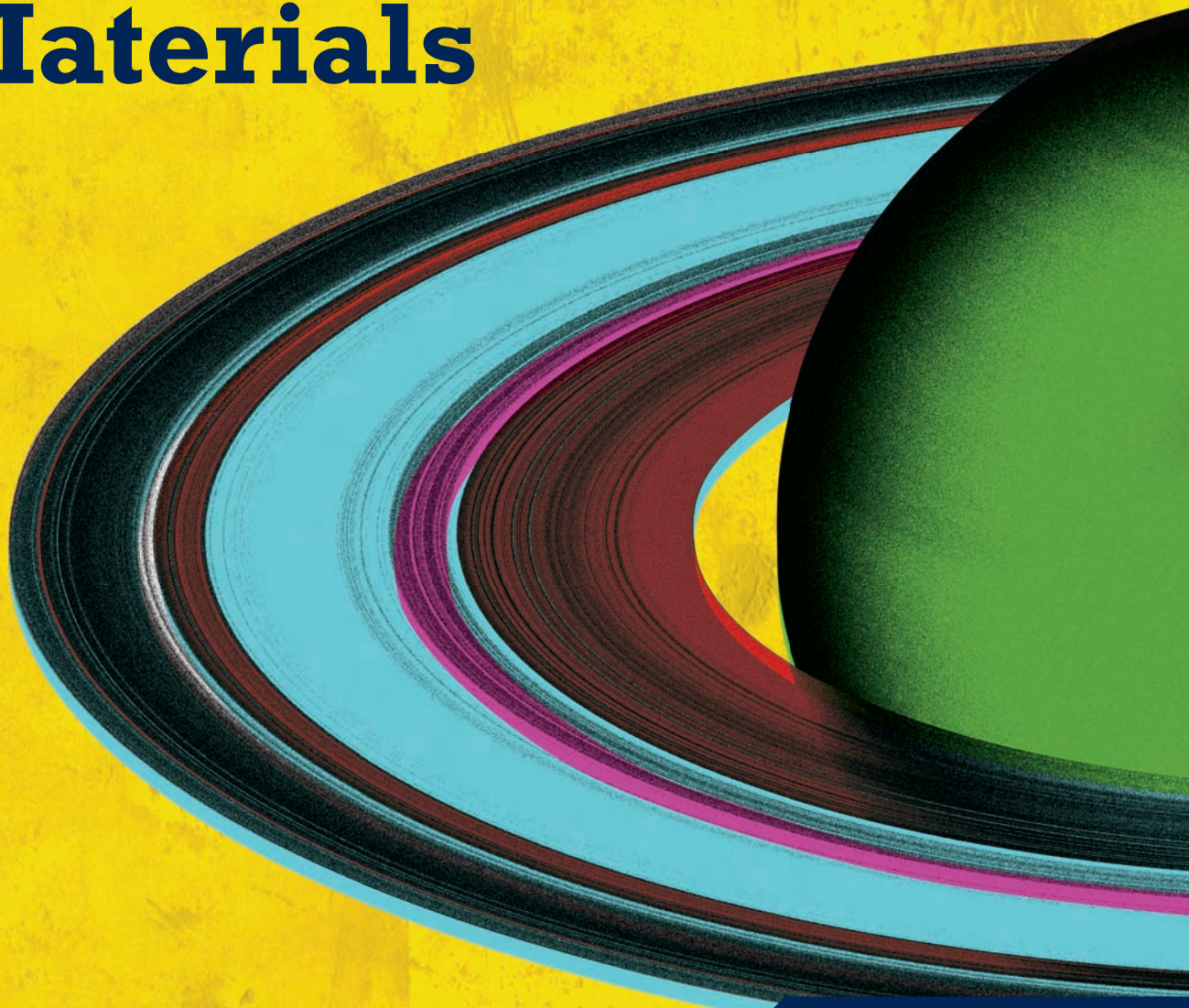


Edexcel GCSE

Astronomy (2AS01)

For first teaching from 2009

Sample Assessment Materials



Welcome to the GCSE 2009 Astronomy Sample Assessment Materials.

These sample assessment materials have been developed to give you and your students a flavour of the actual exam papers and mark schemes so they can experience what they will encounter in their live assessments.

They feature:

- **Accessible paper** using a mixture of questions styles where appropriate – we've worked hard to ensure the paper is easy to follow with an encouraging tone so that the full range of students can show what they know.
- **Clear and concise mark scheme** for the paper, outlining what examiners will be looking for in the assessment, so you can use the papers with students to help them prepare for the real thing.
- **Supported controlled assessment**, including materials to show you the activities students will undertake. Used in conjunction with the guidance in the Teacher's Guide, this will help you manage the controlled assessment in your centre and help students achieve their best.

