PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2013

College of Sciences

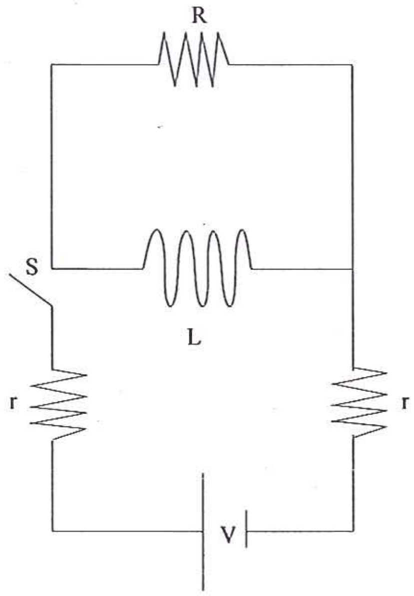
Section 3 Quiz 11 09 May 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

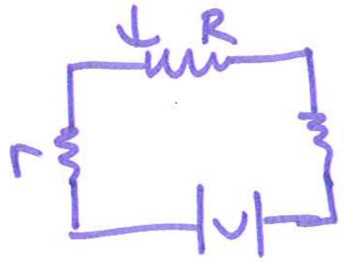
Name: **Student ID:** **Signature:**

The switch S is closed at time t = 0. What is the power dissipated through the resistor R just after t = 0? What is the maximum energy that can be stored in such a circuit?

(Corrected)



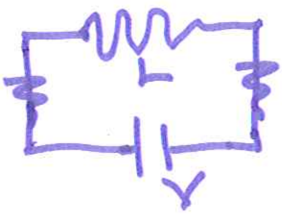
Just after $t=0$, $i_L(0)=0$. So $i_R = \frac{V}{R_{eq}} = \frac{V}{2r+R}$



$\rightarrow P_R = i^2R = \left(\frac{V}{2r+R}\right)^2 \cdot R$

B) $i_{(max)L} \Rightarrow$ when R has no current through it. $\leftarrow$ (as $t \to \infty$)

$i_{(max)L} = \frac{V}{2r}$



B) $U_{max} = \frac{1}{2} L i_{L(max)}^2$

$= \left(\frac{V}{2r}\right)^2 L \cdot \frac{1}{2} = \frac{V^2L}{8r}$

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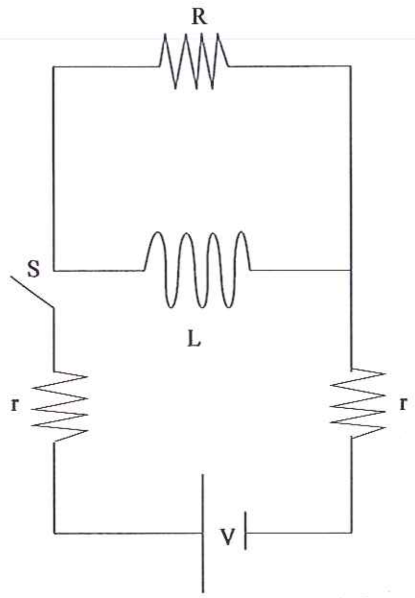
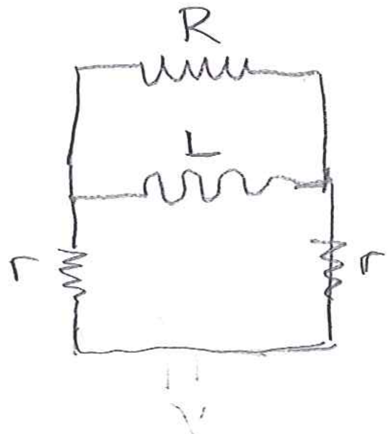
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

The switch S is closed at time t = 0. Find the time constant of this circuit. Explain your reasoning.

