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# Examiners' Report
# June 2017

## GCSE Astronomy 1 5AS01 01

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# Introduction

The Unit 1 examination paper required candidates to demonstrate knowledge and understanding of a wide range of astronomical phenomena, as well as applying their understanding in both familiar and unfamiliar situations.

It was clear from the responses of candidates to this paper that many centres work very hard to ensure that their candidates are not only aware of the key astronomical principles within the Specification but also have a thorough understanding of them. This was particularly clear in questions where students were asked to consider a new or unfamiliar situation, where candidates generally showed considerable flexibility in their understanding. It is also clear that a number of centres ensure that their candidates are extremely well-informed on astronomical developments and discoveries.

This paper identified a few areas where candidates' recall of astronomical information from the Specification were not complete. These included:

- The discoverer of Pluto (Q.3aii)
- The reason for Pluto's classification as a dwarf planet (Q.3c)
- How to find the Andromeda Galaxy and Fomalhaut from the Square of Pegasus (Q.5a)
- The significance of the Arctic Circle (Q.6c)
- The location of globular clusters (Q.11ai)
- The detailed stages of the Giant Impact Hypothesis (Q.16a).

In addition, candidates had some difficulty applying their astronomical knowledge and understanding in the following unfamiliar situations:

- Applying their understanding of absolute magnitude to estimate distances (Q.5d)
- Applying their understanding of astronomical observations to suggest specific strategies for improving the observation of a small, dim object (Q.11b)
- Applying their understanding of intervals on the magnitude scale and the inverse square law to calculate stellar distances (Q.18bii).

## *Question 3 (b)*

Most candidates were able to recall that Pluto's orbit is inclined to the ecliptic and has a higher eccentricity/is more elliptical than the Earth's.

A number of candidates did not follow the instructions in the question and commented on the larger size of Pluto's orbit.

This question also highlighted the need for candidates to differentiate carefully between two often-confused specialist terms in Astronomy - ecliptic and elliptical.

## *Question 3 (c)*

For the award of this mark, candidates needed to give the defining characteristic of Pluto which makes it a dwarf planet rather than a planet, i.e. that it has not cleared its orbit of other bodies.

Many candidates gave other features of Pluto such as its small size.

## *Question 4 (a)*

It was clear that almost all candidates were aware of this important pair of observations and Eratosthenes' deductions from them. However, it was also clear that the majority of candidates were not clear exactly how the differing shadow lengths in these two Egyptian cities require the Earth's surface to be curved.

The most common failing in candidates' answers was the lack of parallel rays of light from the Sun. Many candidates drew the Sun as a body located quite close to the Earth, with rays of light still diverging quite strongly as they approached the Earth. From this starting point, it was almost impossible for these candidates to access any of the marks in this question.

When explaining these observations, it should be stressed that the Sun is tens of thousands of Earth radii away and thus the basis of any diagram should be its parallel rays.

