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Examiners' Report
June 2019

GCSE Astronomy 1AS0 01

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Introduction

The 2019 set of papers for GCSE Astronomy represents the first examination of the new 9-1 GCSE Specification for the subject.

Whilst the majority of the subject content remains the same as in the previous specification, a number of new topics have been introduced in order to:

- provide greater challenge within the new 9-1 qualification, although some of the most challenging questions in the examination are set on existing material.
- improve the coherence and breadth of the material covered in several topic areas, thus helping to support high quality teaching and learning.
- strengthen the observational thread which runs throughout the subject, as emphasised by the group of leading UK astronomers who were consulted from the outset in the development of this specification.

The examination continues to be centred around non-tiered examination papers with the 3½ hours of examination time split between two papers:

- Paper 1 – Naked-eye Astronomy
- Paper 2 – Telescopic Astronomy

The subject content of each paper mirrors a similar division of material within the Specification.

The central focus on observational astronomy is very evident in these examination papers. Many questions are designed around presenting candidates with the results of an astronomical observation and asking them to process the information and arrive at scientific conclusions.

Other questions ask candidates to comment on the conclusions which other people, such as archaeoastronomers, have placed on astronomical data.

Uniquely amongst the scientific subjects studied at GCSE level, Astronomy allows candidates to experience working with a truly observational science, where some of the most incredible scientific advances in human history have been made despite the fact that basic scientific strategies, such as control of variables, are usually impossible.

It is clear from this year's examination that centres and their candidates have more than risen to the challenges of the broader specification and more demanding examination papers.

Despite the changes to the qualification, the enthusiasm and commitment that have always characterised those involved in the teaching and learning of GCSE Astronomy continues to be evident. Centres and their candidates are to be commended for the conspicuous hard work and dedication – often as part of an extra-curricular provision – that went into the preparation of this year's cohort.

Examiners were particularly impressed by the depth with which some candidates have mastered much of the material – and within a relatively short period of time. As is often the case with this subject, it is clear that for many candidates it represents a wider interest extending well before the examination.

Comprehensive *Topic Support Guides* have been produced to support teaching and learning in these new areas. These may be downloaded from the GCSE Astronomy pages of the Pearson website. As well as providing detailed subject knowledge, they contain worked examples and practice examination questions.

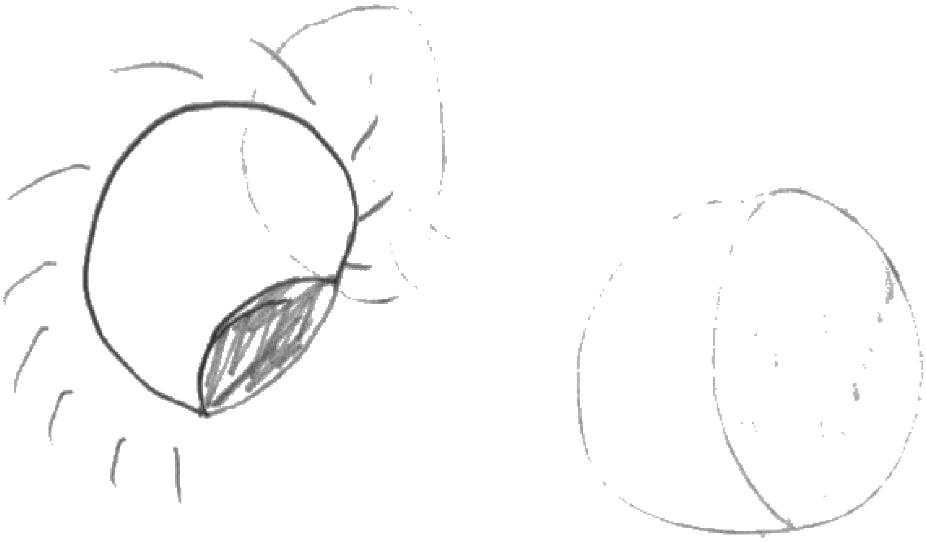
Although it may seem an obvious point, it was clear that a significant number of candidates lost marks because they did not understand the requirements of the question. In particular, candidates must play close attention to the 'command' word used at the beginning of each question. The command words invariably determine the structure of the mark scheme. Candidates should also note that the number of marks indicates the complexity required of the response: the more marks, the more lengthier or complex the response.

Question 1 (c)

This question was answered confidently by most candidates, suggesting that they had direct experience of images or videos of this astronomical event.

(c) Sketch the appearance of the Sun during a partial solar eclipse.

(1)



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Examiner Comments

Most candidates were able to provide a dark lunar disc partially obscuring a solar disc of similar radius. Shading or the use of rays were commonly used to identify the two discs. Some latitude was allowed in the marking of this question as candidates did not have access to compasses or circle templates in the examination.

Question 3 (a)

The majority of candidates were clearly familiar with this prominent constellation and thus able to locate the Orion Nebula (**O**) and the bright star Sirius (**S**) although some placings were very approximate indeed.

A number of candidates misread the instructions and attempted to identify the position of the Pleiades (P), which on this scale would have been comfortably off the top right hand corner of the examination paper.

3 (a) Figure 1 below shows part of the constellation of Orion.

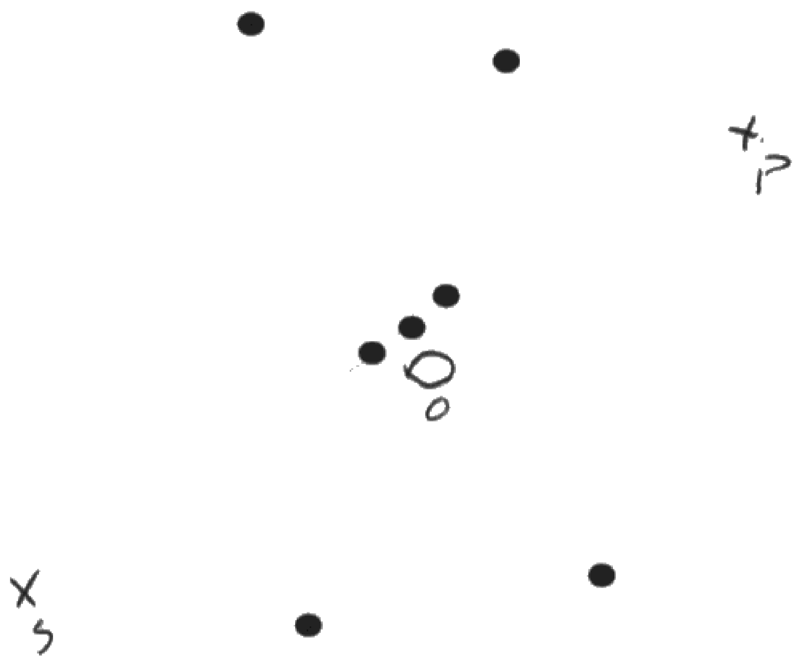

Figure 1

(i) Label the position of the star Sirius on Figure 1. Use the label **S**.

