Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Wednesday 14 June 2023

Afternoon (Time: 1 hour 45 minutes)

Paper reference **1AS0/01**

Astronomy

PAPER 1: Naked-eye Astronomy

You must have:
Formulae and Data Sheet (enclosed)
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need*.
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question*.
- In questions labelled with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

Formulae and Data Sheet

Formulae

Equation of Time = Apparent Solar Time (AST) – Mean Solar Time (MST)	
Kepler's 3rd law:	$\frac{T^2}{r^3}$ = a constant
Magnification of telescope:	magnification = $\frac{f_o}{f_e}$
Distance modulus formula:	$M = m + 5 - 5\log d$
Redshift formula:	$\frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c}$
Hubble's law:	$v = H_0 d$

Data

Mass of Earth	6.0×10^{24} kg
Mean diameter of Earth	13 000 km
Mean diameter of Moon	3500 km
Mean diameter of Sun	1.4×10^{6} km
One Astronomical Unit (AU)	1.5×10^{8} km
Mean Earth to Moon distance	380 000 km
One light year (l.y.)	9.5×10^{12} km
One parsec (pc)	3.1×10^{13} km = 3.26 l.y.
Sidereal day of Earth	23 h 56 min
Synodic day of Earth	24 h 00 min
Temperature of solar photosphere	5800 K
Hubble Constant	68 km/s/Mpc
Speed of light in vacuum	3.0×10^{8} m/s

Name	Type of body	Mean distance from Sun/AU	Sidereal period/Earth year	Mean temperature /°C	Diameter /1000 km	Mass/ Earth mass	Ring system	Moons
Mercury	planet	0.38	0.24	170	4.9	0.055	no	none
Venus	planet	0.72	0.62	470	12.1	0.82	no	none
Earth	planet	1.0	1.0	15	12.8	1.00	no	1: the Moon
Mars	planet	1.5	1.9	–50	6.9	0.11	no	2 small moons: Deimos and Phobos
Ceres	dwarf planet	2.8	4.6	–105	0.95	1.5×10^{-4}	no	none
Jupiter	planet	5.2	11.9	–150	143	318	yes	4 major moons: Ganymede, Callisto, Europa, Io $>$60 others
Saturn	planet	9.5	29.5	–180	121	95	yes	5 major moons: including Titan, Iapetus $>$55 others
Uranus	planet	19.1	84.0	–210	51	15	yes	5 major moons: including Titania, Oberon $>$20 others
Neptune	planet	30.0	165	–220	50	17	yes	1 major moon: Triton $>$12 others
Pluto	dwarf planet	39.5	248	–230	2.4	2.2×10^{-3}	no	1 major moon: Charon $>$4 other moons
Haumea	dwarf planet	43.1	283	–241	1.4	6.7×10^{-4}	no	2
Eris	dwarf planet	67.8	557	–230	2.3	2.8×10^{-3}	no	at least 1

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) A student makes sketches of groups of bright stars in the night sky.

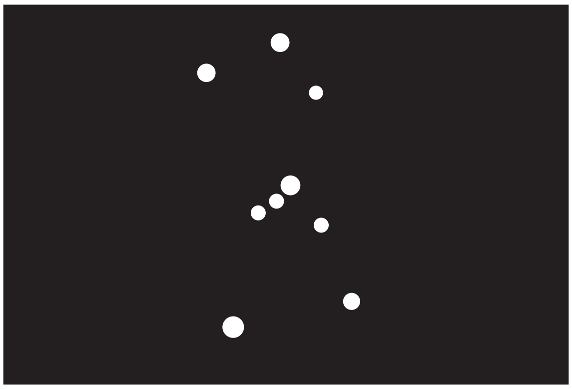

Figure 1

(i) The bright stars shown in Figure 1 are part of the group of stars called: **(1)**

☐ **A** Cassiopeia

☐ **B** Orion

☐ **C** Southern Cross

☐ **D** Ursa Major

Figure 2

(ii) The bright stars shown in Figure 2 are part of the group of stars called: **(1)**

