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)

Monday 3 June 2019

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.
- 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.*

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 ▶

P57250A

1/1/1/1/1/1/1/1

P 5 7 2 5 0 A 0 1 3 2

Pearson

Formulae and Data Sheet

Formulae

Equation of Time = Apparent Solar Time (AST) – Mean Solar Time (MST)	
Kepler's 3rd law:	$\frac{T^2}{r^3} = \text{a constant}$
Magnification of telescope:	$\text{magnification} = \frac{f_o}{f_e}$
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 systems	Moons
Mercury	planet	0.38	0.24	170	4.9	0.55	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: Triton >12 others
Pluto	dwarf planet	39.5	248	–230	2.4	2.2 × 10–3	no	1 major: 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.

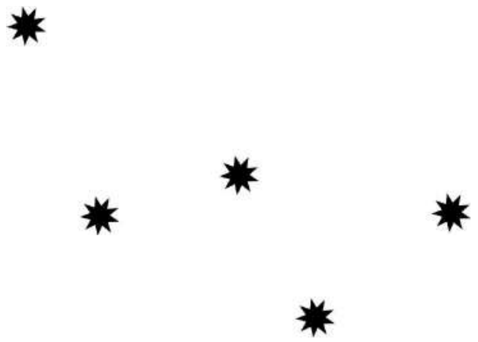
Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 A student made some naked-eye sketches of constellations and asterisms in the night sky.

(a) Identify each of the following from the student's sketches.

(i) Five bright stars forming a 'W' shape.

(1)



☐ **A** Cassiopeia

☐ **B** Cygnus

☐ **C** Pegasus

☐ **D** Summer Triangle

(ii) Four bright stars forming a large square.

(1)

☐ **A** Cassiopeia

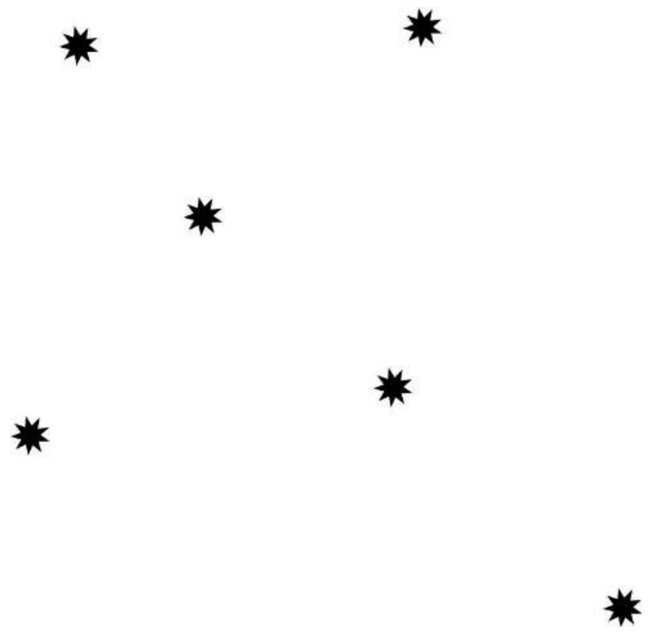
☐ **B** Cygnus

☐ **C** Pegasus

☐ **D** Summer Triangle

(iii) Six bright stars forming the shape of a cross.

(1)



☒ **A** Cassiopeia

☒ **B** Cygnus

☒ **C** Pegasus

☒ **D** Summer Triangle

(b) A student wrote a description of some naked-eye astronomical objects.

Identify each object from its description.

(i) A bright streak of light visible for less than a second.

(1)

☒ **A** Aurora

☒ **B** Comet

☒ **C** Meteor

☒ **D** Planet

(ii) A star-like object with a fuzzy 'tail' that is only visible for a few weeks.

(1)

☒ **A** Aurora

☒ **B** Comet

☒ **C** Meteor

☒ **D** Planet

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

(1)

(Total for Question 1 = 6 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

2 (a) (i) Which of the following theories was introduced by the astronomer Ptolemy?

(1)

- ☒ **A** All planets orbiting in the plane of the ecliptic
- ☒ **B** Elliptical orbits
- ☒ **C** Epicycles
- ☒ **D** The Sun being at the centre of the solar system.