(1)

(ii) Label the position of the Orion Nebula on Figure 1. Use the label **O**.

(1)

(iii) Label the direction of the Pleiades cluster on Figure 1. Use an arrow labelled **P**.

(1)

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Examiner Comments

Although the positions of the Orion Nebula and Sirius are approximately correct, this candidate has attempted to label the position, rather than the direction, of the Pleiades.

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Examiner Tip

Always read the instructions on the examination paper carefully.

Question 3 (b) (i)

Although this question clearly asked candidates to comment on the suggestion that the Egyptian pyramids may not have been very carefully aligned with the stars by their builders, many candidates avoided gaining marks by writing about alternative explanations for their imperfect alignment with the stars in the belt of Orion.

A number of candidates gave highly equivocal answers which neither agreed nor disagreed with the suggestion.

(b) It has been suggested that the positions of the three large pyramids at Giza in Egypt (built around 2500 BCE) match the positions of the three bright stars in Orion's Belt.

Figure 2 shows a plan view of the three pyramids, along with the three stars of Orion's Belt.

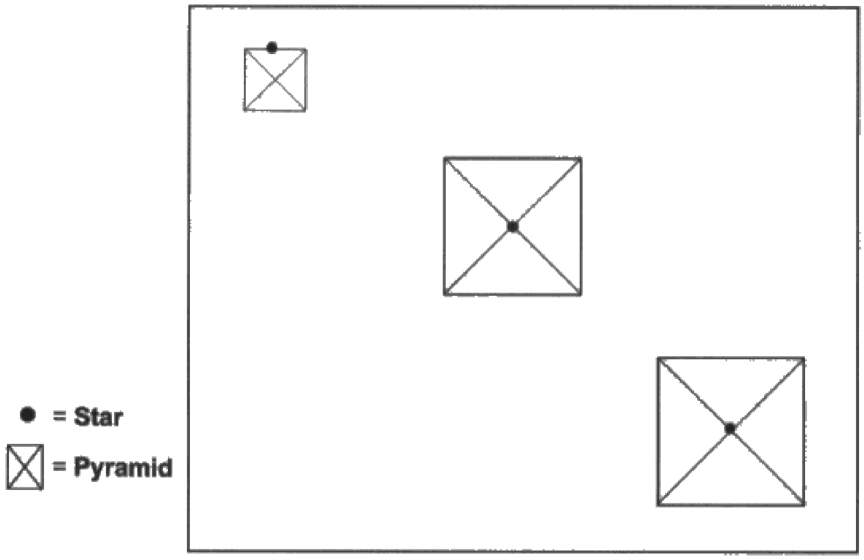

Figure 2

The positions of the stars and pyramids do not align exactly with each other.

Comment on each of the following possible explanations for this.

(i) The Ancient Egyptians did not position these pyramids very carefully.

(2)

This is most likely not true because the Ancient Egyptians where very skilled mathamaticians and would have spent years finding out exatly where the pyramids should go.

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Examiner Comments

This answer scored full marks as it indicated a clear opinion of the suggestion, backed up by evidence regarding the ancient Egyptians' careful use of astronomical alignments in the geometry of their monuments.

Question 3 (b) (ii)

A surprisingly large number of candidates did not seem to be aware of the large difference in timescale between the building of Egypt's pyramids and the stages in the life cycle of a typical star. Consequently, many responses to this question discussed irrelevant points such as rising and setting or even levels of light pollution.

Question 3 (b) (iii)

The third of this series of questions was designed to examine candidates' detailed understanding of precession, specifically its distinction from stars' proper motion. Many candidates were keen to accept the question's suggestion that this misalignment may be caused by precession but only a handful of candidates spotted that precession would move all three stars rather than a single star relative to the other two.

(iii) Because of precession, the stars would have lined up exactly with the pyramids when they were built.

(2)

This is probable but the all three Stars would be out of line not one So there fore i dont ~~believe~~ believe this is fully correct unless there were out of alignment originally

(Total for Question 3 = 9 marks)

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Examiner Comments

Although this candidate is very cautious of firmly disagreeing with the statement, this response is an example of the small number that correctly identified the reason why precession is highly unlikely to be an explanation for the lack of alignment.

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Examiner Tip

When asked to comment on or evaluate a statement, be brave. This will sometimes mean disagreeing with the statement or evidence which the question offers. Be confident about your astronomy and give a clear conclusion, one way or the other.

Question 4 (b)

The first mark in this question was simply for describing that the Sun would rise and set as usual, whilst the second required candidates to appreciate that the date and Alice's latitude would mean that the Sun would pass directly overhead at noon.

Although a diagram was optional, it was by far the most effective way of answering the question, although showing the Sun passing overhead is not straightforward in a diagram on a flat piece of paper and this tested the artistic skills of many candidates.

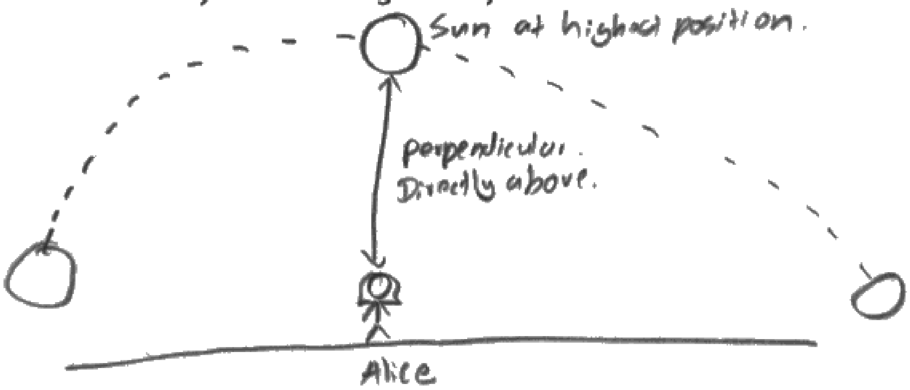
(b) Alice decides to observe the Sun throughout the day on June 21st.

Her location has a latitude of 23½° N.

Describe how the Sun appears to move across the sky from Alice's location on June 21st.

You may include a carefully labelled diagram in your answer.