☐ **A** Cassiopeia

☐ **B** Orion

☐ **C** Southern Cross

☐ **D** Ursa Major

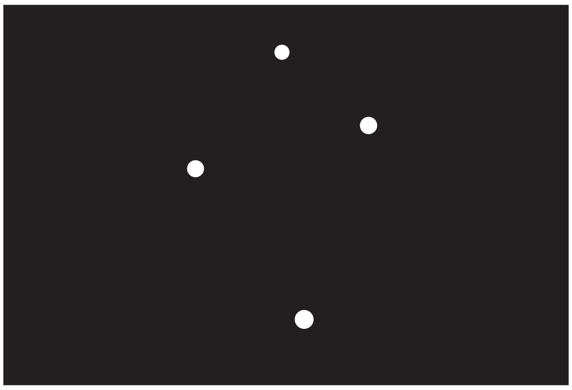

Figure 3

(iii) The bright stars shown in Figure 3 are part of the group of stars called:

(1)

☒ **A** Cassiopeia

☒ **B** Orion

☒ **C** Southern Cross

☒ **D** Ursa Major

(iv) Which **one** of the following groups of stars is an example of an asterism?

(1)

☒ **A** Cassiopeia

☒ **B** Orion

☒ **C** Southern Cross

☒ **D** Ursa Major

(b) Figure 4 shows a sketch of part of the night sky.

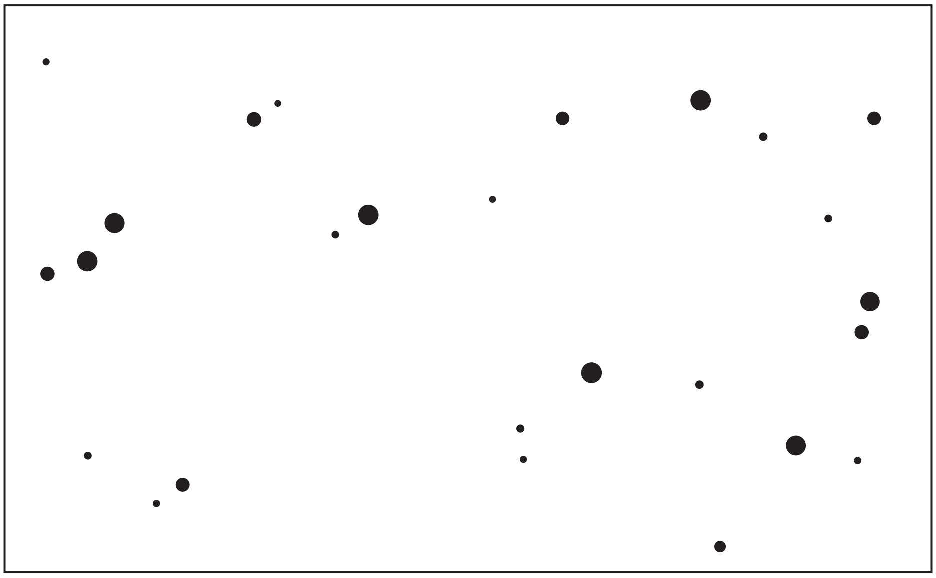

Figure 4

(i) An astronomy student watches a meteor shower for several hours.

The student records the trail of each meteor as a short line.

Draw on Figure 4 to show the finished sketch of the meteor shower.

(1)

(ii) Label on Figure 4 the position of the **radiant** of the meteor shower.

Use the label **R**.

(1)

(Total for Question 1 = 6 marks)

2 (a) A student sees a moving curtain of coloured light in the night sky.

This is caused by:

(1)

☒ **A** a galaxy

☒ **B** a nebula

☒ **C** a planet

☒ **D** an aurora

(b) Which **one** of the following has the largest radius?

(1)

☒ **A** celestial sphere

☒ **B** Earth

☒ **C** Moon

☒ **D** Sun

(c) The point directly above an observer's head is called their:

(1)

☒ **A** cardinal point

☒ **B** horizon

☒ **C** hour angle

☒ **D** zenith

(d) Which **one** of the following observations is caused by libration?

