Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9–1)

Centre Number | | | | | |

Candidate Number | | | | |

Monday 10 June 2019

Afternoon (Time: 1 hour 45 minutes) | Paper Reference **1AS0/02**

Astronomy

Paper 2: Telescopic 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 ▶

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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	0.55	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.

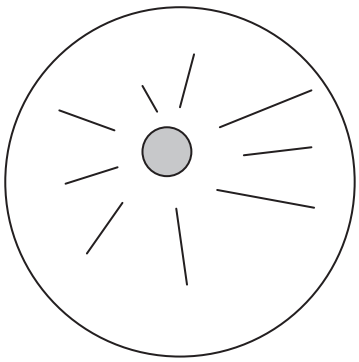
Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 A student used binoculars to make some sketches of objects in the night sky.

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

(i) A circular shape on the surface of the Moon with rays around it.

(1)



☒ **A** crater

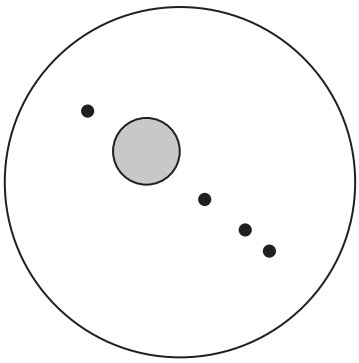
☒ **B** mare

☒ **C** rille

☒ **D** ring

(ii) Four small points of light in a line, close to the planet Jupiter.

(1)



☒ **A** comets

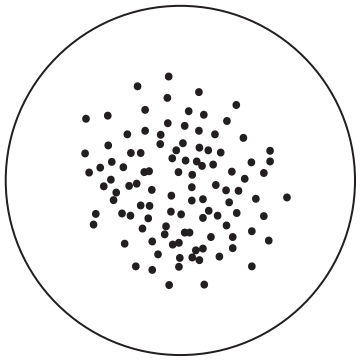
☒ **B** galaxies

☒ **C** meteors

☒ **D** moons

(iii) A sphere of very densely packed stars.

(1)



☒ **A** comet

☒ **B** double star system

☒ **C** globular cluster

☒ **D** planetary nebula

(b) A student writes a description of some objects in the night sky when viewed through a small telescope.

Identify each object from its description.

(i) A long curved structure on the surface of the Moon.

(1)

☒ **A** crater

☒ **B** mare

☒ **C** rille

☒ **D** ring

(ii) A very bright flashing light, which crossed the field of view in a few seconds.

(1)

☒ **A** aeroplane

☒ **B** comet

☒ **C** meteor

☒ **D** planet

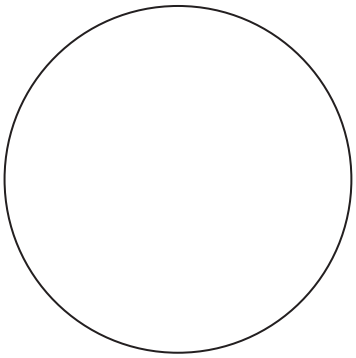
(iii) A group of millions of stars, arranged in a spiral pattern.

(1)

- ☒ **A** aurora
- ☒ **B** cluster
- ☒ **C** galaxy
- ☒ **D** supernova

(c) Sketch the appearance of a sunspot as seen through a powerful telescope.

(2)



(Total for Question 1 = 8 marks)

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2 (a) Which of the following is **not** a possible theory for the origin of the Moon?

(1)

☒ **A** capture

☒ **B** co-accretion

☒ **C** geocentric

☒ **D** Giant Impact

(b) Figure 1 shows the internal divisions of the Moon.

