

1.

- (a) Describe the links between galaxies, black holes and quasars.

(2)

- (b) At a distance of 5.81×10^8 light year, Markarian-231 is the closest known quasar to the Earth. The red shift z of Markarian-231 is 0.0415

Use these data to estimate an age, in seconds, of the Universe.

age = _____ s

(4)

- (c) A typical quasar is believed to be approximately the size of the solar system, with a power output similar to that of a thousand galaxies.

Estimate, with reference to the inverse-square law, how much further the most distant visible quasar is likely to be compared to the most distant visible galaxy.

(3)

(Total 9 marks)

2.

According to NASA nearly 2000 exoplanets had been discovered by 2016, and the search continues. One aim of this search is to find an Earth-like planet orbiting a Sun-like star.

Discuss the difficulties associated with the detection of an Earth-like planet orbiting a Sun-like star.

In your answer you should compare the methods that are used in the search and suggest which may be the most successful.

(Total 6 marks)**3.**

The table shows some properties of the four brightest stars in the constellation Canis Minor.

Name	Apparent magnitude	Absolute magnitude	Spectral class
Gamma A	4.46	-0.50	K
Gomeisa	2.89	-0.70	B
HD 66141	4.39	-0.13	K
Procyon	0.34	2.65	F

- (a) Discuss, with reference to the Hipparcos scale, why many star maps show only two stars in the constellation Canis Minor.

(3)

- (b) State and explain which star in the table above has the most prominent Hydrogen Balmer absorption lines.

(2)

- (c) Deduce which star, Gamma A or HD 66141, has the larger diameter.

(3)

- (d) Astronomers recently used the radial velocity method to discover an exoplanet orbiting HD 66141.

Describe the main features of the radial velocity method in the detection of planets.

(2)

- (e) Calculate the distance from the Earth to Procyon.
Give an appropriate unit for your answer.

distance = _____ unit _____

(3)

(Total 13 marks)

4.

Evidence to support the Big Bang theory comes from cosmological microwave background radiation and the relative abundance of hydrogen and helium in the Universe.

- (a) Explain what is meant by cosmological microwave background radiation and how its existence supports the Big Bang theory.

(b) Explain how the relative abundance of hydrogen and helium supports the Big Bang theory.

(3)
(Total 6 marks)

5.

- (a) The table contains information about two galaxies.

Galaxy	Red shift, z	Distance from Earth / ly
NGC 936	4.8×10^{-3}	6.8×10^7
NGC 3379	3.0×10^{-3}	3.2×10^7

Discuss whether these data are consistent with Hubble's Law.

(3)

- (b) Quasars are the most distant measurable objects.

Discuss **one** problem associated with the determination of the distance from the Earth to a quasar.

(2)**(Total 5 marks)**

6.

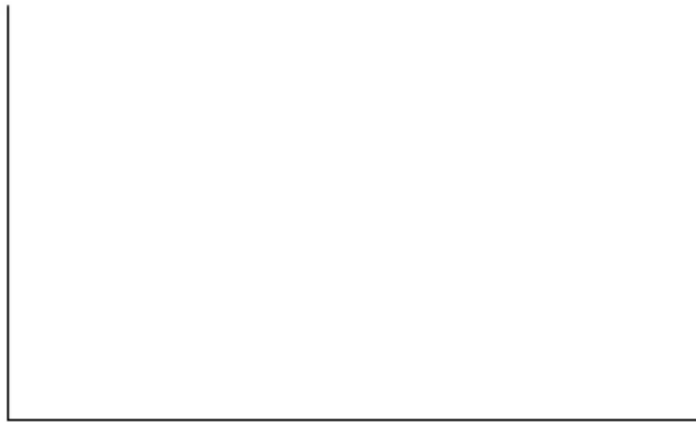
Type 1a supernovae can be used as standard candles.

(a) State what is meant by a standard candle.

(1)

(b) Sketch on the axes below the light curve for a type 1a supernova. Annotate your graph with suitable scales and a unit for time.

absolute
magnitude



time /

(3)

- (c) Measurements of type 1a supernovae are used to find a value for the Hubble constant.

The distance from Earth is known for many type 1a supernovae.

Describe how these values of distance are used, with other data, to find the Hubble constant.

Your answer should include:

- the other data needed and how these data are used
- the graph plotted, including appropriate units for the axes
- how the Hubble constant is obtained and any limitations on the result.

(6)

(Total 10 marks)

7.

IC2497 is a galaxy that contained a quasar. It is believed that the quasar stopped emitting radiation several thousand years ago.

- (a) Suggest why the quasar stopped emitting radiation.

(2)

- (b) IC2497 has a red shift of 0.0516

Determine the distance from the Earth to IC2497.
Give an appropriate unit for your answer.

distance = _____ unit = _____

(4)

(Total 6 marks)