(1)

☒ **A** a lunar eclipse

☒ **B** a solar eclipse

☒ **C** being able to see 59% of the Moon's surface

☒ **D** being unable to see the far side of the Moon

(e) From which place on the Earth would the Sun be directly overhead at noon on 21st March?

(1)

- ☒ **A** Antarctic Circle
- ☒ **B** Equator
- ☒ **C** North Pole
- ☒ **D** Tropic of Capricorn

(f) Which **one** of the following is the shortest period of time?

(1)

- ☒ **A** leap year
- ☒ **B** sidereal day
- ☒ **C** synodic day
- ☒ **D** synodic month

(g) A constellation is called 'zodiacal' if:

(1)

- ☒ **A** it is on the celestial equator
- ☒ **B** it is on the ecliptic
- ☒ **C** it is near to one of the celestial poles
- ☒ **D** it never sets for an observer on the Earth

(Total for Question 2 = 7 marks)

P 7 1 9 3 2 A 0 8 3 6

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DO NOT WRITE IN THIS AREA

3 (a) Figure 5 shows a photograph of the Sun's disc, taken just before sunset.

Figure 5

(i) The Sun's disc does not appear to be perfectly circular.

Explain why the Sun's disc does not appear to be perfectly circular.

You may include a clearly labelled diagram in your answer.

(2)

....

....

....

(ii) The Sun's disc appears to be an orangey-red colour.

Explain why the Sun's disc appears to be an orangey-red colour.

(2)

....

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....

(b) Noctilucent clouds are white clouds that shine brightly in the evening sky, just after sunset.

Figure 6 is a photograph of some noctilucent clouds.

Figure 6

Astronomers believe that noctilucent clouds are made when ice crystals form around pieces of dust in the Earth's upper atmosphere.

(i) State **one** possible source of dust in the Earth's upper atmosphere.

(1)

....

(ii) Observers at latitudes greater than 70°N cannot see noctilucent clouds during the summer months.

Explain the astronomical reason for this.

(2)

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(Total for Question 3 = 7 marks)

4 (a) Bob visits a seaside town and makes a note of the times of high tide on a particular day.

The town had a morning high tide at 02:15 and an afternoon high tide at 13:57.

(i) Explain why most places near the sea have two high tides every 24 hours.

You may include a clearly labelled diagram in your answer.

(3)

....

....

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....

(ii) Calculate the time of the morning low tide at Bob's location.

(2)

Time of low tide = ...

(b) (i) Bob observes the high tides for several days.

He concludes that a spring tide will soon happen.

He can tell this because:

(1)

- ☒ **A** both the high and low tides are getting higher
- ☒ **B** both the high and low tides are getting lower
- ☒ **C** the high tides are getting higher and the low tides are getting lower
- ☒ **D** the high tides are getting lower and the low tides are getting higher

(ii) Bob makes his observations seven days before the spring tide.

State the phase of the Moon at the time of Bob's observations.

(1)

....

(iii) Describe how the phase of the Moon will change over the next seven days.

(2)

....

....

....

(Total for Question 4 = 9 marks)

5 (a) Many early civilisations built large stone circles that appear to line up with astronomical objects in the sky.

(i) State **one** possible reason why people may have built these stone circles.

(1)

....

....

(ii) Many stone circles in the Northern Hemisphere have stones aligned with a line pointing north-east to south-west.

Which **one** of the following aligns with the north-east to south-west direction?

(1)

☒ **A** midsummer sunset

☒ **B** midwinter sunset

☒ **C** Sun at noon

☒ **D** sunrise at the vernal equinox

(iii) Some stone circles contain stones that almost line up with bright stars.

Describe **one** astronomical reason why these stones do not line up exactly with bright stars.

(2)

....

....

....

(b) Figure 7 shows a series of images of the Sun, taken at the Callanish stone circle in Scotland, over a period of one year.

Each image of the Sun was taken at noon on days that were approximately one week apart.

Figure 7

(i) State the approximate date when the image of the Sun at the top of the pattern, labelled 'X', was taken.

