Edexcel

A Level

A Level Physics

Astrophysics 2

Name:

M M E

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Total Marks: /30

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

Total for Question 1: 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]

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

Total for Question 2: 12

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 of the universe. [5]

(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]

3. The future of the universe is not known. This question tackles some of the possible fates.

Total for Question 3: 8

(a) Sketch a graph of size against time showing the three possible fates of the universe. [4]

(b) What is thought to be the critical physical property in determining which course the universe takes? Justify your answer. [2]

(c) The mass of all the stars in a galaxy is calculated using its luminosity. Usually, the estimated mass is only about 10% of that required to reconcile the rotational dynamics of the stars. Explain this observation and why it presents a barrier in determining the fate of the universe. [2]