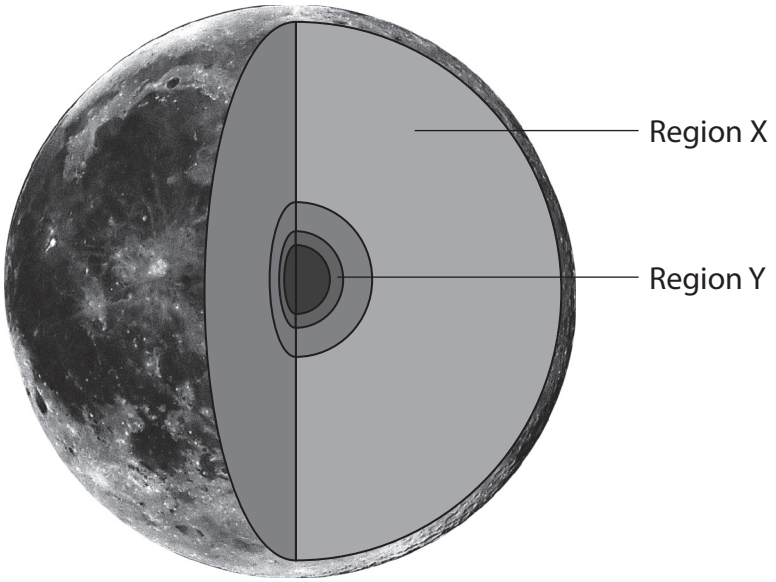

Figure 1

(i) What is the name of Region X?

(1)

☒ **A** crust

☒ **B** inner core

☒ **C** mantle

☒ **D** outer core

(ii) What is the name of Region Y?

(1)

☒ **A** crust

☒ **B** inner core

☒ **C** mantle

☒ **D** outer core

(c) Only one side of the Moon is ever visible from Earth. Explain how astronomers have observed the other side of the Moon.

(2)

.....

.....

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.....

(d) State **two** differences between the appearance of the Moon's near side and far side.

(2)

1 .....

2 .....

(Total for Question 2 = 7 marks)

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3 (a) Figure 2 shows the Sun's interior.

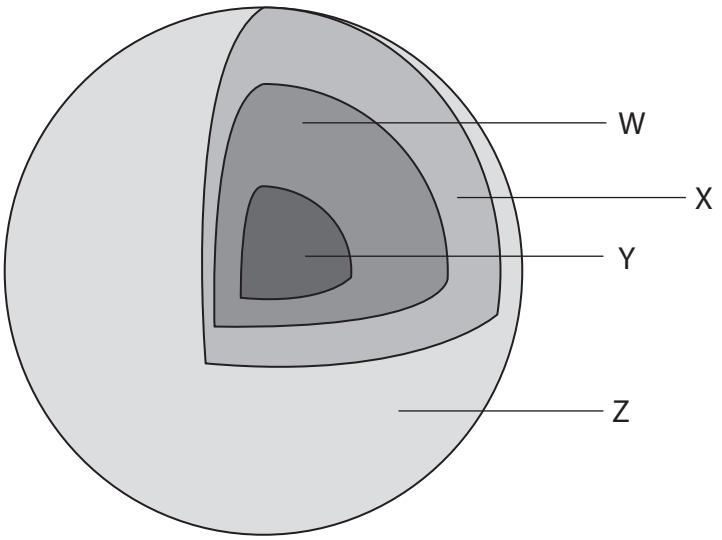

Figure 2

State the name of the internal divisions labelled W, X, Y and Z.

(2)

W .....

X .....

Y .....

Z .....

(b) Which of the following is a correct list of the Sun's features, in order from hottest to coldest?

(1)

☒ **A** chromosphere, photosphere, corona, sunspot

☒ **B** corona, chromosphere, photosphere, sunspot

☒ **C** corona, photosphere, chromosphere, sunspot

☒ **D** photosphere, corona, sunspot, chromosphere

(c) Which of the following is located furthest from the Sun's surface?

(1)

☒ **A** chromosphere

☒ **B** corona

☒ **C** heliosphere

☒ **D** penumbra

(d) Which of the following summarises the proton-proton cycle?

(1)

☒ **A** 1 hydrogen nucleus produces 1 helium nucleus

☒ **B** 1 hydrogen nucleus produces 4 helium nuclei

☒ **C** 4 hydrogen nuclei produce 4 helium nuclei

☒ **D** 4 hydrogen nuclei produce 1 helium nucleus

(e) Describe a safe method of observing the Sun when using a telescope.

