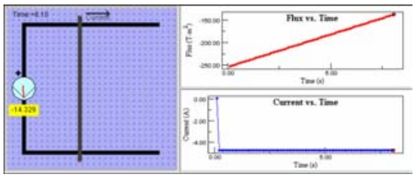
Worksheet for Exploration 29.2: Force on a Moving Wire in a Uniform Field



Faraday's Law is a relationship between a time-varying magnetic field flux (Φ) and an induced emf (voltage), emf = - dΦ/dt **(position is given in meters, current is given in amperes, emf is given in volts, and magnetic flux is given in tesla meter^2)**. In this animation, a wire is pushed by an applied force in a constant magnetic field.

a. What are the fluxes at t = 1 s and t = 3 s (from the graph)?

Φ_1=________ Φ_3=________

b. What is the change in flux/second? (ΔΦ/Δt).

(ΔΦ/Δt)=________

According to Faraday's law, this should be equal to the induced emf.

c. Does your calculated emf agree with the emf reading on the meter connected to the wires?

$emf_{measured}$=________

d. What is the velocity of the sliding rod?

v_{rod}=________

e. What is the change in area/second?

ΔA/Δt=________

f. Since Φ = ∫ **B** • d**A**, which is Φ = BA for this case (why?), what is the value of the magnetic field the wire slides in?
   i. Consider taking the derivative of both sides with respect to time.

The sliding wire has a current flowing in it.

g. In what direction is this current and what is the value of the current (read the current value from the graph) at a given time (pick a time)?

I_{graph}(t=___)=________ Direction: ________________

h. In what direction is the magnetic force on this current carrying wire moving in the external magnetic field (the one you found in part (f) above)? Remember, **F** = I**L** x **B**.

Direction of Force due to External Field=____________________

i. What is the value of the force?

Magnitude of force on rod due to field=___________________

j. Since the wire moves at a constant speed, what must be the direction and magnitude of the applied force? Check your answer by showing the force on the wire.
   i. Sketch a force diagram, and also indicate the net force acting on the wire.

The power dissipated in an electrical circuit is the current times the voltage drop. In this case, I times the emf across the rod.

k. What is the power dissipated?

Power=________

The power delivered by an external force is $\Delta W/\Delta t$, where W = **F • s** is the work done by the applied force, **F**, and **s** is the displacement.

l. Show that the power delivered is also **F** • **v**.

m. What is the power delivered by the external force?

n. Why should this power be equal to the power dissipated by the circuit?

o. Pick a different velocity and calculate the power dissipated by the circuit and the power delivered by the force.