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Centre Number

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Candidate Number

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# Astronomy

## Unit 1: Understanding the Universe

Friday 15 May 2015 – Afternoon  
**Time: 2 hours**

Paper Reference

**5AS01/01**

**You must have:**  
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.*

### 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 on these questions with your spelling, punctuation and grammar, as well as the clarity of expression.*

### 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**

**Answer ALL questions.**

**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) Which of the following astronomical objects is closest to the Earth? (1)

- A Mercury
- B Mars
- C The Moon
- D The Sun

(b) Which of these astronomical objects has the largest diameter? (1)

- A Earth
- B Jupiter
- C The Moon
- D The Sun

(c) What is the approximate value of the Astronomical Unit? (1)

- A 150 000 km
- B 150 000 miles
- C 150 000 000 km
- D 150 000 000 miles

(d) Which of these types of electromagnetic radiation is unable to penetrate the Earth's atmosphere? (1)

- A microwaves
- B radio waves
- C visible light
- D X-rays



(e) The Earth and the planet Venus are of similar size but their atmospheres are very different. Give the name of the **most common** gas found in the atmospheres of:

(i) Earth

(1)

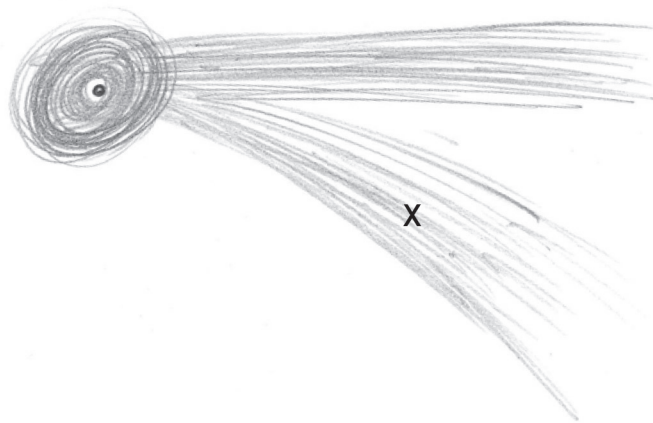
(ii) Venus

(1)

**(Total for Question 1 = 6 marks)**



2 (a) Figure 1 shows a sketch of a comet.



**Figure 1**

(i) What is the name of the curved tail labelled X?

(1)

- A** dust tail
- B** gas tail
- C** ion tail
- D** vapour tail

(ii) On Figure 1, draw an arrow to show the direction of the Sun.

(1)

(b) (i) Meteors are visible when small particles burn up as they pass through the Earth's atmosphere. What is the name of these particles?

(1)

- A** fireballs
- B** meteorites
- C** meteoroids
- D** micrometeorites



(ii) Why do annual meteor showers occur on roughly the same date every year?  
You may use a labelled diagram in your answer.

(2)

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.....

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



3 (a) Figure 2 shows the Moon's nearside.



(Source: © NASA)

**Figure 2**

On Figure 2, indicate the location of the:

- (i) Ocean of Storms (Use the letter **S**)
- (ii) Apennine mountains (Use the letter **A**)
- (iii) Tycho crater (Use the letter **T**)

(3)



(b) (i) The Moon's far side is not visible from the Earth. What did astronomers use to help obtain the first images of the Moon's far side?

(1)

- A ALSEPs package
- B balloon
- C space probe
- D telescope

(ii) State **one** way in which the Moon's far side is different from its nearside.

(1)

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(c) What is the value of the Moon's rotation period?

(1)

- A 27.3 days
- B 28.0 days
- C 29.5 days
- D 31.0 days

**(Total for Question 3 = 6 marks)**



4 (a) Which of the following is **not** in our Local Group?

(1)

- A** 3C 273, a quasar
- B** LMC, an irregular galaxy
- C** M31, Andromeda Galaxy
- D** M33, Triangulum Galaxy

(b) (i) There are numerous types of **active galaxy**. Name **two** of these types.

(2)

1 .....

2 .....

(ii) State **one** way in which an active galaxy is different from a normal galaxy.

