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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.

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RESOURCE

HR (Hertzsprung-Russell) diagram

Effective temperature, K

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			
Gliese 229			

(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.

(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.

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.

(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.

(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.

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?

(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.

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.

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

QUESTION NUMBER

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