Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Section \_\_\_\_\_\_\_ **P212: Quiz for Week 10**

The circuit shown below consists of a 9 V battery, three resistors, an ideal inductor and a switch. Assume that the switch has been open for a long time.

*E*

## L

# *R1*

## 9 V

# *R*2

# *R*3

# *I1*

# *I3*

R1 = 30 Ω

R2 = 100 Ω

R3 = 150 Ω

L = 0.02 H

1). The switch is now closed at *t* = 0. Immediately afterwards, what is the current I3 flowing through resistor R3? [5]

At t=0, no current flows through the inductor. So all the current flows through R1 and R3. The current through R3 is therefore:

I = V/R13 = V/(R1+R3) = (9V)/(30+150 ohms)

**I = 50 mA**

(2) Understanding that no current flows through inductor at t=0

(2) Correct set-up of problem

(1) Correct numerical answer

2). A very long time after the switch has been closed, what is the voltage drop across the inductor? [3]

After a long time, the current through inductor has stabilized, so dI/dt = 0. Therefore:

**ΔVL = L dI/dt = 0**

(2) Understanding that current stabilizes after a long time, so that dI/dt = 0

(1) Correct numerical answer

3). A very long time after the switch has been closed, what is the current I1 through R1? [7]

After a very long time, the inductor offers no resistance to current flow because the current has stabilized. So what we need to do is find the total resistance of the circuit by adding up the individual resistors, then solve for I = V/Rtot.

R2 and R3 add in parallel to give:

R23 = R2R3/(R2+R3) = (100\*150)/(100+150) = 60 ohms

Then R1 adds in series with R23 to give:

Rtot = R1+R23 = 30+60 = 90 ohms

I = V/Rtot = (9 V)/(90 ohms)

**I = 100 mA**

(3) Realizing that inductor offers no resistance to current after a long time

(2) Correctly adding individual resistors to get total circuit resistance

(2) Correct numerical answer

4). The switch is now suddenly opened. How long after opening the switch does it take for the current through the inductor to reach 1/e of its value just before the switch is opened? [5]

The time constant is L/Rtot, so we just need to find Rtot.

R2 and R3 add in series to give Rtot=100+150 ohms = 250 ohms.

Time constant 𝝉 = L/Rtot = 0.02 H / 250 ohms

**τ𝝉** **= 80 μs**

(2) Understanding that 𝝉 = L/Rtot

(2) Correct calculation of Rtot

(1) Correct numerical answer