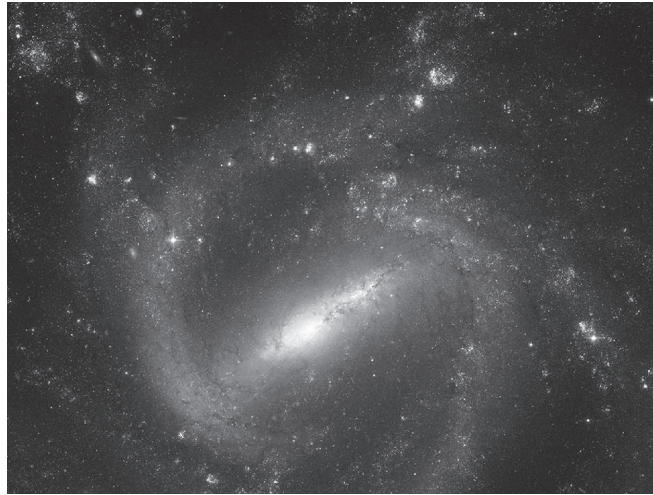
(1)

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(c) (i) Figure 3 shows a galaxy.



(Source: © NASA)

**Figure 3**

What type of galaxy is shown in Figure 3?

(1)

- A** barred spiral
- B** elliptical
- C** irregular
- D** lenticular

(ii) What type of galaxy is the Milky Way?

(1)

- A** elliptical
- B** irregular
- C** lenticular
- D** spiral

**(Total for Question 4 = 6 marks)**



5 (a) What is the temperature of the Sun's photosphere? (1)

- A 5400 K
- B 5600 K
- C 5800 K
- D 6000 K

(b) What is the approximate rotation period of the Sun at its poles? (1)

- A 20 days
- B 25 days
- C 30 days
- D 35 days

(c) Which of these solar features has the lowest temperature? (1)

- A chromosphere
- B corona
- C photosphere
- D sunspot

(d) Which is the most common element found in the Sun? (1)

- A helium
- B hydrogen
- C oxygen
- D sodium

(e) Which type of diagram do astronomers use to determine the length of the solar cycle? (1)

- A Butterfly Diagram
- B Hertzsprung-Russell Diagram
- C Messier Diagram
- D Tuning Fork Diagram



(f) What is the name given to the continuous stream of charged particles moving away from the Sun?

(1)

- A** solar eclipse
- B** solar flare
- C** solar maximum
- D** solar wind

**(Total for Question 5 = 6 marks)**

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6 The earliest official list of just 48 constellations was compiled almost 2000 years ago by Egyptian and Greek astronomers.

(a) This list did not include constellations that were visible from countries such as Australia in the southern hemisphere. Suggest a reason for this. (1)

(b) Suggest why astronomers in countries such as China or India compiled different lists. (1)

(c) There are now 88 recognised constellations and numerous asterisms. In what way does an asterism differ from a constellation? (2)

(d) Name an example of:  
(i) an asterism (1)

(ii) a constellation (1)

**(Total for Question 6 = 6 marks)**



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7 (a) Draw a labelled diagram to show the relative positions of the Sun, Earth and Moon during a total solar eclipse.

(2)

(b) Explain why solar eclipses do not occur every month.

(2)

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(c) Figure 4 shows a photograph of the Moon.



(Source: © Nigel Marshall)

**Figure 4**

(i) What phase of the Moon is shown in Figure 4? (1)

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(ii) Sketch how the Moon would have appeared 8 days earlier. (1)

---

**(Total for Question 7 = 6 marks)**



- 8 Figure 5 shows a photograph of the Milky Way, taken at an observatory in the southern hemisphere.



(Source: © Roger Smith/NOAO)

**Figure 5**

- (a) On a clear night when there is very little light pollution, the Milky Way appears as a faint band of light across the sky.

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

(1)

(ii) Why does the Milky Way appear as a band?

(1)

(iii) Figure 5 shows some dark patches within the Milky Way. Suggest the nature of these dark patches.

(1)

- (b) State **two** ways in which a pair of binoculars or a small telescope improve an observer's view of the Milky Way.

(2)

1 .....

2 .....





(c) Figure 5 also shows two small galaxies that are companions to the Milky Way.  
Name **one** of these galaxies.

(1)

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**(Total for Question 8 = 6 marks)**

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9 (a) A group of astronomers are currently constructing a scale model in which the Solar System has been reduced to the size of the British Isles. In this model, the Earth is 10 km away from the Sun.

