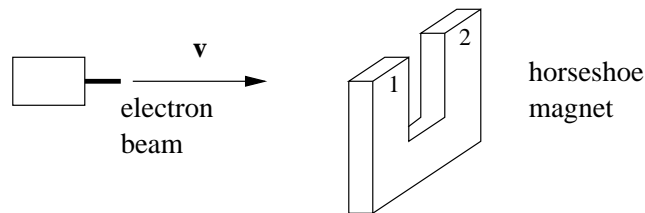


Paragraph style homework 1
Applications of the cross product and dot product
Due: Wed Feb 08

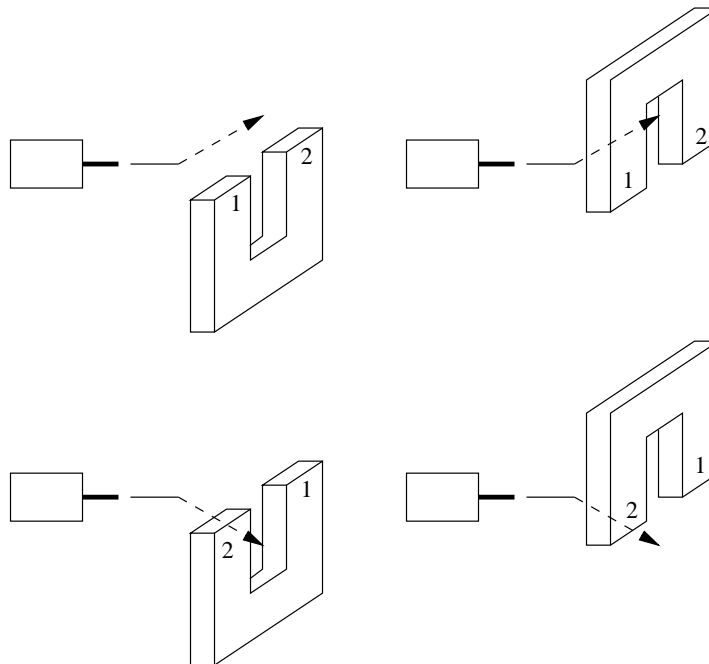
1. A law of electricity and magnetism says that the force vector \mathbf{F} applied by a magnetic field described by the vector \mathbf{B} to a charge of magnitude q travelling at velocity vector \mathbf{v} is

$$\mathbf{F} = q\mathbf{v} \times \mathbf{B}.$$

Now, suppose we have an electron beam, and a horseshoe magnet that exerts a magnetic field at the point halfway between the two poles of the magnet. (For reference, the two poles are numbered 1 and 2, as shown.)



When we hold the magnet in various positions, with the point halfway between its two poles coming directly in the original path of the electron beam, the beam is deflected as shown in the pictures below. (To make this a little easier to see, the magnet is drawn “see-through”.)



In what direction is the magnetic field pointing at the point halfway between the two poles of the magnet? Justify your answer carefully.

2. The WeVo television service determines whether people have similar or different tastes in television shows in the following way. WeVo asks each person to rate 3 shows, *Survivor: Alameda Island*, *Law and Disorder*, and *That Wacky Squirrel Show*, on a scale from -5 (hate it) to $+5$ (love it), and then creates a vector $\mathbf{a} = \langle a_1, a_2, a_3 \rangle$ of that person's ratings of the three shows.

Suppose Alex, Louise, and Nick have the following WeVo vectors:

$$\mathbf{A} = \langle +3, +2, -2 \rangle, \quad \mathbf{L} = \langle 0, -3, +5 \rangle \quad \mathbf{N} = \langle +2, +4, -4 \rangle,$$

- (a) What is the angle between Alex's vector and Nick's vector, to the nearest degree? Would you say that Alex and Nick have similar tastes in television or different tastes in television?
- (b) What is the angle between Alex's vector and Louise's vector, to the nearest degree? Would you say that Alex and Louise have similar tastes in television or different tastes in television?
- (c) Describe how WeVo might determine whether two people \mathbf{u} and \mathbf{v} will have similar or different taste in television shows, based only on the dot product $\mathbf{u} \cdot \mathbf{v}$. Briefly justify your answer.

Note: Real-life similarity comparisons (Do people like the same books? Will potential roommates be compatible?) can be done in much the same way as they are done in question 2. The main difference is, in real life, we would want to compare more than 3 opinions, which would mean that we would have to do geometry in more than 3 dimensions. Even in higher dimensions, however, everything works more or less the same.