Paper Reference(s) 1AS0/02
Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Total Marks

Astronomy
Paper 2
Telescopic Astronomy

Tuesday 18 June 2024 – Afternoon

Time: 1 hour 45 minutes

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

Y75501A

Pearson

YOU MUST HAVE

Formulae and Data Booklet (enclosed)
Calculator, ruler

YOU WILL BE GIVEN

Diagram Booklet

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – 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.

There may be spare copies of some diagrams.

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.

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) An astronomer photographs some astronomical objects through a telescope.

Identify each object from its photograph.

(i) Look at Figure 1 for Question 1(a)(i) in the Diagram Booklet. Identify the object shown in Figure 1.
(1 mark)

☐ A binary star

☐ B comet

☐ C galaxy

☐ D globular cluster

(continued on the next page)

1(a) continued.

(ii) Look at Figure 2 for Question 1(a)(ii) in the Diagram Booklet. Identify the object shown in Figure 2.
(1 mark)

☐ A binary star

☐ B comet

☐ C galaxy

☐ D globular cluster

(continued on the next page)

1 continued.

(b) An astronomer studies some astronomical objects through a telescope.

She writes a short description of each object.

Identify each object from its description.

(i) A reddish-coloured disc with white ice caps at its poles.
(1 mark)

☐ A Mars

☐ B Mercury

☐ C Neptune

☐ D Pluto

(continued on the next page)

1(b) continued.

(ii) A ball-shaped group of thousands of bright stars.
(1 mark)

☐ A accretion disc

☐ B double star

☐ C globular cluster

☐ D planetary nebula

(iii) A rapidly-expanding shell of gas.
(1 mark)

☐ A accretion disc

☐ B double star

☐ C globular cluster

☐ D planetary nebula

(continued on the next page)

1 continued.

(c) A student makes a small telescope, similar in size to the one used by Galileo Galilei in 1609.

He uses the telescope to look at the planet Jupiter.

Look at the blank page for Question 1(c) in the Diagram Booklet. Sketch the appearance of Jupiter through this telescope.
(3 marks)

(Total for Question 1 = 8 marks)

2 (a) (i) Which of the following is the terrestrial planet with the largest mass?
(1 mark)

☐ A Earth

☐ B Mars

☐ C Neptune

☐ D Uranus

(ii) Which of the following is the gas giant planet with the smallest mass?
(1 mark)

☐ A Earth

☐ B Mars

☐ C Neptune

☐ D Uranus

(continued on the next page)

2 continued.

(b) (i) Which of the following missions took astronauts to the surface of the Moon?
(1 mark)

☐ A Apollo

☐ B Giotto

☐ C New Horizons

☐ D Voyager

(continued on the next page)

2(b) continued.

(ii) Which of the following missions took the first detailed photographs of the surface of Pluto?
(1 mark)

☐ A Apollo

☐ B Giotto

☐ C New Horizons

☐ D Voyager

(continued on the next page)

2 continued.

(c) (i) Which of the following is thought to be the origin of long-period comets? (1 mark)

☐ A Asteroid Belt

☐ B Goldilocks Zone

☐ C Kuiper Belt

☐ D Oort Cloud

(continued on the next page)

2(b) continued.

(ii) Which of the following contains the closest dwarf planet to the Earth? (1 mark)

☐ A Asteroid Belt

☐ B Goldilocks Zone

☐ C Kuiper Belt

☐ D Oort Cloud

(continued on the next page)

2 continued.

(d) (i) Which of the following methods is the most accurate way to measure the distance to the Moon?
(1 mark)

☐ A heliocentric parallax

☐ B measuring its redshift and using Hubble's Law

☐ C measuring the luminosity of a Cepheid variable

☐ D timing a beam of light reflected from its surface

(continued on the next page)

2(d) continued.

(ii) Which of the following methods is the most accurate way to measure the distance to the Andromeda galaxy?
(1 mark)

☐ A heliocentric parallax

☐ B measuring its redshift and using Hubble's Law

☐ C measuring the luminosity of a Cepheid variable

☐ D timing a beam of light reflected from its surface

(Total for Question 2 = 8 marks)

3 (a) Look at Figure 3 for Question 3(a) in the Diagram Booklet. It is a drawing of an early design of refracting telescope, used by the astronomer Christiaan Huygens in the seventeenth century.