(i) Which **two** planets would be represented by models placed closer than 10 km from the Sun?

(1)

(ii) The planet Jupiter is 5.2 AU from the Sun. How far in km would the model representing Jupiter be from the model Sun?

(1)

(iii) The model of Saturn is 95 km from the model Sun. How far in AU is the planet Saturn from the Sun?

(1)

(b) A teacher created a different scale model in her classroom. She used a sphere of diameter 1.0 m to represent the Sun.

(i) What diameter of sphere should the teacher use to represent the Earth?

(1)

**A** 0.5 cm

**B** 1.0 cm

**C** 5.0 cm

**D** 10 cm

(ii) In another model, the planet Neptune was 150 m from the Sun. If the actual distance from Neptune to the Sun is 30 AU, calculate the distance from the Sun to the Earth in this model.

(3)

**(Total for Question 9 = 7 marks)**



**10** Nigel and Ruth were observing the stars around Polaris from a latitude of  $58^{\circ}\text{N}$ .

(a) (i) State the declination of Polaris (to the nearest degree). (2)

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(ii) What is the angle of elevation of Polaris when observed from this site? (1)

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(b) Ruth noticed that the stars around Polaris had moved during the course of 2 hours. What is the reason for this apparent motion? (1)

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(c) Nigel observed a constellation and deduced that none of its stars would set below the horizon. What name is given to stars that never set as seen from a given location? (1)

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(d) State whether a star of declination  $+34^{\circ}$  would set from this latitude.  
Use the formula  
declination  $> 90^{\circ} - \text{latitude}$ . (1)

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**(Total for Question 10 = 6 marks)**

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11 (a) Figure 6 shows NASA's infrared observatory near the summit of Mauna Kea on Hawaii.



(Source: © NASA)

**Figure 6**

(i) Give **one** reason why infrared observatories are located on high mountains. (1)

(ii) Name **two** gases in the Earth's atmosphere that absorb large amounts of infrared radiation. (2)

1 .....

2 .....

(b) (i) The Earth's atmosphere has some benefits for humans. State **two** of these benefits. (2)

1 .....

2 .....

(ii) In addition to absorbing infrared radiation, the Earth's atmosphere has further drawbacks for astronomers. State **one** of these drawbacks. (1)

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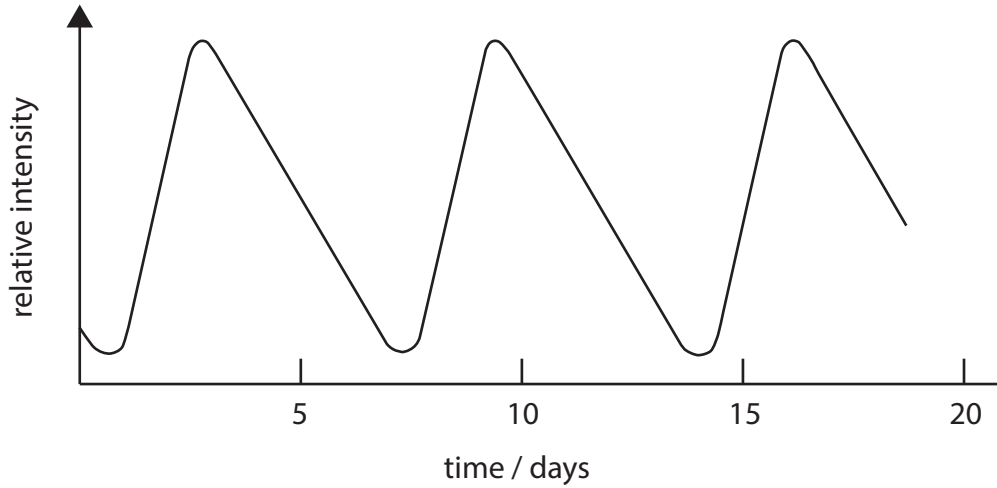
**(Total for Question 11 = 6 marks)**



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12 (a) Figure 7 shows the light curve for a Cepheid variable star.



**Figure 7**

(i) Use Figure 7 to determine the time period to the nearest day of this Cepheid variable.