(ii) Which of the following theories was introduced by the astronomer Johannes Kepler?

(1)

- ☒ **A** All planets orbiting in the plane of the ecliptic
- ☒ **B** Elliptical orbits
- ☒ **C** Epicycles
- ☒ **D** The Sun being at the centre of the solar system.

(b) (i) A star that is circumpolar from a certain location will:

(1)

- ☒ **A** Always be visible
- ☒ **B** Always be below the horizon
- ☒ **C** Always be above the horizon
- ☒ **D** Always be at the observer's zenith

(ii) The Autumnal Equinox takes place on or close to:

(1)

- ☒ **A** 21st March
- ☒ **B** 21st June
- ☒ **C** 21st September
- ☒ **D** 21st December

(c) (i) Which of the following words is the best description of the edge of the Moon's disc passing in front of a bright star?

(1)

- ☒ **A** eclipse
- ☒ **B** occultation
- ☒ **C** opposition
- ☒ **D** transit

(ii) Which of the following words best describes a planet that is due south at midnight?

(1)

☒ **A** eclipse

☒ **B** occultation

☒ **C** opposition

☒ **D** transit

(d) (i) If the mass of the Earth is doubled, the gravitational force between the Earth and the Moon would:

(1)

☒ **A** double

☒ **B** stay the same

☒ **C** halve

☒ **D** drop to one quarter

(ii) If instead the distance between the Earth and the Moon is doubled, the gravitational force would:

(1)

☒ **A** double

☒ **B** stay the same

☒ **C** halve

☒ **D** drop to one quarter

(Total for Question 2 = 8 marks)

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

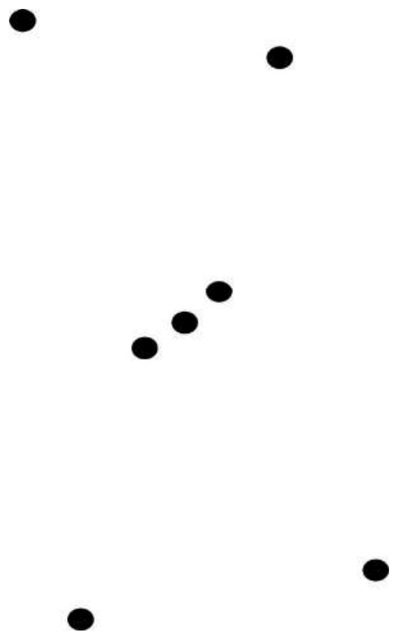


Figure 1

(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)

(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.

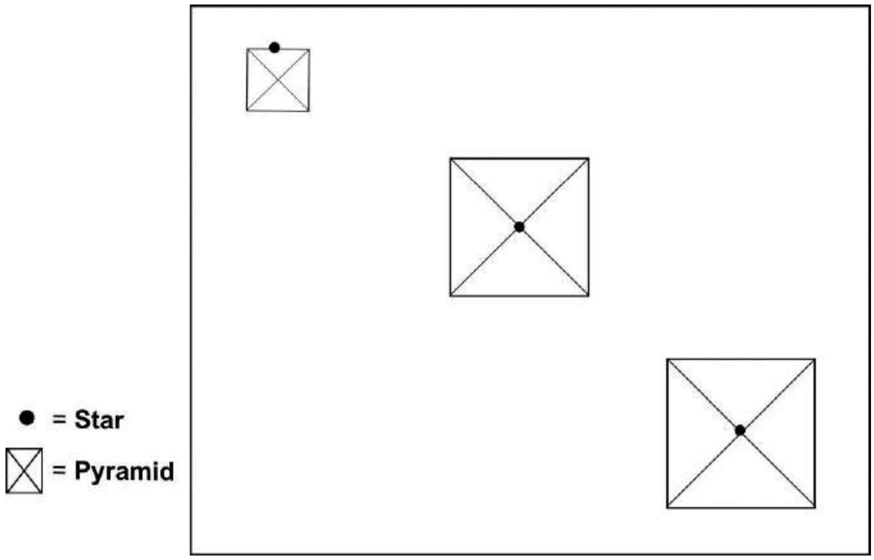


Figure 2

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)

....

....

