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 12 June 2024

Morning (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.*

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 ▶

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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	0.055	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) Figure 1 shows an image of the full Moon.

Three features have been labelled X, Y and Z.

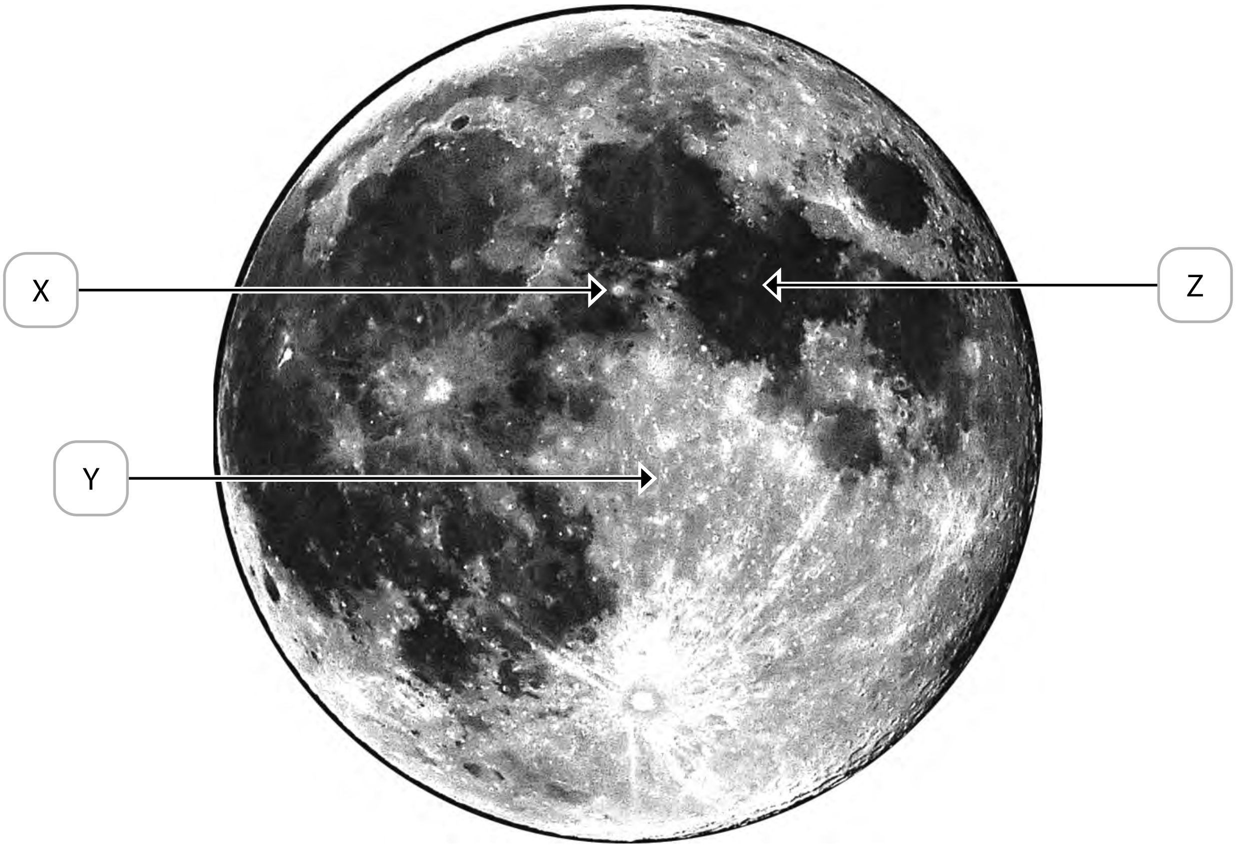


Figure 1

(i) Feature X is a:

(1)

☐ **A** crater

☐ **B** mare

☐ **C** terra

☐ **D** volcano

(ii) Feature Y is a:

(1)

☐ **A** crater

☐ **B** mare

☐ **C** terra

☐ **D** volcano

(iii) Feature Z is a:

(1)

- **A** crater
- **B** mare
- **C** terra
- **D** volcano

(b) A student writes a description of how some astronomical objects appear when viewed with the naked eye.

Identify each object from its description.

(i) A moving, green curtain of light.

