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)

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.
- Good luck with your examination.

Turn over ▶

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P 6 5 4 2 5 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	0.055	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: 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 Figure 1 shows a group of seven bright stars in the night sky.

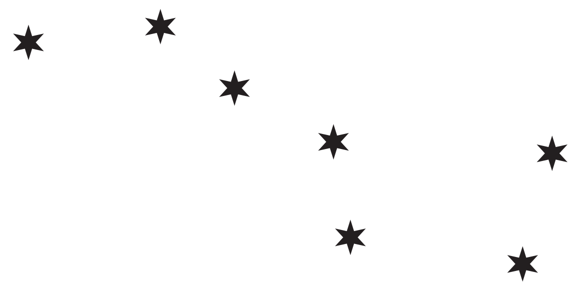

Figure 1

(a) (i) Label the position of the Pole Star in Figure 1. Use the label **P**.

(1)

(ii) Label the position of the star Arcturus in Figure 1. Use the label **A**.

(1)

(iii) The stars in Figure 1 form the asterism called the:

(1)

☒ **A** Plough

☒ **B** Seven Sisters

☒ **C** Southern Cross

☒ **D** Summer Triangle

(iv) The stars in Figure 1 are part of the constellation called:

(1)

☒ **A** Cassiopeia

☒ **B** Orion

☒ **C** Pegasus

☒ **D** Ursa Major

(b) Which **one** of the following constellations contains:

(i) three bright stars in a row called its 'belt'?

(1)

☒ **A** Cassiopeia

☒ **B** Cygnus

☒ **C** Orion

☒ **D** Pegasus

(ii) four stars forming its 'square'?

(1)

☒ **A** Cassiopeia

☒ **B** Cygnus

☒ **C** Orion

☒ **D** Pegasus

(Total for Question 1 = 6 marks)

2 (a) Which **one** of the following parts of the Earth is closest to its surface?

(1)

- ☒ **A** crust
- ☒ **B** inner core
- ☒ **C** mantle
- ☒ **D** outer core

(b) When a planet is at its closest point to the Sun it is said to be at:

(1)

- ☒ **A** aphelion
- ☒ **B** apogee
- ☒ **C** perigee
- ☒ **D** perihelion

(c) The lighter highland areas on the Moon are called:

(1)

- ☒ **A** craters
- ☒ **B** mare
- ☒ **C** terrae
- ☒ **D** valleys

(d) When Mercury is directly opposite the Earth, on the opposite side of the Sun, it is said to be at:

(1)

- ☒ **A** elongation
- ☒ **B** inferior conjunction
- ☒ **C** opposition
- ☒ **D** superior conjunction

(e) The most southerly points on the Earth where the Sun is above the horizon for 24 hours on 21st June form the:

(1)

- ☒ **A** Antarctic Circle
- ☒ **B** Arctic Circle
- ☒ **C** Tropic of Cancer
- ☒ **D** Tropic of Capricorn

(f) If the mass of the Sun and the distance between the Earth and the Sun were **both** doubled, the gravitational force between them would:

(1)

- ☒ **A** increase by four times
- ☒ **B** double
- ☒ **C** stay the same
- ☒ **D** halve

(g) When observing from the Earth's Equator:

(1)

- ☒ **A** all stars are below the horizon
- ☒ **B** all stars are circumpolar
- ☒ **C** all stars rise and set
- ☒ **D** all stars with a declination greater than 23½° are circumpolar

(Total for Question 2 = 7 marks)

3 Maya watches a meteor shower.

Her observations are shown in Figure 2.

Each arrow marks the path of a meteor.

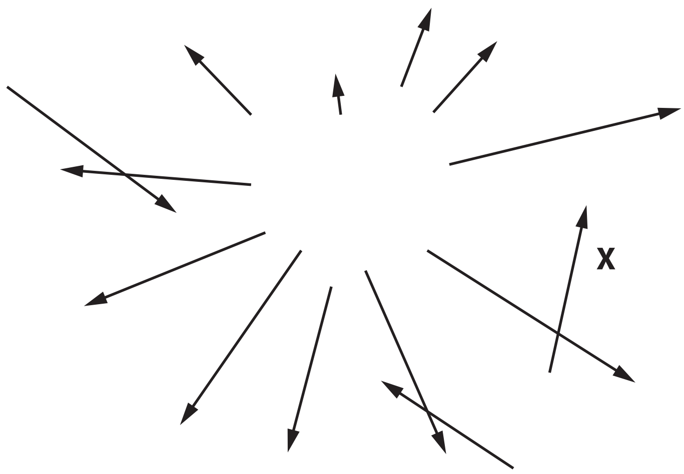

Figure 2

(a) Label on Figure 2 the position of the radiant of the meteor shower.

