Physics 142 – Fall 2010 – Workshop module 7

1. Spaceman Spiff lands on planet Zorgon. He and a Zorgon farmer get into an argument. Spiff wants to put his spacecraft inside the farmer's barn. The farmer says it won't fit. The length of the barn in its rest frame on the ground is 5 m while the length of Spiff's spacecraft is 6 m. The farmer points this out to Spiff. But fearless Spiff tells the farmer to wait and watch. Spiff opens both the front and back door of the barn and passes through the barn with his spacecraft moving at 0.6c. According to the point of view of the farmer standing on the ground by the barn, did the spacecraft fit inside the barn as it passed? After landing, Spiff returns in a dejected mood and announces that the farmer was right. He couldn't fit the spacecraft inside the barn. Why does Spiff say that?

2. Two particles in a particle accelerator are each moving in opposite directions at 0.8c as measured in the laboratory. What is the magnitude of the relative velocity with which the particles approach each other?

3. Break up into groups of two. Each group of two should come up with two different drawings of a positive, negative, or neutral charge moving with a velocity, v, through a magnetic field B. Label ONLY the charge (+,-,0) and the velocity vector (which could have magnitude 0) and the B field vector (which could have a magnitude 0) at a given instant. The directions of the velocity vector and B field vector are arbitrary, though it will be best if you allow the vectors to be in the plane of the paper or perpendicular to the paper. Now each group should go to the board and reproduce their drawings there. The class should discuss and agree on the direction for the magnetic force on each of the moving charges. Try to be tricky with at least one of your drawings! If, for some reason there are too few people in your workshop to make a reasonable number of examples … each person should make up three … or your TA will join in a make up a few.

4. Back into your groups of two … or different groups if you are so inclined. Each group should make two drawings of a straight-line current segment (in the plane of the paper or perpendicular to the paper) in a magnetic field (again, the B vector should be in the plane of the paper or perpendicular to the paper). The current can be either moving positive or negative charge, but you must specify which. Make more than two drawings if you are in a small workshop. Again, take turns showing the workshop your drawings. The group should discuss and agree on the direction of the magnetic force on each current segment.

5. A straight piece of conducting wire of mass M and length L is placed on a frictionless incline tilted at an angle θ from the horizontal. The length of the wire is perpendicular to the direction of the incline. There is a uniform, vertical magnetic field B up at all points. To keep the wire from sliding down the incline, a voltage source is attached to the ends of the wire. Make a sketch of the problem and appropriate free body diagrams. Determine the magnitude and direction of the current in the wire that will cause the wire to remain at rest (i.e., not slide down the incline).

6. A cyclotron for accelerating protons to 25 MeV has a magnetic field of 1.8 T. What is the cyclotron frequency for this machine? What must the minimum radius of the magnet be to achieve a 25-MeV emergence energy?