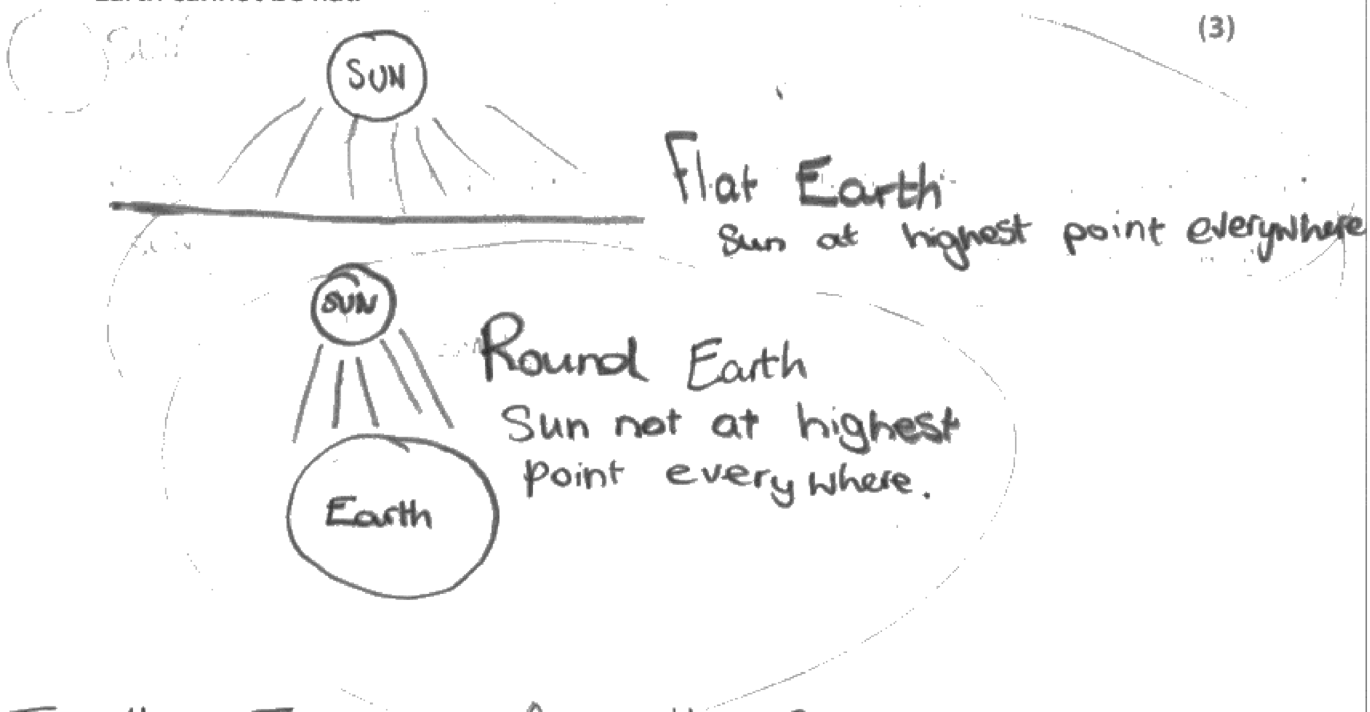
**4** Around 200 BCE, the Greek astronomer Eratosthenes heard that the Sun was directly overhead at midday on June 21st in the southern Egyptian city of Syene.

Observing the Sun on June 21st in Alexandria, in the north of Egypt, he found that it was **not** directly overhead at midday.

He used these observations to prove that the Earth was a sphere.

(a) Explain, using a carefully-labelled diagram, how these observations prove that the Earth cannot be flat.

**(3)**




If the Earth was flat the Sun would reach it's highest point at the Same everywhere in the world. We know the Earth is a Sphere because the time the sun is at it's highest point in one place it isn't in another.

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**Examiner Comments**

In common with a large number of candidates, the diagram provided in this example contains a small Sun which is remarkably close to the Earth's surface. Consequently, the rays of light from the Sun do not reach the Earth's surface as parallel lines. This makes almost all the marks for this question inaccessible.

## *Question 4 (b)*

Most candidates were aware that Eratosthenes needed to know the distance between Alexandria and Syene.

Since the question asked for the measurements which Eratosthenes would have needed to take, the angle between the two cities at the centre of the Earth was not an acceptable answer, even though it is numerically the same as his measurement of the Sun's angle in Alexandria.

## *Question 4 (c)*

The majority of candidates were able to recall the observation of ships disappearing over the horizon or the Earth's curved shadow on the surface of the Moon during a lunar eclipse, although some mis-read the question and offered more modern observations such as photographs from satellites.

## *Question 5 (a)*

Although using the Great Square of Pegasus to find the Andromeda galaxy and the star Fomalhaut are both listed in the Specification, a surprisingly high proportion of candidates were not able to complete either of these tasks correctly.

## *Question 5 (b)*

A number of candidates thought that the Ancient Greeks were the first to discover the stars in this constellation.

## *Question 5 (c)*

Many candidates were aware that Charles Messier produced a list of objects which were clearly not stars. It was encouraging to see that a significant number of candidates also knew (in addition) that this was to assist with his search for comets.

## *Question 5 (d) (ii)*

This question was intended to test candidates' understanding of the definition of absolute magnitude, although many attempted a solution using the distance-modulus equation.

## *Question 7 (a)*

This subjective sketch drawn by eye, with its natural inaccuracies and omissions, represented a rather more challenging labelling task than a photograph. Nevertheless, most candidates were able to identify three named features, with the Sea of Tranquillity, Sea of Crises, Apennine Mountains and Tycho crater being the most common.