You may include a carefully labelled diagram in your answer.

(2)

(f) Calculate the ratio of the Sun's mean diameter to Jupiter's mean diameter.

Use information from the Formulae and Data Sheet.

(1)

☒ **A** 0.98

☒ **B** 9.8

☒ **C** 98

☒ **D** 980

(Total for Question 3 = 8 marks)

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4 (a) A group of astronomers wish to take high resolution images of Mars.

Figure 3 compares three types of space probe that could be used for this mission.

	Fly-by	Orbiter	Impactor
Journey time (days)	70	275	125
Journey distance (million km)	65	160	85
Distance at closest approach (km)	2500	300	0
Number of orbits around Mars	0	200	1

Figure 3

(i) Analyse the data in Figure 3 in order to explain which is the most suitable space probe for this mission.

(2)

.....

.....

.....

.....

(ii) Calculate the minimum distance between Earth and Mars. Give your answer in km.

Use information from the Formulae and Data Sheet.

(2)

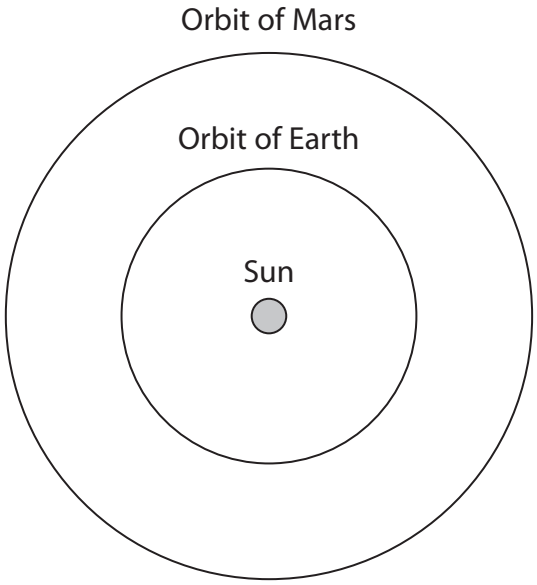
distance = ... km

(iii) The distance travelled by the orbiter space probe is much larger than the fly-by space probe.

State **two** reasons for this difference.

Complete the diagram below to illustrate your reasons.

(2)



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2 .....

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(b) (i) The closest distance between Venus and the Earth is less than the closest distance between the Earth and Mars.

State **two** reasons why there are no future plans to send a manned mission to Venus.

(2)

1 .....

2 .....

(ii) State a reason why Venus is sometimes referred to as Earth's 'twin' planet.

(1)

.....

(Total for Question 4 = 9 marks)

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5 Figure 4 shows a simplified Hertzsprung-Russell diagram.

