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.

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:	$\text{magnification} = \frac{f_\text{o}}{f_\text{e}}$
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 Figure 1 shows sketches of the brightest stars in four different constellations.

The sketches are labelled A, B, C and D.

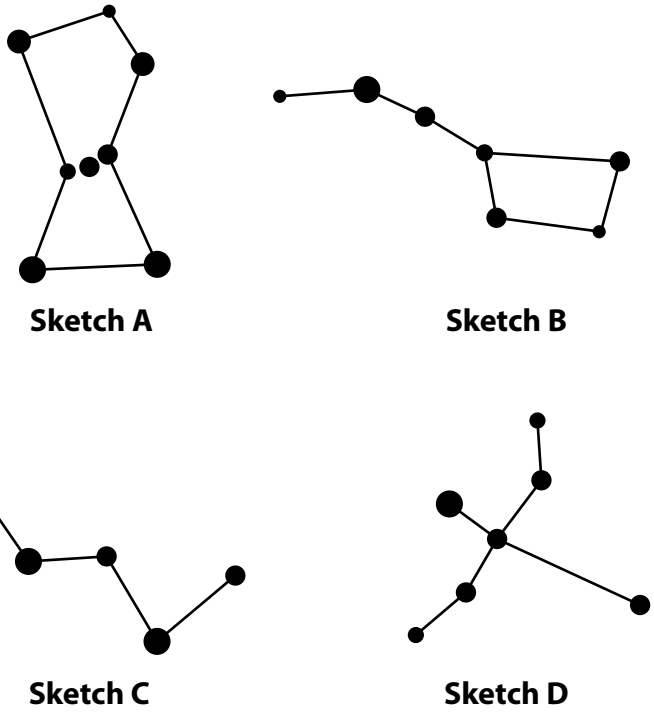

Figure 1

(a) (i) Which **one** of the sketches in Figure 1 shows the brightest stars in Orion?

(1)

☒ **A** Sketch A

☒ **B** Sketch B

☒ **C** Sketch C

☒ **D** Sketch D

(ii) Which **one** of the sketches in Figure 1 shows the brightest stars in Cassiopeia?

(1)

- ☒ **A** Sketch A
- ☒ **B** Sketch B
- ☒ **C** Sketch C
- ☒ **D** Sketch D

(iii) Which **one** of the sketches in Figure 1 shows the brightest stars in Cygnus?

(1)

- ☒ **A** Sketch A
- ☒ **B** Sketch B
- ☒ **C** Sketch C
- ☒ **D** Sketch D

(b) Pinhole projection can be used to observe the Sun safely.

(i) Describe the pinhole projection method.

You may include a clearly labelled diagram in your answer.

(2)

(ii) Describe the appearance of the Milky Way when observed with the naked eye from Earth.

(1)

(iii) Give **one** reason why the pinhole projection method may **not** be suitable when observing the Milky Way.

(1)

(Total for Question 1 = 7 marks)

2 (a) Figure 2 shows part of a cross-section of the Earth and its major internal divisions.

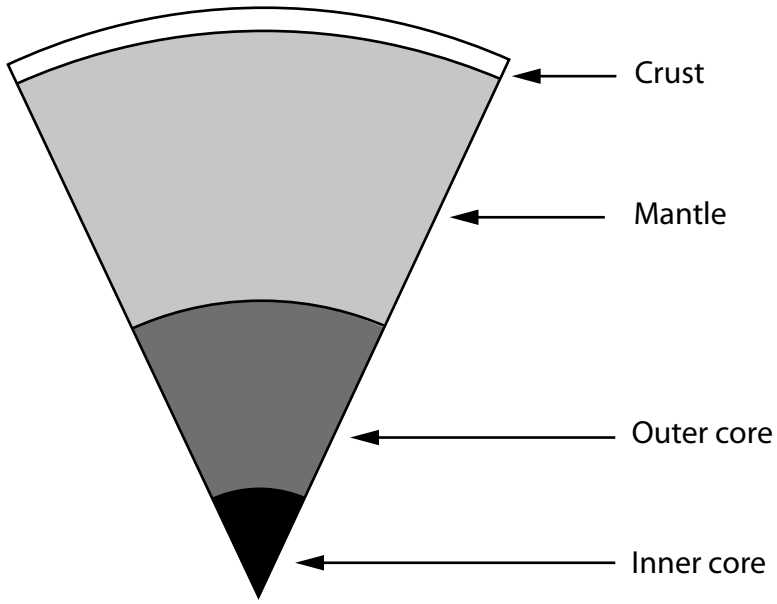

Figure 2

(i) Which **one** of the internal divisions in Figure 2 has the highest average temperature?

