

## Questions for Week 2

1. The emission spectrum of hydrogen in distant galaxies was observed.
  - (a) Explain why the lines in the spectrum have longer wavelengths than the same lines when observed from a source in a laboratory on the Earth.
  
  - (b) A particular line in the hydrogen spectrum has a wavelength of 656 nm. When the same line is observed in the Messier 87 (M87) galaxy, its wavelength is found to be 659 nm.
    - (i) Calculate the value of the cosmological redshift parameter,  $z$ ?
  
    - (ii) Use the redshift parameter to calculate the rate at which the distance between the M87 and ourselves is increasing.
  
2. Quasars are the luminous cores of particularly massive galaxies. Because they are so bright they can be seen to large distances. The quasar 3C 273 has a prominent emission line of hydrogen,  $H_\delta$  ("H-delta") at 475 nm. When this line is measured in a laboratory the rest wavelength is found to be 410 nm.
  - (i) Is this a redshift or a blueshift? Give a reason for your answer.
  
  - (ii) Suggest a reason why the lines in the hydrogen spectrum play an important role in determining redshifts.
  
  - (iii) Calculate the speed of 3C 273 and in what direction is it moving, relative to the Earth?