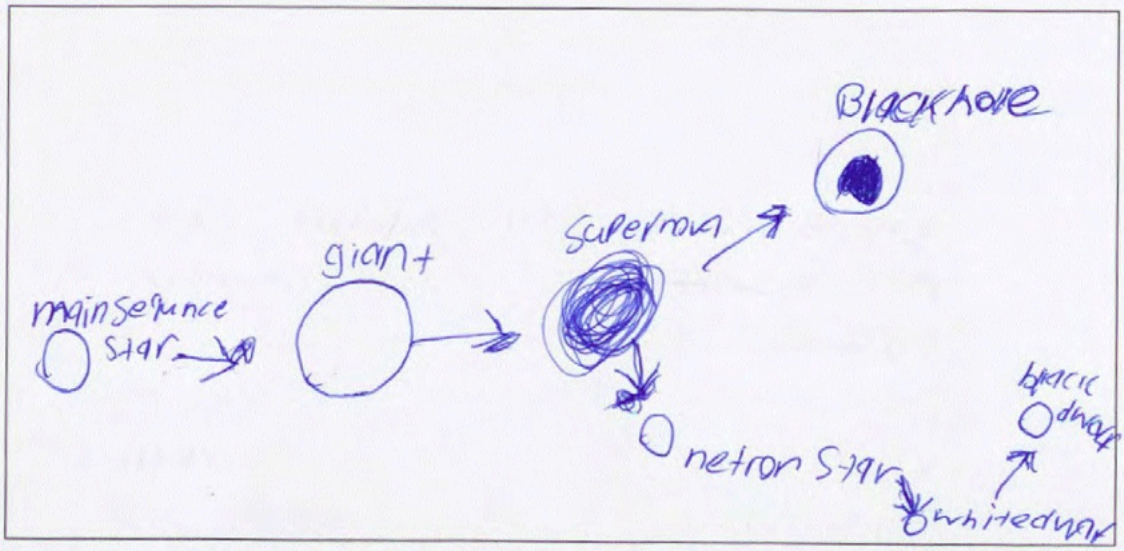
(b) Explain, in detail, the type and behaviour of a star from its main sequence stage until it goes supernova.

In your answer you should:

- state where on the HR diagram this type of star would have been during main sequence
- the energy changes
- the fuel use
- the role of gravity.

An annotated diagram may assist your answer.

for a star on the HR diagram to be able to go supernova at it's main sequence stage would have to be around ~3m sun the energy output and changes of the star would grow as it's uses it's



fuel through its main sequence stage it would be having around 10^8 Lsun in its main sequence stage it would be near the top left of the HR diagram in the main sequence strip the stars fuel use would be hydrogen to helium in it's main sequence stage fusing it's fuel over probably around 1 billion or so years till it burns all it's fuel ~~carbon~~ hydrogen to carbon then it's outer layers start to expand the stars core forcing it out burning it's last bit of fuel making the star grow in a ~~super~~ giant then when gravity finally wins the core contracts causing the star and all it's mass to collapse in on it's self ~~with~~ making the star go supernova.

Question Three continues on the next page.

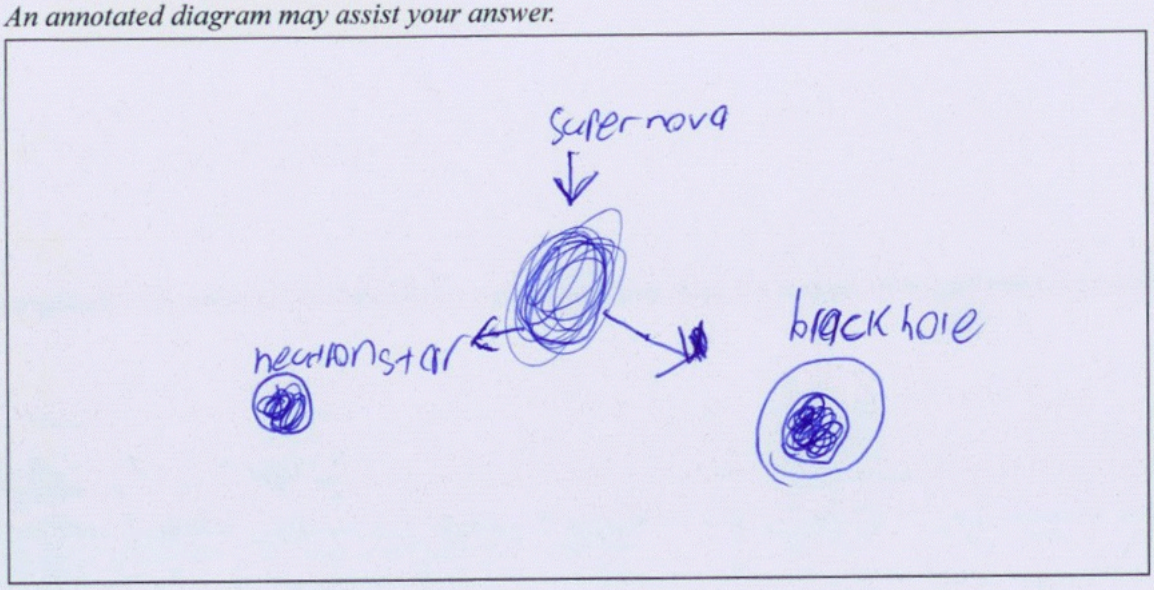
(c) Following the supernova, there are two possible outcomes.

Explain, in detail, the critical factors that would lead to either of these outcomes.

In your answer you should:

- state the two possible outcomes
- consider the role of mass
- consider the role of gravitational forces.

An annotated diagram may assist your answer.



the two possible outcomes after a super nova are the star could turn into a neutron star or a Black hole for a star to be able to go super nova and have enough mass to be any of this has to be over 3 m sun for a neutron star and around 8 m sun for a black hole. a neutron star is only a small star around 20km in size but is extremly dense and is made well out of neutrons supposedly a teaspoon of neutron star is around the weight of ~~mount~~ everest if you could have a teaspoon of it. A black hole is a thing ~~where~~ that is

So super heavy and has such strong gravity not even light can escape it nothing can they suck in all the mass that they can and grow from beoming more and more super massive.

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

QUESTION NUMBER

91192

Merit

Subject: L2 Earth & Space Science

Standard: 91192

Total score: 15

Q	Grade score	Marker commentary
One	M5	The candidate describes the current state of Arneb and Gliese through reference to the HR diagram, mass and fusion process. Reference to the star's luminosity Is not given other a comparison to the Sun. The next step would be to reference luminosity to surface area and include colour as a measure of temperature. Star formation is explained with the assistance of an annotated diagram and relates how a brown dwarf's existence results from insufficient mass to enable fusion to occur.
Two	M5	The candidate provides explanation for the likely reasons for the existence of moons orbiting Mars in terms of origin, gravity, shape and orbit. Collison theory is given as the reason for Earth's moon and used the contextual material as evidence however this could have been extended to explain how the material came to be on the Moon.
Three	M5	The candidate goes through some detail as to the process leading up to a supernova event with the energy changes involved. More detail could have been given relating to the conflict between gravity and star expansion. The two possible eventual outcomes are described but further detail given related to original star mass and resulting core mass post supernova.