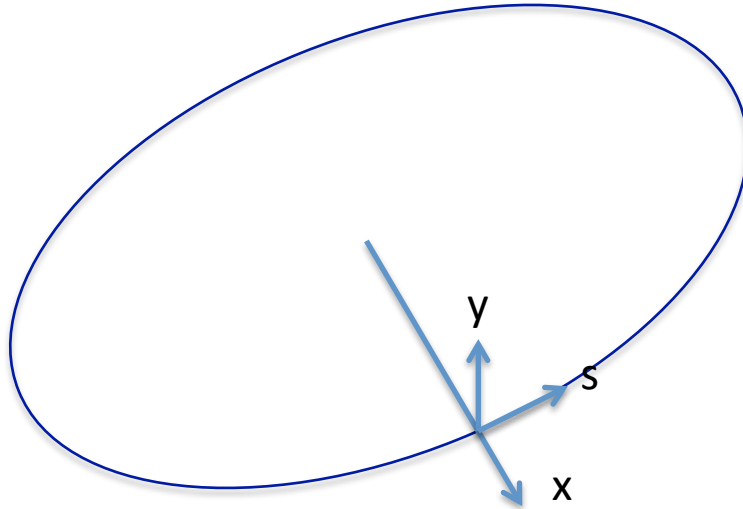


Homework 3

Problem 1. 5 points. Plane symmetry and plane trajectories.

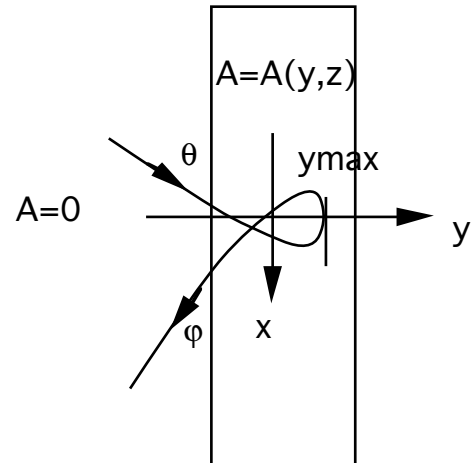


- Plane reference orbit (torsion $\kappa=0$) requires that total out-of plane force is equal zero. Find ratio between radial (x, horizontal) magnetic field and of-plane (vertical, y) electric field to satisfy this condition. What's happens when both of them are equal zero?
- Define full set of condition on EM field providing that all in-plane trajectories (e.g. all trajectories with $y=0$ and $y'=0$, but otherwise arbitrary) to stay in-plane, i.e. $y=0$ is a solutions. Consider that particles have different energies.

Hint: use Lorentz force

Problem 2. 10 points. Magnetic Mirror: An electron propagates through a magnetic field with vector potential $\vec{A} = \vec{A}(y, z)$. Find an additional invariant of motion caused by independence of vector potential on x. Write explicit expression for p_x using this invariant. Consider a magnet with mid-plane symmetry ($\vec{H} = \hat{e}_z H(y)$ at $z=0$ z is perpendicular to the plane of figure) shown below with $\vec{A} = \vec{A}(y, z)$ inside the magnet and $\vec{A} = 0$ outside the magnet. Let's consider an electron entering the magnet in the middle plane $z=0$ with mechanical momentum $\vec{p} = \hat{e}_x p_x + \hat{e}_y p_y = p(\hat{e}_x \cos\theta + \hat{e}_y \sin\theta)$ where $\vec{A} = 0$ laying in the x-y plane, making turn in the magnet and coming out.

- Show that trajectory of electron remains in the plane $z=0$;
- Find angle φ of out-coming trajectory of the electron (reflected angle).
- Find equation defining depth of penetration of electron inside the magnet y_{\max} using $\vec{A}(y, 0)$.



Clues: use Lorentz force to find (1), Use canonical momentum to connect mechanical momentum with $\vec{A}(y,0)$ for (2,3)