Problem C1.1

- (a) How do the frequency ω and the wave vector \vec{k} of a light wave transform under a Lorentz boost in the direction of \vec{k} ?
- (b) Compute the redshift z of light when the source is moving with velocity v relative to the observer. Approximate z for small v.

Problem C1.2 What is the ratio of gravitational interaction energy to Coulomb energy for two protons?

Problem C1.3

- (a) Check that the Planck mass is $M_{\rm Pl} = 1.2 \times 10^{19}$ GeV.
- (b) Convert the Planck units of length, time, and mass into cm, sec, and g.

Problem H1.1 Relate the dimensionless redshift to distance expressed in Mpc.

Problem H1.2 For an expansion law $\vec{v} = \vec{f}(\vec{x})$ to be the same for all observers in non-relativistic phyics, the function \vec{f} must satisfy

$$\vec{f}(\vec{r}_{CA} - \vec{R}_{BA}) = \vec{f}(\vec{r}_{CA}) - \vec{f}(\vec{r}_{BA})$$

Show that the only solution to this equation is given by

 $\vec{f}(\vec{r}) = H\vec{r}$