Wednesday Reading Assessment: Unit 3, Magnetic Forces and Fields

Prof. Jordan C. Hanson

April 1, 2020

1 Memory Bank

- $\vec{F} = I\vec{L} \times \vec{B}$ ... Force on a current-carrying wire.
- $\vec{F} = q\vec{v} \times \vec{B}$ ... Force on a charged particle in a B-field.
- $U = q\Delta V$ ... Potential energy gained by a charge proceeding through a potential.
- $KE = \frac{1}{2}mv^2$ ... Kinetic energy.

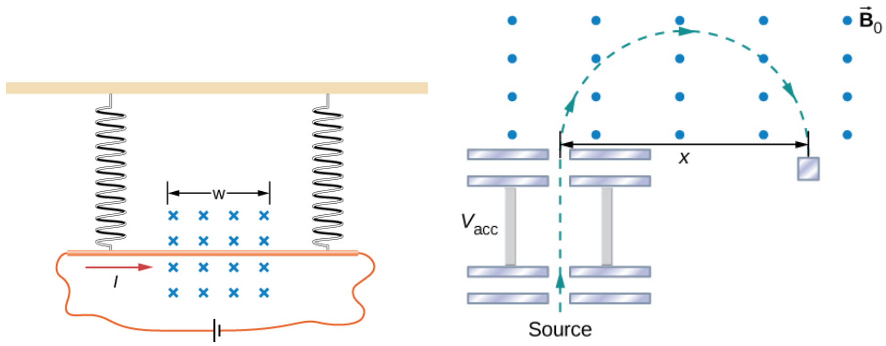

Figure 1: (Left) A current I causes a force on the wire such that the spring tension is eased. (Right) A schematic of a mass spectrometer.

2 Magnetic Forces on a Wire

1. Consider Fig. 1 (left). A metal rod of mass m and length L is hung from the ceiling using two springs of spring constant k. A uniform magnetic field of magnitude B pointing perpendicular to the rod and spring exists in a region of space covering a length w of the copper rod. The ends of the rod are then connected by flexible copper wire across the terminals of a battery. Determine the change in the length of the springs when a current I runs through the copper rod, in terms of the other given variables. *Check units, and take limits...do the results make sense?*

2. A schematic for a device called a *mass spectrometer* that measures the mass of ions is shown in Fig. 1 (right). An ion of mass m and charge q is at rest and accelerated by a potential difference V_{acc} and allowed to enter a region of constant magnetic field B_0. In the uniform magnetic field region, the ion moves in a semicircular path striking a photographic plate at a distance x from the entry point. Derive a formula for x in terms of the other given variables.