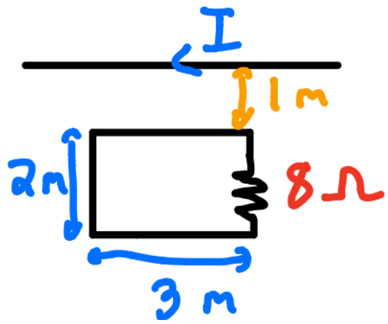
AP Physics C Name: ___________________________________

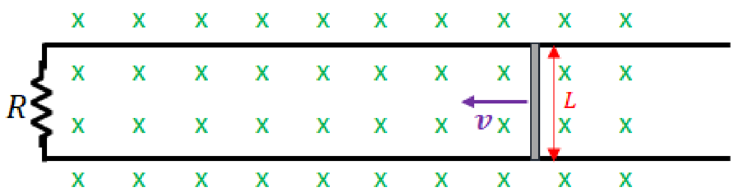
Unit 6 Test: EMI

Directions: Show your fluxing work.

1. A rectangular loops of dimension 2 m x 3 m is in the plane of the page as shown. A long straight wire also in the plane of the page carries a current I in the direction shown, with I varying in time as given by $I(t) = 3 + 3t$. The wire is 1.0 m from the loop.
a) Calculate the magnetic flux through the rectangular loop at time t = 0 s.
b) What direction is the current induced in the loop?
c) Determine the value of the current in the loop at time t = 3 s.

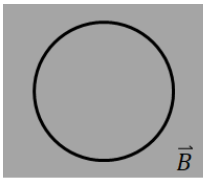


2. A conducting rod is free to move on a pair of horizontal, frictionless conducting rails a distance L= 20 cm apart. The rails are connected at one end so a complete circuit is formed. The rod has a mass m= 0.2 kg, the resistance of the circuit is $R = 20\ \Omega$. and there is a uniform magnetic field of magnitude $|\vec{B}| = 2\ T$. directed perpendicularly into the plane of the rails, as shown. At time t = 0, the rod has a speed $v = 20\frac{m}{s}$ to the left.

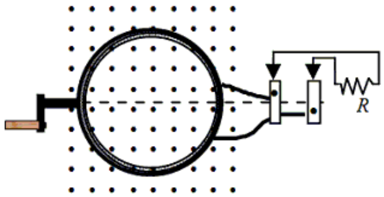


a) Determine the direction and magnitude of the net magnetic force on the rod at time t = 0.
b) Using integral calculus, determine a function for the speed v of the rod as a function of time t
c) Calculate the total energy dissipated by the resistor beginning at t = 0

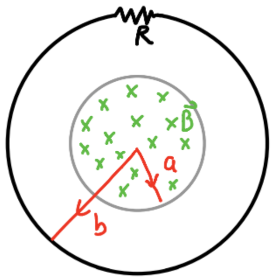
3. A wire loop of area A is placed in spatially uniform magnetic field that is perpendicular to the plane of the loop. The induced emf in the loop is given by $\varepsilon(t) = kA\sqrt{t}$, where k is a constant. rite an expression for the mangetic field as a function of time.



4. A circular coil has 305 turns and a radius of 0.05 m. The coil is used as an ac generator by rotating it in a 0.600 T magnetic field, as shown in the figure. At what angular speed should the coil be rotated so that the maximum emf is 135 V?



5. A magnetic field exists in a circular region of space with a radius of a = 0.5 m, as shown. At time t = 0, the magnetic field is 0, but increasing at a rate of 0.2 T/s. A loop of wire of radius b = 0.8 m is concentric with the field and has a resistor with a resistance of R = 7 Ω.
a) Determine the magnitude and direction of the current in the resistor.
b) Determine the rate at which heat is being produced in the resistor.



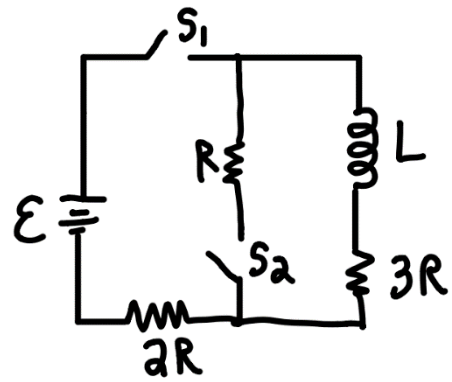
6. A 80 loop solenoid has a radius of 0.1 m and a length of 0.3 m.
a) Calculate the inductance of the solenoid. Show your work.
b) The solenoid is connected to a battery with a variable emf given by $\varepsilon(t) = 2\sin(\pi t)$. Determine an expression for the current in the inductor.

7. There's a circuit on the right. $\varepsilon = 100\ V, R = 50\ \Omega, L = 8\ H$. S1 is initially closed at time t = 0 s while S2 is kept open.

a) Determine the rate of change of current in the inductor when the current in the battery is 0.1 A.

b) Using integral calculus, determine an expression for the current in the inductor starting at t = 0 s.

c) After a long time, S1 is opened while S2 is closed. Determine the initial current (magnitude and direction) in resistor 3R.



8. An LC circuit is set up as shown. At time t = 0, the switch is set to position S1.

a) Calculate the time for the voltage across the resistor to reach -6 V.

b) After oh so long, the switch is set to position S2.

i. Explain why the circuit will oscillate.

ii. Set up a differential equation to determine the charge q, in the capacitor once the switch is flipped. Use your equation to determine the period of oscillation of the LC circuit.

iii. Calculate the charge in the capacitor when current in the inductor is changing at a rate of 1 A/s.