(2)



The sun would rise from the horizon, moving to it's highest position, where it is ~~big~~ directly above alice, perpendicular to the ground. It will then continue to travel till it sets.

ResultsPlus

Examiner Comments

The two points of the Sun rising and setting and reaching Alice's zenith are both conveyed by this response, with the diagram playing a major role. Candidates who attempted to gain all the marks simply by a written description were usually only partially successful.

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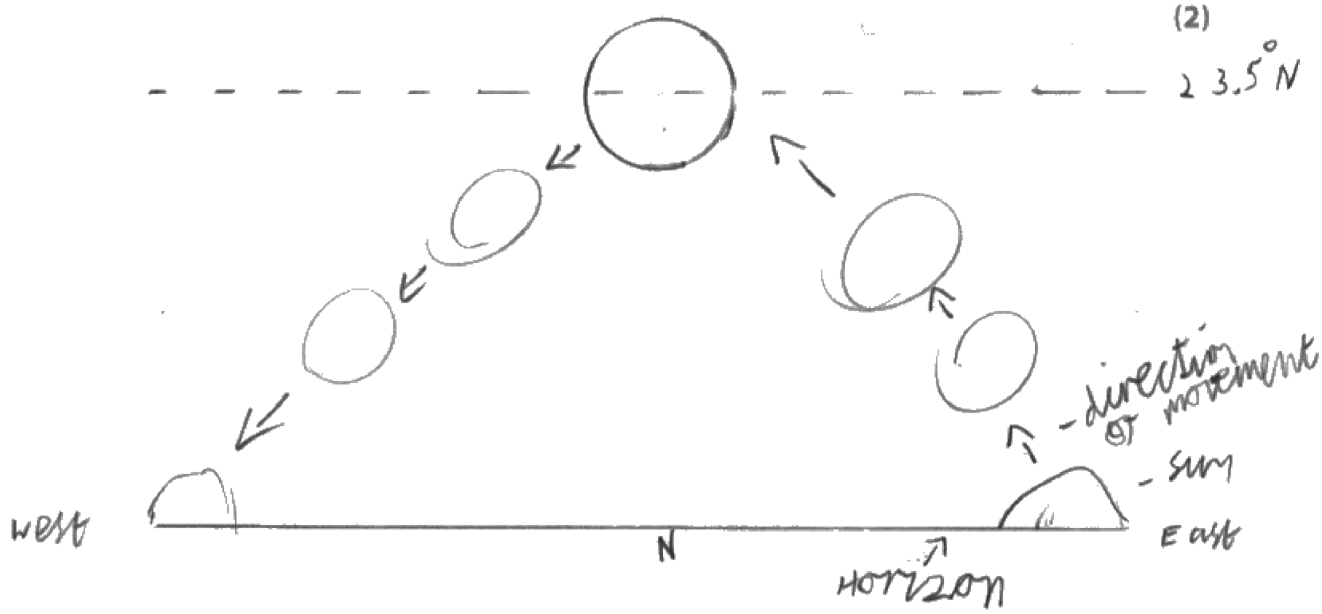
Examiner Tip

Whenever a 'carefully labelled diagram' is 'recommended' it is usually the case that full marks will be much harder to achieve without one.

(2)



The sun would rise due east and at midday the Sun would reach a ~~height~~ altitude of 23.5°N in the sky directly over head ~~due north~~ then set due west

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Examiner Comments

Although this candidate has clearly illustrated the idea of the Sun rising in the East and setting in the West, this is not supported by their diagram which has the Sun reaching its highest point when it is due North. In addition, they have not included the fact that the Sun will be directly overhead at noon for Alice.

Question 4 (c)

This question centred around the idea that the Sun is directly overhead at midday on the summer solstice for places on the Tropic of Cancer and hence one might expect the Sun to be in this constellation. Explaining this idea gained full marks with one mark available for candidates who had realised that Alice was standing on the Tropic of Cancer.

It is clear from this question that many candidates are aware of the location of the tropic of Cancer but significantly fewer can explain its astronomical significance.

(c) Explain the astronomical reason for her statement.

(2)

Yes this would make sense as the sun is moving through the tropic of Cancer

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Examiner Comments

This candidate has realised that the question is to do with the Tropic of Cancer but has not really explained the astronomical reason why, thus gaining one mark. In common with many candidates they have written about the Sun passing through the Tropic of Cancer instead of the Sun passing overhead for observers on the Tropic of Cancer.

A clear explanation of this second mark proved to be one of the most demanding marks on this year's paper.

Question 4 (d)

Many candidates realised that point ‘S’ had moved from the constellation of Cancer to that of Gemini as the result of precession, although only a minority could explain clearly how it caused this shift. The question already states that point ‘S’ is not in the constellation of Cancer and so no marks were available for re-stating this.

Once again, the second mark proved to be a demanding one, requiring candidates to talk about the shift between the celestial poles/equator/ecliptic (and thus point ‘S’) and the background of the stars and their constellations. Centres preparing candidates for this examination in the future should ensure that this point is fully explored.

Question 4 (e)

This question required candidates to give the reason why a constellation would be classified as zodiacal, i.e. by being on the ecliptic or having the Sun pass through it during the year. Repeating the question by stating that it was in the zodiacal band was insufficient for the award of this single mark.

Question 5 (b)

This question was correctly completed by most candidates as it simply required multiplication of the two figures derived by Aristarchus (19 x 175,000) to obtain 3,325,000km, sensibly rounded to 3,300,000 by many candidates.

Question 5 (c)

Most candidates were able to complete this calculation successfully as it reminded them of the equation for calculating percentage error and thus simply required them to look up the correct Earth-Sun value from the Formulae and Data Sheet.

The extremely high final answer (97.8%) clearly confused some candidates who subtracted it from 100% to give 2.2%.

(c) Calculate the percentage error in this value for the Earth-Sun distance.

Use the equation:

$$\text{Percentage error} = \frac{(\text{Calculated distance - true distance})}{\text{True distance}} \times 100\%$$

(2)

$$\frac{3325000 - (1.5 \times 10^8)}{1.5 \times 10^8} \times 100 = -97.783$$

Percentage error = 98%

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Examiner Comments

This candidate has used the equation given on the paper to provide a clear first line for their working, has correctly substituted a correct Earth-Sun value from the Formulae and Data Sheet to arrive at the correct answer, sensibly rounding it to 98%.

Question 5 (d)

The extremely high percentage error given by the Earth-Sun value calculated in this question was intended to provide fertile ground for candidates to suggest some specific areas in Aristarchus' method which could easily be improved.

Consequently, marks were awarded for points specific to this method rather than general statements such as 'observe more carefully' or 'take more readings'.