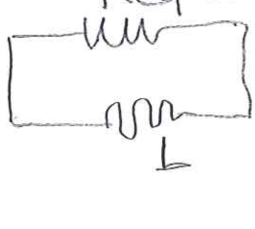


The switch S is closed at $t=0$.
The discharging and charging LC circuit should have the same time constant, Since it is easier to see the time constant from a discharging LC circuit we'll work equivalently work on:



$\equiv$

$$R_{eq} = \frac{2Rr}{R+2r}$$



$$\Rightarrow \tau = \frac{L}{R_{eq}} = \frac{L(R+2r)}{2Rr}$$

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Section **Quiz 11** **09 May 2013**

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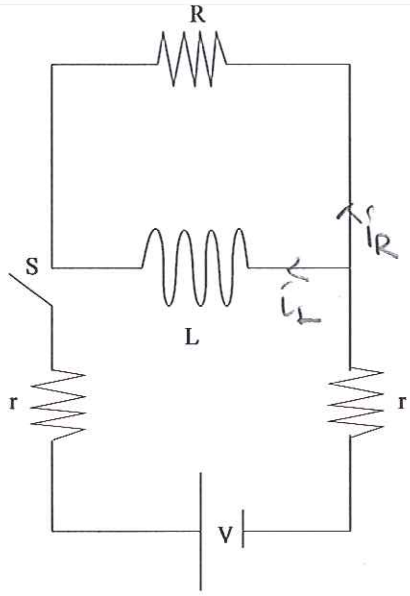
Quiz duration: 10 minutes

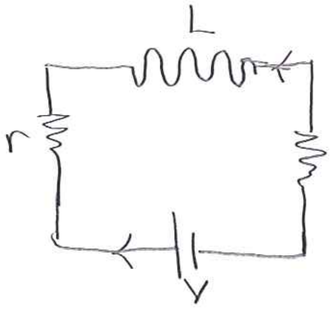
Name: **Student ID:** **Signature:**

Suppose the switch S is closed for a long time and the equilibrium is reached. Then, all of a sudden, if the switch S is reopened at time t = 0, find the power dissipated through the resistor R as a function of time.



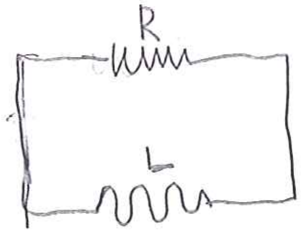
When switch S is closed for a long time $i_R \to 0$.

(L is short circuit)



$$i = \frac{V}{2r}$$

After S is opened at time $t=0$



$$i(t) = i_0 e^{-t/\tau} \qquad \tau = \frac{L}{R}$$

$$i_0 = \frac{V}{2r} = i$$

$$\Rightarrow P_R = i^2(t)R = \left(\frac{V}{2r}\right)^2 R e^{-t/\tau}$$

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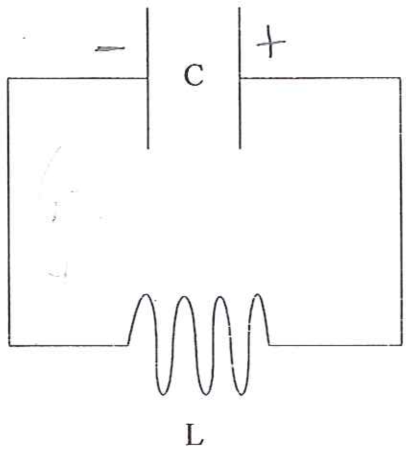
Section 2 **Quiz 11** **09 May 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Consider the LC circuit shown in the figure. If the charge on the left plate of the capacitor is known to be $q = -Q_{max}/2$ and decreasing at time t = 0, find expressions for the charge on the left plate and current as a function of time. Here, Q_{max} is the maximum charge the capacitor can have in such a circuit.