The eyepiece lens (A) is mounted on a tripod in front of the astronomer.

The objective lens (B) is mounted high up on a tall pole (C).

The two lenses are connected by a piece of string (D).

(i) Suggest a reason for the piece of string between the two lenses. (1 mark)

(continued on the next page)

3(a) continued.

Look at Table 1 for Question 3(a)(ii) in the Diagram Booklet. It shows some information about a telescope of this design.

(ii) Calculate the magnification of this telescope.

Use information from Table 1.
(2 marks)

Magnification = _____

(continued on the next page)

3(a) continued.

(iii) An astronomer plans to use this telescope to make detailed observations of the planet Uranus.

Comment on the suitability of this telescope for observing Uranus.

Use information from Figure 3 and Table 1.
(3 marks)

Answer space continues on the next page.

3(a)(iii) continued.

(b) State ONE advantage of using a reflecting, rather than a refracting, telescope for astronomical observation. (1 mark)

(Total for Question 3 = 7 marks)

4 (a) Look at Figure 4 for Question 4(a) in the Diagram Booklet. It shows two drawings of the Moon, made in the seventeenth century using early telescopes.

The left-hand drawing was made by Thomas Harriot in July 1609.

The right-hand drawing was made by Galileo Galilei in November 1609.

(i) Compare the amount of information about the surface of the Moon shown by the two drawings in Figure 4. (3 marks)

Answer space continues on the next page.

4(a)(i) continued.

(continued on the next page)

4(a) continued.

(ii) Explain why drawings like those shown in Figure 4 were considered to be evidence that the Earth was not the centre of the solar system. (2 marks)

(continued on the next page)

4 continued.

(b) Galileo Galilei also made a series of drawings of the planet Venus.

Look at Figure 5 for Question 4(b) in the Diagram Booklet. His drawings are shown in Figure 5.

(i) Explain why the drawings shown in Figure 5 were considered to be evidence that the Earth was not the centre of the solar system.

Look at the blank page for Question 4(b)(i) in the Diagram Booklet. You may use the blank page to include a clearly labelled diagram in your answer.
(2 marks)

Answer space continues on the next page.

4(b)(i) continued.

(continued on the next page)

4(b) continued.

(ii) Explain how observations of a transit of Venus can be used to calculate an accurate value for the Astronomical Unit.

Look at the blank page for Question 4(b)(ii) in the Diagram Booklet. You may use the blank page to include a clearly labelled diagram in your answer.
(3 marks)

(Total for Question 4 = 10 marks)

5 (a) Look at Figure 6 for Question 5(a) in the Diagram Booklet. It shows the Earth and the direction of the incoming solar wind.

(i) Sketch on Figure 6 the shape and position of the Earth's magnetosphere.
(2 marks)

(ii) Label on Figure 6 the position of the Van Allen belts.

Use the label **V**.
(1 mark)

(iii) Label on Figure 6 a position on Earth where an aurora is most likely to be seen.

Use the label **A**.
(1 mark)

(continued on the next page)

5 continued.

(b) (i) The likelihood of seeing an aurora is linked to the Sun's sunspot cycle.

Explain the link between aurorae and the Sun's sunspot cycle.

Look at the blank page for Question 5(b)(i) in the Diagram Booklet. You may use the blank page to include a clearly labelled diagram in your answer.
(3 marks)

Answer space continues on the next page.

5(b)(i) continued.

(ii) Describe how the solar wind can affect human activities such as communication or space travel. (2 marks)

(continued on the next page)

5(b) continued.

(iii) The solar wind can affect bodies in the solar system, other than the Earth.

State ONE other effect of the solar wind, elsewhere in the solar system.
(1 mark)

(Total for Question 5 = 10 marks)

6 (a) Look at Figure 7 for Question 6(a) in the Diagram Booklet. It shows the Lovell radio telescope at the Jodrell Bank Observatory.

It has a large metal dish with a diameter of 76 m

Explain why the dish in this radio telescope needs to have a much larger diameter than the mirror in a large optical telescope.
(3 marks)

Answer space continues on the next page.

6(a) continued.

(continued on the next page)

6 continued.