(d) State **two** major causes of inaccuracy in Aristarchus' value for the Earth-Sun distance.

(2)

1 Measuring with the moon at First Quarter Phase

2 Incorrect Earth-Moon distance

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Examiner Comments

It is clear that this candidate has identified two issues specific to Aristarchus' method but has not written in enough depth to make each one sufficiently clear.

There are several observational issues with taking a measurement of the Earth-Moon-Sun angle at the quarter phase but it is not clear from this answer which specific issue is intended.

Their second point, although tersely phrased, does identify that the very inaccurate/almost 'incorrect' value used for the Earth-Moon distance lies at the heart of the high percentage error obtained earlier.

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Examiner Tip

Specific points are always more likely to score marks than very general statements. Always try to make sure your answers relate directly to the question being asked.

Question 6 (a) (i)

This question simply required candidates to establish that culmination involved an astronomical object being due south/crossing the meridian/reaching its highest point in the sky.

The second mark was for a suitably labelled diagram supporting this idea.

A large number of 'diagrams' were insufficient because they had very little or no labelling, often consisting of a horizontal line with a star drawn in the middle of a curve above it. Either the horizon or the star's path across the sky (preferably both) needed to be labelled for this mark to be awarded.

6 The Greek astronomer Posidonius made the following observations of the bright star Canopus:

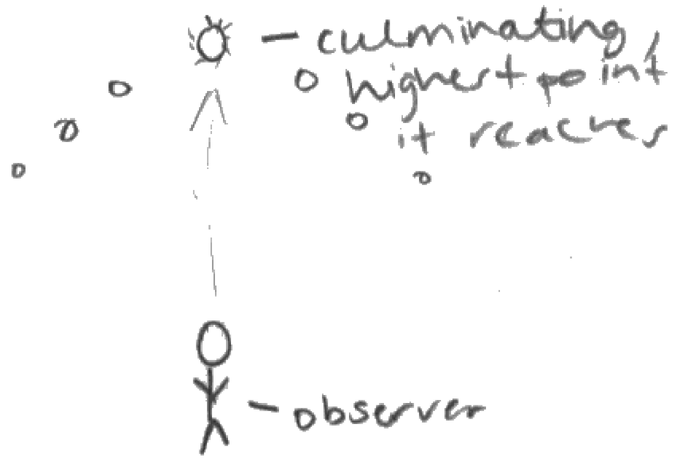
- looking due south from the island of Rhodes, he noticed that Canopus was only just visible on the horizon
- from the city of Alexandria the star Canopus reached an altitude of 7½° when it culminated.

Posidonius estimated that Alexandria was 600 km south of Rhodes.

(a) (i) Describe what is meant when a star is said to 'culminate'.

Use a clearly-labelled diagram in your answer.

(2)



When a star culminates, it's at the highest point in its path.

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Examiner Comments

This very simple diagram is successful as a result of meaningful labelling. Without labels it would convey very little meaning but with them it was more than adequate to establish both marks of this two mark question. The first mark ('highest point in sky') is also established by the text beneath.

ResultsPlus
Examiner Tip

Always label all parts of your diagrams.

Question 6 (a) (ii)

Most candidates identified that Canopus's differing altitude was due to the curvature of the Earth, i.e. the different latitudes of Rhodes and Alexandria, although some confused this with longitude or the cities' different altitudes.

Question 6 (a) (iii)

Many candidates clearly realised that this question involved the same calculation as the more famous one carried out by Eratosthenes, using observations of the Sun at Alexandria and Syene.

The first step of calculating that the 7½° difference in altitude represented 1/48th of the Earth's circumference was widely understood, although some candidates did not make this clear in their working. Most candidates then went on to combine this with the 600km in the question to produce the correct estimate for the Earth's circumference.

(iii) Calculate a value for the circumference of the Earth using Posidonius' observations.

Show your working clearly.

(2)

horizon = 0°

$360 \div 7.5 = 48$

$600\text{ km} = \frac{1}{48}$ th of circumferance

$600 \times 48 = 28800\text{km}$

Circumference = 28800 km

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Examiner Comments

A textbook solution. As well as providing the correct answer, this solution contains a diagram and each step is clearly set out along with some explanation for the mathematical steps.

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Examiner Tip

Answers set out in this way will always score the maximum mark possible, even if the final answer is not correct.

Question 6 (a) (iv)

As in Q5(d), improvements specific to this particular observation were required and very general suggestions such as 'take more careful measurements', 'use better equipment' were insufficient.

Surprisingly few candidates suggested moving south on the Earth or using stars with a more northerly declination in order to avoid taking all measurements so close to the horizon.

(iv) State **two** ways that Posidonius could have improved the accuracy of his observations.

(2)

1 Measured the distance between Rhodes and Alexandria more accurately

2

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Examiner Comments

Many candidates noticed that Posidonius was working with an **estimate** of the distance between Alexandria and Rhodes and could thus improve his final result with a more accurate measurement of this distance.

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Examiner Tip

Keep your answers as **specific** as possible to the particular details in the question.

Question 6 (b)

This calculation followed in the footsteps of later cartographers who essentially performed Eratosthenes' method in reverse to obtain very accurate measurements of the distances between points on the Earth's surface.

Their more accurate angular difference of 5.2° showed that the Rhodes-Alexandria distance in fact represents 1/69th of the Earth's circumference [first mark] giving a more accurate value of 580km [second mark] between them.

(b) Once the circumference of the Earth had been measured accurately, a similar method was used to find the distance between places on the Earth.

Two astronomers carefully measure the altitude of a bright star.

One astronomer is in Rhodes and the other is in Alexandria.

Their measurements are different by 5.2°.

Calculate the distance between Rhodes and Alexandria. → x

Use the data above and a value of 40 000km for the Earth's circumference.

(2)

$$\frac{5.2}{360} = \frac{x}{40000} \quad \text{(}x \rightarrow \text{distance)}$$

$$x = \frac{5.2}{360} \times 4000$$

$x = 577.\dot{7}$ km

$= 578$ km (3sf)

Distance = 578 km

(Total for Question 6 = 9 marks)

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Examiner Comments

A clear and correct solution. Although this was not assessed in this question, **two** significant figures (580km) would perhaps have been more appropriate, given the data in the question.

Question 7 (b)

The two astronomical points required by this question were not well understood by this year's cohort of candidates. A number of candidates misread the question and simply described the Equation of Time as the difference between mean and solar time.

Although a number of candidates knew that this difference is caused by the eccentricity and inclination of the Earth's orbit, only a small number were able to relate this to the Sun's apparently changing speed across the sky during the year and thus gain full marks.