7 Sarah made the drawing of a gibbous Moon shown in Figure 3.

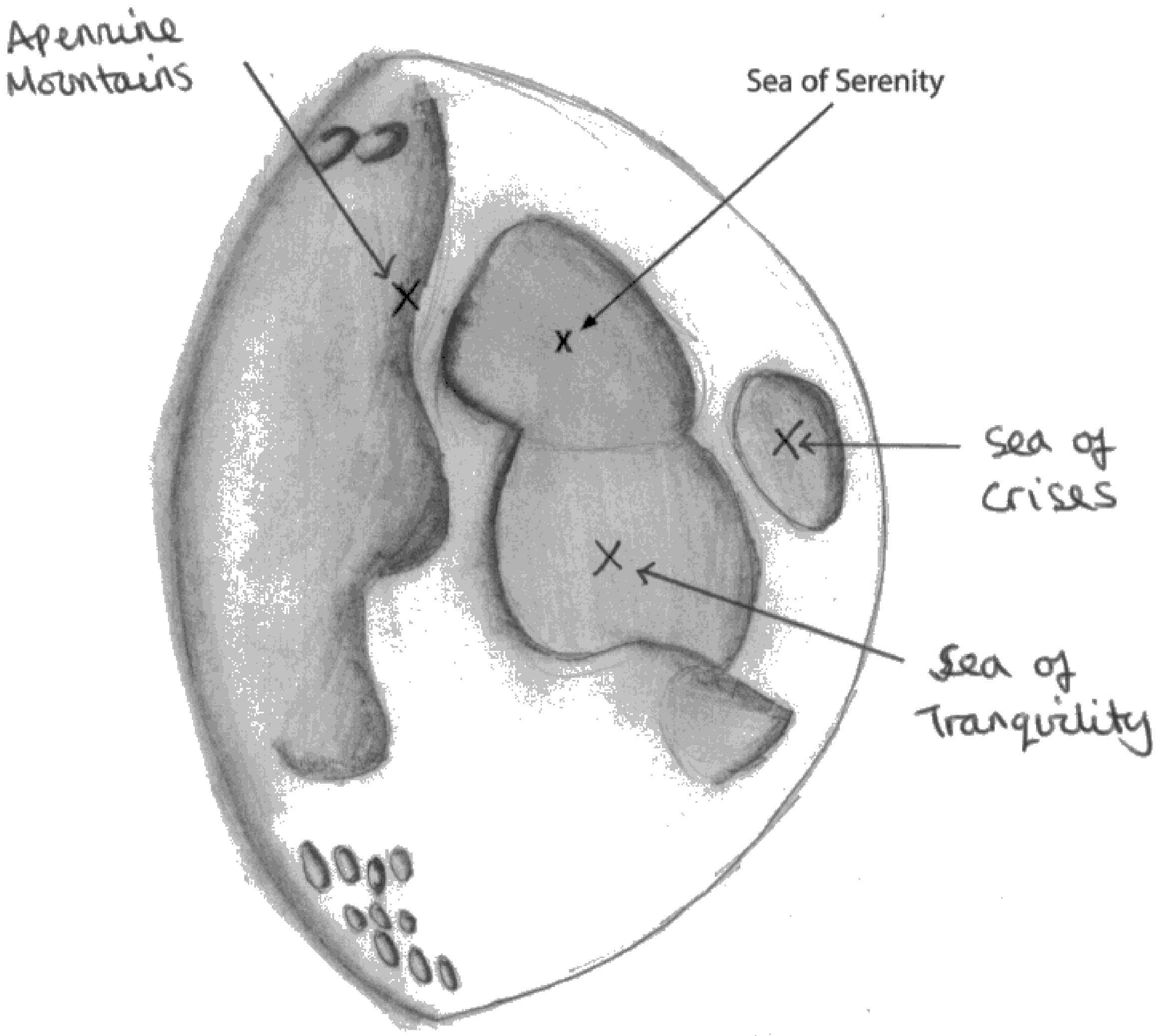


**Figure 3**

(a) Label on Figure 3 the position of **three** named lunar features.

The position of the Sea of Serenity has been labelled for you.

**(3)**

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**Examiner Comments**

This response gained full marks as it clearly identified three further named lunar features.