(1)

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

(ii) Which **one** of the following lists all the internal divisions in Figure 2 that are entirely solid?

(1)

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

(iii) Which **one** of the following lists all the internal divisions in Figure 2 that are made of mainly iron and nickel?

(1)

- ☒ **A** inner core
- ☒ **B** mantle and inner core
- ☒ **C** mantle, inner core and outer core
- ☒ **D** inner core and outer core

(iv) The Earth's inner core is thought to have a mean diameter of 2 400 km.

Name the dwarf planet whose diameter is closest to that of the Earth's inner core.

Use information from the Formulae and Data Sheet.

(1)

(b) The Earth's shape can be described as an oblate spheroid.

Draw an 'oblate spheroid'.

(2)

(c) (i) Which **one** of the following is the line of latitude on which the Sun will **not** rise above the horizon on the 21 December?

(1)

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

(ii) Which **one** of the following is the line of latitude on which the Sun is seen to pass directly overhead on the 21 December?

(1)

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

(Total for Question 2 = 8 marks)

3 Figure 3 shows the orbits of Venus, Earth and Mars around the Sun.

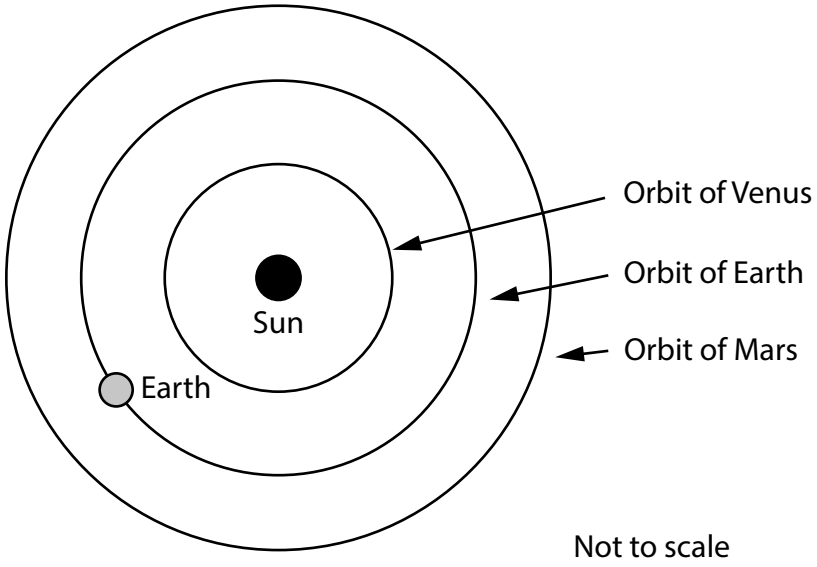

Figure 3

(a) (i) Label on Figure 3 the position of Mars when it is seen to be in opposition for an observer on Earth.

Use the label **M**.

(1)

(ii) Label on Figure 3 the position of Venus when it is seen to be in superior conjunction for an observer on Earth.

Use the label **S**.

(1)

(iii) Label on Figure 3 the **two** possible positions of Venus when it is seen to be at greatest elongation for an observer on Earth.

Use the label **G**.

(1)

(b) Name the **two** planets which **cannot** reach opposition for an observer on the Earth.

(2)

1

2

(c) Name the planet that can be seen to transit in front of the Sun when observed from Venus.

(1)

(d) Calculate the **minimum** possible distance between Venus and Mars.

Use information from the Formulae and Data Sheet.

Give your answer in astronomical units (AU).

(1)

Minimum distance = AU

(Total for Question 3 = 7 marks)

4 (a) (i) Explain why time zones are used on the Earth.

(2)

(ii) The Earth's surface is divided into twenty-four time zones.

Show that each time zone is, on average, fifteen degrees of longitude wide.

(iii) An aircraft flies in a straight line from Mogadishu, which has a longitude of 45°E to Jakarta which has a longitude of 107°E.
It takes the shortest route possible.

Calculate the smallest number of time zones that the aircraft could pass through on this journey.

(2)

Smallest number of time zones =

(b) Figure 4 shows a sundial located in the Earth's southern hemisphere.
It is correctly sited and aligned.