A common misconception was that it was related to the tilt of the Earth's axis.

Question 7 (c)

As set out in the Mark Scheme, the major determinant of the final mark in this question was the quality of the observing programme presented in terms of identifying key parameters and taking accurate observations.

Consequently, candidates should be encouraged to read through their answers before moving on to the next question to ensure that they have described a feasible observing programme in sufficient depth.

Many candidates' answers would have benefitted from being presented as a series of bullet points so as to make the exact actions and their sequence unambiguous. Adding a few bullet points under the heading of 'Accuracy' which listed actions specifically designed to improve accuracy would also have improved the marks of a number of candidates.

In addition, some candidates gave responses which were only a line or two in length which did not provide sufficient evidence for the award of marks at the higher levels within the Mark Scheme.

(c) An observer wishes to make some measurements of the size of the Equation of Time, to show how it changes during the year.

Design a suitable observing procedure that will allow the observer to produce a series of measurements of the Equation of Time at different points in the year.

(6)

- Record the local and apparent time at the same location using a clock and sundial.
- Take repeat readings of these

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Examiner Comments

Although this candidate is describing a viable approach to the problem, there is a complete lack of a detailed observing programme. Consequently, although it is clear that the candidate has some understanding of the astronomical principles here, the shortness of their answer means that their mark on this question does not reflect it. To progress further in the Mark Scheme, the candidate would need to give some indication of **how** they plan to measure these two times, along with some strategies for ensuring accurate results.

The use of bullet points has helped to ensure some clarity in their answer and is a practice to be recommended.

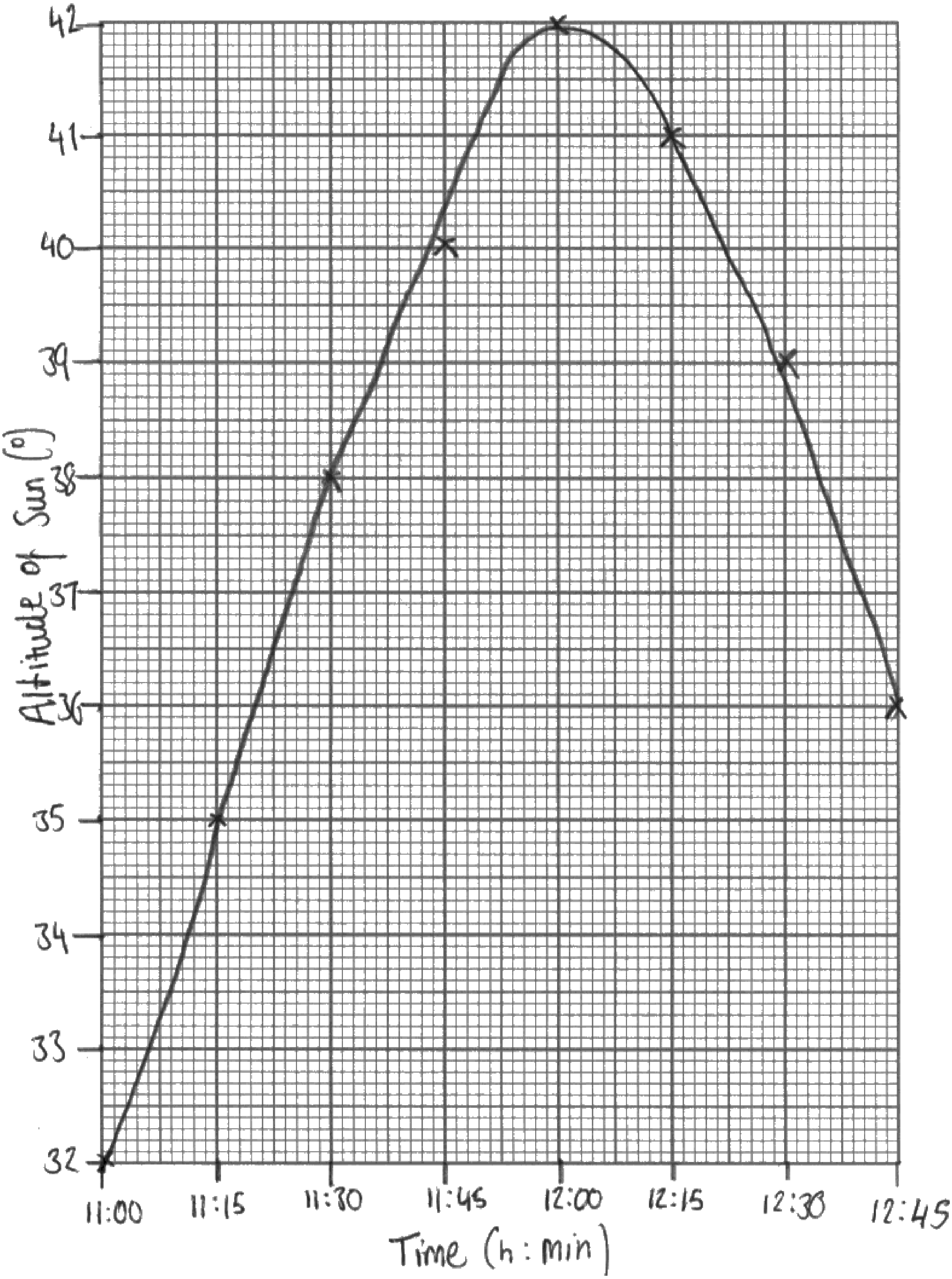
Question 8 (a)

A substantial number of marks were available here for producing a clear and accurate graph of the points provided. The most commonly lost marks were:

- Confusing the dependent (altitude) and independent (time) variables and thus interchanging them on the axes.
- Not labelling each axis with both its quantity (time or altitude) and unit (h:min or °).
- Deciding upon a suitable scale which made full use of the available graph paper.
- Wasting five or ten squares of graph paper around two edges of the rectangle provided by not writing numbers and labels on the white paper surrounding it.
- Not marking points as small crosses or dots.
- Not drawing a smooth curve through the points. Drawing short straight lines between successive points was unfortunately quite common.

(a) Plot a graph of the measurements in Figure 6.

(3)



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Examiner Comments

An excellent example, comfortably gaining all three marks.

Question 8 (b)

The overall quality and clarity of the evaluation were the principal determinants of the mark awarded for this question, as set out in the Mark Scheme.

Once again, many candidates did not score as highly on the Mark Scheme as their answers contained only general points about producing accurate observations and did not focus on the specifics of the situation presented in the question.