## Question 7 (b)

A number of candidates attempted answers centred on the lower light level or smaller amount of the lunar surface being illuminated, ignoring the eye's ability to adapt to different light levels.

## Question 7 (c)

Unusually the key astronomical point required by this question proved easier to establish by writing rather than by diagram, i.e. that the Moon's orbital and rotational periods are the same. A number of candidates' answers ended up essentially re-stating the question by pointing out that the Moon always presents the same face to the Earth.

(c) Even though Sarah waited for over one month, she was only able to draw half of the Moon's surface.

Explain why we can only ever see about half of the Moon's surface from Earth.

You may use a carefully-labelled diagram to support your answer.

(2)


The moons rotational and orbital periods are the same this means that as rotates it orbits at the same time causing the same side of the moon to always face us.

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**Examiner Comments**

The diagram accompanying this response illustrates the difficulty of clearly explaining the Moon's captured orbit. Fortunately the accompanying text clearly establishes that the Moon's orbital and rotational periods are the same, thus securing full marks.

### *Question 8 (a)*

It was important for candidates to establish that the Greek letters denoted the order of brightness as viewed from the Earth. Hence mention of luminosity or absolute magnitude were not appropriate.

### *Question 8 (b)*

Almost every candidate was able to identify the Big Dipper or the Plough within the constellation of Ursa Major, although the spelling 'Plow' is to be discouraged.

### *Question 8 (c)*

This question allowed candidates to demonstrate their level of astronomical ability by the depth of the explanation which they provided.

Most candidates were able to explain that these two stars would be circumpolar from Egypt and a good proportion were able to go on to say that it was related to their high declination. Candidates scoring full marks were also able to show that this was because their declinations both exceeded the co-latitude of Egypt (60°).

(c) Two of the brightest stars in Figure 5 are Phecda (γ in Ursa Major) and Kochab (β in Ursa Minor). Their coordinates are shown in Table 1.

| | Right ascension (h : min) | Declination (°) |
|---|---|---|
| Phecda | 15h 20min | 72° |
| Kochab | 14h 50min | 74° |

**Table 1**

The Ancient Egyptians referred to these two stars as the 'Eternal' or 'Immortal' ones.

Egypt has a latitude of around 30°N.

Explain, using **astronomical** information from Table 1, why they gave them this name.

(3)

Because the declination is above Egypts latitude the two stars will not ~~set~~ ~~beyond~~ beyond the horizon and will always be in the sky for egyptians and thats why they called them eternal or immortal

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**Examiner Comments**

This response comfortably gains a mark for pointing out that neither star will set for observers in Egypt as they are circumpolar and a second mark for suggesting that this is due to their declinations. However, the full explanation required candidates to show that each star's declination was greater than Egypt's co-latitude (90 – latitude).

Because if a stars declination is bigger than 90 - their latitude, they are circumpolar - they don't dip beyond the horizon. Declination > 90 - latitude:

Phecda = 72 > 90 - 30

circumpolar ← 72 > 60

Kochab = 74 > 90 - 30

circumpolar ← 74 > 60

**(Total for Question 8 = 5 marks)**

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**Examiner Comments**

This explanation gains all three marks by showing clearly how each star's declination exceeds the observer's co-latitude (90 - latitude), making them both circumpolar.

## *Question 9*

This question gave candidates four opportunities to replace terms within a rather loose description of the Chelyabinsk fireball with more specific astronomical terms.

A surprising number of candidates did not appreciate that the statement regarding its origin from outside the Solar System was simply incorrect.

Most candidates replaced the term ‘brightness’ with ‘magnitude’ or realised that a meteor as bright as this would be classed as a fireball.

Almost all candidates realised that the term ‘shooting star’ is a colloquial one and replaced it with meteor or fireball.

The majority of candidates appreciated that a meteor which has reached the Earth’s surface should be referred to as a meteorite.

## *Question 10 (a)*

Although many candidates struggled with exact spelling, the term Aurora Borealis was generally widely known.

## *Question 10 (b)*

There were many good attempts at describing this complex process, making effective use of specialist terms and clearly identifying the role of the Solar Wind and the Earth's magnetic field.

As is often the case when candidates are required to provide lengthy explanations, some candidates did not write in sufficient detail to gain all the available marks.

