OCR

A Level

A Level Physics

Astrophysics 2

Name:

MME

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Total Marks: /30

1.   Total for Question 1: 8

(a) Define, in words, the units AU and ly. [2]

(b) Show that 1 pc$=3.1 \times 10^{16}$ m. One astronomical unit is equivalent to 1.5×10^{11} m. [2]

(c) Calculate the distance to a star whose parallax angle measures 0.30 arcseconds. Give your answer [3]
in AU, ly and pc.

(d) Why is the parallax method for determining astronomical distances limited to approximately 100 pc?   [1]

2. The Doppler effect is something simple that you witness on a daily basis. Yet, it also holds the key to estimating galaxies' velocities and to obtaining an estimate for the age of the universe.

Total for Question 2: 10

(a) What are meant by the following?
  i. The Doppler effect. [2]

  ii. Red shift. [1]

The centre of a far-away, receding galaxy has an absorption spectra in which the hydrogen line has been Doppler shifted by 2.00 nm relative to laboratory measurements. Its apparent left edge, at a distance of 5 kpc from the centre, has only been shifted by 1.00 nm. In the laboratory, the absorption line for hydrogen occurs at a wavelength of 656.4 nm.

(b) Calculate the recessional velocity of the galaxy relative to the laboratory on Earth. [2]

(c) Calculate the recessional velocity of the left edge. [2]

(d) What angular velocity does the far-away galaxy have? [2]

(e) What Doppler shift would you expect the hydrogen line of the apparent right edge of the galaxy to have? [1]

3. The table below gives the velocities and distances for seven galaxies.

Velocity / kms^{-1}	Distance / Mpc
6800	89
3000	45
4600	68
4000	58
3600	53
1100	20
6500	85

(a) State Hubble's law, both in words and mathematically. [2]

(b) Plot the data above on a graph of recessional velocity against distance and hence estimate the age [5]
of the universe.

(c) State the cosmological principle.   [2]

(d) What is the primary piece of evidence that supports the theory of an expanding universe.   [1]

(e) The notion that the universe is expanding is not sufficient to confirm the Big Bang Theory, which predicts a cosmic microwave background. In what two ways can the cosmic microwave background be explained? [2]