Quiz 6: Solution

1. A power cord for an electric appliance has two parallel wires carrying current. Is the magnetic force between the two wires attractive or repulsive? *Hint: you know the relative direction of the currents . . .*

The current must be going in opposite directions in the two wires – if one wire carries charges to the appliance, the other must carry them back if we are to have a current. Since the currents must be anti-parallel, they must repel each other.

2. The magnetic field exerts a force on a (moving) charged particle, but doesn't do any work on them. Why? Recall $\vec{\mathbf{F}}_B = q\vec{\mathbf{v}} \times \vec{\mathbf{B}}$ and $W = \vec{\mathbf{F}} \cdot \Delta\vec{\mathbf{x}}$.

The magnetic force is always perpendicular to the particle's velocity, by virtue of its resulting from a cross product of $\vec{\mathbf{v}}$ and $\vec{\mathbf{B}}$. The displacement of the particle, in the absence of any other forces, must be parallel to the velocity. Thus, the magnetic force must be perpendicular to the particle's displacement. Since work is $\vec{\mathbf{F}} \cdot \Delta\vec{\mathbf{x}}$, if force and displacement are perpendicular, their dot product is zero and so is the net work. Adding additional external forces does not change this conclusion, as they will not affect the work done by the *magnetic force.*

Essentially, because magnetic force results from a cross product of velocity and magnetic field, the force is perpendicular to both the motion of the particle and the magnetic field. If force is perpendicular to motion, work is zero because work is the dot product of force and net motion (displacement). It follows that the magnetic force may change the direction of the particle's movement, but it cannot cause it to speed up or slow down (i.e., no change in kinetic energy).