

4)a) The universe is actually believed to be billions of years old; its age can be estimated in two main ways.

(How many words?)  
its

(-1)

Astronomers think of the universe as consisting of galaxy clusters, which are moving away from each other with velocities proportional to the distances between them. This implies a beginning when all the contents of the universe were in the same place at the same time. We can find an upper limit for the time since the beginning by dividing the distances between the clusters by the speeds at which they are moving apart, resulting in a figure of 10 - 20 billion years; the uncertainty is due to that we do not know very well the distances between clusters.

these phrases are probably not meaningful to most of the readers. PTO

this implies a centre

We believe the universe's oldest stars, of which those in small ancient star groupings (globular clusters) in the Milky way are typical, to be 12 - 14 billion years old, which sets a lower limit to the universe's age, since it must be older than the stars it contains.

Accuracy  $2\frac{1}{2}/3$   
clarity  $1\frac{1}{2}/3$   
Adaptability  $2\frac{1}{2}/3$

Both methods imply an age for the universe greater than 10 billion years.

c) Several independent pieces of evidence support big bang theory:

\* The universe is expanding, as if all its parts were thrown out from an explosion.

what is the significance of the \* ?

\* The universe is bathed in a sea of cool radiation. The "temperature" of radiation decreases with increasing wavelength. The wavelength has increased in proportion to the size of the universe, as surely as if it were made suspended between the universes two ends and was stretched as the universe expanded. The radiation is an echo of the fireball in which the universe formed.

No! Very misleading!

At any time the intensity at all wavelengths corresponds to a unique temperature

\* We can estimate the proportions of different chemical elements which would have formed had there been a big bang, and these are similar to those we have detected in deep space.

Not so long ago we thought the universe had existed forever, but these three pieces of evidence, pointing to the same conclusion, are so compelling that we now think the universe formed in a fireball, in which all matter, and time and space was created. This we call the big bang.

These points are too difficult to be covered in the space available

This part is low too ambitious

Acc.  $2\frac{1}{2}/3$   
cl.  $1/3$   
Ad.  $2\frac{1}{2}/3$