Homework #9

1. According to Figure 5 from the review article by Arnett, et al., distributed in class, the bolometric luminosity of SN 1987A was $1 \times 10^{41}$ erg s$^{-1}$ at 250 days. Show how this number can be explained quantitatively.

2. For a supernova ejecting $1 M_\odot$ with kinetic energy $10^{51}$ erg into an interstellar medium of density $n_H = 1 \text{ cm}^{-3}$, at what radius and time does the shock begin to decelerate?

3. A gamma-ray burst comes from a conical jet whose half-opening angle $\theta = 5^\circ$, initial $\Gamma_0 = 200$, and total energy $E = 10^{51}$ ergs. It expands into an interstellar medium of $n_H = 10 \text{ cm}^{-3}$.

   (a) How much mass does the jet contain initially, in solar masses?

   (b) At what observed time after the burst will the jet begin to decelerate?

   (c) How much mass will have been swept up by the jet at the time calculated in (b)?