Our GCSE Astronomy qualification for first teaching in 2009 will be supported better than ever before.

Keep up to date with the latest news and services available by visiting our website:

www.edexcel.com/gcse09

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear

ii) select and use a form and style of writing appropriate to purpose and to complex subject matter

iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Write your name here

Surname

Other names

Centre Number

Candidate Number

Edexcel GCSE

Astronomy

Unit 1: Understanding the Universe

Sample Assessment Material

Time: 2 hours

Paper Reference

5AS01/01

You must have:

Calculator

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** the questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 120.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed.
– *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions.

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

1 Since 2006, some objects in the Solar System have been classified as either planets or dwarf planets.

(a) Which of the following is a planet? Put a cross in the box that indicates the correct answer. (1)

- A** Ceres
- B** Mercury
- C** Pluto
- D** The Moon

(b) Which of the following is a dwarf planet? Put a cross in the box that indicates the correct answer. (1)

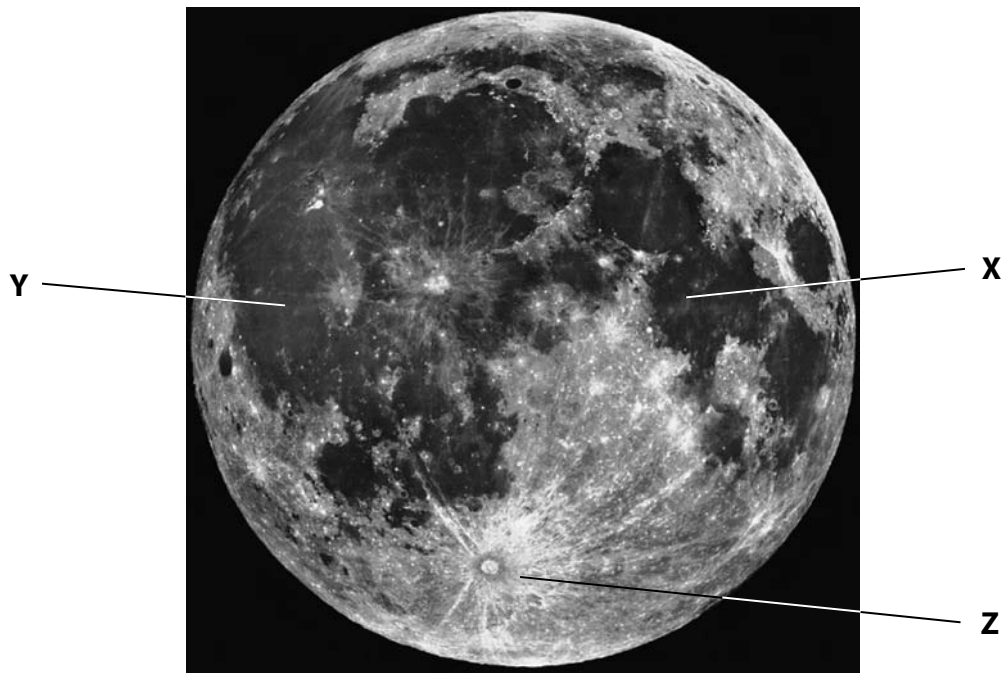
- A** Ceres
- B** Earth
- C** Halley's Comet
- D** Mercury

(c) Most asteroids orbit the Sun between two planets. One planet is Mars, name the other planet. (1)

(d) What is the name of the planet that orbits furthest away from the Sun? (1)

(Total for Question 1 = 4 marks)

2 Figure 1 shows the near side of the Moon.



(Source: NASA)

Figure 1

(a) What is the name of feature **X**? Put a cross ☒ in the box that indicates the correct answer. (1)

- A** Kepler
- B** Ocean of Storms
- C** Sea of Tranquility
- D** Tycho

(b) What is the name of feature **Y**? Put a cross ☒ in the box that indicates the correct answer. (1)

- A** Copernicus
- B** Ocean of Storms
- C** Sea of Crises
- D** Tycho

(c) What is the name of crater **Z**? Put a cross ☒ in the box that indicates the correct answer. (1)

A Apennines

B Copernicus

C Kepler

D Tycho

(d) The Moon's far side is not visible from the Earth. How do astronomers know what the far side looks like? (1)

.....
.....
(e) How is the surface of the Moon's far side different from its near side? (1)

.....
.....
(Total for Question 2 = 5 marks)

3 The Plough is a familiar asterism in the night sky.

(a) How does an asterism differ from a constellation?

(1)

(b) In the space below, sketch the asterism, the Plough.

(2)

(c) In which compass direction are you looking when facing the Plough, in the evening in winter?

