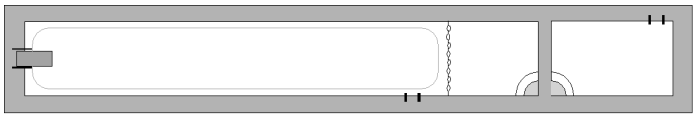
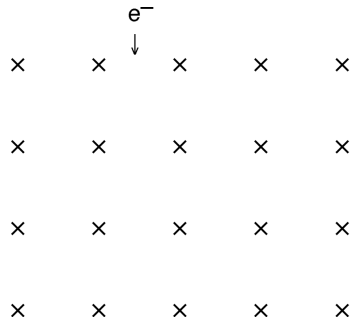
PhyzSpringboard: Motional EMF



I. Nudge, Nudge (magnetic force)

A. THE DEFLECTION OF AN ELECTRON

A single electron moves through the magnetic field as shown in the diagram.

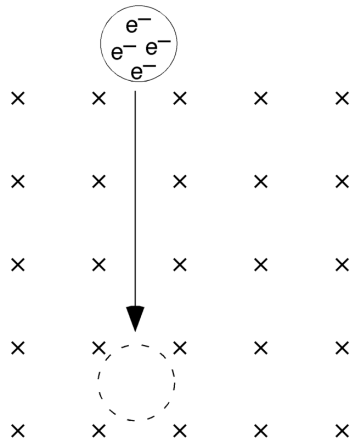


1. Determine the direction of the magnetic force acting on the electron.

2. Draw the path it will follow once in the magnetic field.

B. ELECTRONS IN A BALL

A heavy spherical container filled with free electrons (in other words, a metal ball) moves through the same magnetic field as shown. Initially, the free electrons are distributed evenly throughout the sphere.



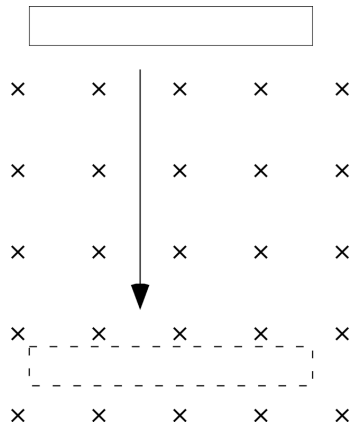
1. Determine the direction of the magnetic force acting on the electrons in the container.

2. Due to the magnetic force on the electrons, they "pile up" on one side of the container as it passes through the magnetic field. Show this "piling up" on the diagram.

3. Why isn't the path of the *container* deflected?

C. THE COPPER BAR

A copper bar moves down through the magnetic field.



1. Why is copper a good conductor of electricity?

2. What is the direction of the force on each free electron in the copper bar?

3. Draw the distribution of free electrons in the copper bar before and during its passage through the magnetic field.

II. Wink, Wink (formula fiesta)

A. THE BASIC RELATIONS

Write down the following formulas (formulæ).

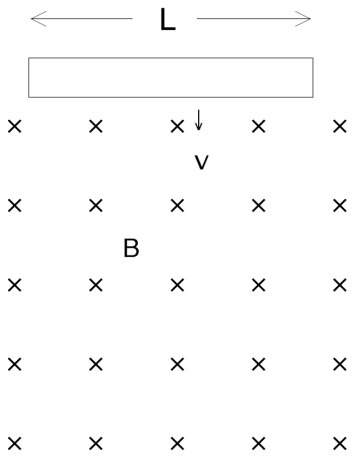
1. The magnetic force *F* on a moving charged particle (in terms of the charge *q*, speed *v*, and magnetic field *B*).

2. Work *W* (in terms of force *F* and distance *d*).

3. Electric potential *V* (in terms of energy *PE* and charge *q*).

B. THE COPPER BAR (AGAIN)

A copper bar of length *L* moves through a magnetic field of strength *B* at a speed *v*.



1. What is the magnitude of the magnetic force *F* acting on an electron of charge *q* that resides within the moving bar? (It's as easy as you think.)

2. If this force pushes the electron from one side of the bar to the other (a distance *L*), how much work *W* has the force done? Write your equation without using the letter F.

3. The potential energy *PE* associated with the electron is equal to the work done on it by the magnetic force. Write this down.

4. Write your equation for electric potential *V* (part II.A, number 3).

5. What is the voltage (electric potential) across the bar, based on the equations above? (Yo! Simplify!)

III. Grin, Grin (with numbers and units)

Determine the voltage (or induced emf) across a 3.0 m copper bar moving at 20 m/s through a 2.0 T magnetic field. CHECK UNITS!