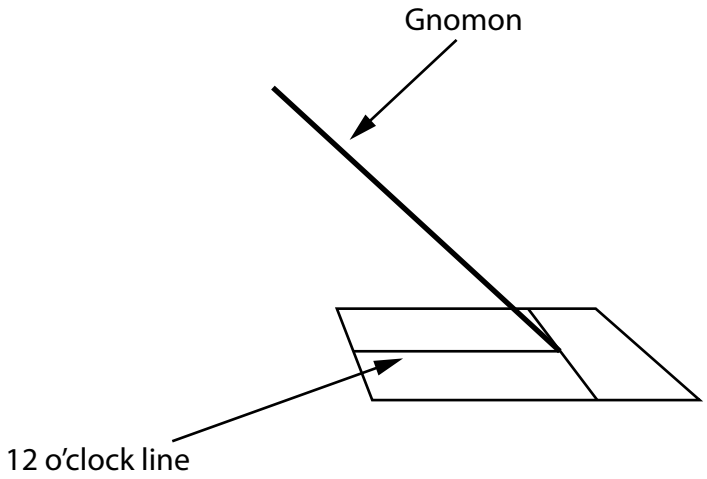

Figure 4

(i) Draw an arrow to show how the sundial can be used to determine the direction of north on Figure 4.

(1)

(ii) Label Figure 4 to show how the sundial can be used to determine the latitude at which this sundial is being used.

(1)

(iii) Ruhee uses a sundial to determine Greenwich Mean Time (GMT).

She records the following data:

Time on her sundial = 11 am
Equation of Time = -12 minutes
Longitude of the sundial = 8° West

Calculate the Greenwich Mean Time (GMT) at the time of her observations.

(2)

GMT = h:min

(Total for Question 4 = 9 marks)

5 Figure 5 is a diagram of the Moon's orbit around the Earth.

Four positions in the Moon's orbit are labelled A, B, C and D.

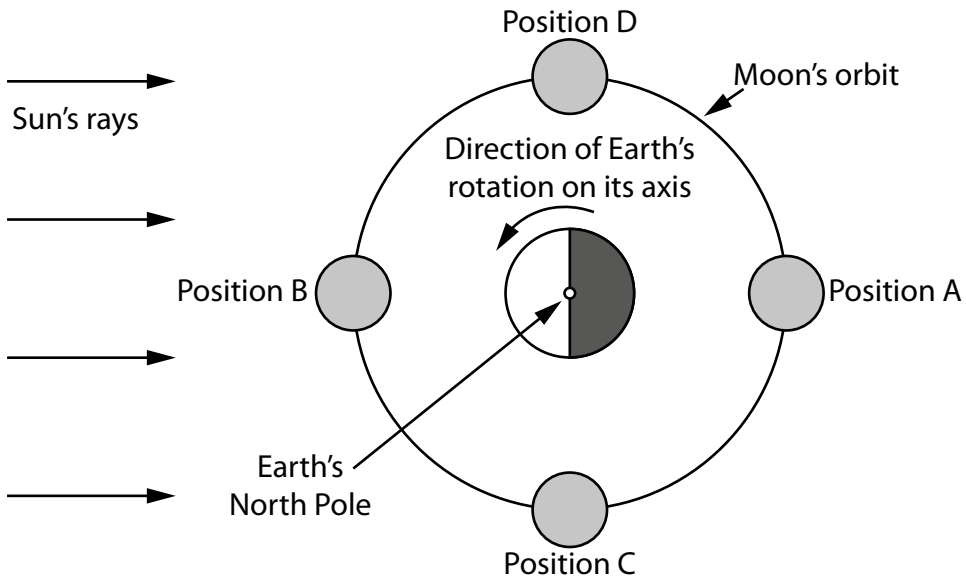

Figure 5

Table 1 shows details of three positions (A, B and C) in the Moon's orbit.

Position	Name of the Moon's phase when seen from Earth	Time at which the Moon will cross the observer's meridian
A	Full	00:00 (midnight)
B		
C		

Table 1

(a) (i) Using Figure 5, complete Table 1 to determine the Moon's phase when seen from Earth and the time at which the Moon will cross the observer's meridian.

(4)

(ii) Which **one** of the following positions of the Moon in Figure 5 will cause a neap tide to occur on Earth?

(1)

- ☒ **A** position A only
- ☒ **B** position B only
- ☒ **C** position A and position B
- ☒ **D** position C and position D

(b) Figure 6 shows the Earth when viewed from above the North Pole. The directions of the Moon and Sun are also shown.