(1)

(d) Some stars can act as 'pointers' to other interesting objects in the night sky. On your sketch of the Plough, show with arrows:

(i) how to find Polaris (label your arrow **To Polaris**)

(1)

(ii) how to find Arcturus (label your arrow **To Arcturus**).

(1)

(Total for Question 3 = 6 marks)

4 A group of Astronomy students are planning a naked-eye observing session of the night sky.

(a) Suggest **two** important pieces of information that the students should obtain whilst planning their observing session.

(2)

1

2

(b) Suggest **two** items of equipment that each student is likely to need during the observing session.

(2)

1

2

The students also plan to use a robotic telescope at some time in the future.

(c) Suggest **one** benefit that using a robotic telescope will have.

(1)

.....

.....

(Total for Question 4 = 5 marks)

5 Figures 2 and 3 show two galaxies, the Small Magellanic Cloud and the Triangulum Galaxy.



(Source: Hubble)

Figure 2

Figure 3

(a) State the **type** of galaxy shown in:

(i) Figure 2

(1)

(ii) Figure 3

(1)

(b) Both galaxies are members of the Local Group.

What is meant by the Local Group?

(1)

(c) Give the names of **two** other galaxies in the Local Group.

(2)

1

2

(Total for Question 5 = 5 marks)

6 (a) Who discovered the principal satellites of Jupiter? Put a cross ☒ in the box that indicates the correct answer. (1)

- A Galileo Galilei
- B Edwin Hubble
- C Johannes Kepler
- D Isaac Newton

(b) Which object in the Solar System was discovered by Giuseppe Piazzi in 1801? Put a cross (☒) in the box that indicates the correct answer. (1)

- A Uranus
- B Neptune
- C Pluto
- D Ceres

(c) What class of objects within the Solar System have orbits mainly in between those of Saturn and Uranus? Put a cross (☒) in the box that indicates the correct answer. (1)

- A Centaurs
- B Comets
- C Dwarf planets
- D Trans-Neptunian Objects

(Total for Question 6 = 3 marks)

7 Astronomy provides the basis for many units of time.

(a) Describe what is meant by a sidereal day.

(2)

.....

.....

.....

.....

(b) Describe what is meant by a solar day.

(2)

.....

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.....

(c) Explain, with the aid of a diagram, why a solar day is longer than a sidereal day.

(2)

.....

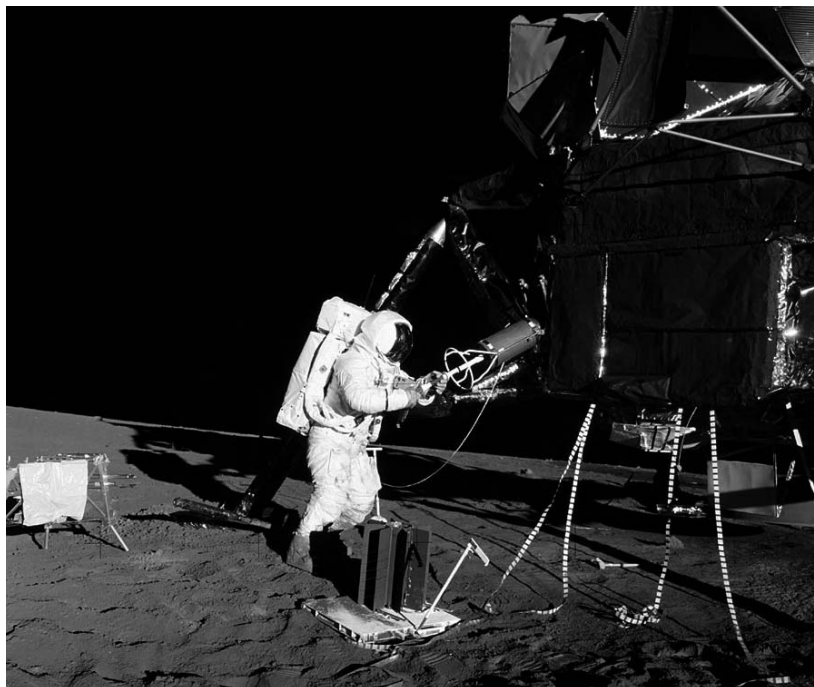
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(Total for Question 7 = 6 marks)

- 8 Figure 4 shows an Apollo astronaut on the surface of the Moon with the Apollo Lunar Surface Experiments Package (ALSEP).



(Source: NASA)

Figure 4

- (a) What was the main astronomical purpose of the Apollo space programme? (1)

.....

.....

- (b) Describe the purposes of **two** scientific instruments contained within ALSEP. (2)

1

.....

2

.....

- (c) Describe the Giant Impact Theory of the likely origin of the Moon. (2)

.....

.....

.....

(d) Describe **two** pieces of evidence from the Apollo programme that support the Giant Impact Theory.

