Introduction to Plasma Physics (PY5012)
Homework 2
*Submit solutions at lecture on Thursday, November 3, 2011*
Note: This homework is worth 10% of total module mark

1. a) Describe the concept of trapping of charged particles making particular reference to the first adiabatic invariant.

    b) Assuming a magnetic field of the form given in the figure below, where $B = B(z)$ and let z be a coordinate along the axis of symmetry, where $z = 0$ corresponds to the mid-plane, so that $B = B_{min}$ at $z = 0$. Show that the magnetic field at the mirror point for a particle with speed v is

    $$B_{mirror} = \left(\frac{v}{v_\perp}\right)^2 B_{max}$$

    where $v_\perp$ is the perpendicular speed of the particle.
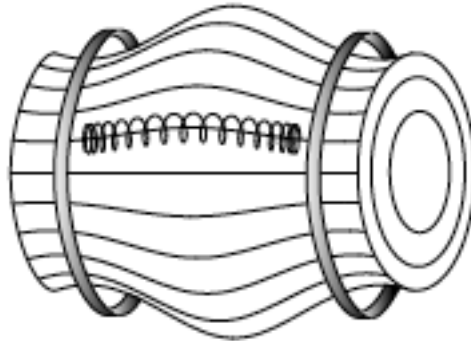
    c) Show that the trapping condition can be written

    $$\frac{|v_\parallel|}{|v_\perp|} < \left(B_{max}/B_{min} - 1\right)^{1/2}$$

    Comment on this equation.

    d) Show that in the B-field given above that the time, τ, taken for a trapped particle on the z-axis to bounce between its two mirror points at $z = L$ and $z = -L$ is

    $$\tau = \frac{\sqrt{2}\pi L}{v}$$