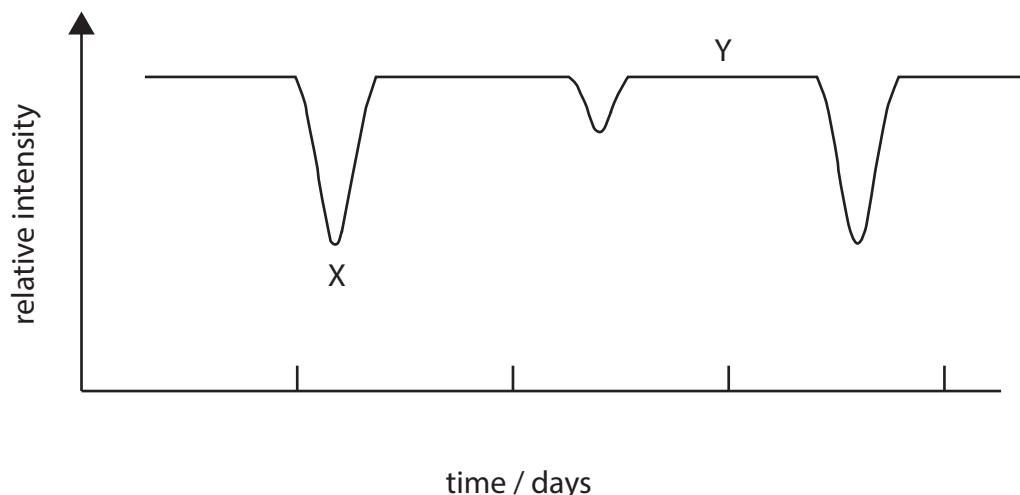
(2)

(ii) Explain how astronomers determine the distance to a Cepheid variable star.

(3)



(b) Figure 8 shows the light curve for an eclipsing binary star.

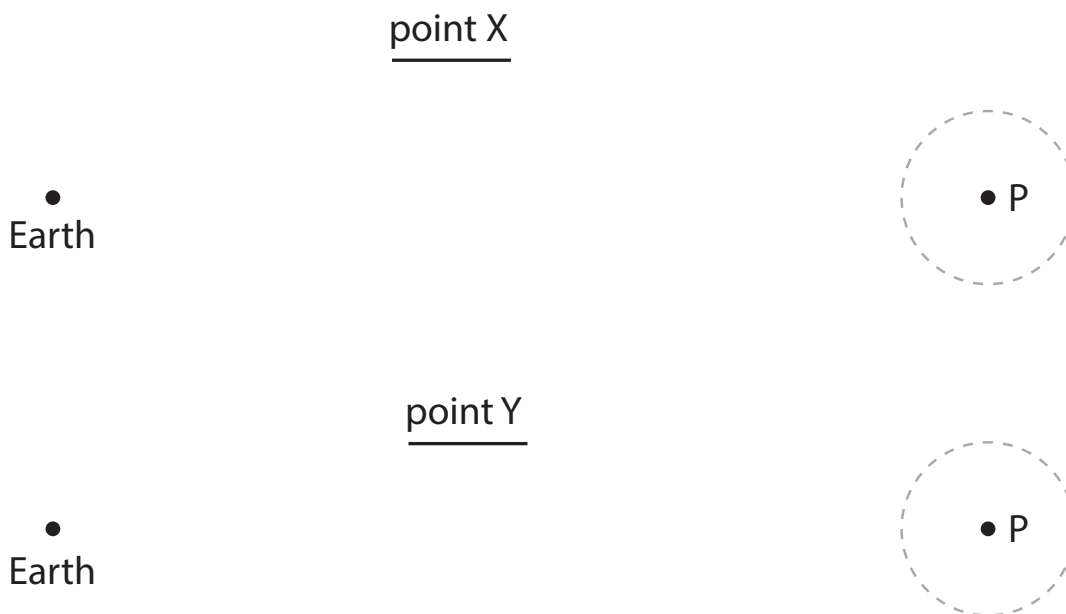


**Figure 8**

- (i) The time period of this eclipsing binary is 26 days. Add the correct numbers to the horizontal scale to show this. (1)
- (ii) The binary star system consists of a brighter primary star (**P**) and a dimmer secondary star (**S**). The first diagram is for point **X** on the light curve (Figure 8) and the second diagram is for point **Y**. The dashed circles represents the orbit of the secondary star.