(2)

1

.....

2

.....

(Total for Question 8 = 7 marks)

9 (a) Describe **three** pieces of evidence that the Earth is spherical.

(3)

1

2

3

(b) Describe, with the aid of a diagram, how the Greek mathematician Eratosthenes determined the circumference of the Earth.

(4)

.....

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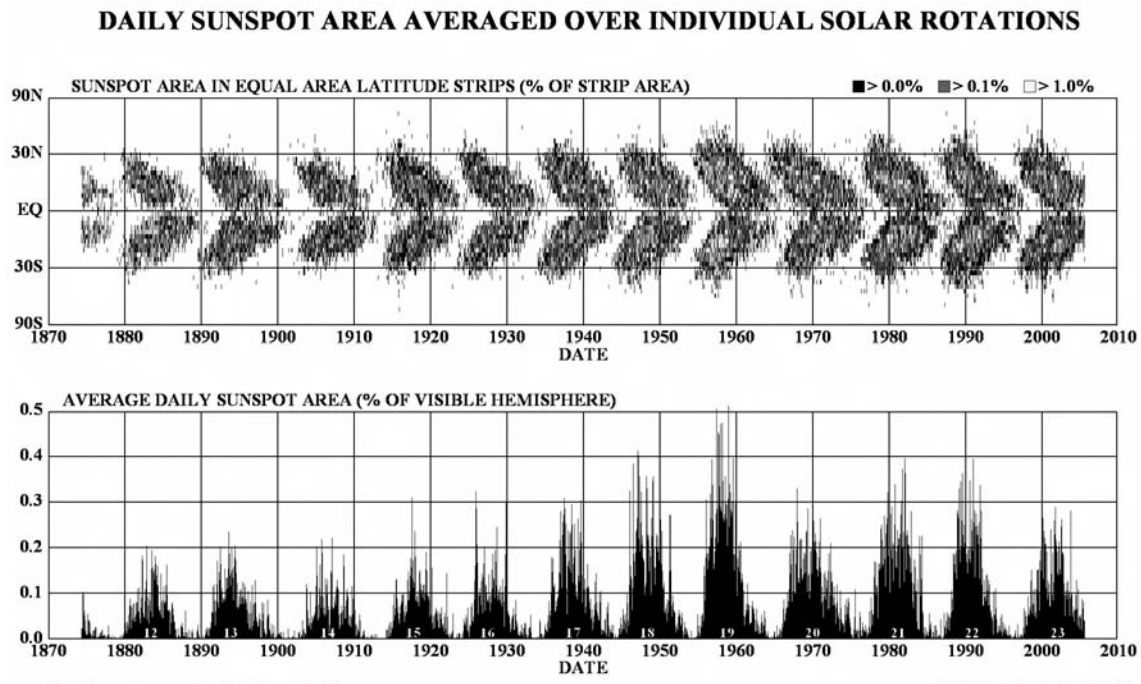
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(Total for Question 9 = 7 marks)

10 A student searched the internet for data on sunspots. Figure 5 shows one of the images that she obtained.



(Source: NASA)

Figure 5

(a) What are sunspots?

(2)

(b) Study Figure 5.

(i) How does the number of sunspots change during one solar cycle?

(1)

(ii) How does the latitude of sunspots change during one solar cycle?

(1)

(iii) What is the value of one solar cycle in years?

(1)

(c) The student then decided to observe sunspots.
Describe **one** method of observing the Sun safely (use a diagram if you wish). (2)

.....

.....

.....

.....

(Total for Question 10 = 7 marks)

11 Figure 6 shows the orbits of Earth and Saturn around the Sun (not to scale). The position of the Earth is labelled **E**.

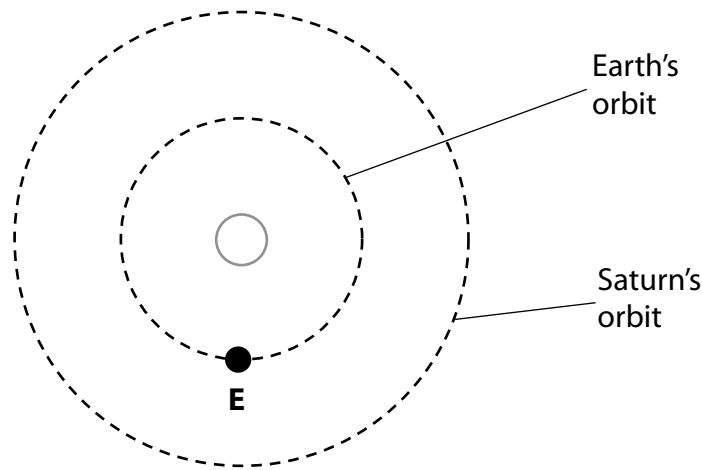


Figure 6

(a) On Figure 6, show:

(i) the position of Saturn when it is at conjunction (label it **C**) (1)

(ii) the position of Saturn where it is best placed for viewing from Earth (label it **V**). (1)

(b) On Figure 6:

(i) draw the orbit of a typical short-period comet (2)

(ii) show on the orbit the comet at perihelion (label it **P**). (1)

(c) What is the source of most short-period comets? Put a cross in the box that indicates the correct answer. (1)

- A** Goldilocks Zone
- B** Kuiper Belt
- C** Oort Cloud
- D** Zodiacal Band

(Total for Question 11 = 6 marks)

12 The Milky Way can sometimes be seen in the night sky.

(a) (i) Under what condition is it possible to observe the Milky Way with the naked eye on a clear night? (1)

.....
.....

(ii) Describe the appearance of the Milky Way when it is observed with the naked eye. (1)

.....
.....

(iii) Explain why the Milky Way appears like this. (1)

.....
.....

(b) Name the astronomer who first observed the Milky Way through a telescope. (1)

.....
.....

(c) What type of galaxy is the Milky Way? (1)

.....
.....

(Total for Question 12 = 5 marks)

***13** Astronomers have recently discovered that many stars possess planetary systems (exoplanets).

Describe **two** methods that astronomers use to detect the presence of exoplanets. **(6)**

1

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.....

.....

.....

.....

2

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.....

(Total for Question 13 = 6 marks)

14 (a) Describe **two** ways in which the Earth's atmosphere protects us from space. (4)

1

.....

2

.....

(b) One major drawback to astronomers is that only visible light and radio waves are able to penetrate the atmosphere in significant amounts.

(i) From where should X-ray observations be carried out? (1)

.....

(ii) State **one** advantage of siting an infra-red telescope high up on a mountain. (1)

.....

.....

(iii) State **one other** key region of the electromagnetic spectrum used by astronomers. (1)

.....

(Total for Question 14 = 7 marks)

15 (a) What are Potentially Hazardous Objects?

(1)

.....
.....

(b) Why do astronomers think that it is important to monitor these objects?

(1)

.....
.....

(c) During the Solar System's history, there have been many impacts between meteoroids or asteroids and planetary-sized bodies.

Describe **two** pieces of evidence for this.

(2)

1

2

(d) Our knowledge about asteroids and comets has increased greatly during the last decade through the use of space probes.

Describe briefly **one** such mission, naming the probe, its 'target' and **one** major piece of information that was obtained.

(3)

Probe

Target

Information

.....
.....
.....

(Total for Question 15 = 7 marks)

16 The table gives data for four of the stars in a constellation.

Star	Apparent magnitude (m)	Distance / pc (d)
α	-0.8	10
β	1.2	100
δ	3.8	1000
ε	8.5	100

(a) What is the significance of the letters α , β , δ and ε ? (1)

(b) How many times brighter than β does star α appear? (2)

(c) Which is the **faintest** star in the constellation that could be seen with the naked eye on a clear night? (1)

(d) Calculate the absolute magnitude (M) of β . Use the formula (using log base 10):
$$M = m + 5 - 5 \log d$$
 (2)

(e) Deduce which star would have the greatest luminosity. (1)

(Total for Question 16 = 7 marks)

17 (a) In the space below, sketch a Hertzsprung-Russell diagram. Label the axes clearly. (2)

(b) Clearly indicate the positions of:

(i) the main sequence (1)

(ii) the Sun (1)

(iii) a red giant (1)

(iv) a white dwarf. (1)

(Total for Question 17 = 6 marks)

18 Figure 7 shows the light curve for a typical Cepheid variable star.

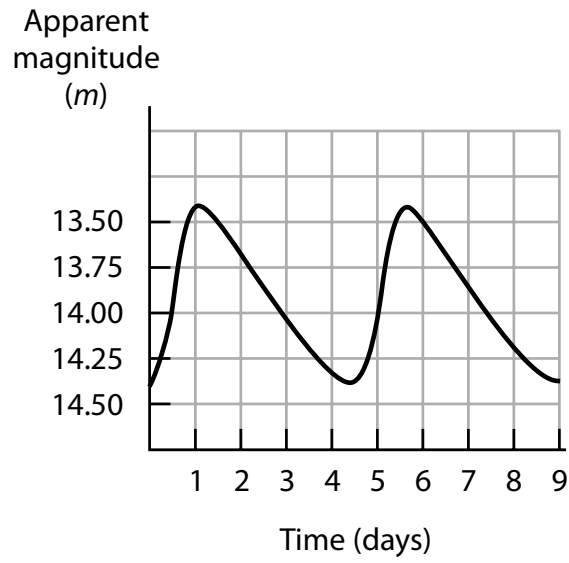


Figure 7

(a) Deduce the time period of the Cepheid variable.