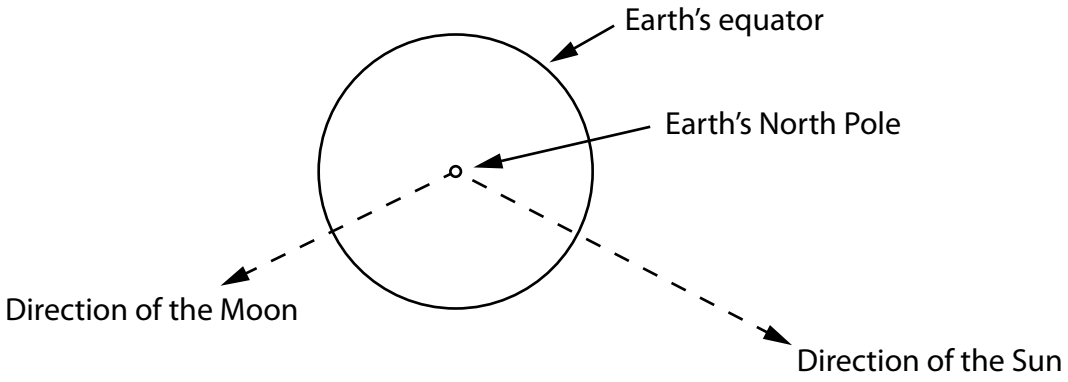

Figure 6

Label on Figure 6 **two** positions on the Earth's equator where a low tide is most likely to occur.

Use the labels **L1** and **L2**.

(2)

(c) The first column in Figure 7 shows a sketch of the Moon's phase when observed from a latitude of 60° N.

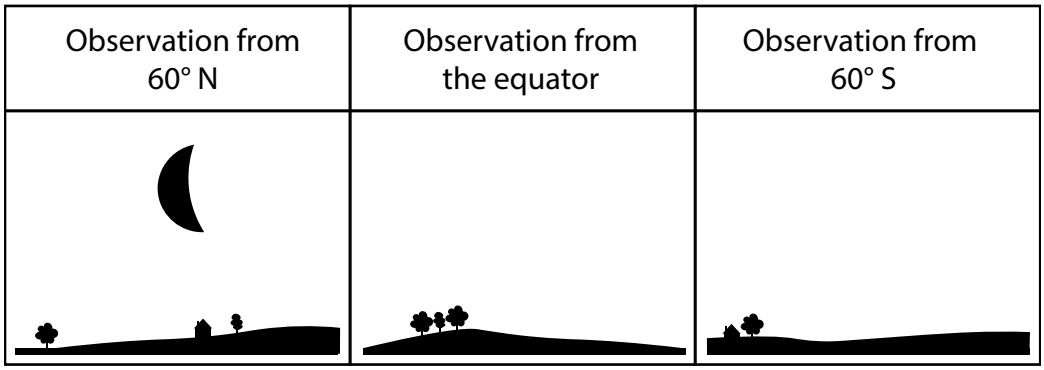

Figure 7

On the same night, the Moon is also observed from the equator and from a latitude of 60° S.

Draw on Figure 7 how the Moon would appear on the same night when observed from the equator and from a latitude of 60° S.

(2)

(Total for Question 5 = 9 marks)

6 (a) A model of the Universe which has the Earth at its centre is called:

(1)

- ☒ **A** circumpolar
- ☒ **B** geocentric
- ☒ **C** heliocentric
- ☒ **D** synodic

(b) Figure 8 shows a cross-section of the celestial sphere and an astronomer.

Point **X** on Figure 8 is located directly above the astronomer.

The astronomer measures the angle between the North celestial pole and X as 32°.

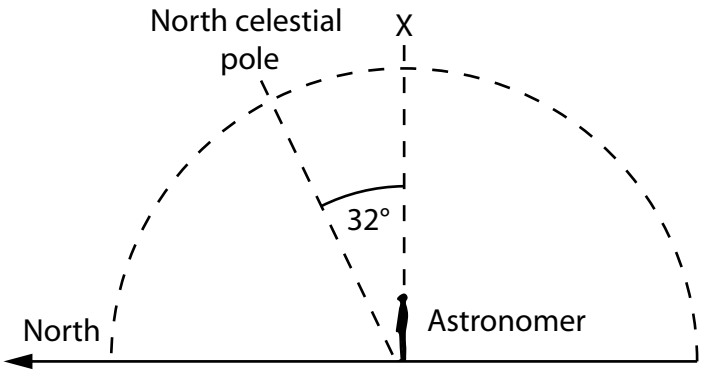

Figure 8

(i) Name the bright star which is located very close to the North celestial pole.

