PH 102 Quiz 4: Magnets and Such

1. Consider a proton moving with a speed of $1 \cdot 10^5 \text{ m/s}$ through the earth’s magnetic field ($|\vec{B}| = 55 \mu \text{T}$). When the proton moves east, the magnetic force acts straight upward. When the proton moves northward, no force acts on it. What is the direction of the magnetic field?

○ North
○ South
○ East
○ West

2. What is the magnitude of the magnetic force in the previous example?

○ $2.2 \cdot 10^{-9} \text{ N}$
○ $6.6 \cdot 10^{-15} \text{ N}$
○ $8.8 \cdot 10^{-19} \text{ N}$
○ $4.4 \cdot 10^{-13} \text{ N}$

3. The figure shows a simplified mass spectrometer. Particles with charge $q$ and mass $m$ enter at left with a velocity $v$, and encounter a region with both an $E$ and $B$ field as shown. What is the relationship between $v$, $B$, and $E$ for particles that make it through the aperture in the middle of the detector?

○ $EB = v$
○ $E/B = v$
○ $E^2/B = v$
○ $B/E = v$

4. Once the particle enters the second region of the detector from the previous question, it is in a region of magnetic field only. In this region, the particle travels in a circular path. What is the radius of the circle?

○ $r = mB/qv$
○ $qvB/m$
○ $r = qB/mv$
○ $r = mv/qB$
5. Permanent magnets sticking to a refrigerator door happens because the permanent magnet is able to induce magnetic poles in the steel of the door. This process is analogous to electrically charging objects by induction, where a charged object induces opposing charges in a conductor without contact.

Can a process like conduction, where a charged object transfers some of its charges to another, happen with magnets? Refer to the figure at left for the analogy.

- No, because there are no single magnetic charges.
- Yes, but it is a small effect due since \( \mu_0 << \epsilon_0 \)
- Yes, this is how permanent magnets become magnetized
- No, because magnetic poles are not mobile.