## *Question 10 (c)*

The fact that the photograph in Figure 7 was taken using a long exposure was well understood by candidates although significantly fewer showed an understanding of the fact that the stars' apparent motion was caused by the rotation of the Earth, as required for the second mark.

(c) Explain why the images of stars in Figure 7 are slightly curved lines, rather than dots.

(2)

Because it was a long exposure photo, it captured the movement of the stars.

**ResultsPlus**

**Examiner Comments**

This response gains one mark for identifying the use of a long exposure but would have needed to explain that the apparent 'movement' of the stars was caused by the Earth's rotation to gain the second mark.

## *Question 11 (a) (i)*

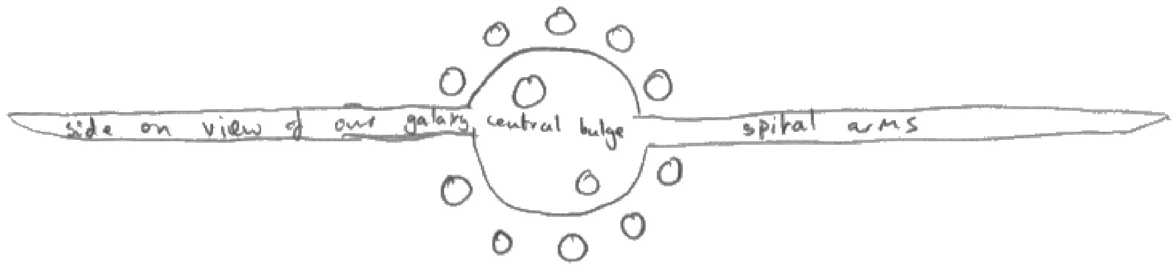
Although most candidates drew a reasonable sketch of the side view of our galaxy, the ‘halo’ of globular clusters was often so large that it almost covered the entire galaxy, thus losing the second mark in this question.

(a) (i) Where are globular clusters located in relation to the Milky Way?

Use a sketch of the Milky Way galaxy in your answer.

(2)

O = globular cluster




Globular clusters surround the central bulge in the halo of the galaxy but not in the central bulge.

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**Examiner Comments**

This response shows a recognisable side view of the galaxy, with globular clusters shown in a tight halo around the centre, thus gaining both marks.

## *Question 11 (a) (ii)*

A significant number of candidates did not take note of the question’ requirement of differences apart from location.

## *Question 11 (b)*

The majority of candidates identified the small angular size and faint magnitude of 47 Tucanae as potential difficulties for the observer with a pair of small binoculars. Despite the astronomical data given in Table 2, many candidates missed the opportunity to use specific astronomical terms such as 'magnitude' or 'angular diameter'. It was also common practice for candidates to suggest the use of a 'better' or 'more powerful' telescope, without using specific astronomical terms such as 'higher magnification' or 'larger aperture'.

A number of candidates gave excellent answers based around the low declination of 47 Tucanae in relation to Owen's latitude, correctly calculating that, even at culmination, it would be extremely close to the horizon.

Owen is observing from Costa Rica (Latitude = 10°N) using a small pair of binoculars. He is planning to make some detailed drawings of 47 Tucanae.

Identify **two** difficulties that Owen will encounter when making these observations and suggest a solution for each one.

(4)

Difficulty:

Very dim apparent magnitude so binoculars may not be sufficient

Solution:

Use a large telescope

Difficulty:

The cluster can only be seen in the southern hemisphere (dec −72°) whereas he is in the northern hemisphere (lat 10°N)

Solution:

Move further south, into the southern hemisphere

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**Examiner Comments**

Firstly, this candidate has correctly identified the cluster's faint apparent magnitude, which would make it appear dim through a small pair of binoculars. However, their solution is too vague to score a second mark – a phrase such as 'larger aperture' was necessary here.

Although they then correctly focus on the cluster's low declination, their statement that it cannot be seen from the northern hemisphere is incorrect. However, their suggestion of moving to a more southerly observing site is correct, thus gaining them a third mark.

## *Question 13 (a)*

The majority of candidates appreciated that the very small size of Phobos and Deimos would make them extremely difficult to observe from Earth, with some also pointing out that the bright light from Mars itself would hinder their observation even further.

Only a small number of candidates showed an understanding of the fact that their irregular rocky surfaces would mean that they would not be very efficient reflectors of light, in comparison to a planet with an atmosphere, such as Mars.

