PY541 Problem Set 5: Due Tuesday, December 3, 2002 in class

1) Calculate the leading correction to the Fermi energy of an ideal gas due to the *orbital* magnetic field, of $O(B^2)$, expressing your result in terms of the density and constants of nature only.
You may need the Euler-Maclaurin sum formula to next order. You can find this various places, such as on the web in Mathematica, in Gradshtein and Ryzhick, etc. It is usually written in a slightly different form, however. I believe, the correct result to next order can be written:

$$\sum_{n=0}^{\infty} f(n+1/2) \approx \int_0^{\infty} f(x)dx + (1/24)f'(0) - (7/5760)f'''(0) + \ldots \tag{1}$$

2) Calculate the cubic term in the orbital magnetization, $M_O(B)$ at $T = 0$ expressing your result in terms of the density and constants of nature only.
3) Derive an exact expression for the orbital magnetization at $T = 0$ of a 2-dimensional ideal Fermi gas with the usual quadratic energy momentum relation: $\epsilon(p) = p^2/2m$. Express the magnetization per unit volume as a function of the electron density and B for all B (at fixed density) and sketch the result.
4) Pathria problem 8.4a, second part: Calculate the isothermal and adiabatic compressibility of an ideal Fermi gas to $O(T^2)$ at low T. The answer is in Pathria; derive it carefully.