(1)

- **A** aurora
- **B** galaxy
- **C** meteor
- **D** supernova

(ii) A bright star that suddenly appeared in the night sky and then faded after several weeks.

(1)

- **A** aurora
- **B** galaxy
- **C** meteor
- **D** supernova

(iii) A bright streak of light moving across the sky in one second.

(1)

- **A** aurora
- **B** galaxy
- **C** meteor
- **D** supernova

(Total for Question 1 = 6 marks)

2 (a) Which term is used to describe:

(i) the Moon passing in front of Venus and blocking its light? **(1)**

- ☐ **A** apogee
- ☐ **B** elongation
- ☐ **C** occultation
- ☐ **D** transit

(ii) Venus passing in front of the Sun's disc? **(1)**

- ☐ **A** apogee
- ☐ **B** elongation
- ☐ **C** occultation
- ☐ **D** transit

(iii) the angle between Venus and the Sun, measured from the Earth? **(1)**

- ☐ **A** apogee
- ☐ **B** elongation
- ☐ **C** occultation
- ☐ **D** transit

(b) Different naked-eye techniques can be used to help observe a faint star.

(i) In which naked-eye technique does the observer look at the faint star with their peripheral vision?

(1)

- ☐ **A** averted vision
- ☐ **B** dark adaptation
- ☐ **C** indirect sight
- ☐ **D** night vision

(ii) In which naked-eye technique does the observer wait 20 minutes in dark conditions and avoid looking at any bright light?

(1)

- ☐ **A** averted vision
- ☐ **B** dark adaptation
- ☐ **C** indirect sight
- ☐ **D** night vision

(iii) State **one** reason why a pinhole camera would **not** be suitable for observing a faint star.

(1)

(Total for Question 2 = 6 marks)

3 (a) The Moon is an oblate spheroid and has a mean diameter of 3 475 km.

What is the Moon’s polar diameter?

(1)

- ☐ **A** 3 475 km
- ☐ **B** 6 950 km
- ☐ **C** greater than 3 475 km
- ☐ **D** less than 3 475 km

(b) Which features on the Moon are caused by:

(i) impacts from space rocks?

(1)

- ☐ **A** canyons
- ☐ **B** craters
- ☐ **C** maria
- ☐ **D** mountains

(ii) large plains of magma that have turned solid?

(1)

- ☐ **A** canyons
- ☐ **B** craters
- ☐ **C** maria
- ☐ **D** mountains

(c) The Moon takes 27.3 days to orbit once around the Earth.

(i) What is this time period called?

(1)

- ☐ **A** calendar month
- ☐ **B** sidereal month
- ☐ **C** solar month
- ☐ **D** zodiacal month

(ii) Calculate the angle through which the Moon appears to move in one hour against the background stars.

(1)

Angle = °

(iii) State **two** reasons why it is difficult to observe the movement of the Moon against the background stars with the naked eye.

(2)

1

2

(Total for Question 3 = 7 marks)

4 (a) The geocentric model is an early model of the universe.

Geocentric means:

(1)

- ☐ **A** all planets orbit the Earth
- ☐ **B** all planets orbit the Sun
- ☐ **C** the Earth is flat
- ☐ **D** the Sun lies on the Celestial Equator

(b) Figure 2 shows part of a star chart.

Each month, the position of Mars was marked on the chart.

These positions show the path that Mars appeared to take in a six-month period against the background stars.

The apparent path of Mars is shown by a solid curve in Figure 2.

