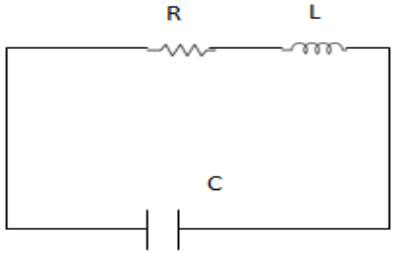
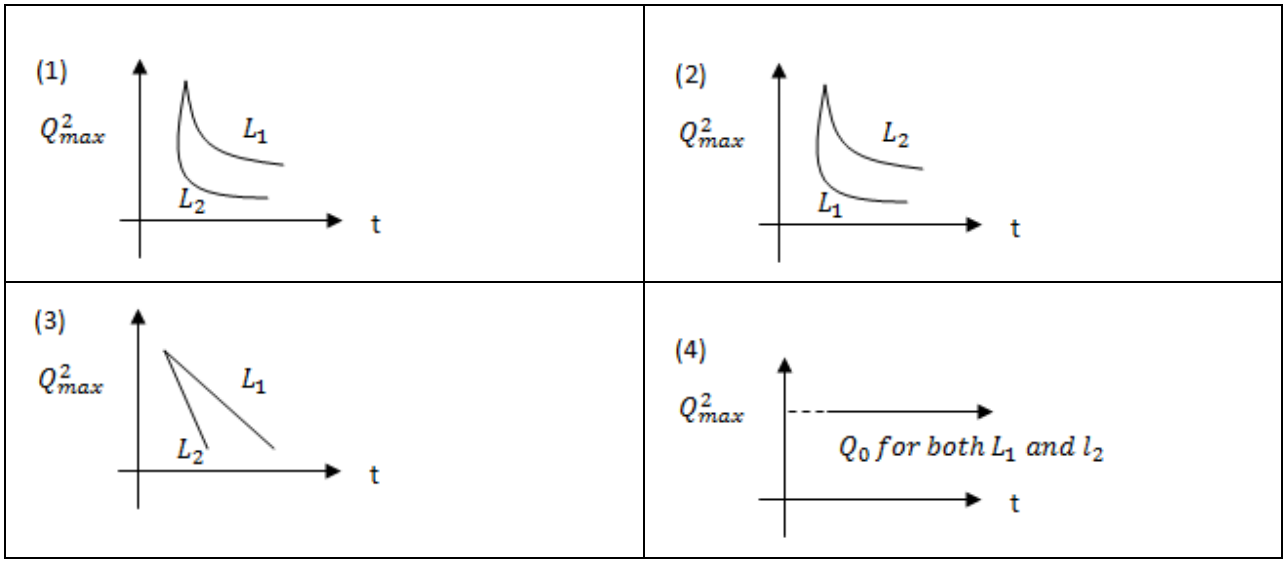
30. An LCR circuit is equivalent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown below:



If a student plots graphs of the square of maximum charge (Q^2_{Max}) on the capacitor with time (t) for two different values L_1 and L_2 ($L_1 > L_2$) of L then which of the following represents this graph correctly? (Plots are schematic and not drawn to scale)



Answer: For discharge of capacitor through inductance and resistance (LCR circuit) emf equation

$\frac{q}{c} = iR + L\frac{di}{dt} \rightarrow (1)\ i = \frac{dq}{dt}\ therefore\ \frac{q}{c} = R\frac{dq}{dt} + L\frac{d^2q}{dt^2} \rightarrow (1)$

$for\ maximum\ value\ of\ q = Q_{max}\ , \frac{dq}{dt} = 0$

$or\ \frac{Q_{max}}{C} = L\frac{d^2Q_{max}}{dt^2}$ Solving differential equation we get

$Q_{max} = Q_0\, e^{-\frac{t}{\sqrt{LC}}}$ therefore if $(Q_{max})_{L_1} = \frac{Q_0}{e^{\frac{t}{\sqrt{L_1C}}}}\ also\ (Q_{max})_{L_2} = \frac{Q_0}{e^{\frac{t}{\sqrt{L_2C}}}}$

Since $L_1 > L_2$ therefore $(Q_{max})_{L_1} > (Q_{max})_{L_2}$.

Correct Option is (1)