Complete the two diagrams below to show the position of the secondary star for points **X** and **Y** on Figure 8. Use the letter **S**.

(2)



(Total for Question 12 = 8 marks)



13 (a) Figure 9 shows the orbit of a short-period comet around the Sun.



**Figure 9**

(i) On Figure 9 indicate the position of the comet when it is at perihelion. Use the letter **P**. (1)

(ii) What is the name of the shape of this orbit? (1)

(b) In 2012 it was possible to observe a transit of the planet Venus. Describe how to observe a transit safely. (2)

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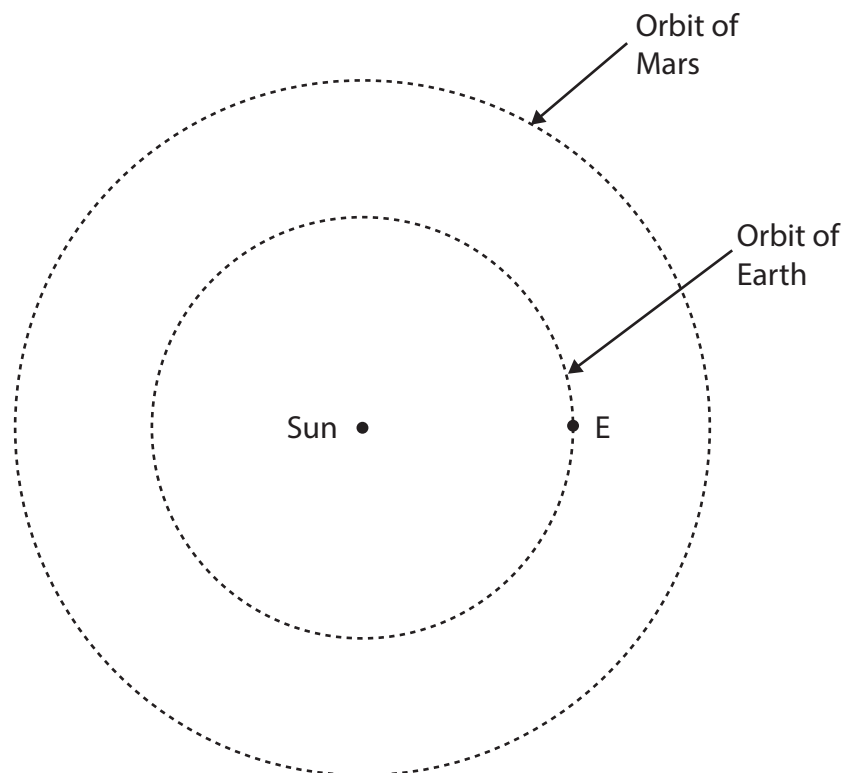
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(c) Figure 10 shows the orbits of the Earth and Mars around the Sun.



**Figure 10**

When the Earth is at position E, indicate the position of Mars when it is at **conjunction**. Use the letter **C**.

(1)

(d) The mean distance from Mars to the Sun is 1.5 AU.

(i) How far is Mars from the Earth when it is at conjunction?

(1)

(ii) Calculate the orbital period of Mars.

Use the formula

$$T^2 = r^3$$

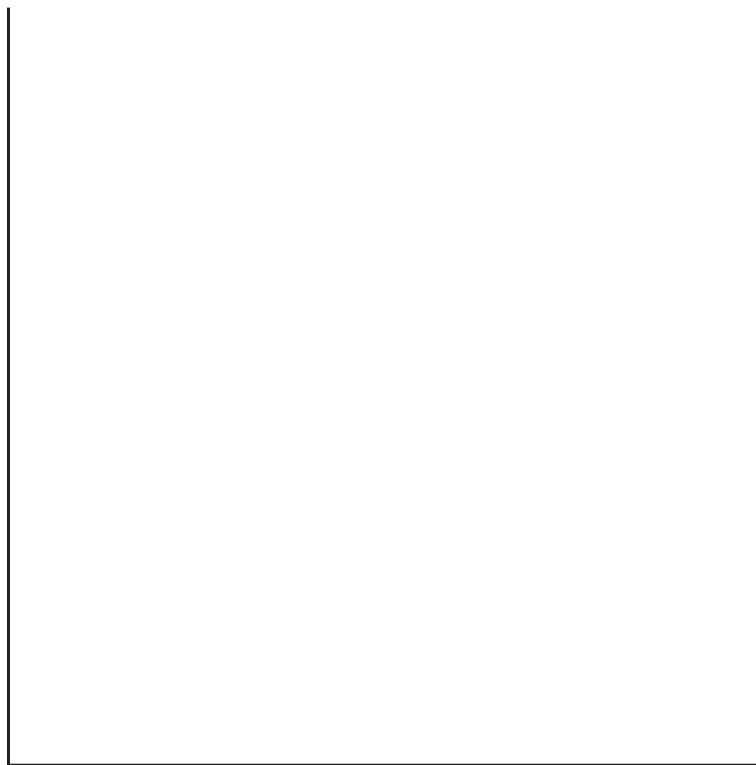
Give your answer to 2 significant figures and state the unit.

