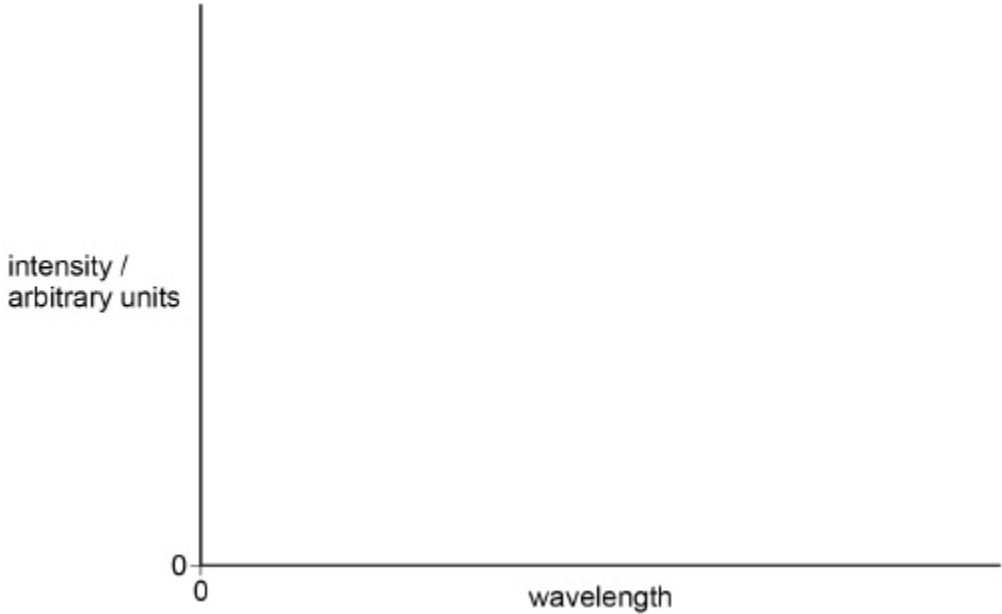**2**

(a) Sketch, on the axes, the black-body radiation curve for a typical star.

(2)

(b) Explain, with reference to the SI units involved, how the curve you have drawn can be used to determine the black-body temperature of the star.

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(3)

(c) Two stars, 61 Cygnus A and 61 Cygnus B, can be seen very close together in the constellation Cygnus. Early astronomers were unsure whether the two stars form a binary system, or simply appear in the same line of sight.

The table shows some of the properties of the two stars.

	Temperature / K	Radius / km	Apparent magnitude
61 Cygnus A	4500	4.7×10^5	5.2
61 Cygnus B	4100	4.1×10^5	6.1

Evaluate whether the data support the suggestion that the two stars form a binary system.

In your answer you should

- compare the two stars as seen by an observer on Earth
- support your evaluation with suitable calculations.

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(6)

(d)   What is the spectral class of 61 Cygnus A?
        Tick (✓) the correct box.

A ☐

F ☐

G ☐

K ☐

(1)
(Total 12 marks)

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

_____

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(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.

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(3)
(Total 9 marks)

8   (a)   Sketch, on the axes, the light curve for a typical type 1a supernova.
Label the axes with suitable scales.

absolute
magnitude

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|_____
                                    time/days

(3)

(b)   Type 1a supernovae can be used as standard candles.

Explain what is meant by a standard candle.

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(1)

(c)   Measurements of type 1a supernovae in 1999 led to a controversy concerning the behaviour of the Universe.

Describe this controversy and how the measurements led to it.

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(3)

(Total 7 marks)

9   In 2013 a gamma-ray burst was detected from a region of space between the constellations of Leo and Ursa Major.

(a)   State the event that was the likely cause of this gamma−ray burst.

_____

_____

(1)

(b)   Measurements of the optical remnant of the event revealed an object with a red shift z of 0.34.

Calculate, ignoring relativistic effects, the distance to this object in light year. Give your answer to an appropriate number of significant figures.

distance = _____ light year

(4)

(c)   The total energy of the gamma−ray burst was estimated to be 10^{47} J. Many scientists are concerned that a gamma-ray burst in the direction of the Earth could cause major problems.

Show that this is similar to the energy that would be released if the mass of the Sun were all converted to energy.

(2)
(Total 7 marks)

(3)