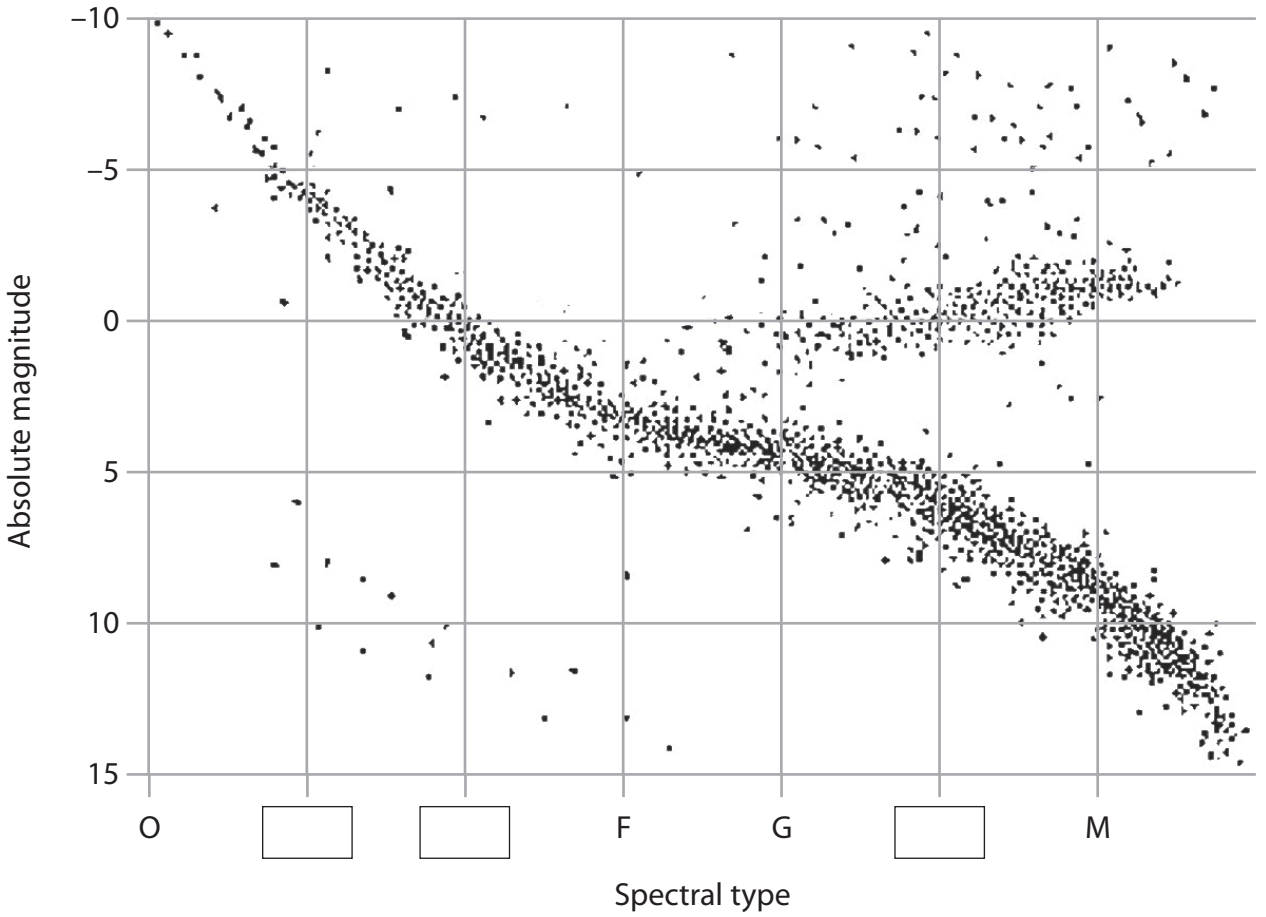

Figure 4

(a) Complete the labels on the horizontal axis by filling in the missing spectral types.

(1)

(b) Label Figure 4 with the positions of:

(i) the Sun. Use the label **S**.

(1)

(ii) a blue giant star. Use the label **BG**.

(1)

(iii) a supergiant star. Use the label **SG**.

(1)

(c) Label Figure 4 with the positions of a star that has its gravitational collapse balanced by:

(i) radiation pressure. Use the label **RP**.

(1)

(ii) electron pressure. Use the label **EP**.

(1)

(d) State why neutron stars are **not** plotted on the Hertzsprung-Russell diagram.

(1)

.....

.....

(e) By studying the mass of the Sun astronomers predict that it will eventually become a planetary nebula.

Explain this prediction.

(2)

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(Total for Question 5 = 9 marks)

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6 (a) There is observational evidence for both the Big Bang theory and the Steady State theory.

Complete Figure 5 below. Use a tick (✓) to indicate that the observational evidence supports the theory or a cross (✗) to indicate that it proves the theory wrong.

(3)

	Observational evidence for the Steady State theory	**Observational evidence for the Big Bang theory**
Hubble Deep Field image		
Quasars		
Redshift of distant galaxies		
The expanding Universe		

Figure 5

(b) Figure 6 illustrates two possible evolutionary paths of the Universe.

