# Assessment Schedule – 2018

## Earth and Space Science: Demonstrate understanding of stars and planetary systems (91192)

### Evidence Statement

**Question One**

| Expected Coverage | Achievement | Merit | Excellence |
|---|---|---|---|
| The features of the three stages in the **life cycle** of the star Canopus include:<br>**Birth**<br>• giant molecular cloud (GMC)<br>• GMC condensing under gravity<br>• Protostar.<br>**Life**<br>• main sequence<br>• Canopus spends most of its life as a main sequence star using hydrogen as fuel. The fuel source is hydrogen fusing to helium.<br>**Death**<br>• blue / white supergiant<br>• supernova<br>• black hole.<br>The **birth stage** is explained: A very large GMC condenses under gravity to become dense. As it condenses, the particles become hotter (due to friction) and eventually become hot enough to become a protostar.<br>Canopus's birth explained with associated energy changes: Dense GMC collapsing changes gravitational potential energy into heat energy. When this heat energy/temperature reaches a critical point, nuclear fusion of hydrogen into helium occurs.<br>Life Stage Explained: Canopus was once a main sequence star; this is where Canopus spends most of its **life**. Main sequence stars use hydrogen gas as their fuel. Hydrogen atoms fuse together (by nuclear fusion) to form helium and this releases energy. At this stage the star is in hydrostatic equilibrium. Canopus's time on the main sequence will be relatively short due to its massive initial mass and it will run out of its fuel quickly.<br>Death Stage Explained: As Canopus **runs out** of hydrogen as the fuel source it expands to become a supergiant star. It is massive enough to fuse the other elements of the periodic table until it reaches iron. At this point, the iron is too heavy for the core and the core of Canopus will collapse on itself.<br>After collapsing, the other layers of the star will explode outward (supernova) and emit as much energy in this short time as it did in its entire time as a main sequence star.<br>Canopus's very large mass means that it will become a black hole. When the star's fuel is depleted, there is no force to push back on gravity and so the core will collapse on itself. Gravity will further collapse the core, | Identifies and describes:<br>• a feature associated with each of the three stages in the life cycle of Canopus. | Explains in detail:<br>• the birth of Canopus in terms of TWO of energy changes, mass, and gravity<br>• the life of Canopus in terms of TWO of energy changes, mass, fuel use, and gravity<br>• the death of Canopus in terms of TWO of energy changes, mass, fuel use, and gravity. | Explains comprehensively:<br>• TWO or THREE of the stages during the life cycle of Canopus, with reference to TWO of energy changes, fuel source and use, mass, and gravity. |

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| meaning the entire star becomes very small and can be considered to have no volume. This incredibly small but very strong gravitational field in space will not allow light to escape and so Canopus is said to become a black hole. | | | |

| Not Achieved | | | Achievement | | Achievement with Merit | | Achievement with Excellence | |
|---|---|---|---|---|---|---|---|---|
| **NØ** | **N1** | **N2** | **A3** | **A4** | **M5** | **M6** | **E7** | **E8** |
| No response; no relevant evidence. | States TWO characteristics of Canopus from the HR diagram, e.g.:<br>• temperature approximately 8 000 K<br>• brightness $1 \times 10^{-6}$<br>OR gives a feature in the life cycle of Canopus. | Describes a feature of ONE stages in the life cycle of Canopus. | Describes a feature of TWO stages in the life cycle of Canopus. | Describes a feature of all THREE stages in the life cycle of Canopus. | Explains in detail ONE stage~~s~~ of Canopus's life in terms of TWO of energy changes, mass, fuel use, and gravity. | Explains in detail TWO stages of Canopus's life in terms of TWO of energy changes, mass, fuel use, and gravity. | Explains comprehensively TWO stages during the life cycle of Canopus, with reference to TWO of energy changes, fuel use, mass, and gravity. | Explains comprehensively ALL THREE stages during the life cycle of Canopus, with reference to TWO of energy changes, fuel use, mass, and gravity. |