The planet Mars has two moons orbiting it – Phobos and Deimos. Although Mars can be seen with the naked eye from Earth, Phobos and Deimos were not discovered until 1877, using a large telescope.

(a) Explain why these two moons are so much harder to see than the planet Mars itself.

(2)

They are harder to see because they are much smaller. ~~them~~

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**Examiner Comments**

In common with many responses to this question, this example correctly identifies that Phobos and Deimos are much smaller than the planet Mars, without going on to provide any further reasons for the second mark.

## *Question 13 (b)*

Almost all candidates were able to recall that the two Martian moons are thought to be captured from the Asteroid Belt.

## *Question 13 (c)*

Despite the erratum in the data provided with this question, the majority of candidates identified the differing speeds of motion of the two moons, for an observer on the surface of Mars.

Many candidates did not explicitly state that both moons would appear to move relative to the background of the stars, leaving this implicit in their answer.

Despite the clear instruction in the question, a number of candidates included a description of the apparent sizes of the two moons in their answers.

## *Question 14*

The principle that this question rewarded the level of astronomical detail which candidates were able to include in their answers was generally well understood. Almost all candidates were able to identify the major disadvantages of attempting to send humans to the surface of Venus. Those scoring higher marks were able to express their ideas using scientific and astronomical terms and also to integrate the data provided in Table 4. The most effective answers were able to select the most relevant data from Table 4, rather than attempting to include all items.

The most effective discussions also prioritised the potential difficulties and focused mainly on the major issues to do with the atmosphere and the surface temperature and pressure, often leaving much more minor concerns such as differences in gravity and day length out altogether.

*14 Table 4 shows some information about the planet Venus.

| | |
|---|---|
| average distance from the Sun | 0.7AU |
| orbital period | 225 days |
| rotation period | 243 days |
| diameter (Earth =1 ) | 0.95 |
| gravity at surface (Earth = 1) | 0.91 |
| surface temperature (average) | 465°C |
| atmospheric pressure (Earth = 1) | 90 |
| atmosphere | 96% carbon dioxide<br>3% nitrogen |

**Table 4**

A group of astronomers wish to take some detailed measurements of surface conditions on Venus and are planning to send a manned mission to the planet.

Discuss some of the difficulties in sending a mission of this kind along with its advantages over sending a robotic probe.

Your answer should include information from Table 4.

**(6)**

One difficulty off Sending people to venus is that the average Surface temperature is 465°C So people Couldn't survive on the Surface. Another difficulty is the pressure is 90 times Stronger than Earths So it isn't possible for humans to go. There are advantages of sending humans since they can gather materials and more advanced data and bring it back to Earth whereas a probe would stay there. Another advantage of a manned mission is people can give a description of what it's like what the surface feels like wheras a robot cant.

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**Examiner Comments**

This response provides an example of the more discursive style of writing, containing specific astronomical terms and integrating relevant data from Table 4, which was required by the intermediate band of the Mark Scheme.

The surface temperature of Venus is an average of 465°c which is far too hot to consider landing human beings on the planet. Its atmospheric pressure, of 90 times that on the Earth is similarly too high for it to be safe to land on the surface.
The long rotation period would mean that any robotic probe,

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This response was placed in the lowest band of the Mark Scheme as it provides only a simple statement of some of the difficulties involved with a mission taking humans to the surface of Venus.

## *Question 15 (a)*

Some excellent descriptions of the nuclear fusion of hydrogen into helium in the core of the Sun were provided for this question. Many candidates included additional details, often from beyond the requirements of the Specification, illustrating their genuine interest in the subject. The most effective answers also explained why conditions at the core of the Sun allowed the fusion process to occur.

## *Question 15 (b)*

Most candidates were able to recall the evolutionary path of a solar-mass star, through red giant to white (and eventually black) dwarf.

(b) The Sun is known as a Main Sequence star.

Describe the stages of evolution it will pass through once it stops being a Main Sequence star.

(2)

The sun will become a red giant star and will then explode. It will then cool down to form a white dwarf

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**Examiner Comments**

This response gained two marks as it correctly identifies the red giant stage, followed by the white dwarf stage. The description of the process in between (exploding and cooling) is far from ideal but represents unnecessary additional detail which does not negate the marks awarded.