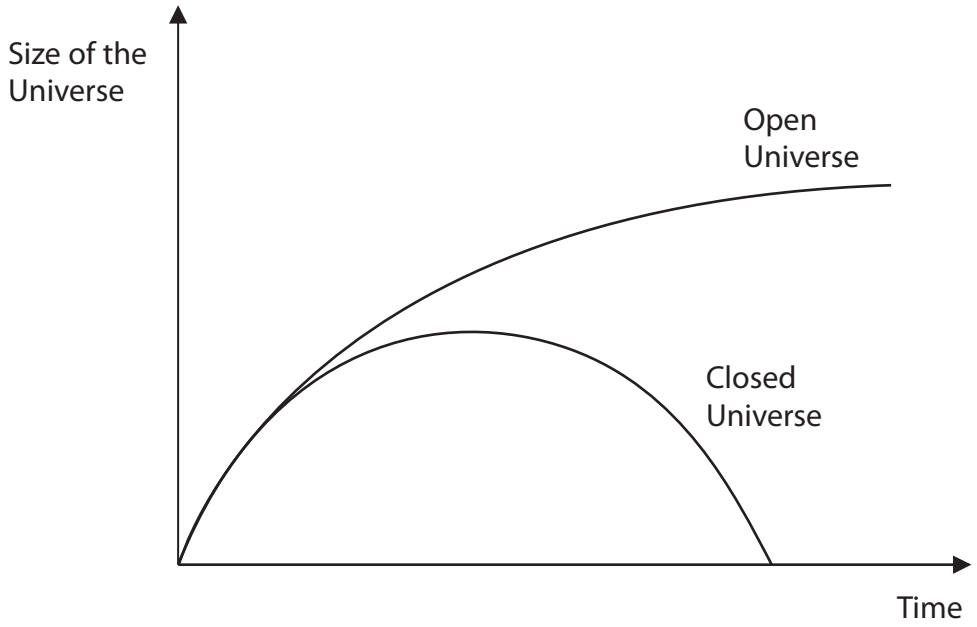


Figure 6

Label Figure 6 with the positions of:

(i) the Big Bang. Use the label **B**.

(1)

(ii) the Big Crunch. Use the label **C**.

(1)

(c) The existence of Dark Energy has been proposed.

Complete Figure 6 to show the future evolutionary path of the universe due to Dark Energy.

(2)

(d) The Andromeda galaxy is approximately 0.78 Mpc from Earth.

Calculate the time in years it takes for the light from this galaxy to reach Earth.

Use the Formulae and Data Sheet.

(2)

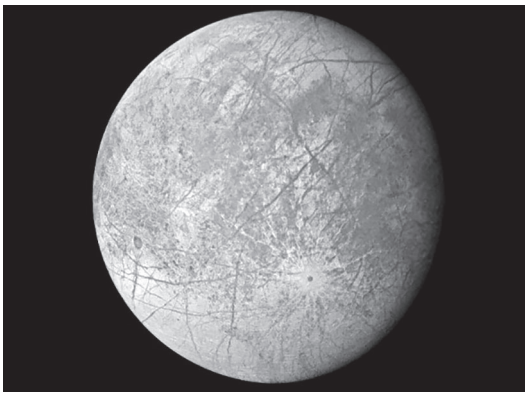
time taken = ... years

(Total for Question 6 = 9 marks)

7 Astronomers think liquid water is a requirement for lifeforms to exist.

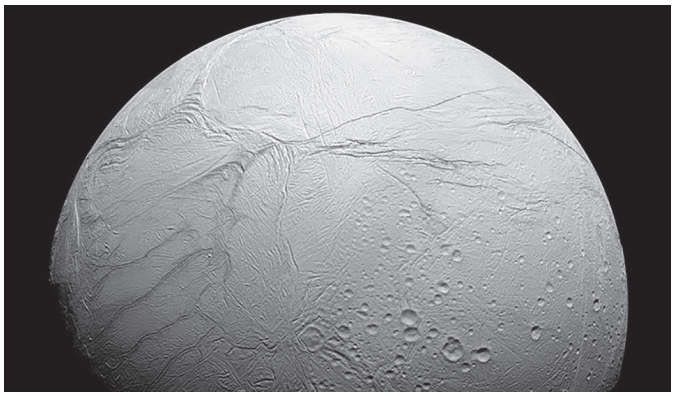
Liquid water is below the surface of Enceladus.