A surprisingly small number of candidates noticed that the calculation of latitude presented in the question is incorrect. The astronomer has calculated the altitude of the Celestial Equator, which is equal to their co-latitude, not their altitude.

(b) Evaluate the accuracy of the astronomer's value for his ship's latitude, based on the observational procedures he has used.

(6)

I think that the astronomers accuracy ~~could~~ should be improved because he measured Altitude of the sun every 15 minutes and so when he got his maximum value, there isn't enough data close enough to the value at 12:00 to be sure that the peak altitude of the sun that day was 42°. He should have recorded the altitude of the sun every 5 mins, which would have produced a much more accurate curve of best fit and so would have shown a better peak altitude. looking at the points either side of the peak altitude, you can ~~deter~~ ~~infer~~ deduce that ~~would have~~ the Peak altitude of the sun would have occured after 12:00. Therefore I think that his result of latitude is too low and that it should be higher. Also his Altitudes were measured to 2 significant figures, which could be improved to 3 s.f.

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Examiner Comments

This candidate has identified one of the ‘major inadequacies’ of the astronomer’s results and has ‘linked it to a particular shortcoming of the method used’ – characteristic of a Level 2 answer. The Level 2 status of the answer is strengthened by their use of ‘relevant astronomical theory’, along with feasible suggestions for improvement.

The candidate could have gone on to explore other issues with the latitude calculation.

Question 8 (c)

Most candidates were able to perform the conversion between time difference (between mean and solar time) and longitude in part (i). A number were confused as to whether their answer of 20^o indicated that the ship had travelled east or west resulting in some candidates calculating 110^oW for part (ii).

(c) The astronomer's ship has been sailing for several days.

When it is local noon at the ship's location, an accurate clock on board shows that it is 13:20 at its home port.

(i) Calculate how many degrees of longitude the ship has covered since leaving its home port.

(2)

1:20 = 80 minutes

$\frac{80}{4} = 20^\circ$

Answer = 20 °

The ship's home port has a longitude of 130° W.

(ii) Calculate the ship's current longitude.

(2)

130 − 20 = 110 W

Answer = 110° W

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Examiner Comments

Although a straightforward calculation, the steps are presented clearly in this correct solution.

Question 9 (a)

A large number of candidates spotted that Aldebaran's right ascension can be obtained by subtracting its hour angle from the local sidereal time and thus gained the first mark in this question. However, only a small proportion of these candidates were able to give an astronomical reason for this and even fewer could provide a clearly labelled diagram to illustrate it.

Drawing diagrams to illustrate quantities such as hour angle and right ascension is not straightforward and is clearly a skill which future candidates would be well advised to practise beforehand. As the examples below show, even the highest scoring candidates had some difficulty achieving this third mark.

Candidates are advised to ensure that they have labelled all relevant parts of their diagrams such as the observer's horizon and meridian, Aldebaran's hour circles and position of the First point of Aries. All angular distances between these items should then be clearly and unambiguously marked so that the relationships between them are firmly established.

Judging by the efforts of candidates this year, trying to draw diagrams such as these in '3-D' is probably best avoided. Imagining the area of sky above the horizon either side of the observer's meridian as a large sheet of graph paper is probably the best technique in questions of this kind.

9 An astronomer observing from Rome sees the star Aldebaran setting. The local sidereal time (LST) is 10:42 and the star's hour angle (HA) is 06h 06min.

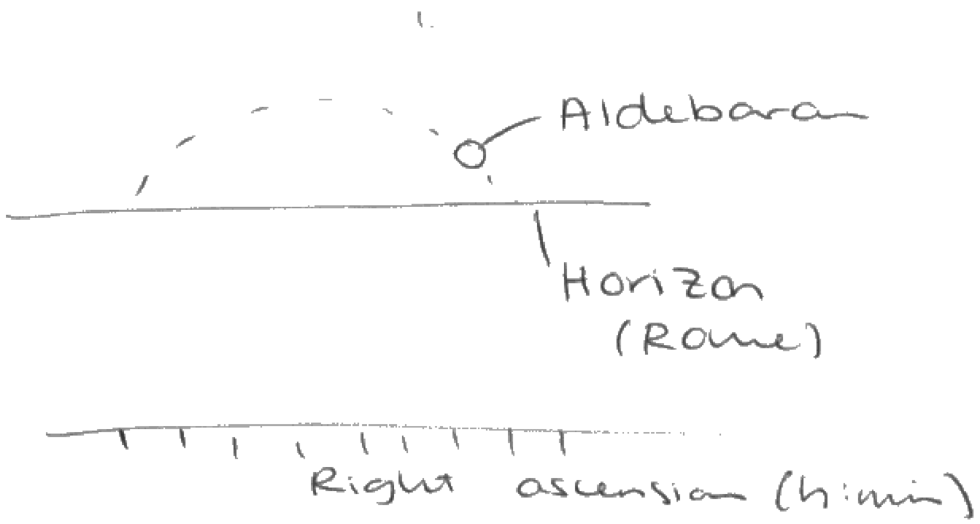
Rome has a latitude of 42°N and a longitude of 12°30′E.

(a) Show that Aldebaran has a right ascension (RA) of 04h 36min.

Use the observational data given above.

Include a carefully labelled diagram in your answer.

(3)



Hour Angle = LST − RA

= 10:42 − RA

RA = 10:42 − 06:06

= 04:36 → 04h 36 min

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Examiner Comments

In common with the work of many candidates on this question, this response shows the correct relationship between LST, HA and RA and has used it to produce the correct Right Ascension for Aldebaran. However, the diagram (required by the question) does not show how these three angles relate to each other.

Question 9 (b)

The calculation which would yield Aldebaran's declination was less obvious from the data in the question than that in 9(a), making this question rather more difficult.

Rome's co-latitude (48°N) gives the altitude of the Celestial Equator on the meridian. For Aldebaran to have an altitude of 64° 30' it must therefore lie 64° 30' – 48° = 16° 30' above the Celestial Equator.

The angles in this question are probably best represented in a diagram as distances up the observer's meridian. Once again, many candidates had great difficulty drawing a convincing diagram of the situation, for similar reasons to those discussed in Q9(a).

(b) The astronomer waits until Aldebaran is due south and measures its angle above the horizon as 64° 30'.

Show that Aldebaran has a declination (Dec) of 16° 30'.

Use the observational data given above.

Include a carefully labelled diagram in your answer.

(2)

Altitude – latitude which Aldebaran would culminate = declication ~~= 16° 30'~~

64°30' – 48 = 16°30'

ResultsPlus
Examiner Comments

Although this candidate has not given the correct relationship between altitude, latitude and declination in this case, they have correctly used Rome's co-declination to produce the correct declination. This response therefore scored one mark out of two.