....

(ii) These three stars were not visible when the Ancient Egyptians built the pyramids.

(2)

....

....

....

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

(2)

....

....

....

(Total for Question 3 = 9 marks)

4 Figure 3 shows a star map of the area around the constellation of Gemini.

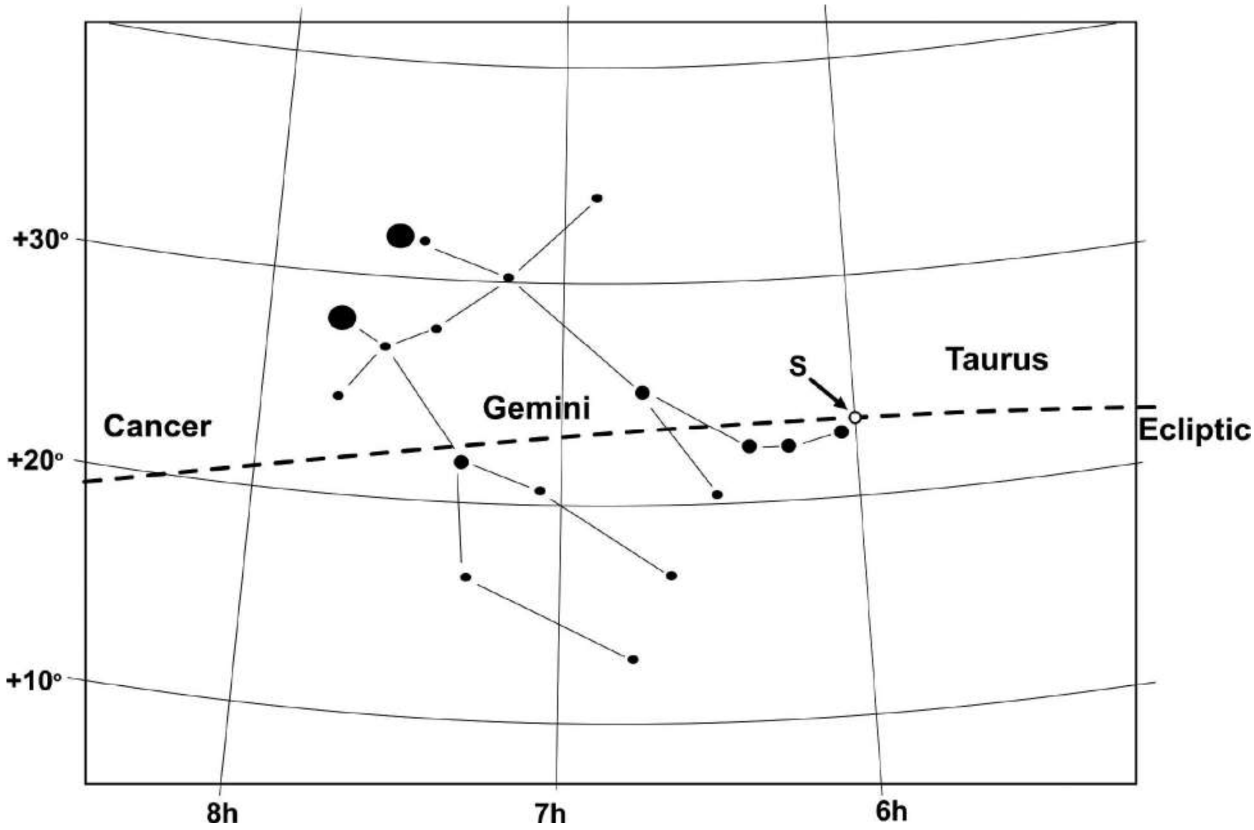


Figure 3

The ecliptic passes through this area of the sky.

On 21st June, the Sun reaches the most northerly point on the ecliptic, labelled '**S**' in Figure 3.

(a) State the astronomical name given, in the northern hemisphere of the Earth, to the day when the Sun is at 'S'.

(2)

....

(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)

....

....

....

After looking at a map of the Earth, Alice says that she would have expected the point 'S' to be in the constellation of Cancer.

(c) Explain the astronomical reason for her statement.

(2)

....

....

....

(d) Explain why the point 'S' is not in the constellation of Cancer.