It may also be under the surface of Europa, a moon of Jupiter.



(Source: NASA)

Figure 7 – Europa



(Source: NASA)

Figure 8 – Enceladus

(a) Name the planet that Enceladus orbits.

(1)

.....

(b) Astronomers are proposing to send a space probe to one of these moons to search for the evidence of lifeforms.

Compare the advantages and disadvantages of sending a lander rather than an orbiter.

(3)

.....

.....

.....

.....

.....

.....

(c) The energy requirements for sending a space probe to Europa or Enceladus are much greater than those required to orbit the Earth.

State a reason for this.

(1)

.....

.....

(d) Comets are made of water ice. Figure 9 gives some data about the two moons Enceladus and Europa and the nucleus of the comet 67P.

	Enceladus	**Europa**	**Nucleus of the comet 67P**
Recorded Surface Temperature (°C)	–200	–220	–70
Diameter (km)	500	6200	4
Distance from parent planet (km)	238 000	671 000	Does not orbit a parent planet
Type of parent planet	Gas giant	Gas giant	None
Presence of liquid water below the surface	Yes	Yes	No

Figure 9

(i) It is possible for water to exist as a liquid below the surface of Enceladus and Europa.

Analyse the data in Figure 9 in order to explain this statement.

(2)

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.....

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(ii) Liquid water is not thought to exist in the nucleus of the comet 67P.

Analyse the data in Figure 9 in order to explain this statement.

(2)

(e) Name the equation used to estimate the number of civilisations in our galaxy.

(1)

(f) Figure 10 shows Phoebe, one of the moons of Saturn. It has a much smaller mass than Europa.

(Source: NASA)

Figure 10

Explain why Europa is spherical but Phoebe has an irregular shape.

(2)

(Total for Question 7 = 12 marks)

8 Figure 11 shows a sketch of a binary star system made by an astronomer using a small telescope.

The two stars in the binary system are just resolved and labelled A and B.

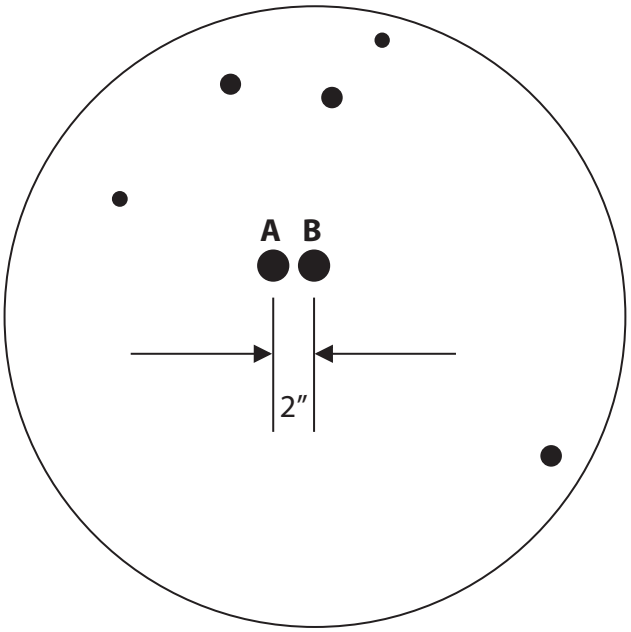

Figure 11

(a) (i) Define the term 'binary star system'.

(1)

.....

(ii) Define the term 'field of view' of a telescope.

(1)

.....

(iii) The angular separation of stars A and B is 2 seconds of arc (2″).