Question 9 (c)

This question also centres around understanding that the altitude of the Celestial Equator will be the same as the observer's co-latitude – 38° 15'. Aldebaran's declination will put it a further 16° 30' above the Celestial Equator.

The number of candidates who appreciated this was relatively small. They were often the candidates who had drawn a rough sketch of the key angles in the space provided as visualising their interconnections was crucial for success in this question.

(c) The astronomer contacts a colleague in Oxford and tells her the right ascension (RA) and declination (Dec) of Aldebaran.

Oxford has a latitude of 51° 45' N and a longitude of 1° 15' W.

Calculate the highest altitude that the star Aldebaran will reach, as seen by the astronomer in Oxford.

(2)

90 − 51 45 + 16

38°15' + 16°30'

Altitude = 54 ~~62~~ ° ~~15~~ 45'.

ResultsPlus
Examiner Comments

This type of question, which requires candidates to visualise positions on the Celestial Sphere, is always best approached with the aid of a diagram. This candidate has worked in this way and has successfully achieved the correct answer.

ResultsPlus
Examiner Tip

Diagrams can be extremely useful, even when the question does not supply one.

Question 9 (d)

Q9(d)(i)

Local Sidereal Time is equal to the right ascension of any object's on the observer's meridian. In this question it will therefore be equal to the right ascension of Aldebaran.

Q9(d)(ii)

Since Local Sidereal Time starts when the First Point of Aries crosses the meridian it will also be equal to the hour angle of the First Point of Aries, giving the same answer as in part (i). Credit was given to candidates who had the wrong answer for (i) but had identical answers for parts (i) and (ii).

Question 10 (a) (i)

Many candidates were able to achieve the first two marks on this question by showing the relative positions of the Earth, Moon and Sun during a lunar and a solar eclipse. However, to complete the explanation candidates needed to make explicit the fourteen days needed for the Moon to move between these positions, rather than expecting the marker to draw this inference for themselves.

10 (a) Figure 7 shows a sign marking one of the places in the north of the United Kingdom where a total solar eclipse was visible on 29th June 1927.

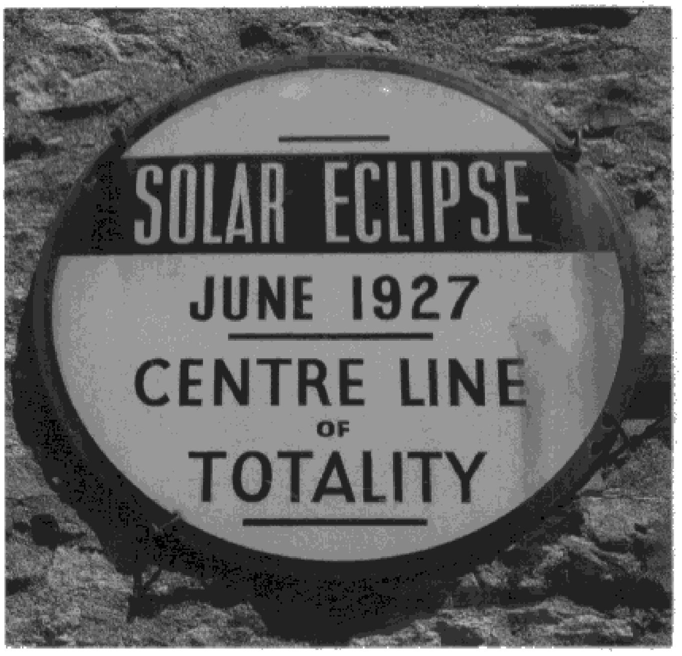


Figure 7

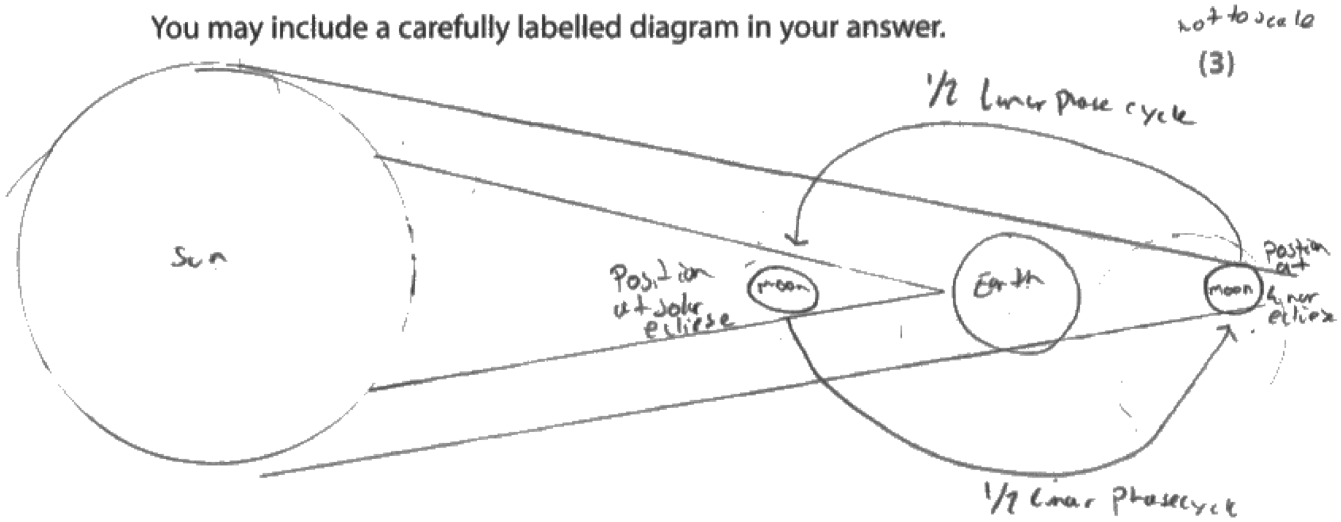
14 days earlier, on 15th June 1927, a total lunar eclipse was visible from a quarter of the Earth's surface.

(i) A total solar eclipse can happen exactly 14 days after a total lunar eclipse.

Explain this statement.

You may include a carefully labelled diagram in your answer.

(3)



a lunar phase cycle takes 29.5 days. ~~it take~~ a sidereal month is 27 days. it takes 14 days for the moon to travel from having the earth in between it and the sun (the position at which a lunar eclipse can occur) ~~and~~ to being directly in between the sun and earth (the position at which a solar eclipse can occur).