## *Question 16 (a)*

The three stages within the Giant Impact Hypothesis were generally widely appreciated by candidates, with some very effective 'flow chart' diagrams included to clarify the process. Some candidates were a little unclear about the middle stages of the process, giving answers which suggested that the Moon sprang fully-formed from the Earth as a direct result of the impact with 'Theia'.

## *Question 16 (b)*

There was widespread understanding of the fact that there are strong similarities between the rocks at the surface of the Moon and the Earth. However, the question asked for detailed descriptions of two (different) pieces of evidence. Consequently, only those candidates who included mention of specific details such as oxygen or KREEP isotopes gained the full two marks for their description.

The fact that the traditional 'capture' process for acquiring a moon is extremely unlikely to account for the Earth's Moon, was only offered by a few candidates, even though it lends strong support to theories such as the Giant Impact Hypothesis.

(b) Observation of the Earth and Moon system has produced evidence to suggest that the Giant Impact Hypothesis is correct.

Describe in detail **two** of these pieces of evidence.

**(4)**

1 The Earth and Moon have similar amount of Oxygen isotopes in their rocks.

2 There are KREEP rich rocks in more on the moon, which ~~was left behind by~~ contain the same substances as lava. from volcanoes on earth.

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**Examiner Comments**

This response gained the full four marks as it provided two distinct pieces of evidence, each with specific details provided.

1 The rocks collected from the moon are similar to the rocks on Earth.

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**Examiner Comments**

Although this example makes a correct statement, only one piece of evidence is given and no specific details are given, resulting in only one of the four available marks being awarded.

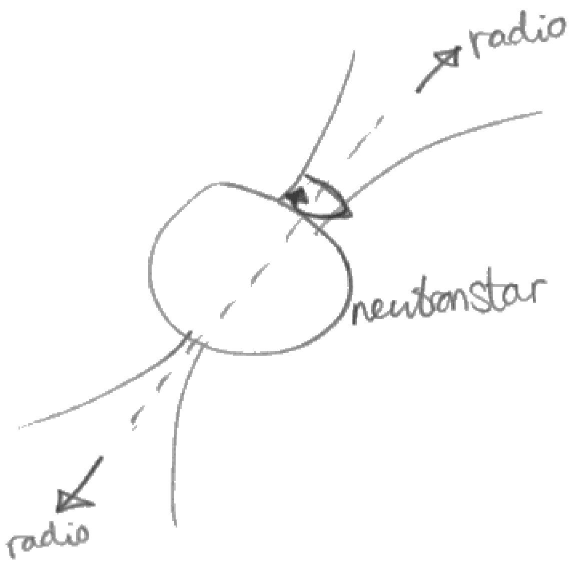
## *Question 17 (a)*

A surprising number of candidates thought that the pulsed signal received from a neutron star is due to actual pulsation in the star's output. Once again, a full explanation of the process by which we receive a pulsed signal often required quite detailed multi-stage diagrams, supported by detailed text, focused closely on the problem set out by the question.

(a) These radio waves are now known to come from a neutron star.

Explain why the radio waves from a neutron star appear as pulses when received on Earth. You may use a clearly-labelled diagram to support your answer.

**(3)**




Radio waves are emitted from poles as it spins on axes very quickly. ~~Extreamly~~ Very large gravity, so radio signals are sent at intervals.

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**Examiner Comments**

In common with many responses to this question, this example establishes the rotation of the neutron star and the fact that radio waves are only emitted from parts of its surface and thus gains two marks.

To gain the third mark, the diagram would need to include an indication of the direction of the Earth, thus fully explaining the pulsed nature of the received signal.

## *Question 17 (b)*

Most candidates identified the highly constant time period of the pulsed signal as more characteristic of an artificial signal. Far fewer also wrote about the constant signal strength.

## *Question 18 (a)*

The task of identifying the seven-day period of the star's variation proved extremely straightforward but a number of candidates failed to include the correct units (days) and thus gained only one mark out of the two available.

## *Question 18 (b) (i)*

This question required candidates to look up a magnitude value from a graph. No unit was required.

## *Question 18 (b) (ii)*

This question tested students' understanding of the magnitude scale and the inverse square law, as opposed to their ability to manipulate numbers in the distance-modulus equation. The three steps of reasoning required to answer this question made it very demanding, with only a small number of candidates successfully working through to the correct answer of 40pc.