(b) Look at Figure 8 for Question 6(b) in the Diagram Booklet. The Very Large Array radio telescope contains 28 dishes, as shown in Figure 8.

The dishes are spread out over a distance of 21 km

Each dish in the Very Large Array has a diameter of 25 m

(i) Show that the area of the dish in the Lovell telescope is about nine times larger than each of the dishes in the Very Large Array. (2 marks)

Answer space continues on the next page.

6(b)(i) continued.

(continued on the next page)

6(b) continued.

(ii) Despite the smaller size of its dishes, the Very Large Array has a much higher resolution than the Lovell Telescope.

Explain how the Very Large Array is able to achieve this.
(3 marks)

Answer space continues on the next page.

6(b)(ii) continued.

(continued on the next page)

6(b) continued.

(iii) The Lovell Telescope has an angular resolution of half an arcminute $(0{\cdot}5')$.

Estimate the angular resolution of the Very Large Array.

Give your answer in arcseconds $('')$.
(2 marks)

Answer space continues on the next page.

6(b)(iii) continued.

Angular resolution = _____″

(Total for Question 6 = 10 marks)

7 (a) An astronomer observes five stars.

Look at Table 2 for Question 7(a) in the Diagram Booklet. Data on these five stars are given in Table 2.

The astronomer wishes to identify the star that is a red giant.

Evaluate which of these five stars is most likely to be a red giant star.
(6 marks)

Answer space continues on the next page.

7(a) continued.

(continued on the next page)

7 continued.

(b) Look at Figure 9 for Question 7(b) in the Diagram Booklet. It shows some stars from a constellation.

(i) State the meaning of the labels α, β and γ in Figure 9. (1 mark)

(continued on the next page)

7(b) continued.

(ii) Star β has an absolute magnitude of $-3{\cdot}1$ and is 60pc from Earth.

Calculate the apparent magnitude of star β.
(2 marks)

Use the equation:

$$M = m + 5 - 5 \log d$$

Answer space continues on the next page.

7(b)(ii) continued.

$$M = m + 5 - 5 \log d$$

Apparent magnitude = _____

(continued on the next page)

7(b) continued.

(iii) Star α and star γ have the same absolute magnitude.

The apparent magnitudes of the stars differ by 3

Star α is 20pc from Earth.

Calculate the distance of star γ from Earth.

Give your answer in parsecs (pc).
(3 marks)

Answer space continues on the next page.

7(b)(iii) continued.

Distance = _____ pc

(Total for Question 7 = 12 marks)

8 (a) Look at Figure 10 for Question 8(a) in the Diagram Booklet. It shows an image of Saturn's ring system.

Explain how the force of gravity is believed to have created this ring system.

Look at the blank page for Question 8(a) in the Diagram Booklet. You may use the blank page to include a clearly labelled diagram in your answer.
(2 marks)

(continued on the next page)

8 continued.

(b) Look at Figure 11 for Question 8(b) in the Diagram Booklet. It shows an image of Hyperion, a small moon of Saturn.

Hyperion follows a predictable orbit around Saturn but spins in an unpredictable way.

Explain why Hyperion spins in an unpredictable way.
(2 marks)

(continued on the next page)

8 continued.

(c) Look at Figure 12 for Question 8(c) in the Diagram Booklet. It shows a chart of the sizes of the orbits of the asteroids in the Asteroid Belt.

Figure 12 shows that almost no asteroids have the orbital radii labelled **A**, **B**, **C** or **D**.

Explain why there are these 'gaps' in the orbital sizes within the Asteroid Belt.
(3 marks)

Answer space continues on the next page.

8(c) continued.

(continued on the next page)

8 continued.

(d) Look at Figure 13 for Question 8(d) in the Diagram Booklet. It shows a diagram of the Earth's orbit around the Sun, with five important points (1, 2, 3, 4 and 5) labelled.

(i) Explain why a group of small asteroids is found at points 4 and 5 on Figure 13. (2 marks)

(continued on the next page)

8(d) continued.

(ii) A number of space probes have been placed at some of the points labelled 1–5 in Figure 13.

State ONE advantage of placing space probes at one of these points.
(1 mark)

(continued on the next page)

8(d) continued.

(iii) The James Webb Space Telescope is an infrared telescope.

It has been placed in an orbit around point 2 in Figure 13.