**Question Two**

| Expected Coverage | Achievement | Merit | Excellence |
|---|---|---|---|
| As the star formed from a giant molecular cloud (GMC), there were leftover gas and dust particles. These particles rotate around the young star and flatten into a gaseous protoplanetary disc around the star. A protoplanetary disc is a flattened disc shape. This contains rocky particles that condense together due to gravity. As the disc is spinning, the particles begin to collide and form bigger masses. The bigger masses collect more particles due to increasing gravitational attraction to form planetesimals.<br>The factors that affect the formation of planets are: the material within the nebula, the temperature, and the presence or absence of solar winds.<br>The **inner planets** have formed in a higher temperature zone, and so are formed from the heavier higher melting point material found in the protoplanetary disc. This material is less abundant than the lighter gases, and so the inner planets will be smaller and rocky compared to the outer planets. They also contain less gas than outer planets because they had their gases blown off from the intense solar winds. These gases were blown further away from the inner planets towards the outer planets.<br>The **outer planets** have formed further away from the central star in a lower temperature zone (beyond the frost line), and so will form from the lower melting point materials such as gases with some frozen volatiles e.g. methane. As there are far more gases in the protoplanetary disc than heavier elements, the outer planets will be bigger than the inner planets. They will also be able to form giant planets comprised of gas and ices as they formed further away from the star and so didn't get affected by the solar winds. This is because the massive distance from the star meant that the solar winds and heat radiation didn't affect them. | Describes:<br>• formation of protoplanetary disc<br>• formation of planetesimals<br>• formation of inner planets in terms of temperature or material or solar winds<br>• formation of outer planets in terms of temperature or material or solar winds. | Explains in detail:<br>• formation of protoplanetary disk in terms of particles rotating around star<br>• formation of inner planets in terms of TWO of temperature, material or solar winds<br>• formation of outer planets in terms of TWO of temperature, material or solar winds. | Explains comprehensively:<br>• relative sizes of the inner and outer planets in terms of location (presence or absence of solar winds) and formation material<br>• formation of inner planets in terms of temperature, material and solar winds<br>• formation of outer planets in terms of temperature, material and solar winds. |

| Not Achieved | | | Achievement | | Achievement with Merit | | Achievement with Excellence | |
|---|---|---|---|---|---|---|---|---|
| NØ | N1 | N2 | A3 | A4 | M5 | M6 | E7 | E8 |
| No response; no relevant evidence. | Partially describes ONE Achievement point. | Describes ONE Achievement point. | Describes TWO Achievement points | Describes THREE Achievement points. | Explains ONE Merit points. | Explains-TWO Merit points. | Explains comprehensively TWO Excellence points. | Explains comprehensively ALL Excellence points. |

**Question Three**

| Expected Coverage | Achievement | Merit | Excellence |
|---|---|---|---|
| Sirius is a main sequence star and Sirius B is a white dwarf.<br>The birth stage of both stars is virtually identical except for the initial mass: giant molecular cloud (GMC) condenses under gravity. As it condenses, the particles become hotter (due to friction) and eventually become hot enough to become a protostar.<br>Both stars then became main sequence where they spend the majority of their lives. Main sequence stars use hydrogen gas as their fuel. Hydrogen atoms fuse together (by nuclear fusion) to form helium and release energy.<br>Sirius is still in the main sequence fusing hydrogen to helium whereas Sirius B used up all of its hydrogen and became a red giant star. This is when the core heated up enabling Helium to be fused to Carbon. At the same time the outer layers of the star expanded and cooled greatly increasing its size. When all of the helium was used up Sirius B was unable to fuse heavier elements due to its mass. As a result of this Sirius B collapsed under gravity and the outer layers were puffed off, forming a planetary nebula and leaving a dense core – a white dwarf. A white dwarf does not have a fuel source and is hot but dim, radiating leftover heat.<br>Sirius was initially smaller than Sirius B because it has not progressed through its life cycle at the same rate as Sirius B. Sirius B must have been of greater initial mass, as in the same amount of time it has reached the end of its life cycle. The higher initial mass led to a faster rate of fuel usage, which meant that Sirius B used up its hydrogen long before Sirius did. | Describes:<br>• the current stage of each star<br>• birth stage of both stars described as identical because they formed at the same time<br>• the main sequence in terms of fuel source<br>• Sirius B further on in life cycle. | Explains in detail:<br>• life cycle of Sirius B in terms of size / mass and fuel source<br>• life cycle of Sirius up to main sequence in terms of size / mass and fuel source<br>• Sirius as initially smaller / Sirius B initially larger because it is further through its life cycle OR used fuel faster. | Comprehensively explains:<br>• justifying that Sirius was initially smaller than Sirius B as Sirius B is further through its life cycle and used fuel at a faster rate due to its initial increased size. |

| Not Achieved | | | Achievement | | Achievement with Merit | | Achievement with Excellence | |
|---|---|---|---|---|---|---|---|---|
| NØ | N1 | N2 | A3 | A4 | M5 | M6 | E7 | E8 |
| No response; no relevant evidence. | Partial description of either Sirius or Sirius B life cycle. | Describes ONE point. | Describes TWO points | Describes THREE points | Explains ONE point. | Explains TWO points | Comprehensive explanation given but may omit minor details. | Comprehensive explanation given in terms of life cycle and rate of fuel usage. |

## Cut Scores

| Not Achieved | Achievement | Achievement with Merit | Achievement with Excellence |
|---|---|---|---|
| 0 – 6 | 7 – 12 | 13 –18 | 19 – 24 |