(1)

(ii) Name the point **X** in Figure 8, which is located directly above the astronomer.

(1)

(iii) A star located on the celestial equator is culminating.

Draw the position of this star on Figure 8.

Use the label **S**.

(1)

(iv) Calculate the altitude of the North celestial pole from this location.

(1)

Altitude = °

(v) State the astronomer's latitude.

(1)

(vi) State the declination of point **X**.

(1)

(c) Figure 9 shows a cross-section of the celestial sphere and a second astronomer at a different location.

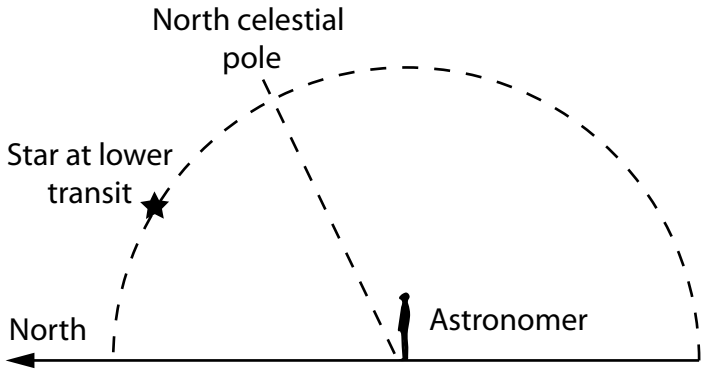

Figure 9

A circumpolar star is shown at its lower transit, crossing the astronomer's meridian.

The North celestial pole has an altitude of 68°.

The star has a declination of +70°.

(i) Draw the position of the star during its upper transit on Figure 9.

Use the label **U**.

(1)

(ii) Calculate the altitude of the star above the astronomer's northern horizon during its upper transit.

(2)

Altitude = °

(d) An astronomer incorrectly describes an observation of 'the constellation of the Plough'.

State a correct version of the astronomer's statement.

(1)

(Total for Question 6 = 11 marks)

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7 (a) Light pollution can be a problem for astronomers.

(i) State **one** source of light pollution.

(1)

(ii) State **one** effect that light pollution has on observations of objects in the night sky.

(1)

(iii) Astronomers in ancient times did not have to overcome the problems associated with light pollution.

Give **one** reason for this.

(1)

(b) An astronomer makes observations of the night sky with the aid of a star chart.

He then decides to replace the star chart with a planisphere.

(i) Give **two** observational **advantages** of using a planisphere instead of a star chart.

(2)

1

2

(ii) Give **one** observational **disadvantage** of using a planisphere instead of a star chart.

(1)

(c) An astronomy student observes five objects in the night sky.

She tries to use her observations to identify each object.

Her observational record is shown in Figure 10.

Observation	Description of observation	Suggested object
1	a bright streak of light that travelled across the sky in under one second	a meteor
2	a faint fuzzy blob of light about half the size of the full Moon	a galaxy
3	a very bright star (visible before all the other stars in the sky) seen on the western horizon just after sunset	the planet Uranus
4	about six or seven faint stars tightly clustered together	a star cluster
5	a steady, faint point of light moving quite quickly across the sky in about 2 minutes. It disappeared before it reached the horizon	an aeroplane

Figure 10

Evaluate the suitability of her suggested objects in Figure 10.

Where necessary, suggest alternative objects that could fit her observations.

(6)

(Total for Question 7 = 12 marks)

8 Figure 11 shows a simplified sketch made by an astronomer observing the apparent path taken by a star during the night.

The position of the star is shown when the astronomer's local mean time was 01:30.

