Assessment Schedule – 2015

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

Evidence Statement

Question One:

<table>
<tr><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
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<td>
<table>
<tr><th></th><th>Colour</th><th>Brightness</th><th>Type of Star</th></tr>
<tr><td>Deneb</td><td>white</td><td>1×10^5</td><td>Supergiant</td></tr>
<tr><td>Sirius B</td><td>white</td><td>1×10^{-4}</td><td>White Dwarf</td></tr>
</table>
Deneb is a supergiant, whereas Sirius B is a White dwarf. Deneb is very luminous.
So Deneb is very bright and luminous in the night sky, while Sirius B is very dim in the night sky, despite being the same surface temperature.
The fact their surface temperature is the same means that both stars are emitting the same amount of energy per square metre. As Deneb has a larger surface area than Sirius B, this means that Deneb is a very luminous supergiant star, whereas Sirius B is also emitting the same amount of energy per metre squared, but is dim which means this star is the small white dwarf star.
This is because Deneb is massive and has a large surface area over which to emit a lot of energy per second. Sirius B also emits the same amount of energy per second, but has a far smaller surface area to emit the energy over, and so appears very dim in the night sky.
</td>
<td>Describes:
• Three characteristics of both stars.
• Sirius B has small surface area / small size
• Deneb has large surface area / large size
• Link between size and luminosity
• Relevant point with respect to brightness, luminosity or absolute magnitude.</td>
<td>Explains:
• Sirius B has a small surface area (small size) and so is not luminous.
• Deneb has a large surface area (large size) and so is luminous.</td>
<td>Explains in detail that Sirius B and Deneb emit the same amount of energy per square metre, but that Deneb has a large surface area, so appears more luminous and so is a supergiant, whereas Sirius B is a white dwarf.</td>
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</table>

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Describes more than two characteristics of Deneb and Sirius B.	One Achievement point.	Two Achievement points.	Three Achievement points.	ONE Merit point.	TWO Merit points compared.	Partial detailed explanation.	Full detailed explanation.

Question Two:

Expected Coverage	Achievement	Merit	Excellence
As the star HD 23514 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 disk around the star. A protoplanetary disk is a flattened disk shape. This contains rocky particles that condense together due to gravity. The disk is swirling (to conserve angular momentum), and so the particles begin to collide and form bigger masses. The bigger masses collect more particles due to increasing gravitational field strength. There are two things that affect the formation of planets – temperature and the presence or absence of solar winds. 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 disk. 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. The outer planets have formed further away from the central star in a lower temperature environment, and so will form from the lower melting point material, which is gaseous in nature. As there is far more gas in the protoplanetary disk than heavier elements, the outer planets will be bigger than the inner planets. They will also be able to form bigger planets that are probably gas giant in nature as they formed further away from HD 23514 and so didn't get affected by the solar winds. This is because the massive distance from the central star meant that the solar winds didn't affect them.	Describes: • Formation of protoplanetary disk. • Formation of inner planets in terms of temperature, material or solar winds. • Formation of outer planets in terms of temperature, material or solar winds.	Explains: • Formation of protoplanetary disk in terms of particles rotating around star. • Formation of inner planets in terms of TWO of temperature, material or solar winds. • Formation of outer planets in terms of TWO of temperature, material or solar winds.	Explains in detail: • Relative sizes of the inner and outer planets in terms of location (presence or absence of solar winds) and formation material. • Formation of inner planets in terms of temperature, material and solar winds. • Formation of outer planets in terms of temperature, material and solar winds.

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 TWO Merit points.	Explains THREE Merit points.	Explains in detail TWO Excellence points.	Explains in detail ALL Excellence points.

Question Three:

Expected Coverage	Achievement	Merit	Excellence
A black hole has a massive giant molecular cloud (GMC). The star started life as a cloud of dust and gas that is called nebula or a Giant Molecular Cloud (GMC). The dust and gas can be caused to condense together by an outside force, such as a nearby star going supernova, or just the gravity of a near star. As the GMC condenses under gravity, it forms a protostar. As the protostar condenses, the particles become hotter (due to friction) and eventually become hot enough to become a protostar. Eventually a critical mass is reached, with a high enough temperature inside the protostar to cause nuclear fusion to occur. At this point the star is a main sequence star. Star birth explained with associated energy changes: GMC collapsing changes gravitational potential energy into heat energy. When this heat energy temperature reaches about 1 000 000 K, nuclear fusion of hydrogen into helium occurs. All stars spend a period of time on the main sequence where the star's fuel is hydrogen fusing to make helium in nuclear fusion. As this main sequence star has a massive initial GMC, it is a large main sequence star, and so uses its fuel at a very rapid rate. This phase of the star's life is the most stable (star is in hydrostatic equilibrium), but because the star is heavy enough to form a black hole, this main sequence phase of its life is relatively short due to the rapid use of its hydrogen fuel. As the hydrogen fuel runs out, no hydrogen remains in the core of the star and so the star starts to contract into a red supergiant. Fusing of heavier fuel sources such as helium, carbon up to iron may provide an outwards force opposing the gravitational force towards the centre of the star, but this is short-lived. At this point, the pressure of the nuclear fusion reaction cannot oppose the force of gravity within the star, and the star starts to collapse. The massive star is unstable and this collapse triggers a violent explosion called a supernova. This is where the outer layers of the star are violently expelled, leaving the star as an extremely small and heavy (dense) star with the core unable to support itself, and so the core collapses further to form a neutron star where the matter inside the star is a dense shell of neutrons. At this point if the neutron star is dense enough (about 3x mass of our Sun) the star will collapse so completely that the star will pull light into its middle and so be an incredibly high region of gravity known as a black hole.	Describes stages in the life cycle of the black hole • formation of massive GMC • main sequence • red supergiant • supernova • neutron star • black hole.	Explains the birth of a star that leads to a black hole in terms of TWO of energy changes, mass, and gravity. OR Explains the life of a star that leads to a black hole in terms of TWO of energy changes, mass, fuel use, and gravity. OR Explains the death of a star in terms of TWO of energy changes, mass, fuel use, and gravity.	Explains in detail TWO stages during the life cycle of a star leading to a black hole with reference to TWO of energy changes, fuel use, mass, and gravity

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Describes TWO stages in the life cycle of the black hole.	Describes THREE stages in the life cycle of the black hole.	Describes FOUR stages in the life cycle of the black hole.	Describes MORE THAN FOUR stages in the life cycle of the black hole.	Explains TWO stages of the life cycle of a black hole.	Explains ALL stages of the life cycle of a black hole.	Explains in detail TWO stages of the life cycle of a black hole.	Explains in detail ALL stages of the life cycle of a black hole.

Cut Scores

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