1. a) From Special Relativity:

\[
1 + z = \frac{\lambda_{\text{obs}}}{\lambda_{\text{lab}}} = \sqrt{1 + \beta} \quad \text{where } \beta = \frac{v_r}{c}
\]

Show that:

\[
\beta = \frac{(1+z)^2 - 1}{(1+z)^2 + 1}
\]

b) At what redshifts does the approximation \(\beta = z\) differ from the relativistic value by 1%? At what redshifts do they differ by 10%?

c) Given the peculiar velocities of galaxies can often be as large as 600 km s\(^{-1}\), at what redshifts does the equation \(v = H_0 d\) give a distance that could be in error by as much as 10%?

2. Look up NGC 4151 on the NED web site. Using the information you find there, list or determine its following properties. For each, list how the property was determined and the reference, when appropriate.

   a) Right Ascension and Declination (J2000)
   b) Redshift
   c) Distance: from redshift and from non-redshift techniques
   d) Host galaxy and Seyfert types
   e) Scale (arcsec/kpc): calculate from redshift and compare to NED values
   f) NED Major and minor axes of galactic disk (in arcmin and kpc)
   g) Inclination of host galaxy disk (zero degrees is face-on)
   h) Galactic (Milky Way) reddening (\(E_{B-V}\))

3. Given a standard AGN torus with inner edges defined by polar angle \(\theta \geq \theta_{\text{min}}\) with respect to its axis and an observed ratio \(x = \#\text{Seyfert 2s}/\#\text{Seyfert 1s}\), derive the equation for \(\theta_{\text{min}}\) as a function of \(x\). What is \(\theta\) for \(x = 2\) and \(x = 3\)?

4. Based on the discussion in Chapter 10 of Peterson, list the ways in which a “complete” sample might be biased, and therefore not account for all of the AGN to some flux level, as well as possible corrections for such biases. Can you think of any other biases specific to a particular waveband?