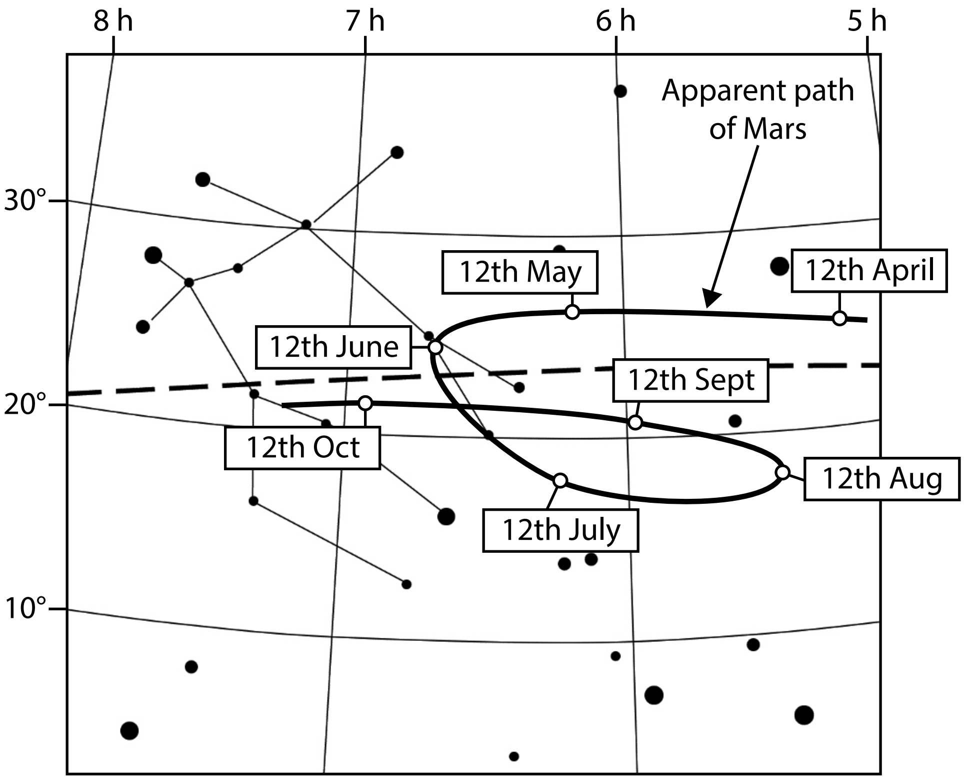


Figure 2

(i) State the Right Ascension and Declination of Mars on 12th May.

Use information from Figure 2.

(2)

Right Ascension = h min

Declination = °

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

(ii) Name the dashed line on the star chart in Figure 2.

(1)

(iii) During these observations Mars appeared to move in a retrograde direction against the background stars.

State the number of months that Mars appeared to move in a retrograde direction against the background stars.

Use information from Figure 2.

(1)

Number of months =

(c) The astronomer Ptolemy proposed a geocentric model with the addition of epicycles.

Explain how these epicycles helped to account for the apparent retrograde motion of Mars.

Use a clearly labelled diagram in your answer.

(3)

(Total for Question 4 = 8 marks)

5 (a) Table 1 shows part of a tide chart for a port in Scotland.

The levels of high and low tides are shown from 19th October to 31st October.

Date	**Level of water (m)**			
	First high tide	**First low tide**	**Second high tide**	**Second low tide**
19 Oct	5.3	1.9	5.2	2.0
21 Oct	4.9	2.3	4.9	2.4
23 Oct	4.6	2.5	4.7	2.5
25 Oct	4.9	2.4	5.0	2.3
27 Oct	5.3	2.0	5.4	1.9
29 Oct	5.6	1.8	5.6	1.7
31 Oct	5.5	1.8	5.3	2.0

Table 1

(i) Explain why there are two high tides each day.

You may include a clearly labelled diagram in your answer.

(2)

(ii) Analyse the data in Table 1 in order to determine the date when the Moon's phase was either first or last quarter.

(2)

(b) The Greek astronomer Aristarchus used a total lunar eclipse to estimate the diameter of the Moon.

Figure 3 shows the Moon passing through the Earth's shadow during a total lunar eclipse.

The Moon is shown at each of the four umbral contacts.

The time at which the Moon reaches each umbral contact is labelled.