(1)

....

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P 7 1 9 3 2 A 0 1 4 3 6

(ii) The solar images in Figure 7 form a 'figure of 8' pattern.

Explain why the pattern appears to have this shape.

You may include a clearly labelled diagram in your answer.

(2)

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....

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(iii) Point 'X', at the top of the pattern in Figure 7, is at an altitude of 55¼°.

Calculate the latitude of the Callanish stone circle.

(3)

Latitude = ... °

(Total for Question 5 = 10 marks)

6 Annabel set up a sundial on a piece of level ground, as shown in Figure 8.

She used a compass to help her align the sundial.

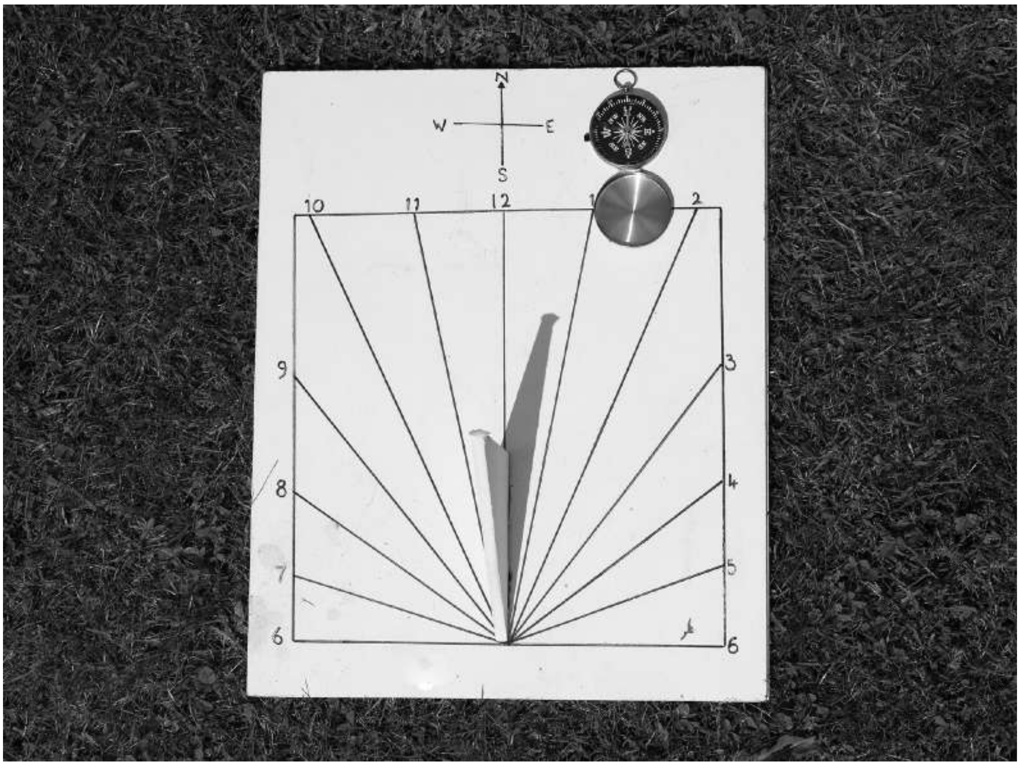

Figure 8

Annabel recorded the time shown on the sundial at ten-minute intervals around midday.

Table 1 shows her results.

Reading Number	Clock Time (h:min)	Sundial Time (h:min)
1	11:30	11:38
2	11:40	11:48
3	11:50	11:57
4	12:00	12:08
5	12:10	12:18
6	12:20	12:29
7	12:30	12:38

Table 1

P 7 1 9 3 2 A 0 1 6 3 6

(a) Plot a graph on Figure 9 of Annabel's Sundial Time readings.

Use the data in Table 1.

The labels on the Clock Time axis have been marked for you.

