

Solutions

2.1 An increase in the wavelength of light from most distant galaxies; the spectral lines shift towards the red end.

2.2 The further away the galaxy, the faster it is receding.

2.3 Distant galaxies are receding ever faster – accelerating expansion.

3.1 Light from most distant galaxies shows an increase in wavelength (red-shift); this shows the galaxies are moving away from us – receding; the further the galaxy, the faster it recedes, so the whole universe is expanding; traced backwards, the expansion began from a very small, extremely hot and dense region – the Big Bang.

3.2 (a) Galaxy A. (b) Galaxy A. (c) It is not receding – stationary relative to us (or moving sideways); accept “not moving away”.

3.3 Supporting evidence: red-shift of distant galaxies matches an expanding universe, and the 1998 supernova observations extend the picture with accelerating recession. But the theory is incomplete: observations cannot yet explain dark matter and dark energy, which the universe seems mostly made of – so “complete” is not justified; it is the best-supported current model.