ResultsPlus
Examiner Comments

This response established the positions of the Earth, Moon and Sun during a lunar and a solar eclipse. It also showed clearly the Moon's approximately fourteen day journey between these positions. Although some of the rays of light drawn in the diagram are a little confusing, effort in producing a diagram which directly answers the question has paid off.

Question 10 (a) (ii)

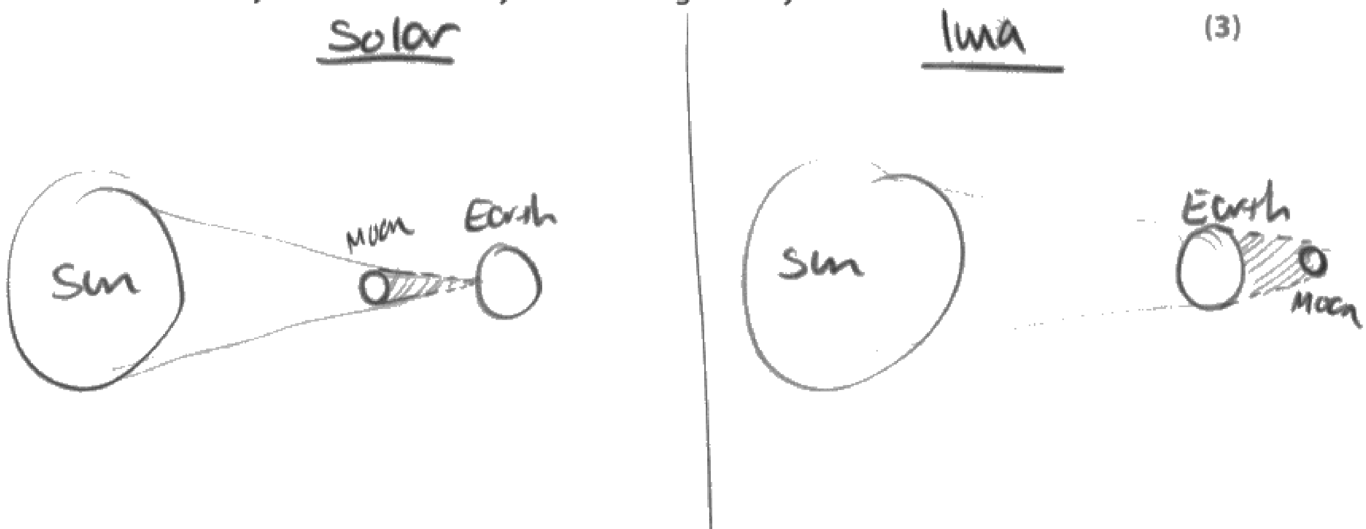
The key to this question was in identifying the different shadow cones involved in a lunar and solar eclipse. Carefully labelled diagrams of these will show why a solar eclipse can only be seen from a small area of the Earth whereas a lunar eclipse is much more widely visible. The most effective diagrams highlighted the parts of the Earth's surface from which each eclipse would be visible. Some candidates tried to combine the two diagrams into one, with a Moon drawn on both sides of the Earth, which was not always successful in supporting a clear explanation.

(ii) A total solar eclipse is only visible from a few places on Earth but a total lunar eclipse is visible from a large proportion of the Earth's surface.

Explain this statement.

You may include a carefully labelled diagram in your answer.

(3)



As in a solar eclipse the shadow of the moon is very small as the moon is smaller than Earth ~~be~~ so only covers small section of Earth. While during a solar eclipse Earths shadow is big so moon is in Earths shadow for more time and space and more area for people to see

as Earth > moon

more dark area

ResultsPlus
Examiner Comments

Although a relatively simple pair of diagrams, all the key bodies are labelled and the different areas in eclipse are clearly shaded. This diagram provides a flying start for the following explanation, helping it to establish all three points required by the Mark Scheme.

ResultsPlus
Examiner Tip

A good diagram is often at the heart of a high-scoring explanation.

Question 10 (b) (i)

Although the use of Kepler's Third Law has been in the Specification for some years, this question provided a considerable challenge for many candidates since the required time period is best calculated by comparison with the Moon's existing distance and period (from the Formulae and Data Sheet). This resulted in a demanding multi-stage calculation. Clear working was essential, both to ensure a correct answer but also to ensure that marks for each stage in the working could be awarded.

(b) It is thought that in the past the Moon orbited closer to the Earth than it does at present.

Around 2500 million years ago, the Moon's orbit had a radius which was only 52 times bigger than the Earth's radius.

(i) Calculate the Moon's orbital period when its orbit had this radius.

The Moon's orbital period is currently 27.3 days.

Use information from the Formulae and Data sheet.

(3)

380000 km

$52 \times \frac{13000}{2} = 338000$ km

$\frac{T^2}{r^3} = \frac{T^2}{r^3}$

$\frac{27.3^2}{380000^3} = \frac{T^2}{338000^3}$ $T = 22.9$ days.

Moon's orbital period = 22.9 days

ResultsPlus
Examiner Comments

This response provides a correct solution, set out in clear stages. This would have helped the candidate to stay on track with their calculations but would also have ensured the award of one or two 'working' marks, if the final answer had been wrong.

ResultsPlus
Examiner Tip

Clear working provides an effective insurance against scoring zero marks - particularly important in high-value calculations such as this one.

Question 10 (b) (ii)

Another demanding application of Kepler's Third Law which only a few candidates were able to complete in full. The provision of data as multiples of the Moon's current orbit combined with the need to give the answer in kilometres helped to increase the challenge.

Given the number of marks awarded, candidates are reminded of the need to show clearly the stages in their working as there were obviously a large number of marks available for correct calculation along the way.

(ii) In the future, the Moon will orbit further from the Earth than it does at present.

Calculate the mean radius of the Moon's orbit when it has an orbital period double its present value.

(4)

$27.3 \times 2 = 54.6$

$r = \sqrt[3]{54.6^2}$

$= 14.39$

Radius = 14.39 km

ResultsPlus
Examiner Comments

Although this candidate has not been able to find the correct solution, their working has allowed them to be awarded two marks on this demanding calculation.

Firstly, they have correctly doubled the Moon's existing orbital period and secondly it is clear that they are using Kepler's Third Law (although a statement of the equation would have been even better).

Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- Ensure that candidates have been exposed to all parts of the Specification before the examination.

- Remember to use the *Topic Support Guides* – download from the GCSE Astronomy pages of the Pearson website.

- Review worked examples in the support material.

- Practice examination questions under timed conditions.

- Read the question carefully, then read it again. Notice the command word.

- Check how many marks a question is worth – the more marks, the longer or more complex your response will need to be.

Grade Boundaries

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