Estimate the field of view of this telescope.

Take suitable measurements from Figure 11 and give your answer in minutes of arc.

(3)

field of view = ... minutes of arc

(iv) Figure 12 shows some data about this telescope.

Diameter of objective (cm)	20
Focal length of objective (m)	1.50
Magnification	50×

Figure 12

Calculate the focal length of the eyepiece that produces this magnification.

Give your answer in mm.

(2)

focal length = ... mm

(b) The stars A and B are observed with a naked-eye.

Describe **two** ways in which their appearance differs from that shown in Figure 11.

(2)

1 .....

2 .....

(c) Another method of observing these stars is with a radio telescope.

(i) Explain why radio telescopes need very large apertures to maintain a useful resolution.

(2)

.....

.....

.....

(ii) State another method that radio astronomers use to improve resolution.

(1)

.....

(Total for Question 8 = 12 marks)

9 An astronomer wants to compare the stellar densities inside and outside the plane of the Milky Way.

She takes two photographs.

Details of her images are shown in Figure 13.

	Photograph A Inside the plane of the Milky Way	**Photograph B** Outside the plane of the Milky Way
Photograph		
Date	18 December	08 August
Time	01:20 GMT	21:30 GMT
Lunar phase	New	Full
Exposure time	30 seconds	10 seconds
Number of visible stars		15

Figure 13

(a) (i) State the type of object that could have caused the faint dotted line that is visible in photograph A.

(1)

.....

(ii) Analyse the information in Figure 13 to determine a value for the ratio of the number of stars in photograph A to the number of stars in photograph B.

(2)

ratio = ...

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(iii) Evaluate ways of improving the accuracy of these measurements based on the observational procedures that were used.

(6)

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(b) (i) Describe the observational evidence that the Milky Way galaxy is classified as spiral rather than elliptical.

(2)

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.....

.....

.....

(ii) State how astronomers determined the structure of the Milky Way galaxy.

(1)

.....

.....

(Total for Question 9 = 12 marks)

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10 (a) Figure 14 shows the light curve of a Cepheid variable star.