(2)

....

....

....

(e) State why the constellations Gemini and Cancer are referred to as 'zodiacal' constellations.

(1)

....

....

(Total for Question 4 = 9 marks)

P 5 7 2 5 0 A 0 1 4 3 2

5 (a) Figure 4 shows a student's sketch of the Moon's surface.

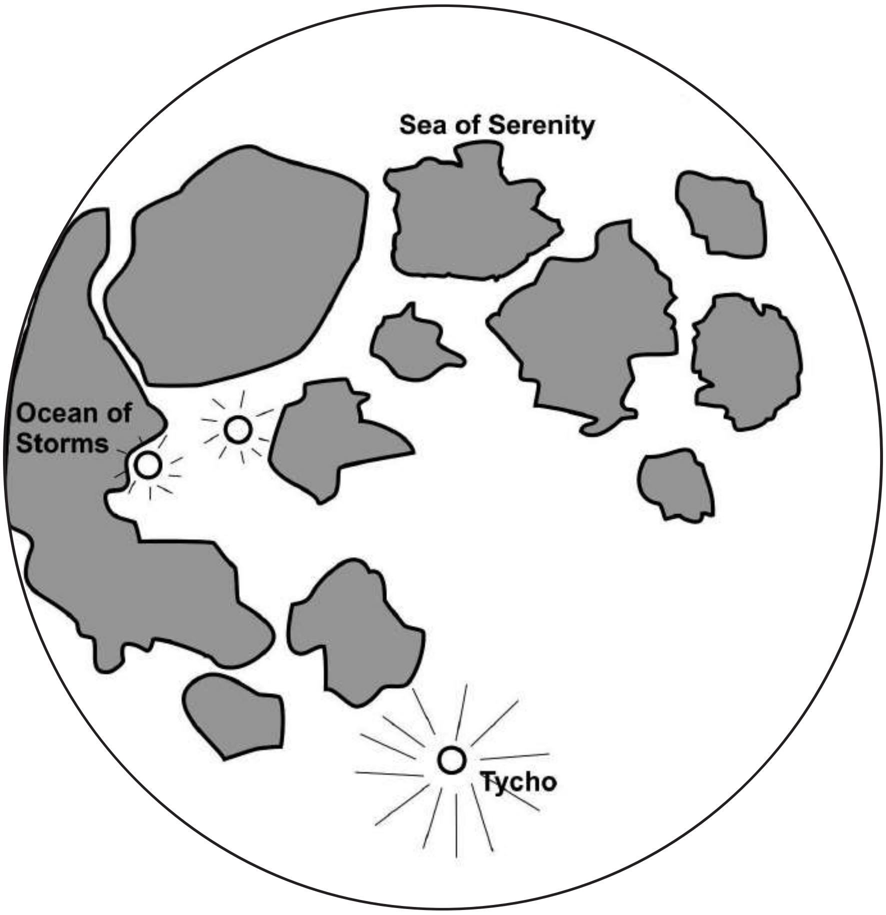


Figure 4

Label the following features on Figure 4.

(i) The Sea of Tranquillity – use the letter '**T**'.

(1)

(ii) The crater Copernicus – use the letter '**C**'.

(1)

(iii) The Apennine mountain range – use the letter '**A**'.

(1)

(b) The Greek astronomer Aristarchus made observations of the Moon at the First Quarter phase. He measured the angle between the Moon and the Sun when the Moon was at the First Quarter phase.

His measurements are summarised in Figure 5 below.

Angle between Moon and Sun (°)
87
89
86
85
88

Figure 5

From these measurements he calculated that this angle was 87°, which meant that the Sun was 19 times further from the Earth than the Moon.

From earlier observations, he had also calculated that the distance between the Earth and the Moon was 175 000 km.

Analyse Aristarchus' observations and calculate a value for the distance from the Earth to the Sun.

(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)

Percentage error = ...

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

(2)

1 ....

2 ....

(Total for Question 5 = 9 marks)

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)

....

....

....

(ii) State the reason for Canopus appearing at different altitudes in the sky, when viewed from Rhodes compared with from Alexandria.

(1)

....

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

Show your working clearly.

(2)

Circumference = ... km

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

(2)

1 ....

