3.16.3.2: Electric and Magnetic Forces Simulation

In this simulation you can select an electric field and two different orientations of a magnetic field to see their effects on neutral, positive and negative charges. For the electric field case the particles have zero initial velocity. In second case with a magnetic field in the x-direction the initial velocity is zero but there is a check-box so that you can give the particles an initial velocity in the $+x$ direction. In the third case the magnetic field is rotated so that it points into the screen (which is now the x direction) and the particles have an initial velocity in the $+z$ direction. For this case a black arrow shows the direction of the force on the particle. Light grey arrows show the velocity of the particle.

Simulation Questions:

1. With the electric field case selected, run the simulation for each of the three particles (neutral, positive and negative) and describe what happens (reset the simulation between each choice). Do the charges have a constant velocity or are they accelerating? Hint: The length of the gray arrow is proportional to the speed of the particle.
2. Reset the simulation and choose the second case with a magnetic field in the x-direction and the particles with a zero initial velocity. What happens to the particles? Can the magnetic field cause them to accelerate if they are initially stationary?
3. For the magnetic field in the x-direction, use the check-box to give the particle an initial x-velocity. Try the other charges, resetting the simulation each time. Describe the motion of the particles. Do they accelerate in this case? (Again; the length of the gray arrow is proportional to the speed.)
4. Reset the simulation and choose the magnetic field pointing into the screen (the third case at the top). Each of the particles start with the same initial x-velocity, indicated by the grey arrow. Describe what happens in each case.

Questions on Magnetic Fields:

1. Electric fields come from charges. Where do magnetic fields come from (your answer should include more than just saying "magnets")?
2. In what sense can we say that the ultimate source of all magnetic fields (even permanent magnets) is moving charge?
3. What is an electromagnet?
4. Suppose you float a magnet in a bowl by attaching it to a piece of Styrofoam. Will it drift towards the north side of the bowl due to the attraction of the north pole of the magnet? Why or why not?
5. Opposite magnetic poles attract each other. So why does the north end of a compass point north?
6. If a compass needle could point in any direction (north, south, up, down, etc.) which way would it point if it were located at the earth's geographical north pole?
7. Does a compass still point north if it is in the southern hemisphere, or does it reverse?
8. Do electrical charges always feel a force due to a magnetic field? Explain.
9. If a charged particle moves in a straight line through a region of space at constant speed, can you say that the magnetic field in that region is zero? Explain.
10. What is the origin of the Aurora Borealis (the Northern Lights)? Why are the not usually seen near the equator?
11. Residents of Alaska get hit by more cosmic rays (charged particles from space) than residents of Panama. Why is that?
12. Explain how an electric motor works.