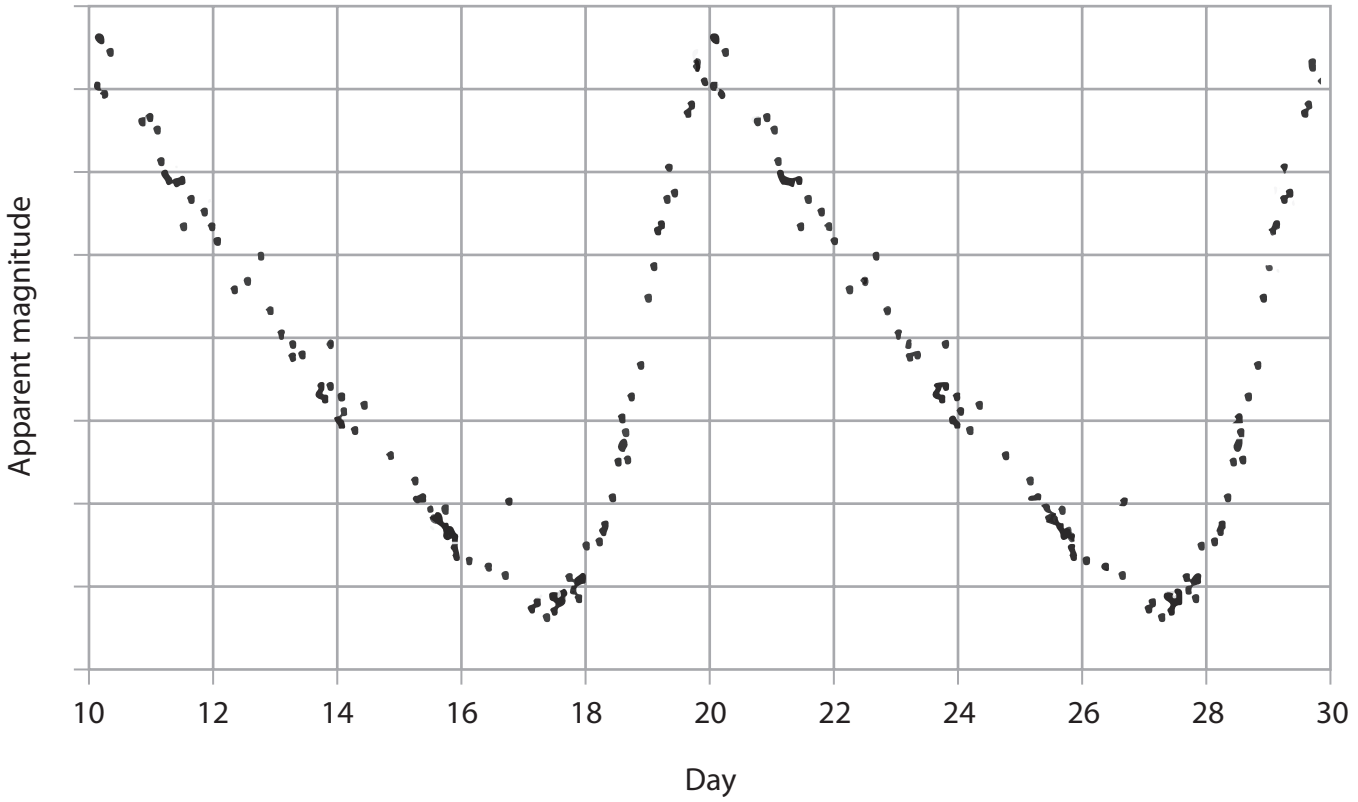

Figure 14

(i) Determine the period of the Cepheid variable star in Figure 14.

(1)

Period = ... days

Figure 15 shows the period-luminosity relationship for Cepheid variables.

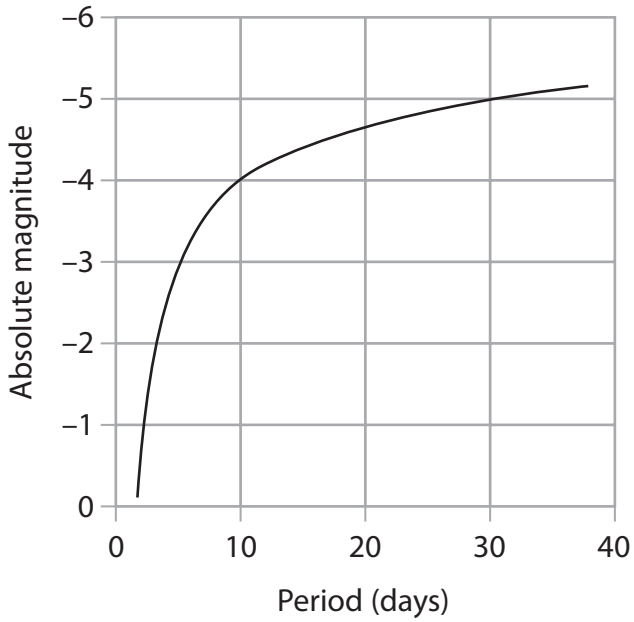

Figure 15

(ii) Determine the absolute magnitude of the Cepheid variable star in Figure 14.

(1)

.....

(iii) The Cepheid variable star shown in Figure 14 has an average apparent magnitude of +1.0.

Calculate the distance to this star in parsecs.

(3)

distance = ... pc

(b) (i) Name **one other** method that astronomers use to measure stellar distances.

(1)

.....

(ii) Describe this method.

(2)

(c) Delta Cephei, a star that can be seen with the naked-eye, is a Cepheid variable star in the circumpolar constellation of Cepheus.

Design an observational procedure to determine the distance to this star.
Your design should include the following:

- the observations that should be made
- how you could process and analyse these observations to find the distance to the star.

(6)

(Total for Question 10 = 14 marks)

TOTAL FOR PAPER = 100 MARKS

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