State ONE advantage of placing an infrared telescope in this orbit.
(1 mark)

_____

_____

_____

(Total for Question 8 = 11 marks)

9 (a) Hanaya uses a camera mounted on a tripod to take a star trail photograph of the night sky.

Look at Figure 14 for Question 9(a) in the Diagram Booklet. She uses an exposure time of 98 minutes. Her photograph is shown in Figure 14.

Hanaya measures the angle covered by some of the bright star trails in her photograph.

Look at Table 3 for Question 9(a) in the Diagram Booklet. Her measurements are shown in Table 3.

Analyse the information in Figure 14 and Table 3 in order to calculate a value for the Earth's rotation period.

Give your answer in hours and minutes. (3 marks)

Answer space continues on the next page.

9(a) continued.

Rotation period = _____ h _____ min

(continued on the next page) Turn over

9 continued.

(b) Evaluate ways to improve Hanaya's observations in order to obtain a more accurate value for the Earth's rotation period.
(6 marks)

Answer space continues on the next page.

9(b) continued.

(continued on the next page)

9 continued.

(c) Hanaya's method gives a value for the length of the sidereal day. Explain the difference between the sidereal and synodic day.
Look at the blank page for Question 9(c) in the Diagram Booklet. You may use the blank page to include a clearly labelled diagram in your answer.
(2 marks)

(continued on the next page)

9 continued.

(d) The image of the Pole Star is labelled P in the photograph in Figure 14.
Explain why the Pole Star does not appear as a dot in the star trail photograph in Figure 14.
(2 marks)

(Total for Question 9 = 13 marks)

10 (a) The Drake Equation can be used to estimate the number of civilisations in the Milky Way galaxy with which communication might be possible.

The Drake Equation can be written in the following way:

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

where:

N = the number of civilisations in the Milky Way galaxy with which communication might be possible

R_* = the average rate of star formation in the Milky Way galaxy

f_p = the fraction of those stars that have planets

n_e = the average number of planets that could support life, orbiting each of these stars

(continued on the next page)

10(a) continued.

f_l = the fraction of planets that could support life that actually develop life

f_i = the fraction of planets with life that actually develop intelligent life

f_c = the fraction of civilisations that develop a technology that releases detectable signs of their existence

L = the average length of time for which these civilisations release detectable signals.

Astronomers are not certain about the correct value to use for each of the quantities in the Drake Equation.

(continued on the next page)

10(a) continued.

(i) Explain why the accuracy of the data for estimating f_p and n_e has improved greatly since the equation was proposed in 1961. (2 marks)

(continued on the next page)

10(a) continued.

(ii) Describe the evidence that f_l is close to 1·0
(1 mark)

(continued on the next page)

10(a) continued.

(iii) Explain why it is very difficult for astronomers to agree on accurate values for quantities such as f_l, f_i and f_c.
(2 marks)

(continued on the next page)

10 continued.

(b) Look at Table 4 for Question 10(b) in the Diagram Booklet. It shows some information related to three of the quantities in the Drake Equation.

(i) Show that the expected number of habitable planets forming in the Milky Way galaxy each year is approximately 0·9

Use the data in Table 4.
(2 marks)

(continued on the next page)

10(b) continued.

(ii) Look at Table 5 for Question 10(b)(ii) in the Diagram Booklet. It shows estimates for the other quantities in the Drake Equation.

The expected number of habitable planets forming in the Milky Way galaxy each year is approximately 0·9

Analyse the data in Table 4 and in Table 5 in the Diagram Booklet, in order to determine a value for **N**, the number of civilisations in the Milky Way galaxy with which communication might be possible. (2 marks)

Answer space continues on the next page.

10(b)(ii) continued.

Number of civilisations = _____

(continued on the next page)

10 continued.

(c) Look at Figure 15 for Question 10(c) in the Diagram Booklet. The radio telescope shown in Figure 15 is part of the **SETI** (Search for Extra-Terrestrial Intelligence) programme.

These telescopes monitor the sky for artificial radio signals from beyond the Earth.

State TWO reasons why the **SETI** programme searches for artificial signals with wavelengths of around **21 cm**
(2 marks)

Answer space continues on the next page.

1 _____

_____

_____

10(c) continued.

2 _____

_____

_____

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER