*Physics 853 Quiz #3 - Monday, Oct 8, 2012*

FYI: For massless particles, the chiral representation is especially useful,

$$\alpha_i = \begin{pmatrix} \sigma_i & 0 \\ 0 & -\sigma_i \end{pmatrix}.$$

1) [10 pts] Consider a massless fermion interacting with a vector field,

$$\begin{aligned} i(\not{\partial} - e\not{A})\psi &= 0 \\ A_y &= \begin{cases} 0, & x < 0 \\ \infty, & x > 0 \end{cases} \\ A_x &= 0 \\ A_z &= 0 \\ A_0 &= 0. \end{aligned}$$

Solve for the B.C. for the wave function at the boundary, i.e.,

$$M\psi(x=0) = \psi, \quad \text{find } M \text{ in terms of the Dirac matrices } \alpha_x, \alpha_y \text{ and } \alpha_z.$$

2) Now, consider the massless particle in a potential in cylindrical coordinates,

$$\begin{aligned} A_\phi &= \begin{cases} 0, & r < R \\ \infty, & r > R \end{cases} \\ A_r &= A_z = A_0 = 0. \end{aligned}$$

where $r = \sqrt{x^2 + y^2}$.

a) (5 pts) Write down the B.C. at $r = R$.

b) (10 pts) What is the ground state energy?