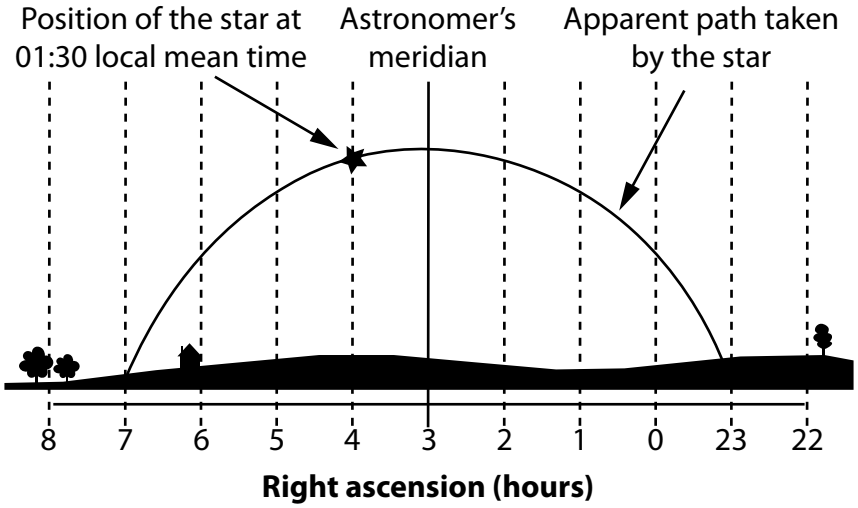

Figure 11

(a) (i) State the right ascension of the star.

(1)

Right ascension = hours

(ii) Draw the position of the star two hours earlier on Figure 11.

Use the label **S**.

(1)

(iii) State the number of hours that the star spends above the astronomer's horizon during this night's observation.

(1)

(iv) Which **one** of the following is the astronomer's local mean time when the star was culminating?

(1)

- ☒ **A** 02:00
- ☒ **B** 02:30
- ☒ **C** 03:00
- ☒ **D** 03:30

(v) Which **one** of the following is the star's hour angle at 01:30 local mean time?

(1)

- ☒ **A** 01:00
- ☒ **B** 03:00
- ☒ **C** 04:00
- ☒ **D** 23:00

(vi) Which **one** of the following is the local sidereal time at 01:30 local mean time?

(1)

- ☒ **A** 01:00
- ☒ **B** 03:00
- ☒ **C** 04:00
- ☒ **D** 23:00

(b) The apparent motion of the Sun can be used to help find positions on the surface of the Earth.

Alice and Bob make observations of sunrise times and day lengths from two different locations.

Alice makes her observations from London.

Bob makes his observations from another European city.

Table 2 shows their results.

	Alice (London)		**Bob (European city)**	
Date	Time of sunrise (GMT)	Day length (h:m)	Time of sunrise (GMT)	Day length (h:m)
Feb 1	07:39	09:09	05:30	10:17
Mar 1	06:44	11:00	04:56	11:22
Apr 1	06:35	12:59	04:09	12:38
May 1	05:31	14:53	03:28	13:47

Table 2

(i) Analyse Table 2 in order to determine the location of Bob.

Include in your answer whether he is:
- north or south of London
- east or west of London.

(3)

(ii) Suggest a practical problem with using the apparent motion of the Sun to determine your latitude.

(2)

(Total for Question 8 = 11 marks)

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9 The following is an extract from an astronomy newsletter.

'A "blue moon" is the name given to the second of two full moons which have occurred in the same calendar month. A blue moon occurred on the 31st January 2018.

A total lunar eclipse also occurred on this date. This lunar eclipse would have looked especially impressive because it was a "supermoon" as the Moon was near its perigee on 31st January 2018.'

(a) (i) Determine the date in January 2018 on which the first full moon of the month occurred.

(1)

(ii) Explain why a supermoon can look more impressive than other full moons.

(2)

(iii) Analyse this extract in order to determine the orbital positions of the Earth, Moon and Sun at the time of the blue moon.

You may include a clearly labelled diagram in your answer.

(3)

(b) An astronomer sketched the Moon from the same location on two dates.

One date was near the summer solstice and the other was near the winter solstice.

He noted that the Moon had the same phase on both dates.

Figure 12 shows the astronomer's sketches.

Figure 12

Explain the Moon's differing appearance when observed on these two dates.

You may include a clearly labelled diagram in your answer.

(2)

(c) Patrick wants to observe the following three features on the surface of the Moon:

- Sea of Tranquility
- the crater Tycho
- Apennine mountain range.

Figure 13 shows a lunar phase calendar for the month in which Patrick is planning to observe.