Use the label **R**.

Show clearly how you found its position.

(2)

(b) Give **one** reason for the path of the meteor labelled **X** in Figure 2.

(1)

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(c) There is a meteor shower called the Leonids. It is called this because:

(1)

☒ **A** all its meteor trails are within the constellation of Leo

☒ **B** it can be seen whenever the constellation of Leo is in the sky

☒ **C** its discoverer was called Leonid

☒ **D** its radiant is in the constellation of Leo

(d) Explain how the streaks of light called meteors are caused.

You may include a clearly labelled diagram in your answer.

(2)

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(Total for Question 3 = 6 marks)

4 Figure 3 shows a lunar eclipse.

Figure 3

(a) The appearance of the Moon during a lunar eclipse is evidence that the Earth has a curved surface.

Explain this statement.

(2)

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(b) 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 Figure 4.

Umbral contact	Time (h:min)
1st	19:14
2nd	20:47
3rd	23:52
4th	01:25

Figure 4

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

Analyse the observations in Figure 4 in order to calculate a value for the diameter of the Moon.

Show each stage in your calculation 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 = ... %

(iii) State **one** reason why it is hard to obtain an accurate value for the Moon's diameter using Eratosthenes' method.

(1)

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(c) The Chinese astronomer Shi Shen made some of the earliest observations of sunspots, in the fourth century BCE, long before the invention of the telescope.

Describe a **safe** method for observing the surface of the Sun with the naked eye that could have been used in the fourth century BCE.

You may include a clearly labelled diagram in your answer.

(2)

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(Total for Question 4 = 10 marks)

5 (a) The position of the First Point of Aries moves very slowly amongst the stars.

This movement is called precession.

Explain the cause of precession.

You may include a clearly labelled diagram in your answer.

(2)

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(b) It has been suggested that some ancient civilisations were aware of the effects of precession, using only naked-eye observations.

(i) State **one** feature of precession that makes this suggestion a possibility.

(1)

....

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(ii) State **one** feature of precession that makes this suggestion unlikely.

(1)

....

....

(c) Figure 5 shows the Sphinx, a large stone monument in Egypt.

Figure 5

On 21st March each year the Sphinx faces directly into the rising Sun.

(i) The astronomical name for 21st March is the:

(1)

☒ **A** autumnal equinox

☒ **B** summer solstice

☒ **C** vernal equinox

☒ **D** winter solstice

(ii) State the **date** of the **other** day each year when the Sphinx faces directly into the rising Sun.

(1)

....

(iii) The Sphinx is facing:

(1)

☒ **A** east

☒ **B** north

☒ **C** south

☒ **D** west

P 6 5 4 2 5 A 0 1 4 3 2

(iv) Figure 6 shows the path taken by the First Point of Aries as it precesses through the constellations at the rate of 14° every thousand years.

Its current position is marked by ♈.