(3)

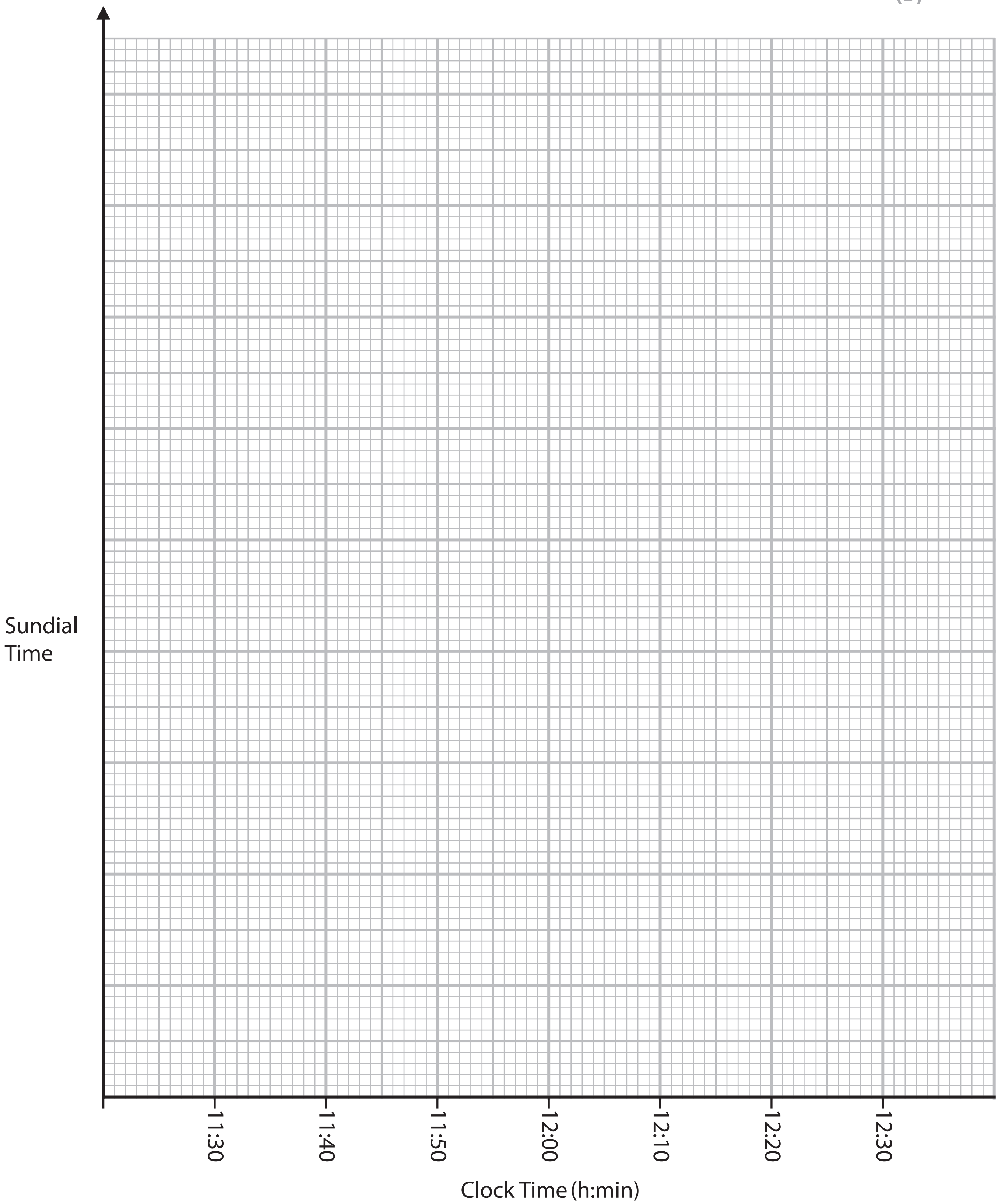

Figure 9

(b) Annabel used her readings and the following information to calculate her longitude.

The Equation of Time on the day of her observations was –3 minutes.

She calculated her longitude to be 2¾°E.

Evaluate the accuracy of Annabel's method for finding her longitude from her readings of Sundial and Clock Time.