(1)

(b) Explain how astronomers can determine the distances of Cepheid variables.

(3)

(c) Describe, with the aid of a diagram, **one** other method of determining the distance to a star.

(3)

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.....

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(Total for Question 18 = 7 marks)

19 Cosmic Microwave Background (CMB) radiation was discovered in 1965.

(a) Describe how CMB radiation was discovered? (2)

.....

.....

.....

(b) Explain how the existence of CMB radiation supports the Big Bang model of the origin of the Universe. (2)

.....

.....

.....

(c) Our knowledge about CMB radiation has increased greatly during the last decade through the use of instruments flown on satellites.
Describe briefly **one** such study, naming the satellite and **one** major piece of information that was obtained as a result of the study. (3)

Name of satellite

Major piece of information

.....

.....

.....

(Total for Question 19 = 7 marks)

20 Quasars were discovered in 1963 and are believed to be some of the most distant galaxies in the Universe. It is currently thought that they contain an Active Galactic Nucleus (AGN) at their centre.

(a) In which region of the electromagnetic spectrum were the first quasars discovered? (1)

(b) Give **two** further examples of galaxies containing AGNs. (2)

1

2

(c) How do astronomers believe that AGNs are powered? (1)

(d) The rest wavelength of an absorption line in the spectrum of light from a quasar is 220 nm. Observations of the quasar suggest that it is moving away from us at 35% of the speed of light. Use this information to calculate the observed wavelength of the spectral line in the spectrum of the quasar.

Use the formula $\frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c}$ (3)

(Total for Question 20 = 7 marks)

TOTAL FOR PAPER = 120 MARKS

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Sample Mark Scheme

Question Number	Answer	Mark
1(a)	B Mercury	1

Question Number	Answer	Mark
1(b)	A Ceres	1

Question Number	Answer	Mark
1(c)	Jupiter	1

Question Number	Answer	Mark
1(d)	Neptune	1

Question Number	Answer	Mark
2(a)	C Sea of Tranquility	1

Question Number	Answer	Mark
2(b)	B Ocean of Storms	1

Question Number	Answer	Mark
2(c)	D Tycho	1

Question Number	Answer	Mark
2(d)	Observations/photographs from space probes/satellite	1

Question Number	Answer	Mark
2(e)	Fewer/hardly any/no seas/maria/dark areas or far more mountainous/lots more craters	1

Question Number	Answer	Mark
3(a)	An asterism is a smaller group/pattern of stars (within a constellation)	1

Question Number	Answer	Mark
3(b)	Rough sketch of the Plough showing at least seven stars (1) More detailed sketch showing true pattern, or scale (1)	2

Question Number	Answer	Mark
3(c)	North/northwest/northeast	1

Question Number	Answer	Mark
3(d)(i)	Arrow following line of two stars on right of Plough upwards	1

Question Number	Answer	Mark
3(d)(ii)	Arrow following handle of Plough to left	1

Question Number	Answer	Mark
4(a)	Any two of the following examples (or other sensible piece of information) up to a maximum of two marks: <ul style="list-style-type: none"> • local weather forecast • visibility (of stars/planets) • RA/dec of star/stellar coordinates • phase of Moon • etc. <p style="text-align: right;">(2 x 1)</p>	2

Question Number	Answer	Mark
4(b)	Any two of the following examples (or other sensible piece of equipment) up to a maximum of two marks: <ul style="list-style-type: none"> • star chart/planisphere • sketchpad and pencil • torch with red filter • etc. <p style="text-align: right;">(2 x 1)</p>	2

Question Number	Answer	Mark
4(c)	Any one of the following examples (or other sensible piece of information): <ul style="list-style-type: none"> • clearer images/'better pictures' • data in computer file format • view objects not visible from UK • etc. 	1

Question Number	Acceptable Answers	Reject	Mark
5(a)(i)	Irregular Spiral	Barred Spiral	1

Question Number	Acceptable Answers	Reject	Mark
5(a)(ii)	S Sa Sb Sc	SB SBa SBb SBc	1

Question Number	Answer	Mark
5(b)	Small collection/assembly of nearby galaxies linked by gravity	1

Question Number	Answer	Mark
5(c)	Any two of the following (or other) examples of galaxies within the Local Group, up to a maximum of two marks: <ul style="list-style-type: none"> • Large Magellanic Cloud/LMC • Andromeda Galaxy/M31 • IC 10 • Fornax galaxy etc. <p style="text-align: right;">(2 x 1)</p>	2