On multi-stage calculations like this, it is obviously important that candidates show clearly their answer at each stage, if they are to achieve any partial credit. A large number of candidates gained no marks on this question as it was not possible for examiners to follow the stages in their working.

## *Question 19 (a)*

For this single mark, most candidates were able to recall one of the current pieces of evidence for the existence of Dark Matter, with the rotational velocity of the arms of spiral galaxies being the most popular.

(a) Describe **one** observation that astronomers have made that suggests the existence of Dark Matter.

(1)

~~The universe is even~~ Black areas between galaxies are solid.

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**Examiner Comments**

In common with the responses given by many candidates, this answer suggests that the candidate has a general awareness of some of the properties of Dark Matter but is unable to provide any correct and specific details, as required for the award of the mark.

## *Question 19 (b)*

Given its name, almost all candidates pointed out that Dark Matter does not emit any form of electromagnetic radiation but far fewer were able to give a second, different practical difficulty with its detection.

(b) Describe **two** practical difficulties involved in detecting Dark Matter.

(2)

1 It dosnt reflect light

2 It dosnt absorb or reflect radiation.

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**Examiner Comments**

A very popular style of response to this question was to essentially give the same reason twice, i.e. stating that Dark Matter does not emit/reflect light and that it does not emit/reflect any other form of electromagnetic radiation. Examples such as these therefore only scored one mark.

### *Question 19 (c)*

A number of candidates confused the evidence for Dark Energy with that for Dark Matter in their answers to this question. Some candidates, who clearly knew the answer to this question, did not write in sufficient detail or at sufficient length to gain both the marks available and the Quality of Written Communication mark available.

### *Question 19 (d)*

Dark Energy's effect of increasing the expansion rate of the universe was widely known, along with several of the terms which have been coined for the potential outcome for the universe, such as the 'Big Rip'.

## *Question 20 (a)*

The fact that the surface temperature of the Earth is mostly between 0°C and 100°C was a popular answer, although many candidates then struggled to give a second reason. Some enterprising candidates attempted to give 'temperature above 0°C' and 'temperature below 100°C' as two separate reasons, although this response was awarded only one mark.

The fact that the Earth lies in the Sun's Habitable or Goldilocks Zone was also accepted as a valid reason.

(a) State **two** reasons why liquid water is able to exist on the surface of the Earth.

**(2)**

1 because Earth is located in the habitable zone and so the temperature allows water to ~~exsist~~ exist in liquid form.

2 The Earth's gravity and atmosphere stop the water from floating or evapourating away.

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**Examiner Comments**

Any of the physical conditions on the Earth's surface which allow liquid water to exist were acceptable answers to this question, along with the use of specific terms such as the Habitable or Goldilocks Zone. This example therefore scored the full two marks.

## *Question 20 (b)*

In answering this question, there was wide awareness of the proposal that water was brought to Earth as a result of ice-bearing comets impacting the early Earth. As was often the case with extended questions such as these, a number of candidates did not provide sufficient depth or detail to justify the award of all the available marks.

## *Question 20 (c)*

The use of probes to compare the composition of ice on comets with ice on Earth was the most popular answer to this single-mark question.

## Paper Summary

Based on their performance on this paper, candidates are offered the following advice. Specific questions which illustrate each of these points are given in parentheses:

- Candidates should ensure that their answers are focused on the specific requirements of the question. They should not simply write a list of all the things that they know about the topic in question (Q.9 & 14)
- Candidates should pay close attention to the 'command' word at the start of each question such as, State, Describe or Explain. These words are always closely reflected in the Mark Scheme and should therefore be a guide to what is written in the candidate's answer. In particular, when a question asks for an Explanation, there will be little or no credit given for a Description. (Q.7b, 8c, 10c, 17a)
- In questions where a diagram forms part of the answer, full credit will only be given if it is carefully drawn (with a ruler where appropriate) and fully labelled (Q.4a, 10b, 16a, 17a)
- Candidates should avoid very general answers which could apply to a wide range of situations and include specific details wherever possible. (Q.7b, 11b, 14, 16b, 19a)
- Candidates should ensure that they make each stage in their calculations clear so that partial credit can be awarded wherever appropriate (Q.18bii).

## Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

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