

Assessment Schedule – 2016

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

Evidence Statement

Question One

Expected Coverage	Achievement	Merit	Excellence
<p>Procyon B is a white dwarf star that is around 8000 K in temperature. It is a yellow star. Barnard’s star is a main sequence (Red Dwarf) star of around 3000 K and is red in colour. They both have the same luminosity of around $1 \times 10^{-3 \text{ to } -4}$, which is very low. Luminosity can be thought of as the amount of energy that radiates each second in all directions. So as both stars have around the same luminosity they must have the same energy output. As Procyon B is hotter than Barnard’s star, Procyon B gives out more energy per second per metre and so must therefore be smaller in size than Barnard’s star. Barnard’s star is lower in temperature and so gives out less energy per second per metre and so is a larger star than Procyon B.</p> <p>Procyon B is now a white dwarf, its initial mass was higher than Barnard’s star as Procyon B’s life cycle was main sequence to red giant and then white dwarf. Barnard’s star is a main sequence red dwarf star and did not have enough mass to leave the main sequence. This means that Barnard’s star was initially smaller than Procyon B.</p>	<p>Describes THREE characteristics (star type, luminosity, temperature, absolute magnitude, or colour) of BOTH stars from the HR diagram.</p>	<p>Explains in detail how characteristics are used to determine:</p> <ul style="list-style-type: none"> • Procyon B hotter than Barnard’s star or vice versa. • that due to same luminosity, both stars have same energy output. • that Procyon B is smaller than Barnard’s star or vice versa. 	<ul style="list-style-type: none"> • Justifies that Procyon B is smaller than Barnard’s star due to higher temperature or vice versa. • Explains comprehensively energy output and luminosity of the stars with reference to the HR diagram. • Explains comprehensively using the life cycle of both stars that Barnard’s star was initially smaller.

N0	N1	N2	A3	A4	M5	M6	E7	E8
<p>No response; no relevant evidence.</p>	<p>Has ONE correct aspect of each star from HR diagram.</p>	<p>Describes TWO characteristics of each star from the HR diagram.</p>	<p>Describes THREE characteristics of EACH star from the HR diagram.</p>	<p>Describes THREE characteristics of EACH star from the HR diagram AND describes Barnard’s star as larger than Procyon B (or vice versa).</p>	<p>TWO points.</p>	<p>THREE points.</p>	<p>ONE point.</p>	<p>TWO points.</p>

Question Two

Expected Coverage	Achievement	Merit	Excellence
<p>Pluto is a dwarf planet that orbits the Sun like other planets; however this orbit is not in the same plane as the other planets, and doesn't have the same shape.</p> <p>Pluto has a big enough mass to be regularly shaped like other planets but Pluto's mass is small and so its gravity is also small. This is because gravity is the attraction found between two masses and the distance between them. Due to the low mass of Pluto the gravitational attraction is also small. This small gravitational force means that Pluto cannot attract or push away other bodies in its orbit and as a result cannot swallow up or push away other bodies in its orbit, and its orbit has space material in it, which is in contrast to the orbits of planets.</p> <p>Pluto's elliptical orbit and the fact that its orbit goes beyond that of Neptune, could suggest that Pluto was a captured Kuiper Belt object that has been pulled into the solar system's gravitational pull.</p>	<p>Describes that:</p> <ul style="list-style-type: none"> • Pluto has orbit that is around the sun, but different in shape to other planets • Pluto's orbit is affected by its close proximity to the gas giants • Pluto's orbit is not in the same plane as other planets • Pluto is smaller in mass than other planets and has less gravity • Pluto is regularly shaped and not like an asteroid (rock) • Pluto is captured space debris. 	<p>Explains in detail that:</p> <ul style="list-style-type: none"> • gravity of a planet is due to the amount of mass the planet has, because Pluto has a small mass, it has a corresponding small gravity • Pluto's orbit is not clear due to its small gravitational force which means its orbit has other space material in it • Pluto may be a captured Kuiper Belt object, and so doesn't orbit in the same plane as other planets. 	<p>Explains comprehensively that:</p> <ul style="list-style-type: none"> • gravity is the attraction between two masses and as Pluto's mass is small, the gravitational force it exerts is small • Its small gravitational force due to its small mass cannot attract other space material to it; nor can Pluto push other space material out of the way, and so Pluto's orbit has other space material in it • Pluto may be a captured Kuiper Belt object, as it does not orbit in the same plane as the other planets, and its orbit is outside that of Neptune's, which may mean it started at that point before being pulled into the solar system's gravity.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	One point at Achievement.	TWO points at Achievement.	THREE points at Achievement.	FOUR points correct.	ONE point.	TWO points.	ONE point.	TWO points.