$dq < 0$ on left plate
(C is charging)
(negativeness increases)

$q = Q_{max}\cos(\omega t + \phi)$, $\omega = \frac{1}{\sqrt{LC}}$

$q(0) = Q_{max}\cos\phi = -Q_{max}/2$

$\cos(\phi) = -1/2$

$\phi = \frac{2\pi}{3}$ or $\frac{4\pi}{3} = -\frac{2\pi}{3}$

$q = Q_{max}\cos\left(\omega t \pm \frac{2\pi}{3}\right)$ since $dq<0$

$\equiv$ the solution should decrease w.r.t. $t>0$

$\Rightarrow \phi = +\frac{2\pi}{3}$

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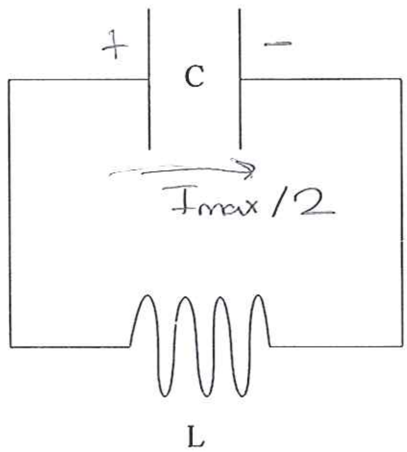
Section 4 Quiz 11 09 May 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Consider the LC circuit shown in the figure. If the current $i = I_{max}/2$ is known to flow in the clockwise direction and the charge on the left plate is known to be positive at time t = 0, find expressions for the current and charge on the right plate of the capacitor as a function of time. Here, I_{max} is the maximum current in such a circuit.

charge at right plate <0 at time $t=0$



$q(t) = Q_{max} \cos(\omega t + \phi)$

$i(t) = -Q_{max}\,\omega \sin(\omega t + \phi) = I_{max} \sin(\omega t + \phi)$

$q(0) = Q_{max} \cos(\phi) < 0$

$i(0) = I_{max} \sin(\phi) = \frac{I_{max}}{2}$

$\Rightarrow \sin\phi = \frac{1}{2} \Rightarrow \phi = \frac{\pi}{6}$ or $\pi - \frac{\pi}{6}$

$= -\frac{I_{max}}{\omega}$

$dq > 0,\ i > 0$

$\phi = \pi - \frac{\pi}{6} = \frac{5\pi}{6} \Rightarrow q(t) = Q_{max} \cos\left(\omega t + \frac{5\pi}{6}\right)$

$i(t) = I_{max} \sin\left(\omega t + \frac{5\pi}{6}\right)$

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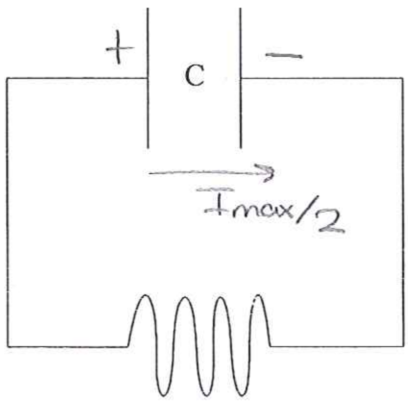
Section 5 **Quiz 11** **09 May 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Consider the LC circuit shown in the figure. If the current $i = I_{max}/2$ is known to flow in the clockwise direction and the charge on the left plate is known to be positive at time t = T/2 where T is the period of an LC circuit, find expressions for the current and charge on the right plate of the capacitor as a function of time. Here, I_{max} is the maximum current in such a circuit.



→ discharging

$q(t) = Q_{max}\cos(\omega t + \phi)$ (on the right plate of capacitor)

$i(t) := \frac{dq}{dt} = -\omega Q_{max}\sin(\omega t + \phi)$

$T = \frac{2\pi}{\omega} \Rightarrow \frac{T}{2} = \frac{\pi}{\omega}$, $I_{max} = -\omega Q_{max}$

$i\left(\frac{T}{2}\right) = -\omega Q_{max}\sin\left(\omega\frac{\pi}{\omega} + \phi\right) = \frac{I_{max}}{2} \Rightarrow \sin(\pi + \phi) = \frac{1}{2}$

$\Rightarrow \phi = -\frac{\pi}{6}$ or $\frac{\pi}{6} - \pi$

$\Rightarrow$ Since $dq > 0$ (negativeness on right plate decreases)

$i > 0 \Rightarrow i(t) = I_{max}\sin\left(\omega t - \frac{5\pi}{6}\right)$

$q(t) = -\frac{I_{max}}{\omega}\cos\left(\omega t - \frac{5\pi}{6}\right)$