1. Figure 1.5 of the class notes illustrates the amplitude spectrum of geomagnetic field variations at Earth’s surface. Use the information supplied in this figure to make a rough estimate of the size of the internal and external parts of the field. Compare (or contrast) your result for the internal part with your estimate of the equivalent internal contribution derived from the spatial power spectrum of Figure 3.4.6.1. State any assumptions you find it necessary to make in obtaining each of your results.

2. In paleomagnetism it is common to approximate the time-averaged geomagnetic field by that due to a dipole aligned with the rotation axis.
   
   (a) Show how this approximation can be used to predict the expected magnetic field at any latitude. Use this and knowledge of the axial dipole moment derived from the IGRF model to calculate the field at IGPP.
   
   (b) Explain how you would calculate a more accurate estimate of the geomagnetic field strength and direction at IGPP. Use the current IGRF model to make such an estimate.
   
   (c) What is the approximate size of the error you make if you neglect to correct for the ellipsoidal shape of the earth and use geocentric latitude and longitude in calculating the field from a spherical harmonic model?
   
   (d) How close do you expect your prediction in (b) to be to an actual measurement, and what contributes to any differences?

3. (a) Make an estimate of the minimum rate of Joule heating generated in Earth’s core. Compare this with terrestrial heat flow at the surface.

   (b) A toroidal magnetic field $B_T$ fills a conducting sphere of radius $a$; its scalar is the function $T(r)$. Imagine creating a contour map of values of $T$ on the surface $S(b)$ with $b < a$. What connection does the contour map of the scalar $T$ have with the magnetic field $B_T$?

Hints: For problems 2 and 3 you may find it useful to consult the IGRF web pages referenced in the notes.