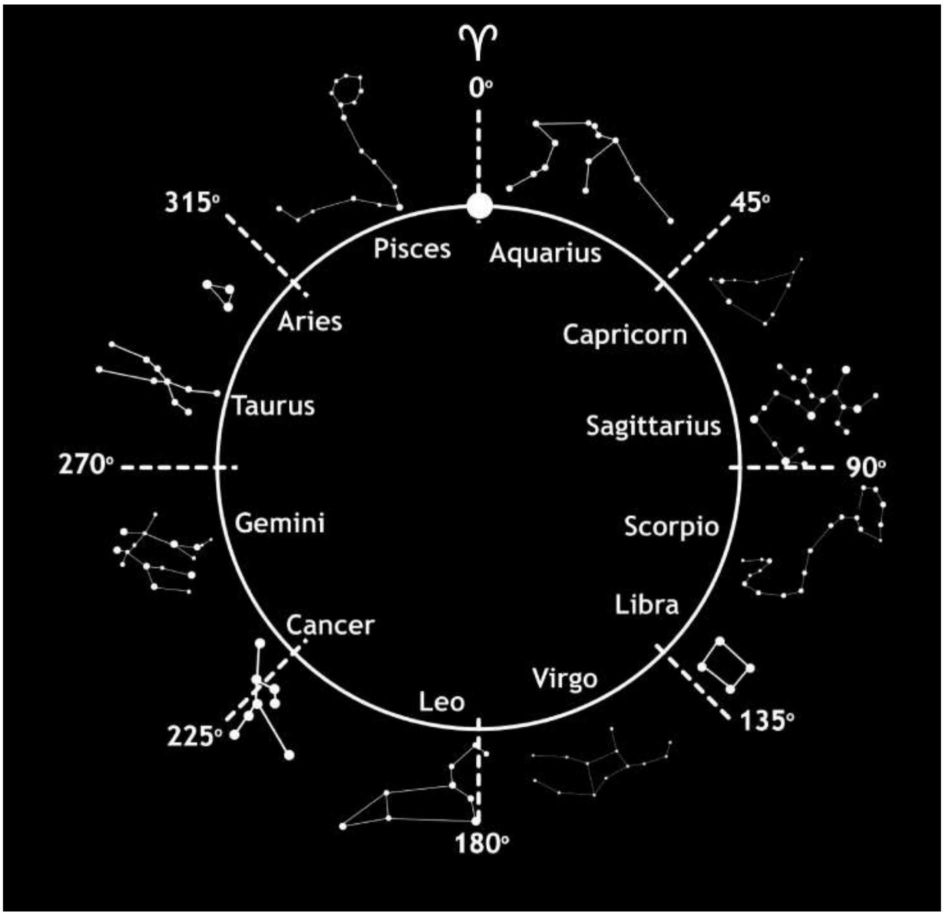

Figure 6

It has been suggested that the precession of the First Point of Aries is evidence that the Sphinx was built around 11 000 BCE.

Analyse the information in Figure 6 in order to comment on this suggestion.

(3)

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(Total for Question 5 = 10 marks)

6 Charlie designs an observing programme to measure the number of hours of daylight.

As shown in Figure 7, he puts a metal pole in the ground and watches closely for the shadow cast by the Sun.

Figure 7

He records the time of sunrise when he first sees a shadow in the morning.

He records the time of sunset when the shadow disappears in the evening.

Charlie's results are shown in Figure 8.

Day	Time of sunrise (h:min)	Time of sunset (h:min)
0	04:41	21:34
2	04:39	21:36
4	04:37	21:38
6	04:41	21:42
8	04:36	21:41
10	04:36	21:42
12	04:37	21:42
14	04:38	21:42
16	04:40	21:40

Figure 8

A graph of the Time of sunset data from Figure 8 has been plotted in Figure 9.

(a) Plot a graph of the Time of sunrise data in Figure 9.

(3)