(6)

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(Total for Question 6 = 9 marks)

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7 Mercury is an inferior planet.

(a) State what is meant by an 'inferior' planet.

(1)

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....

(b) Figure 10 shows the planet Mercury at several positions in its orbit, labelled A, B, C and D.

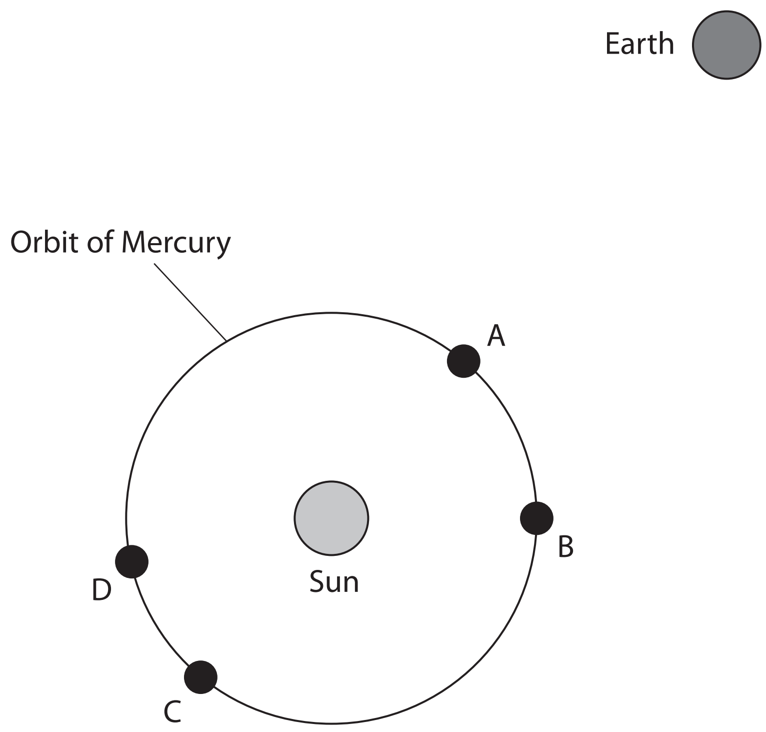

Figure 10

(i) At which **one** of the four positions labelled in Figure 10 (A, B, C or D) will Mercury appear to be in the full phase to an observer on Earth?

(1)

☒ **A** Position A

☒ **B** Position B

☒ **C** Position C

☒ **D** Position D

(ii) At which **one** of the four positions labelled in Figure 10 (A, B, C or D) will Mercury appear to be in the crescent phase to an observer on Earth?

(1)

☒ **A** Position A

☒ **B** Position B

☒ **C** Position C

☒ **D** Position D

(iii) One **other** planet in the solar system shows phases when viewed from Earth.

Name this other planet.

(1)

....

(c) An astronomer wishes to make some **naked-eye** observations of the planet Mercury.

Design a suitable observing programme that will allow her to make these observations safely.

(6)

(d) Figure 11 shows the orbit of a moon around a planet.

Four points in the moon's orbit have been labelled (A, B, C and D).

