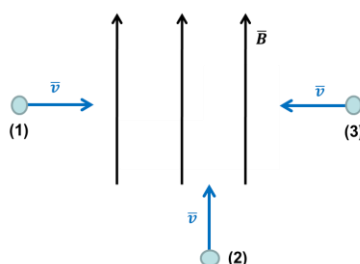


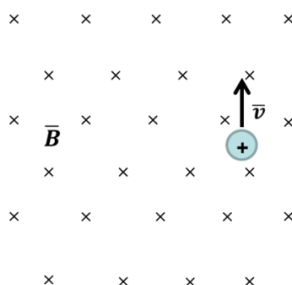
## Hardware 2 TX00EW86-3009 - 3011 / Magnetism / Problem Set 1

- All three protons enter a 0.10-T magnetic field at 2.0 Mm/s, as shown in the figure.



Find the magnetic forces (magnitudes and directions) for all protons. (Answers: 32.04 fN for (1), 0 for (2), 32.04 fN for (3))

- Combinations of an electric and a magnetic field can deflect particles from their original direction of motion (used in velocity selectors). Assume a space in a velocity selector where uniform electric and magnetic fields with strengths of 24 kN/C and 60 mT, respectively, are in perpendicular direction to each other. Consider a case where an electron enters this space horizontally and in perpendicular direction to both fields.
  - Draw a figure of the given situation and show the directions of the electric and magnetic forces in it.
  - At what speed will the electron pass through the selector undeflected? (Answer: 400 km/s)
- The magnitude of Earth's magnetic field is about 0.5 G near Earth's surface. What is the maximum possible force on an electron with kinetic energy of 1 keV? (Answer:  $1.5 \cdot 10^{-16}$  N)
- The following picture shows one situation of a positively charged particle in a uniform and perpendicular magnetic field.



How does the particle continue its motion (speed and direction are to be considered)?

- Microwaves in a microwave oven are produced by electrons circling in a magnetic field at frequency of 2.4 GHz. (Hint: The time of one revolution (called a period) is  $T = \frac{2\pi R}{v}$  and the frequency is  $f = \frac{1}{T}$ .)
  - What is the magnetic field strength in the oven? (Answer: 86 mT)
  - The electrons' motion takes place in a tube called a magnetron. What is the maximum electron energy if the maximum diameter of the tube is 2.5 mm? (Answer: 1.01 keV)
- A silver ribbon carries a 100-A current through a cross-sectional area height  $\times$  thickness of 1.0 cm  $\times$  0.20 cm and lies in a uniform magnetic field, which is along the thickness of the ribbon. Silver contains about  $5.9 \cdot 10^{28}$  charge carriers/m<sup>3</sup>. The measured Hall potential was 7.9  $\mu$ V. What was the magnetic field strength? (Hint: See the figure in the theory file on page 12.) (Answer: 1.5 T)