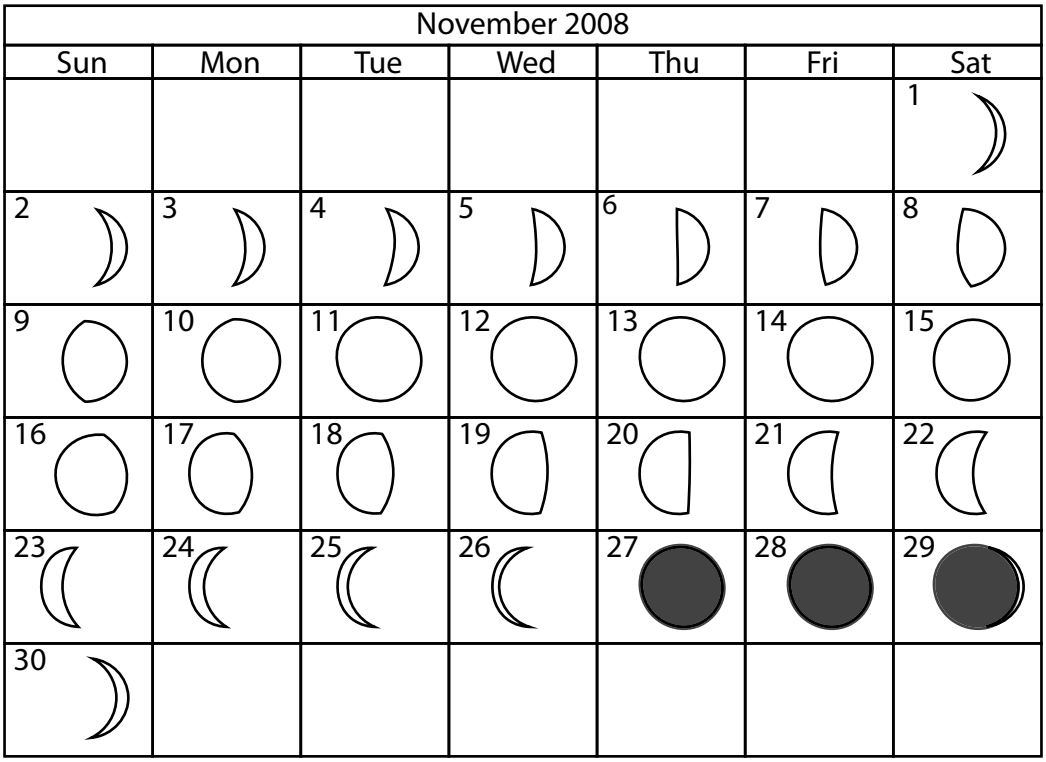

Figure 13

Design an observational programme that will allow Patrick to make the best possible observations of each of his three chosen features.

Use information from Figure 13.

Your observational programme should include:

- possible days of the month when each of his three chosen features will be best placed for observation
- reasons why you selected each of these days of the month.

(6)

(Total for Question 9 = 14 marks)

10 Uranus has twenty-seven known moons.

Table 3 shows data for some of these moons.

Moon	T, the orbital period of the moon (days)	r, the mean orbital radius of the moon ($\times 10^5$ km)	T^2, the orbital period of the moon squared ($days^2$)	r^3, the mean orbital radius of the moon cubed ($\times 10^{15}$ km^3)
Puck	0.8	0.9	0.6	0.7
Mab	0.9	1.0	0.8	1.0
Miranda	1.4	1.3	2.0	2.2
Ariel	2.4	1.8	5.8	5.8

T = orbital period of the moon in days.

r = mean orbital radius of the moon $\times 10^5$ km.

Table 3

(a) (i) Using the data in Table 3, plot a graph of T^2 (vertical axis) against r^3 (horizontal axis) on Figure 14.

Draw a line of best fit for your data points.

(3)