(2)

**(Total for Question 13 = 8 marks)**



14 In the space below, draw a sketch of the Hertzsprung-Russell Diagram.



Label the axes.

Indicate and label the Main Sequence.

Indicate and label the locations of White Dwarf stars and Red Giant stars.

**(Total for Question 14 = 5 marks)**

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15 (a) Which of the following compounds is regarded by scientists as being essential to life?

(1)

- A ammonia
- B carbon dioxide
- C methane
- D water

\*(b) Name and describe **one** method that astronomers use to detect exoplanets. You may draw a labelled diagram to support your answer.

(4)

name

description

(Total for Question 15 = 5 marks)



**16** (a) Explain what is meant by the term **redshift**.

(2)

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\* (b) Describe how quasars were discovered.

(4)

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**(Total for Question 16 = 6 marks)**



17 Table 1 lists the properties of five stars in a constellation.

star	apparent magnitude	absolute magnitude	spectral type
$\alpha$	1.3	- 8.7	A
$\beta$	2.1	- 6.1	F
$\gamma$	2.8	- 1.8	G
$\delta$	4.1	- 0.7	B
$\epsilon$	6.9	- 2.3	K

**Table 1**

(a) How many times would star  $\beta$  appear brighter than star  $\delta$ ? (1)

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

(c) Give the Greek letter of the star which:  
(i) is the hottest (1)

(ii) is furthest to the right on a Hertzsprung-Russell Diagram (1)

(iii) is the furthest away from us. (1)

**(Total for Question 17 = 5 marks)**



**\*18** Describe the discoveries of the two dwarf planets Ceres and Pluto. Name the astronomers who discovered them and the method of discovery.

**Ceres**

discoverer

method of discovery

**Pluto**

discoverer

method of discovery

**(Total for Question 18 = 5 marks)**



19 A group of students were observing the night sky from the Isle of Skye in Scotland. Table 2 gives the coordinates of some of the stars that they observed.

**Data for some of the stars**

star	Right Ascension	declination / °
$\alpha$	20 h 45 min	+45
$\beta$	19 h 30 min	+27
$\gamma$	20 h 20 min	+40
$\delta$	19 h 45 min	+42

**Table 2**

(a) Give the Greek letter of the star that appeared:

(i) furthest east

(1)

(ii) highest in the sky.

(1)

(b) The students recorded the culmination of star  $\beta$  at 23:00 GMT.

(i) What is meant by the term **culmination**?

(1)

(ii) At what time (GMT) did star  $\alpha$  culminate on the same night?

(1)

(iii) At what time (GMT) would star  $\beta$  culminate two nights later?

(2)

**(Total for Question 19 = 6 marks)**



20 (a) Data for a spectral line in the light from a distant galaxy are given below.

observed wavelength = 420 nm

rest wavelength = 380 nm

Calculate the radial velocity of the galaxy.

Use the formula

$$\frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c}$$

The speed of light is 300 000 km/s.

Give your answer to 2 significant figures and give the unit.

(3)

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(b) Astronomers determine that a different galaxy has a recession velocity of  $1.2 \times 10^5$  km/s. Calculate the distance to this galaxy.

Use the formula

$$v = H d$$

The Hubble constant is 77 km/s/Mpc.

Give your answer to 2 significant figures and give the unit.

(3)

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**(Total for Question 20 = 6 marks)**

**TOTAL FOR PAPER = 120 MARKS**

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