Physics 123B: Homework 3
due February 1, 5pm in the box at the PSR

1. **IQHE:**
   Assuming a 2d electron gas with fixed 2d electron density $n$ and mass $m$, and assuming all electrons are spin polarized (i.e. they are all spin up), find the sequence of magnetic fields $B_k$, such that exactly $k$ Landau levels are filled, with integer $k$. These fields correspond to the centers of plateaus in the IQHE.

2. **Topological insulators:**
   In class, we showed by solving the Dirac equation that the edge state on the right side of the spin-orbit-coupled graphene system with spin up, associated with the $K$ node, had energy $\epsilon = \epsilon_0 - vq_y$, i.e. it was “left-moving”.

   (a) Show by solving the Dirac equation for the $K'$ node that the edge state on the same edge for spin down has energy $\epsilon = \epsilon_0 + vq_y$, i.e. it is “right-moving”.

   (b) Show that the spin up edge state on the left edge of the sample propagates in the opposite direction from the one we found in class (taking the same $V > 0$ to occur outside the sample).