Question Number	Answer	Mark
6(a)	A Galileo Galilei	1

Question Number	Answer	Mark
6(b)	D Ceres	1

Question Number	Answer	Mark
6(c)	A Centaurs	1

Question Number	Answer	Mark
7(a)	Time taken for the Earth to rotate (1) (exactly once/on its axis/in relation to the stars /by 360 degrees) (1)	2

Question Number	Answer	Mark
7(b)	Time taken for the Sun (1) to reappear at the same point in the sky/meridian/highest (some indication of 'returning' to same point) (1)	2

Question Number	Answer	Mark
7(c)	Diagram indicating Earth rotating and orbiting Sun (1) Indication that during its rotation, the Earth has moved in its orbit around the Sun by $\sim 1^\circ$ per day (= 4 mins) so an extra 4 mins needed to bring the Sun back to 'same position' (1)	2

Question Number	Answer	Mark
8(a)	Manned exploration of lunar surface, and safe return to Earth	1

Question Number	Answer	Mark
8(b)	Any two of the following examples (or other sensible piece of equipment) up to a maximum of two marks: <ul style="list-style-type: none"> • detect/measure Moon's magnetic field • collect/detect solar wind particles • detect/measure moonquakes • measure/monitor Earth-Moon distance • etc. <p style="text-align: right;">(2 x 1)</p>	2

Question Number	Answer	Mark
8(c)	Mars size object collides with Earth (1) (accept something quite big) (reject small rock, asteroid, comet) Cores merged and splash material forms Moon (1)	2

Question Number	Answer	Mark
8(d)	Any two of the following examples (or other sensible pieces of evidence) up to a maximum of two marks: <ul style="list-style-type: none"> • lunar rocks show similar oxygen content to those found on Earth • suggestion that a large part of Moon was once molten (accept kreek-rich rocks) • lunar crust is mainly anorthosite • etc. <p style="text-align: right;">(2 x 1)</p>	2

Question Number	Answer	Mark
9(a)	Any three of: <ul style="list-style-type: none"> • images from space • ships disappear over horizon • shape of Earth's shadow during partial lunar eclipse • satellites able to orbit Earth • etc. <p style="text-align: right;">(3 x 1)</p>	3

Question Number	Answer	Mark
9(b)	Correct diagram showing Earth and two places (Syene and Alexandria) at different latitudes. (1) Simple explanation in terms of different shadow formation in two cities (at summer solstice) (1) Further clarification eg relating distance (d) (1) between two cities and angular distance (from shadow data) (1)	4

Question Number	Answer	Mark
10(a)	Cooler/darker regions (1) (accept Earth-sized cooler/darker regions) on surface/photosphere of Sun (1)	2

Question Number	Answer	Mark
10(b)(i)	Increases then decreases	1

Question Number	Answer	Mark
10(b)(ii)	Moves towards equator/lower latitudes	1

Question Number	Answer	Mark
10(b)(iii)	11 (years)	1

Question Number	Answer	Mark
10(c)	Sensible diagram showing filter or projection method stated (1) Correct description of method (1) Labelled diagram can replace two points above	2

Question Number	Answer	Mark
11(a)(i)	C labelled at 'top' of Saturn's orbit	1

Question Number	Answer	Mark
11(a)(ii)	V labelled at 'bottom' of Saturn's orbit	1

Question Number	Answer	Mark
11(b)(i)	closed ellipse drawn (1) with Sun close to one focus (1)	2

Question Number	Answer	Mark
11(b)(ii)	with P labelled at the closest point to the Sun	1

Question Number	Answer	Mark
11(c)	B Kuiper Belt	1

Question Number	Answer	Mark
12(a)(i)	No light pollution or moonlight	1

Question Number	Answer	Mark
12(a)(ii)	Fuzzy/diffuse band (of faint light/stars)	1

Question Number	Answer	Mark
12(a)(iii)	Some reference to plane of our galaxy	1

Question Number	Answer	Mark
12(b)	Galileo (accept any reasonable spelling)	1

Question Number	Answer	Mark
12(c)	Spiral/S/Sb or barred spiral/SB/SBb	1

Question Number	Answer	Mark
13 QWC	<p>Any two of the following points, up to a maximum of two marks each, for stating method and describing it</p> <p>eg:</p> <ul style="list-style-type: none"> • look for Doppler-shift 'wobble' in star (radial velocity) • look for regular dimming of star (transit method) • gravitational microlensing • detect dust clouds around stars • and other sensible methods. <p>For each method chosen students can gain a maximum of 3 marks as follows:</p> <p>for 3 marks students will have the required point clearly communicated using appropriate technical language</p> <p>for 2 marks students will have the required point clearly communicated using limited technical language</p> <p>for 1 mark students will have the required point communicated with basic technical language.</p> <p style="text-align: right;">(3 x 2)</p>	6