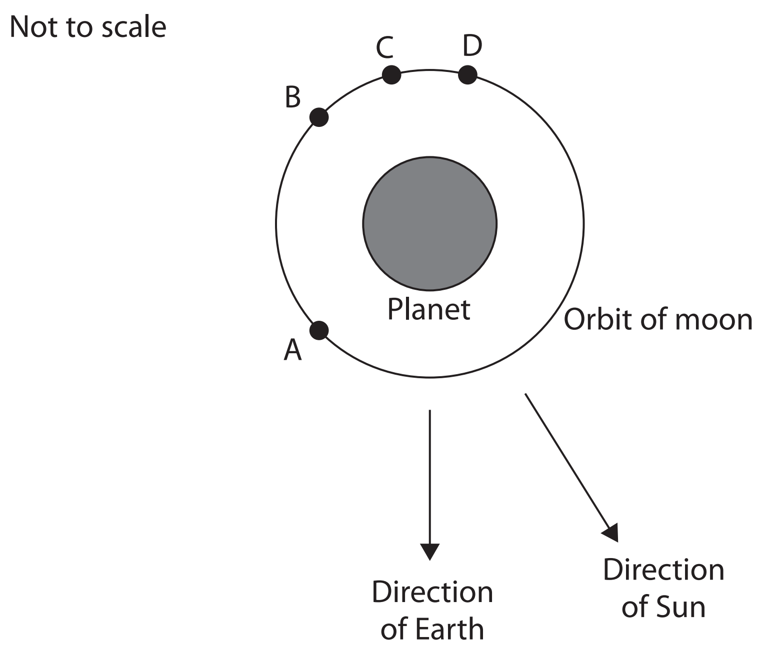

Figure 11

Complete Table 2 to show the visibility of the moon for an observer on the Earth.

You may put one or two ticks in each row.

The first row has been completed for you.

(3)

Point in orbit	Visible	Eclipsed	Occulted
A	✓		
B			
C			
D			

Table 2

(Total for Question 7 = 13 marks)

8 (a) In 1178 Gervase of Canterbury wrote the following account of the appearance of the crescent Moon one evening:

"The upper edge of the Moon seemed to split in two and a flaming torch jumped up, throwing out, for a considerable distance, fire, hot coals and sparks. Meanwhile the main part of the Moon moved and throbbed like a wounded snake. Afterwards the Moon went back to its proper shape. Then, the Moon from point to point, along its whole length, took on a blackish appearance".

Figure 12 shows a modern photograph of the area of the Moon that Gervase wrote about in 1178.

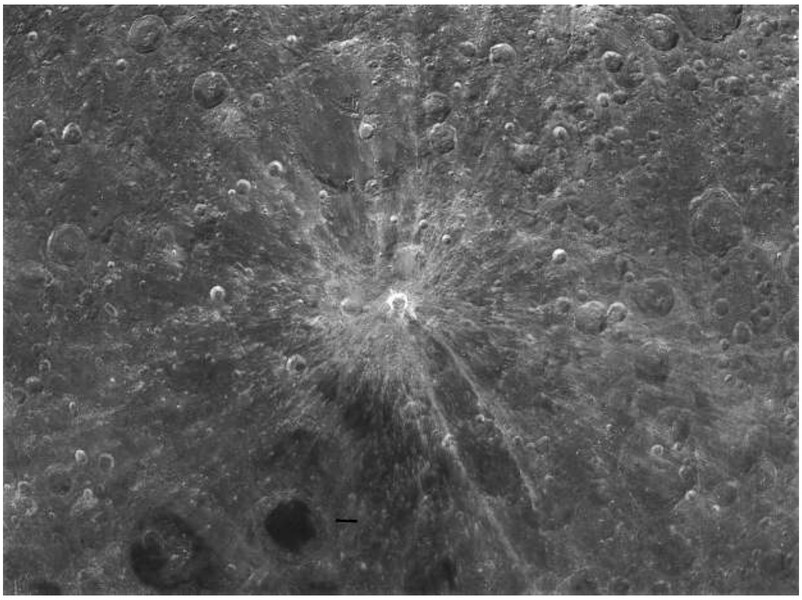

Figure 12

(i) Describe the astronomical event that took place at this area of the Moon in 1178.

(2)

....

....

....

(ii) State **one** reason why it is still possible to see the effects of this event, hundreds of years after it happened.

(1)

....

....

(iii) Figure 13 shows an image of the Moon's surface.

The Moon's North Pole is at the top of the image.

Figure 13

The event of 1178 is thought to have taken place just to the north-west of the Sea of Tranquillity.

Draw on Figure 13 the possible position of this event.

Use the label **X**.

(2)

(b) Astronomers have proposed many theories for the formation of the Earth's Moon.

One of these theories is called the Giant Impact Hypothesis.

This hypothesis suggests that the Moon was formed after a collision between the Earth and another planet-sized body.

State **two** pieces of evidence that suggest that the Giant Impact Hypothesis is correct.

(2)

1 ....

....