Question Three

Expected Coverage	Achievement	Merit	Excellence
<p>The features of the stages in the life cycle of the star Rigel include:</p> <ul style="list-style-type: none"> • giant molecular cloud (GMC) • GMC condensing under gravity • protostar • main sequence • Rigel spends most of its life as a main sequence star using hydrogen as fuel. The fuel source is hydrogen fusing to helium • blue / white giant • supernova • black hole. <p>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.</p> <p>Rigel birth explained with associated energy changes: Dense 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.</p> <p>Rigel was once a main sequence star; this is where Rigel spends most of its life. Main sequence stars use hydrogen gas as their fuel. Hydrogen fuses together (by nuclear fusion) to form helium and release energy. Rigel’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.</p> <p>As Rigel runs out of hydrogen as the fuel source, the star is massive enough to fuse the other elements of the periodic table until it reaches iron. At this point the iron element is too heavy for the core and the core of Rigel will collapse on itself.</p> <p>After collapsing, the other layers of the star will explode outward and emit as much energy in this short time as it did in its entire time as a main sequence star.</p> <p>Rigel’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, meaning the entire star becomes very small and can be considered to have no volume. This incredibly small very strong gravitational field in space will not allow light to escape (light would need to go faster than the speed of light to escape) and so Rigel is said to become a black hole.</p>	<ul style="list-style-type: none"> • Identifies and describes a feature associated with each of the three stages in the life cycle of Rigel. 	<ul style="list-style-type: none"> • Explains in detail the birth of Rigel in terms of energy changes, mass, and gravity. <p>OR</p> <p>Explains in detail the life of Rigel in terms of TWO of energy changes, mass, fuel use, and gravity.</p> <p>OR</p> <p>Explains in detail the death of Rigel in terms of TWO of energy changes, mass, fuel use, and gravity.</p>	<ul style="list-style-type: none"> • Explains comprehensively TWO of the stages during the life cycle of Rigel, with reference to TWO of energy changes, fuel source and use, mass, and gravity.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	States TWO characteristics of Rigel from the HR diagram, eg: <ul style="list-style-type: none"> • temperature approximately 20 000 K • brightness 1×10^6 OR gives a feature in the life cycle of Rigel.	<ul style="list-style-type: none"> • Gives two features in the life cycle of Rigel. 	States THREE features of stages in the life cycle of Rigel, eg THREE of: <ul style="list-style-type: none"> • giant molecular cloud (GMC) • protostar • main sequence • blue / white giant • supernova • black hole. 	Describes a feature for TWO stages in the life cycle of Rigel.	Explains in detail ONE stage of Rigel's life in terms of TWO of energy changes, mass, fuel use, and gravity.	Explains in detail TWO stages of Rigel's life in terms of TWO of energy changes, mass, fuel use, and gravity.	Explains comprehensively TWO stages during the life cycle of Rigel, with reference to TWO of energy changes, fuel use, mass, and gravity.	Explains comprehensively ALL THREE stages during the life cycle of Rigel, with reference to TWO of energy changes, fuel use, mass, and gravity.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 18	19 – 24