Physics 4B
Fall 2017

Name: Answer Key

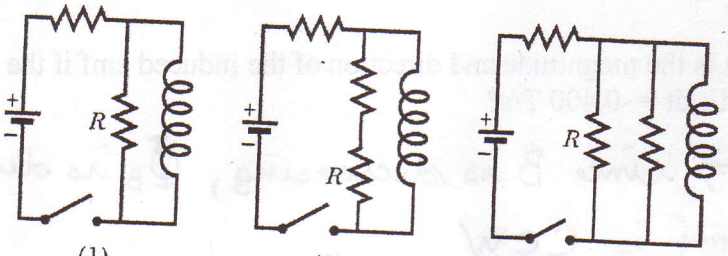
Lab (circle one): 8:00 am 11:15 am 2:45 pm

Quiz #8: Induction and Inductance

Problem 1 (2 points)
The figure below shows three circuits with identical batteries, inductors, and resistors. In each circuit, the switch has been closed for a *very long time*. Rank the circuits according to the current through the resistor labeled R (a) immediately after the switch is reopened, and (b) a long time after the switch is reopened, greatest first.

3

1) (a) 1 > 2 > 3 (b) all tie
2) (a) 1 = 3 > 2 (b) all tie
3) (a) 1 = 2 > 3 (b) all tie
4) (a) 1 > 2 > 3 (b) 1 = 3, 2
5) none of the above



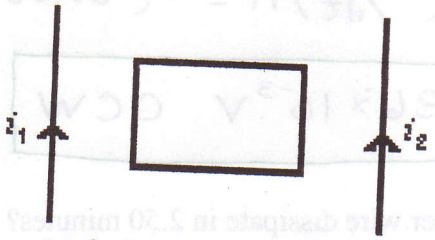
(1) (2) (3)

Problem 2 (2 points)
A rectangular loop of wire is placed midway between two long straight parallel wires as shown. The wires carry currents i_1 and i_2 as indicated. What is the direction of the induced current (if any) in the rectangular loop if (a) i_1 is increasing and i_2 is constant, (b) both i_1 and i_2 are decreasing at the same rate?

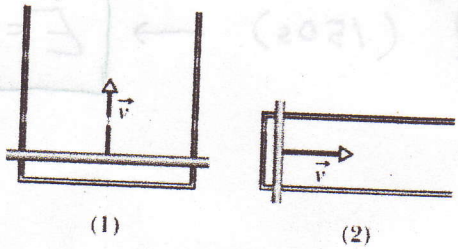
a) CCW

b) no induced current

↳ flux through loop is zero



Problem 3 (2 points)
The figure below shows two circuits in which a conducting bar is slid at the same speed v through the same uniform magnetic field and along a U-shaped wire. The parallel lengths of the wire are separated by 2L in circuit 1 and by L in circuit 2. The current induced in circuit 1 is clockwise. (a) Is the direction of the magnetic field into or out of the page? (b) Is the emf induced in circuit 1 larger than, smaller than, or the same as that in circuit 2?



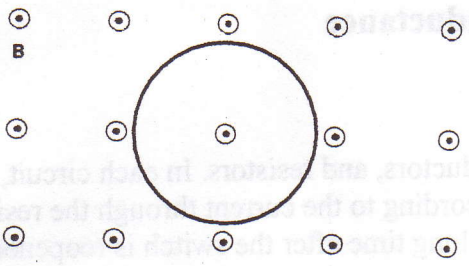
(1) (2)

a) out of page

b) larger than

↳ Φ_B is changed more because area is changing more

Problem 4 (4 points)
A copper wire with resistance R = 2.50 Ω and length 32.5 cm is formed into a circular loop and placed in a uniform magnetic field pointing out of the page as shown below.



$C = 2\pi r = 0.325\ m$

$r = 0.0517\ m$

a) What is the magnitude and direction of the induced emf if the magnitude of the magnetic field decreases at a rate of dB/dt = -0.400 T/s?

⇒ since B is decreasing, Φ_B is decreasing so the induced emf is CCW

$\mathcal{E} = -N\, d\Phi_B/dt \qquad N = 1 \qquad \Phi = BA \qquad A = \pi r^2$

$\mathcal{E} = -d/dt\,(BA) = -(dB/dt)\,A = -(-0.400\ T/s)\,\pi\,(0.0517\ m)^2$

$$\boxed{\mathcal{E} = 3.36 \times 10^{-3}\ V \quad CCW}$$

b) How much energy will the copper wire dissipate in 2.50 minutes?

$P = E/t \rightarrow E = Pt \qquad P = \mathcal{E}^2/R$ for resistor

$E = (\mathcal{E}^2/R)\,t$

$$E = \frac{(3.36 \times 10^{-3}\ V)^2}{2.50\ \Omega}\,(150\ s) \rightarrow \boxed{E = 6.73 \times 10^{-4}\ J}$$