2 ....

(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.

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

(2)

Distance = ... km

(Total for Question 6 = 9 marks)

7 (a) A sundial in the United Kingdom shows 11:15 am on a day when the Equation of Time is -6 minutes.

The sundial's longitude is 3° W.

These observations mean that:

(i) A clock at the sundial's location would show:

(1)

☒ **A** 11:15

☒ **B** 11:21

☒ **C** 11:27

☒ **D** 11:33

(ii) Greenwich Mean Time is:

(1)

☒ **A** 11:15

☒ **B** 11:21

☒ **C** 11:27

☒ **D** 11:33

(iii) The Local Mean Time at the sundial's location is:

(1)

☒ **A** 11:15

☒ **B** 11:21

☒ **C** 11:27

☒ **D** 11:33

(iv) The Apparent Solar Time at the sundial's location is:

(1)

☒ **A** 11:15

☒ **B** 11:21

☒ **C** 11:27

☒ **D** 11:33

(b) Explain **one** of the causes of the Equation of Time.

(2)

....

....

....

(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)

(Total for Question 7 = 12 marks)

8 An astronomer on board a ship took measurements of the Sun to measure the ship's latitude.

These measurements are shown in Figure 6 below.

Time (h : min)	**Altitude of Sun (°)**
11:00	32
11:15	35
11:30	38
11:45	40
12:00	42
12:15	41
12:30	39
12:45	36

Figure 6

The astronomer also looked up the declination of the Sun, which was 8°.

The astronomer used these measurements to make the following conclusion.

The Sun is at 42° when it is at its highest point.

This means that latitude = 42° - 8°

So, the **ship's latitude** = **34°**

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

(3)

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

(6)

....

....

....

....

....

....

....

....

....

....

....

....

(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)

Answer = ... °

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

(ii) Calculate the ship's current longitude.

(2)

Answer = ...

(d) State the name of the clockmaker who made the first clock that kept accurate time on board a ship at sea.

(1)

....

(Total for Question 8 = 14 marks)

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)

....

....

....

....

(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)

....

....

....

....

(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)

Altitude = ...° ....′

P 5 7 2 5 0 A 0 2 7 3 2

Turn over

(d) (i) Calculate the local sidereal time (LST) in Oxford when Aldebaran transits the observer's meridian.

(2)

local sidereal time = ... : ....

(ii) Calculate the hour angle (HA) of the First Point of Aries at this time.

(2)

hour angle = ... h ....min

(Total for Question 9 = 11 marks)

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.

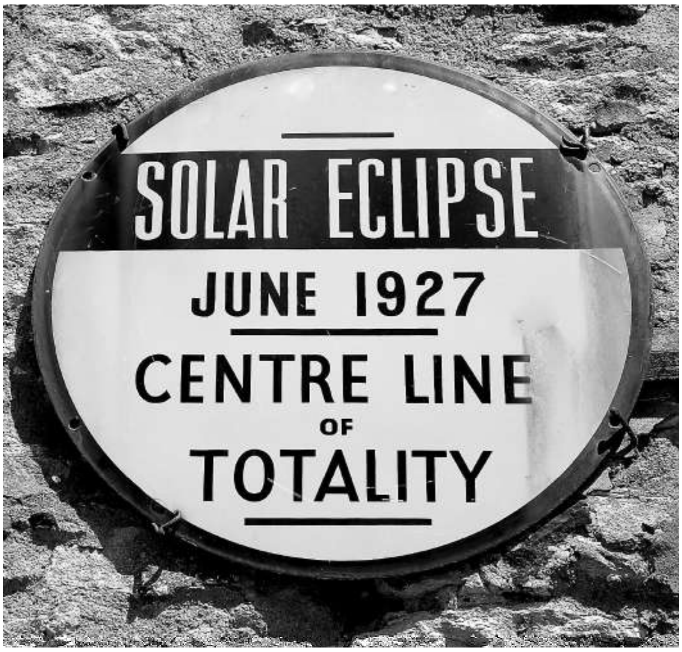


Figure 7

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)

....

....

....

....

(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)

....

....

....

....

(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)

Moon's orbital period = ... days

(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)

Radius = ...km

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE