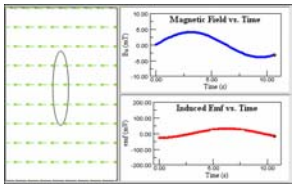
Worksheet for Exploration 29.4: Loop in a Time-varying Magnetic Field



The animation shows a wire loop in a changing magnetic field. The graphs show the magnetic field in the x direction as a function of time and the induced emf in the loop **(position is given in meters, magnetic field strength is given in millitesla, 10^{-3} T, and emf is given in millivolts)**.

a. The vectors show the field through the loop as a function of time. What do the different colors indicate?

b. What impact does changing the maximum value of the magnetic field have on the induced emf?
   i. For example what happens when you double the amplitude of the magnetic field?

c. What impact does changing the frequency of the oscillation of the magnetic field have?
   i. Likewise again, consider doubling the frequency.

d. Develop an expression to relate the change in the emf to the parameters you can vary.

e. Develop an equation for the magnetic field as a function of time and the parameters you can vary.

   B=_____

f. What is the area of the loop? Therefore, what is the flux through the loop as a function of time?

Flux(t)=_____

g. Using Faraday's law, show that the emf should be equal to $|B_{max}|A\omega\cos(\omega t + \varphi)$, where $|B_{max}|$ is the maximum value of the magnetic field in the x direction, A is the area of the loop, ω is the angular frequency of the oscillation, and φ is a phase angle.

h. Verify that this expression matches the graph for the emf versus time.