

Astronomy 1F03: Assignment 4

Due Date: Thursday 1st Dec, 2016; hand in to **ABB241 by 2pm** (10% per day late penalty)

Write your answers on a separate sheet showing your working and explaining any formulae you use.

1. The escape velocity from the surface of a spherical object mass, M , and radius, R , is given by $v_{\text{esc}} = \sqrt{2GM/R}$. Calculate the escape velocity from each of the following four objects (express your answer for each in km/s and as a fraction of c , the speed of light):
 - a. The Sun;
 - b. $0.5M_{\odot}$ White Dwarf, radius 10,000km;
 - c. $1.6M_{\odot}$ Neutron star, radius 10km;
 - d. $1M_{\odot}$ object, radius 3km (comment on the result for this object).
2. Consider a spiral galaxy with a “flat” rotation curve beyond the central 2 kpc.
 - a. Derive the general relation giving the orbital period, P , of a star (or other object) in the disc orbiting the centre of the galaxy, as a function of the radius, R ($>2\text{kpc}$), from the galactic centre.
 - b. If stars in the flat part of the rotation curve are orbiting at 250km/s, calculate the orbital period, P in years, for a star at 8kpc from the galactic centre and a hydrogen cloud at 30kpc.
3. For the galaxy in the previous question, use the modified form of Kepler’s third law to estimate the mass interior to the circular orbits at 8kpc and 30kpc. Express your answers in solar masses.
4. Consider a galaxy observed to have an absorption feature at 140nm. This feature is identified as Ly alpha absorption that has a rest wavelength of 122nm. Using the Doppler shift and Hubble’s law calculate the distance to this galaxy in Mpc.
5. At the time of decoupling, what was the distance between what would become the centre of the Milky Way and the Coma cluster? (The present distance to Coma is 100Mpc.)
6. For the standard cosmological model with no cosmological constant (no acceleration), what is the maximum possible age of the universe if the present value of $H_0 = 70\text{km/s/Mpc}$?