Question Number	Answer	Mark
14(a)	<p>Any two of the following benefits, up to a maximum of two marks:</p> <ul style="list-style-type: none"> • protection from UV/X-rays/gamma rays • protection from impactors • etc. <p style="text-align: right;">(2 x 1)</p> <p>Any two sensible corresponding reasons, up to a maximum of two marks:</p> <ul style="list-style-type: none"> • that could damage our skin cells • that could impact with Earth • etc. <p style="text-align: right;">(2 x 1)</p>	4

Question Number	Answer	Mark
14(b)(i)	in space/above Earth's atmosphere/satellites	1

Question Number	Answer	Mark
14(b)(ii)	Any one of: <ul style="list-style-type: none"> • above most of the Earth's atmosphere • above water vapour • cooler. 	1

Question Number	Acceptable Answers	Reject	Mark
14(b)(iii)	Ultra violet UV Microwaves Gamma-rays	Visible Infra-red IR Radio X-ray Sound	1

Question Number	Answer	Mark
15(a)	Any sensible description involving objects/asteroids/comets/meteoroids that have orbits that come relatively close to Earth so that there is a chance of a collision (or words to that effect)	1

Question Number	Answer	Mark
15(b)	Any sensible reason concerned with projected orbit trajectory and damage caused through a collision with Earth	1

Question Number	Answer	Mark
15(c)	Any two of the following examples up to a maximum of two marks: <ul style="list-style-type: none"> • craters on Moon • unusual appearance of many moons/satellites of planets • craters found on Earth/Barringer Crater • tilt of Uranus/Venus • Shoemaker-Levy collision with Jupiter • etc. 	(2 x 1) 2

Question Number	Answer	Mark
15(d)	Correct name of probe (eg Giotto, Deep Impact, NEAR) (1) Correct 'target' (eg Halley's Comet, a comet, etc.) (1) Statement of one finding/result of mission (eg structure/composition) (1)	3

Question Number	Answer	Mark
16(a)	Indicates relative brightness of stars	1

Question Number	Answer	Mark
16(b)	Indication of two magnitudes difference (1) 6.25 (accept 6.3) (1) award 2 marks for just answer or 6.25	2

Question Number	Answer	Mark
16(c)	delta (δ)	1

Question Number	Answer	Mark
16(d)	some attempt at calculation/correct substitution (1) correct answer: -3.8 (1)	2

Question Number	Answer	Mark
16(e)	delta (δ)	1

Question Number	Answer	Mark
17(a)	Vertical axis correctly labelled (luminosity or absolute magnitude) (1) Other axis correctly labelled (spectral type or temperature or colour index) (1)	2

Question Number	Answer	Mark
17(b)(i)	Main sequence correctly shown and labelled	1

Question Number	Answer	Mark
17(b)(ii)	Sun correctly placed in middle of main sequence	1

Question Number	Answer	Mark
17(b)(iii)	Red giant correctly shown and labelled	1

Question Number	Answer	Mark
17(b)(iv)	White dwarf correctly shown and labelled	1

Question Number	Answer	Mark
18(a)	4.5 days accept 4.3 to 4.7 days	1

Question Number	Answer	Mark
18(b)	Deduce time period (1) 'Convert' to luminosity (use period-luminosity law) (1) Determine apparent magnitude, and use formula (distance modulus formula) to calculate d (1)	3

Question Number	Answer	Mark
18(c)	Suitable diagram (eg parallax method) (1) Brief description (1) More detailed description (1)	3

Question Number	Answer	Mark
19(a)	Any two of: discovered accidentally by microwave/radio antennae/receivers (1) by Penzias and Wilson/Bell Telephone Labs (New Jersey)(1) (2 x 1)	2

Question Number	Answer	Mark
19(b)	Predictions suggested Big Bang was extremely hot and has now cooled to about 3 K (1) CMB corresponds to temp of 3 K (1)	2

Question Number	Answer	Mark
19(c)	Name of satellite, eg COBE/WMAP (1) Brief description of information received (1) More detailed description (1)	3

Question Number	Answer	Mark
20(a)	Radio	1

Question Number	Answer	Mark
20(b)	Any two of the following examples up to a maximum of two marks eg <ul style="list-style-type: none"> • Seyfert Galaxies • radio galaxies • BL Lac objects (blazars) • N galaxies • etc. <p style="text-align: right;">(2 x 1)</p>	2

Question Number	Answer	Mark
20(c)	Matter falling onto (super-) massive black hole	1

Question Number	Answer	Mark
20(d)	$v/c = 0.35$ (1) Attempt to use formula (correct substitution) (1) Correct answer: 297 nm (1)	3

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Authorised by Roger Beard

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Edexcel
One90 High Holborn,
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