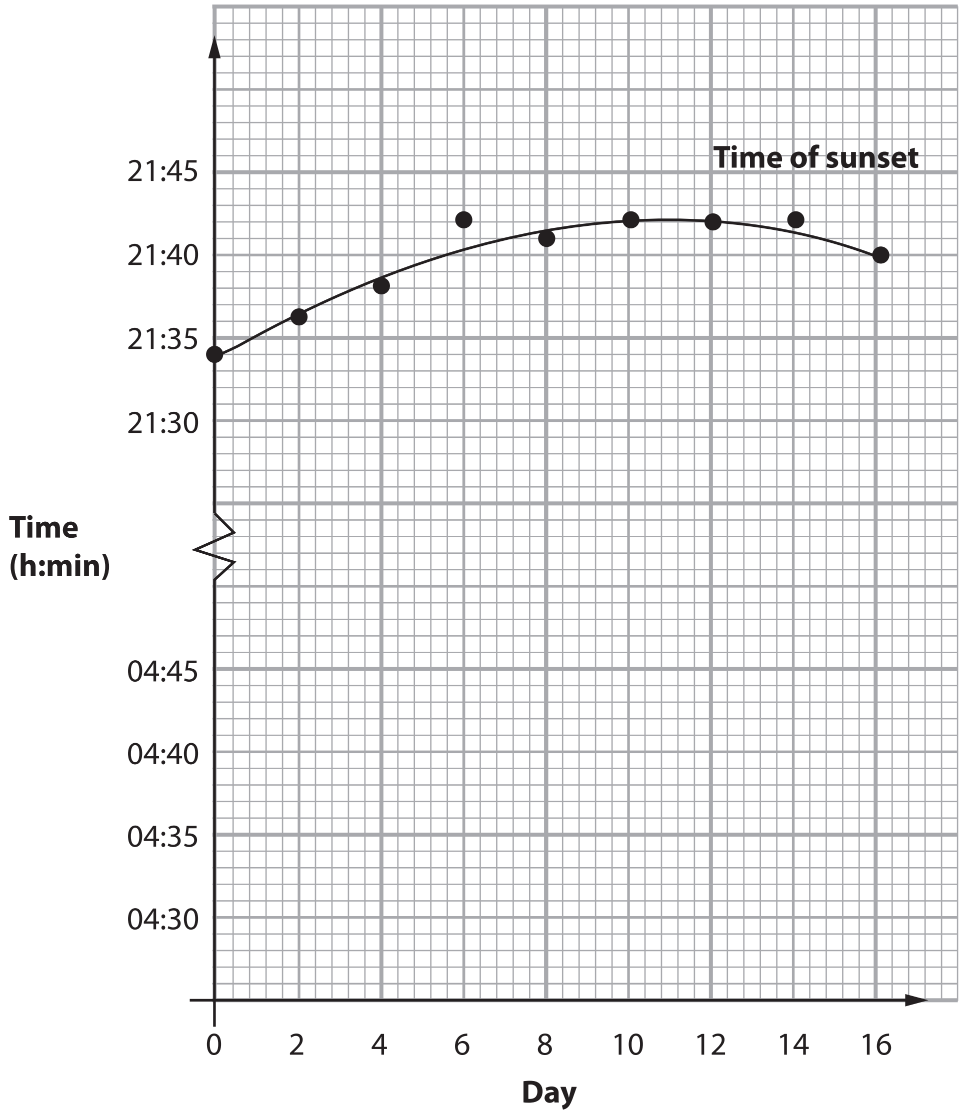
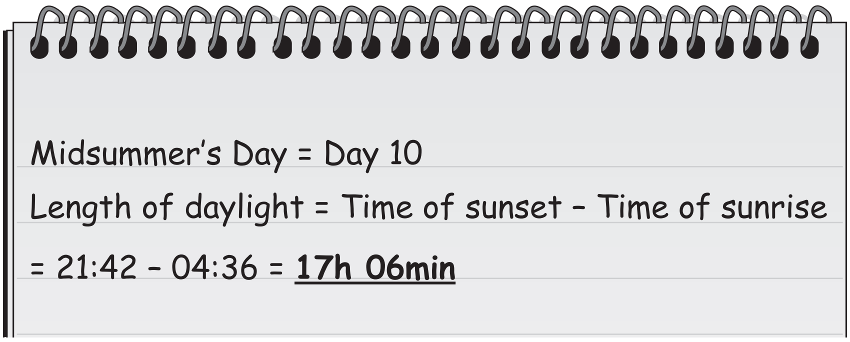


Figure 9

Using his results, Charlie made the following estimate of the length of daylight on Midsummer's Day.



(b) Evaluate the accuracy of Charlie's value for the length of daylight on Midsummer's Day, based on the observational procedures he has used.

(6)

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(Total for Question 6 = 9 marks)

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7 Alice visits a town near the sea. She sees a sign showing the times of the morning (left-hand dial) and afternoon (right-hand dial) high tides.

This sign is shown in Figure 10.

Figure 10

(a) (i) Explain why most places near the sea have **two** high tides each day.

You may include a clearly labelled diagram in your answer.

(3)

....

....

....

....

(ii) Calculate the time of the daytime low tide at Alice's location.

(2)

Time of low tide = ...

(b) Alice notices that the level of the sea water at high tide has been getting steadily higher every day.

She also notices that the Moon is approaching its full phase.

Explain how these two observations are connected.

You may include a clearly labelled diagram in your answer.

(3)

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(c) Bob wishes to measure the exact length of the Moon's phase cycle.

Design a suitable observing procedure that will allow Bob to produce a series of measurements from which he can calculate the exact length of the Moon's phase cycle.