2 ....

....

(c) The Greek astronomer Eratosthenes used observations of a lunar eclipse to estimate the size of the Moon compared to the Earth.

Measurements from a similar experiment are summarised in Table 3.

Umbral Contact	Time
1st	20:07
2nd	21:41
3rd	00:45
4th	02:18

Table 3

(i) From earlier observations Eratosthenes had calculated that the diameter of the Earth was around 14 000 km.

Analyse Eratosthenes' observations in order to determine a value for the diameter of the Moon.

Show each stage in your working clearly.

(3)

Diameter of the Moon = ... km

(ii) Calculate the percentage error in this value for the diameter of the Moon.

Use information from the Formulae and Data Sheet.

Use the equation:

$$\text{Percentage error} = \frac{(\text{calculated diameter} - \text{true diameter})}{\text{true diameter}} \times 100\%$$

(2)

Percentage error = ...%

(Total for Question 8 = 12 marks)

9 St. Helena is a small island in the South Atlantic Ocean.

St. Helena has a latitude of 16°S.

A view from St. Helena is shown in Figure 14.

Figure 14

(a) An astronomer tries to view some bright stars from a location on St. Helena.

(i) State **two** reasons why St. Helena is a good site for astronomical observation.

(2)

1 ....

2 ....

(ii) The star Mintaka is located very near to the Celestial Equator.

Estimate the maximum altitude of the star Mintaka for an observer on St. Helena.

(1)

Maximum altitude = ... °

(iii) The star Ahfa al Farkadain in the constellation of Ursa Minor has a declination of 77°48′.

Show that an observer on St. Helena will never be able to see this star.

You may include a clearly labelled diagram in your answer.

(3)

....

....

....

....

(iv) State **one** difficulty of using naked-eye observations of stars to determine the latitude of St. Helena.

(1)

....

....

(b) A ship arrives at St. Helena exactly at local noon.

The chronometer carried on the ship was set to local time at Greenwich at the start of its voyage and now reads 12:22:45.

Calculate the longitude of St. Helena.

(3)

Longitude of St. Helena = ...

(c) In 1761 a group of astronomers sailed to St. Helena. They made observations to test the lunar distance method for finding longitude.

Explain how the lunar distance method can be used to find an observer's longitude.

You may include a clearly labelled diagram in your answer.

(3)

....

....

....

....

(Total for Question 9 = 13 marks)

10 For thousands of years, humans have observed objects in the night sky and used models to predict their positions.

(a) The earliest models of the solar system were geocentric.

This means that:

(1)

- ☒ **A** the Earth was at the centre
- ☒ **B** the Sun was at the centre
- ☒ **C** the models used circular orbits
- ☒ **D** the models used elliptical orbits

(b) The Greek astronomer Ptolemy recorded the use of a model that included epicycles.

Explain how the introduction of epicycles allowed astronomers to explain the retrograde motion of the planets.

You may include a clearly labelled diagram in your answer.

(4)

(c) The German astronomer Johannes Kepler proposed three laws.

These laws helped to predict the positions of objects in the solar system.

Figure 15 shows an image of Comet Encke, near to its perihelion position on March 10th 2017.

Figure 15

The mean distance between Comet Encke and the Sun is 2.22AU.

(i) Show that Comet Encke has a sidereal period of about 3.3 years.

You are advised to show your working clearly.

(3)

(ii) Estimate the first date when Comet Encke reached aphelion, after March 2017.

(2)

Month: .... Year: ....

(iii) Estimate the month in 2023 when Comet Encke will reach its perihelion position.

(2)

Month of perihelion = ...

(iv) Comet Encke orbits the Sun at a mean distance of 2.22AU and has an orbital period of 3.3 years.

Calculate the orbital period of Comet Encke if it orbited a star with a mass three times that of the Sun, at a mean distance of 2.22AU.

(2)

Orbital period = ...

(Total for Question 10 = 14 marks)

TOTAL FOR PAPER = 100 MARKS

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Figure 13
Courtesy NASA

Figure 14
Darrin Henry/Shutterstock

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