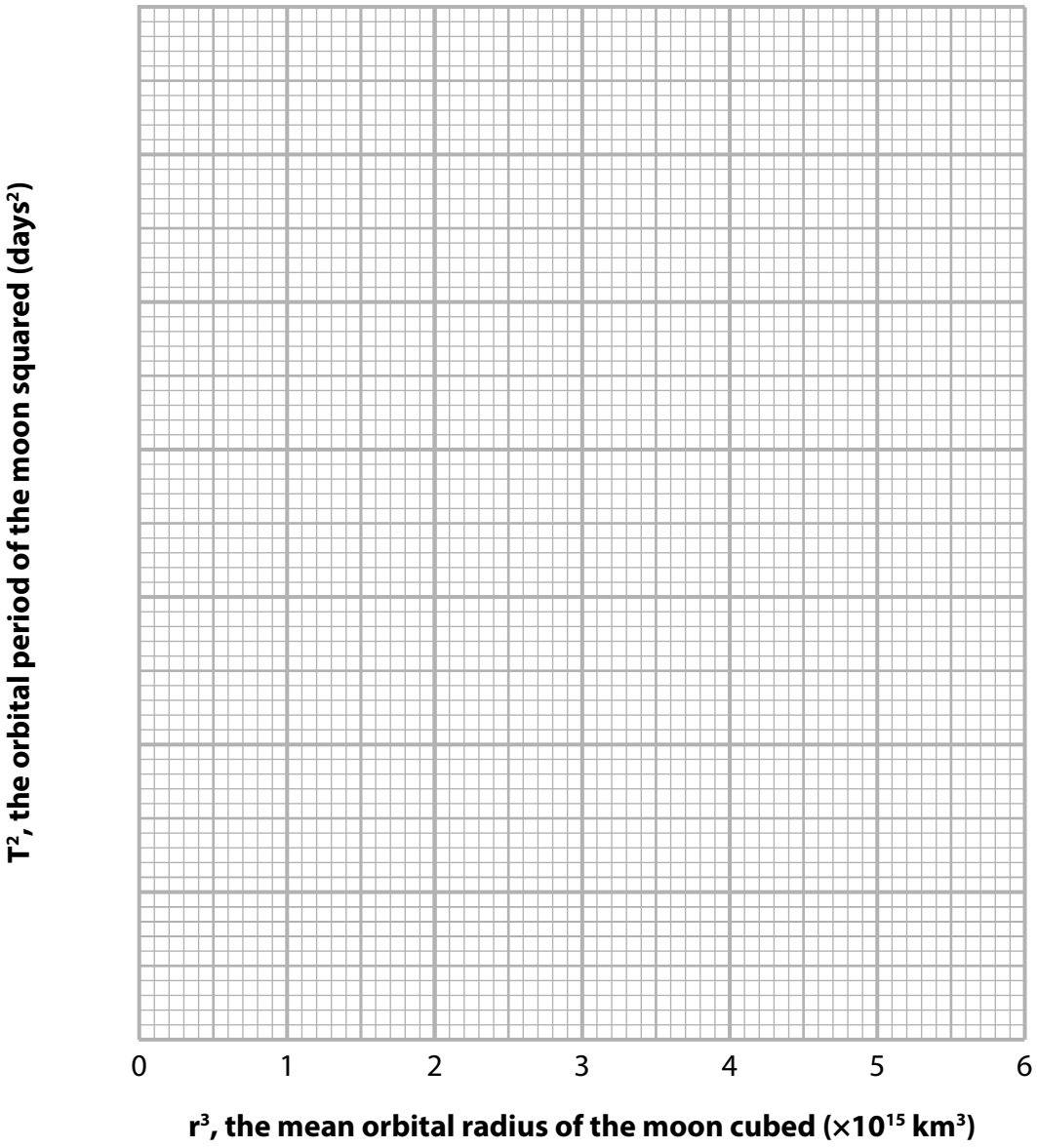

Figure 14

(ii) Another moon of Uranus has a mean orbital radius of 1.6×10^5 km.

Calculate the orbital period of this moon.

Use the graph in Figure 14.

Give your answer in days.

(3)

Orbital period = days

(b) Astronomers can use Kepler's Third Law to calculate the orbital period of moons around planets in the Solar System.

Kepler's Third Law can be written in the form:

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

(i) State how this constant can be determined from the graph drawn in Figure 14.

(1)

(ii) For the moons of Uranus, this constant is equal to 0.91×10^{-15} day^2/km^3.

However, this constant **cannot** be used to calculate the orbital periods of the moons orbiting Saturn.

Explain this statement.

(2)

(iii) An astronomer wishes to calculate the constant used in Kepler's Third Law for the planet Saturn.

Show that the ratio of the mass of Saturn to the mass of Uranus is approximately 6.3.

Use information from the Formulae and Data Sheet.

(1)

(iv) Calculate the constant used in Kepler's Third Law for Saturn.

Use the constant for the moons of Uranus, equal to 0.91×10^{-15} day^2/km^3.

Use the ratio of the mass of Saturn to the mass of Uranus which is equal to 6.3.

Give your answer in $\times 10^{-15}$ days^2/km^3.

(2)

Constant for Saturn = $\times 10^{-15}$ days^2/km^3

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

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