(6)

(Total for Question 7 = 14 marks)

8 Figure 11 shows the Danish astronomer Tycho Brahe making observations of objects in the sky.

Figure 11

He is shown using his 'mural quadrant'. This was a very large protractor, reading from 0° to 90° with a radius of about 4 metres.

Using this equipment, he was able to measure the positions of objects in the sky to a precision of around 8 minutes of arc (8′), without the use of a telescope.

(a) (i) Explain how Brahe was able to make such precise measurements without the use of a telescope.

(2)

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(ii) The disc of the full Moon has a diameter of about half a degree (½°).

Calculate the fraction of the full Moon's diameter covered by an angle of 8′.

(1)

Fraction of diameter of full Moon = ...

(b) Brahe's observations of the planet Mars were used by the astronomer Johannes Kepler to show that it has an elliptical rather than a circular orbit around the Sun.

It took Kepler many years to make this discovery because Mars' position in the sky was very similar for both an elliptical and a circular orbit.

(i) Explain why predictions of the position of Mars in the sky made using a circular orbit are so close to its actual position.

(2)

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....

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(ii) State the name of the scientist who explained that the planets' elliptical orbits are caused by the force of gravity.

(1)

....

(c) A student estimates that Mars has a sidereal period of 760 days.

He does this by measuring the time it takes for Mars to return to the same position on the celestial sphere.

(i) Calculate a value for the average radius of Mars' orbit, based on this estimate of 760 days for its sidereal period.

Give your answer in kilometres.

(3)

Average radius of Mars' orbit = ... km

(ii) Explain why this calculation gives an incorrect value for the average radius of Mars' orbit.

(2)

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....

(Total for Question 8 = 11 marks)

9 Figure 12 shows the view looking north for an observer in London.

London has a latitude of 52°N.

Figure 12

The point labelled **P** is the position of the Pole Star.

The point labelled **LT** is the position of the circumpolar star Dubhe, at its lower transit.

The star Dubhe has a declination of 62°.

(a) Explain what is meant by the term 'circumpolar'.

(2)

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(b) (i) Draw the path of the star Dubhe over the next 24 hours on Figure 12.

(2)

(ii) Label the position of the star Dubhe when it is at its upper transit.

Use the label **UT**.

(1)

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(c) (i) State the altitude of the Pole Star from this location.

(1)

Altitude of Pole Star = ... °

(ii) Calculate the altitude of Dubhe when it is at its lower transit (**LT**).

(2)

Altitude at lower transit = ... °

(d) (i) Explain the difference between the sidereal and synodic day.

You may include a clearly labelled diagram in your answer.

(2)

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....

(ii) Dubhe reaches its lower transit (point **LT**) at 21:00 GMT.

Calculate the time at which Dubhe will reach its upper transit (**UT**).

(3)

Time of upper transit = ...

(Total for Question 9 = 13 marks)

10 For thousands of years ships sailing out of sight of land have used the stars to find their position on the Earth.

(a) (i) Explain how the position of the Pole Star in the night sky can be used to determine an observer's latitude.

You may include a clearly labelled diagram in your answer.

(2)

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(ii) The position of the Pole Star **cannot** be used to determine an observer's longitude.

Explain the reason for this.

(2)

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....

(iii) Describe an **astronomical** method for finding a ship's longitude at night.

You may include a clearly labelled diagram in your answer

(2)

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....

(b) A ship sets sail due west from a port in Ecuador (Latitude = 0°, longitude = 80°W).

It carries a clock set to the local time in Ecuador.

After sailing for 40 days, the clock is used to help calculate the ship's longitude.

When the Sun is directly due south, the clock shows a time of 16:24.

(i) Calculate the ship's current longitude.

(3)

Longitude = ... ° ....

Unfortunately, the clock loses 12 seconds of time every day.

(ii) Show that the ship's calculated longitude is 2° from its true value.

(2)

....

....

....

....

(iii) The Earth has a circumference of 40 000 km at the Equator.

Calculate the ship's true distance from its home port.

(3)

Distance = ... km

(Total for Question 10 = 14 marks)

TOTAL FOR PAPER = 100 MARKS

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Acknowledgements

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Figure 5: © Daily Travel Photos/Shutterstock

Figure 11: Wikimedia

Figure 12: © city vector/Shutterstock