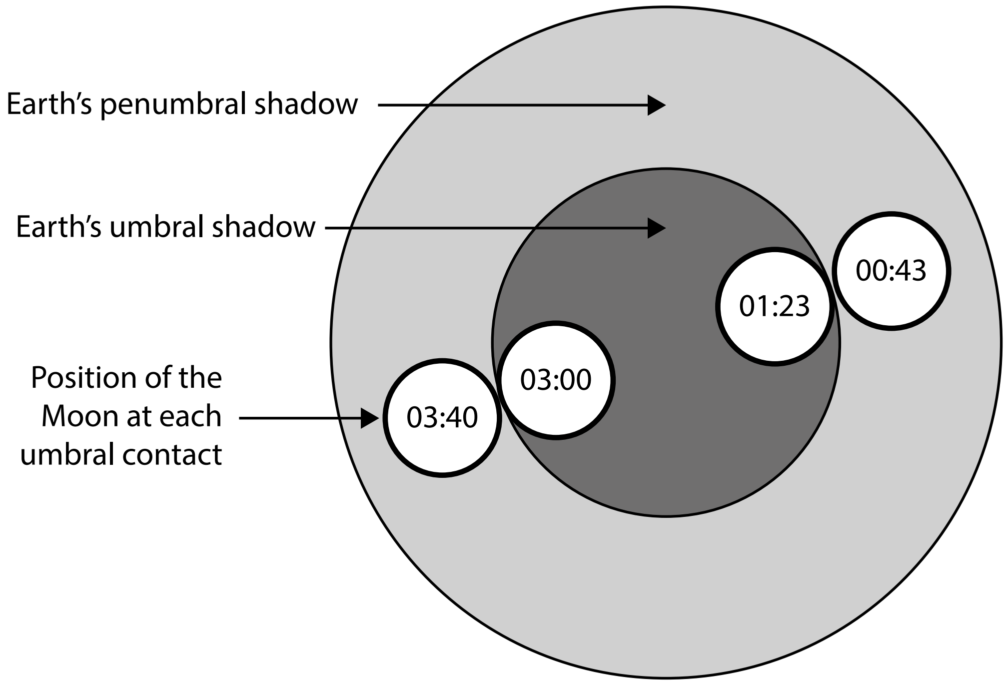


Figure 3

Calculate an approximate value for the diameter of the Moon.

Use information from Figure 3 and the Formulae and Data Sheet.

Give your answer in km.

(3)

Diameter of the Moon = ... km

(c) State **two** reasons why a total lunar eclipse appears to take longer than a total solar eclipse, when viewed from the Earth.

(2)

1

2

(Total for Question 5 = 9 marks)

6 The following is an extract from an article about astronomy.

"It is thanks to the astronomical observations made by Tycho Brahe, that Johannes Kepler was able to discover the laws of planetary motion."

(a) Explain why Tycho Brahe's observations were so important in the development of Kepler's three laws of planetary motion.

(2)

One of Kepler's laws of planetary motion can be stated as:

"The line between the Sun and a planet sweeps out equal areas in equal times."

(b) Explain how this statement can be used to describe how the orbital speed of a planet changes during its elliptical orbit.

Use a clearly labelled diagram in your answer.

(3)

(c) Kepler's third law of planetary motion can be written as:

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

Table 2 shows the mean orbital radius and orbital period for some of the moons of Jupiter.

Moon of Jupiter	Mean orbital radius (million km)	Orbital period (days)
Io	0.422	1.76
Europa	0.670	3.52
Ganymede	1.075	

Table 2

Calculate the orbital period of Ganymede.

Give your answer in days.

(3)

Orbital period = ... days

(d) Moon X orbits Saturn with a mean orbital radius of 0.422 million km.

Explain why Moon X does not have an orbital period of 1.76 days.

(2)

(Total for Question 6 = 10 marks)

7 (a) Figure 4 shows a sketch of the asterism known as 'The Plough'.

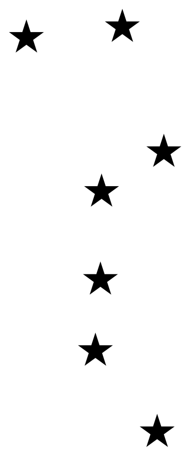


Figure 4

(i) Draw on Figure 4 the position of the star Polaris.

Use the label **P**.

(1)

(ii) Draw on Figure 4 the position of the star Arcturus.

Use the label **A**.

(1)

(iii) State what is meant by the term 'asterism'.

(1)

(b) A GCSE Astronomy student in London wants to measure the seeing conditions when observing stars.

She decides to observe the star Polaris and counts the number of times the star appears to 'twinkle' in a period of time.

She repeats this on four different nights in March.

Table 3 shows the student's results.

Date	Duration of observation (seconds)	Number of times Polaris was observed to twinkle
10th March	25	12
11th March	15	8
12th March	30	20
13th March	20	17

Table 3

The student concludes that the seeing conditions were worst on the night of 12th March.

(i) Analyse Table 3 in order to comment on the accuracy of her conclusion.

(2)

(ii) Give **two** reasons why Polaris was a suitable star for her investigation.

(2)

1

2

(c) Another GCSE Astronomy student wants to investigate the effect of skyglow (light pollution) on the number of stars that are visible in the night sky.

The student designed the following investigation:

1. point a long cardboard tube at the zenith
2. look through the tube and count the number of visible stars
3. lower the tube by approximately 10 degrees and repeat the observation
4. continue lowering the tube and counting the number of visible stars until the tube is pointing at the horizon
5. record the data and plot a graph of the tube's angle from the zenith (x-axis) against the number of observed stars (y-axis).

Evaluate the suitability of this method for determining the effect of skyglow on the number of stars visible in the night sky.

(6)

(Total for Question 7 = 13 marks)

8 A teacher wants to use a scale model of the Earth, Moon and Sun to demonstrate the scale of the Solar System.

(a) State why a scale model is needed to show the distances between the Earth, Moon and Sun.

(1)

(b) The teacher decides that the distance between the Earth and the Moon should be 10.0 cm in this scale model.

(i) Calculate the distance between the Earth and the Sun for this scale model.

Give your answer in m.

Give your answer to three significant figures.

Use information from the Formulae and Data Sheet.

(3)

Earth-Sun distance in the scale model = ... m

(ii) Proxima Centauri is the nearest star system to the Sun.

It is 4.2 light years from the Sun.

Explain why the teacher's scale model would not be suitable for demonstrating the distance to Proxima Centauri.

Support your answer with a relevant calculation.

Assume 1 light year (l.y.) = 9.5×10^{12} km.

(2)

(c) The core of the Earth is approximately 54% of the Earth's diameter.

Determine which planet has approximately the same diameter as the Earth's core.

Use information from the Formulae and Data Sheet.

Include all stages of your working.

(2)

Planet =

(d) Two astronomers want to determine the Earth's diameter.

They decide to use two shadow sticks situated at different locations on the Earth.

Design an observational programme that would enable the two astronomers to determine the Earth's diameter using two shadow sticks.

Your observational programme should include:

- the readings that the astronomers should take
- how the astronomers will analyse their data to determine the Earth's diameter.

(6)

(Total for Question 8 = 14 marks)

9 (a) Describe **one** similarity and **one** difference between the design of an equatorial sundial and a horizontal sundial.

(2)

Similarity

Difference

(b) Figure 5 shows the annual variation of the Equation of Time.

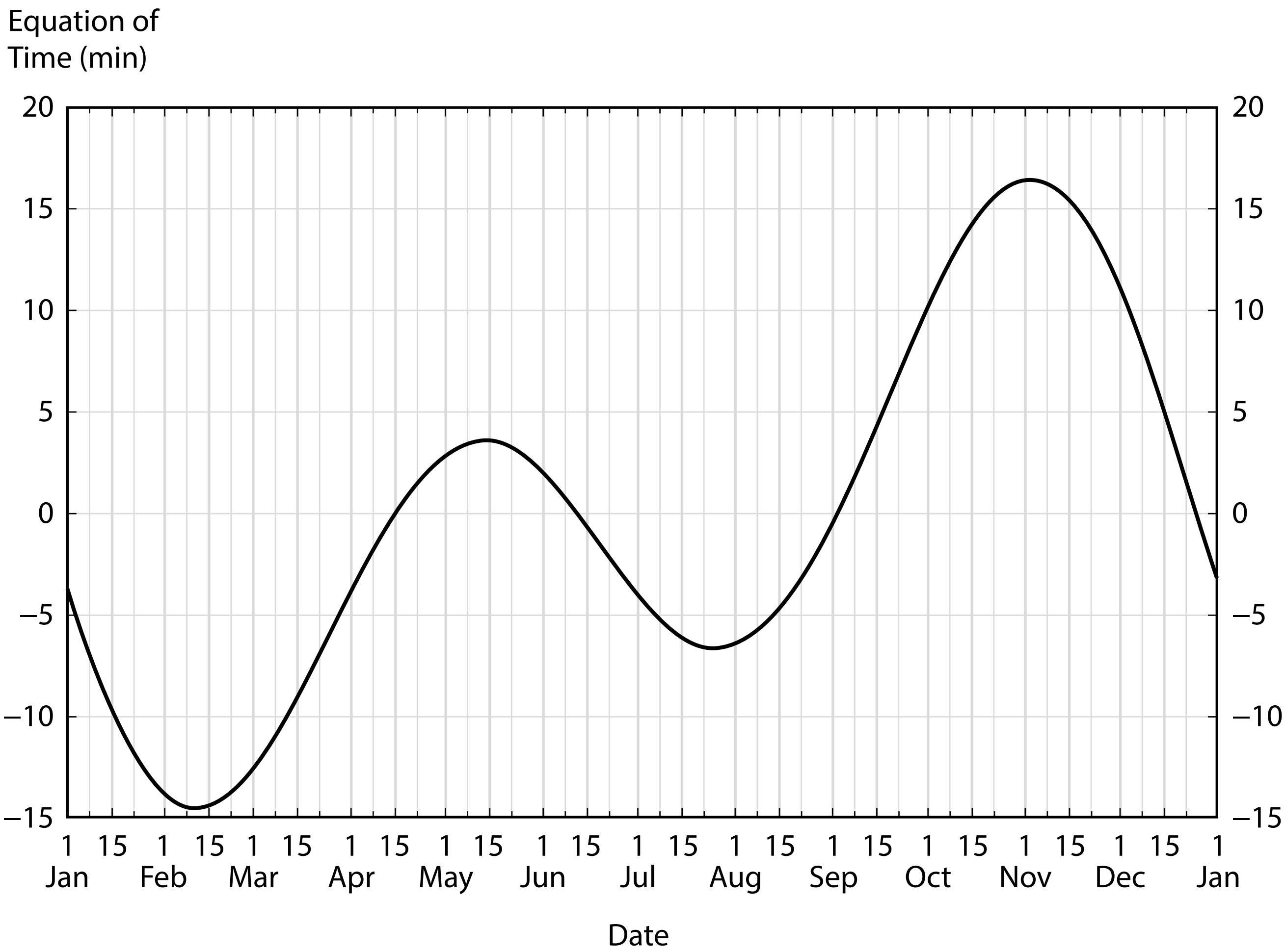


Figure 5

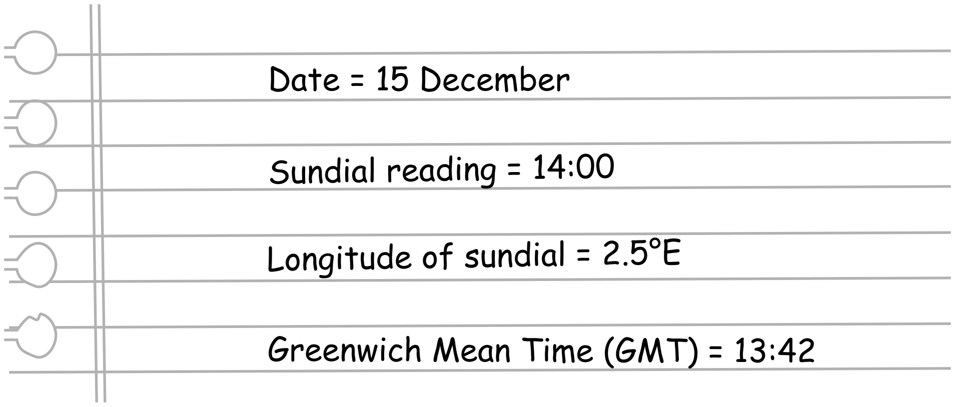
(i) State the date nearest to the vernal equinox when the local Mean Solar Time is equal to the local Apparent Solar Time.

(1)

(ii) Explain why Figure 5 suggests that a sundial reading would differ greatly from local Mean Solar Time in November.

(2)

(c) A correctly aligned sundial is used to produce the following results.



The accuracy of the sundial is defined as:

accuracy of sundial = corrected sundial reading – GMT

Calculate the accuracy of the sundial.

Use information from Figure 5.

Give your answer to the nearest minute.

(4)

Accuracy = ... min

(d) Two causes of the annual variation of the Equation of Time are the Earth's elliptical orbit around the Sun and the Earth's axial tilt to the ecliptic.

Figure 6 shows how these two causes contribute to the annual variation of the Equation of Time.

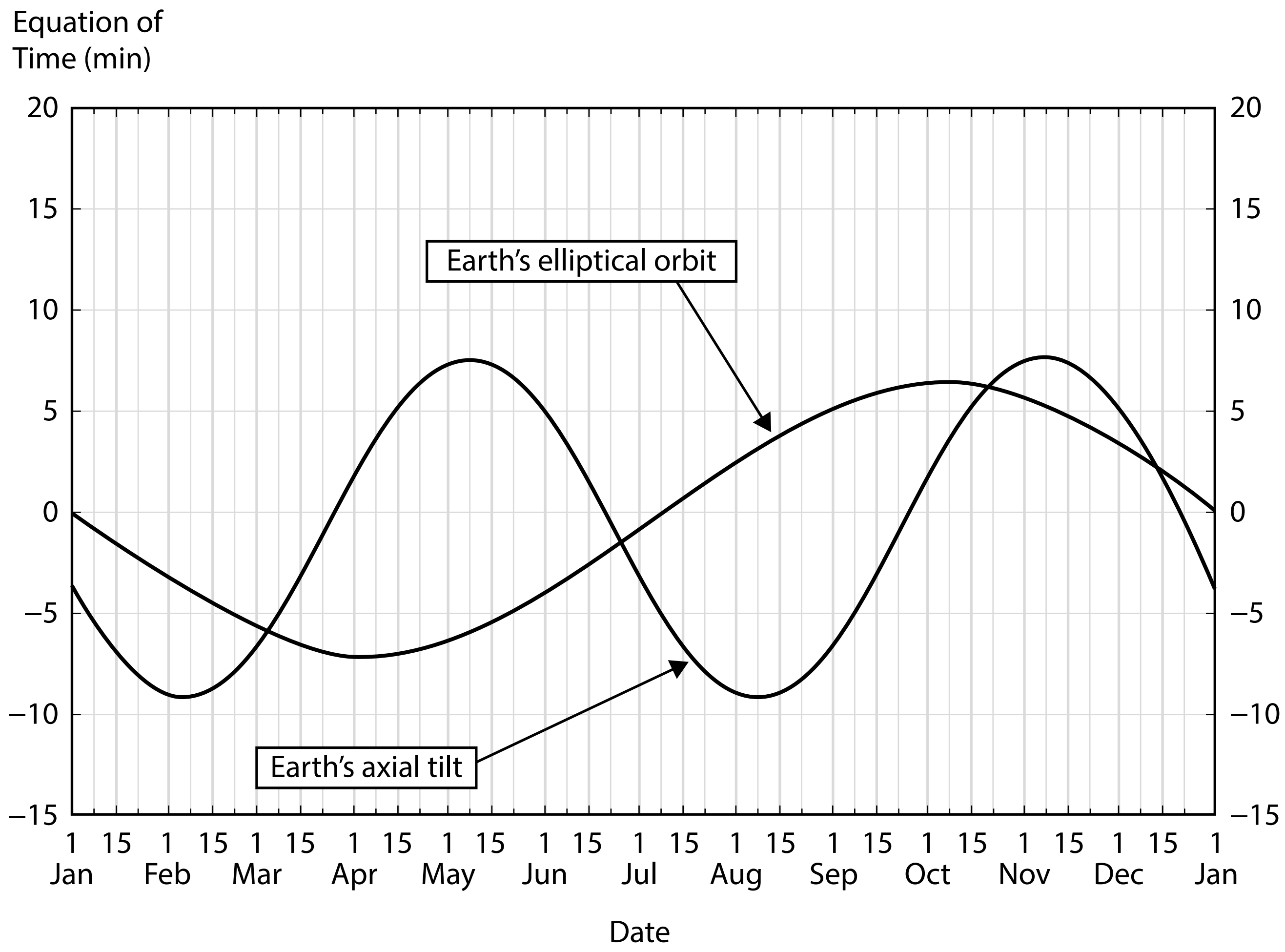


Figure 6

(i) Analyse Figure 6 in order to explain why the Equation of Time can have a value of zero on some dates.

(2)

(ii) Analyse Figure 6 in order to determine which of these two causes gives the greater contribution to the annual variation of the Equation of Time.

(2)

(Total for Question 9 = 13 marks)

10 An astronomer in the northern hemisphere observes and records the altitude of star A between 20:00 and 06:00.

Table 4 shows the altitude of star A above the astronomer's horizon between 20:00 and 06:00 during the observation.

The data in Table 4 are shown as a graph in Figure 7.

Time (GMT)	Altitude of star A (°)
20:00	40
22:00	52
00:00	55
02:00	48
04:00	33
06:00	15

Table 4

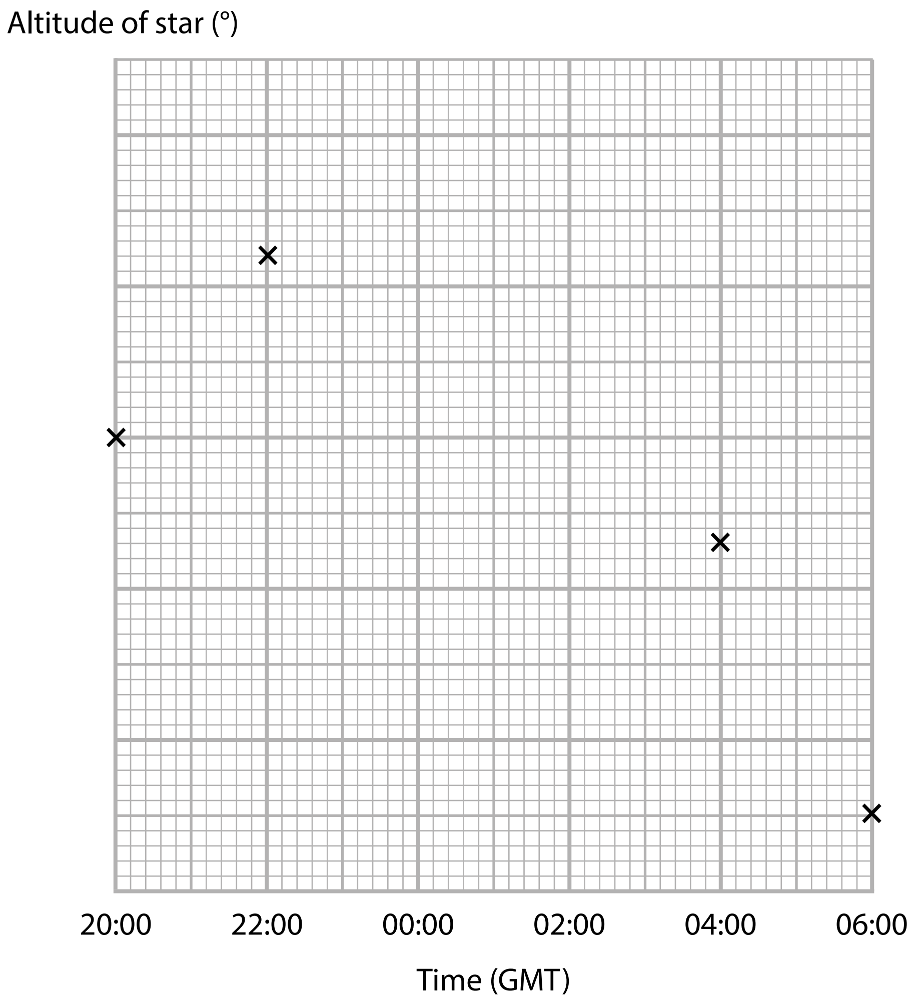


Figure 7

(a) Complete the graph in Figure 7 using the data in Table 4.

You should:

- add an appropriate scale on the vertical axis
- plot the remaining points
- draw a line of best fit.

(3)

(b) State the time at which star A culminated.

(1)

Time = :

(c) State the hour angle of star A at 02:00.

(1)

Hour Angle = h min

(d) In which direction was the astronomer looking at 03:00 to observe star A?

Use data from Figure 7.

(1)

- ☐ **A** north-east
- ☐ **B** south-east
- ☐ **C** south-west
- ☐ **D** north-west

(e) Explain why star A's altitude changed over the course of the observation.

(2)

(f) Explain why star A is not circumpolar.

Use data from Figure 7.

(2)

(g) The astronomer was located at a latitude of 26° N.

Calculate the declination of star A.

Use the equation:

altitude of the star at culmination = observer's latitude + (90 − declination of the star)

(2)

Declination = ... °

(h) Star B has a declination that is 10 degrees further from the north celestial pole than star A.

Sketch on Figure 7 a line or curve to show how the altitude of star B changes between 20:00 and 06:00.

(2)

(Total for Question 10 = 14 marks)

TOTAL FOR PAPER = 100 MARKS

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