Analog assignment

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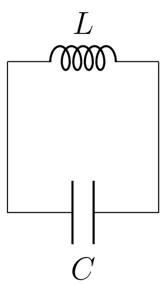
1 Problem 12.7.8

A charged 30 µF capacitor is connected to a 27 mH inductor. Suppose the initial charge on the capacitor is 6mC.What is the total energy stored in the circuit initially? What is the total energy at later time?

Given,
initial charge on capacitor is 6mC.



Quantity	Meaning	Value
q	Initial charge on capacitor	6mC
L	Value of inductance	27mH
C	Value of capacitance	$30\mu F$

Table 1: Given data

Total energy stored initially=Work done to bring the charge of 6mC to capacitor from infinity.

We know that , where A is some point in space.

$$V_A = \frac{W_{\infty\to A}}{q}$$

Here ,

$$q = Quantity\,of\,charge\,brought\,from\,infinity\,to A$$
$$V_A = Electric\,potential\,at\,some\,point\,A$$

So,

$$dW = V.dq$$

Equation of a capacitor is ,

$$q = CV$$

From this V can be replaced by ,

$$V = \frac{q}{C}$$

So,

$$dW = \frac{q}{C}.dq$$

Now,integrate on both sides

$$\int_0^W dW = \int_0^6 \frac{q}{C} dq$$

Note: Here the units of charge is milli-coulombs(mC)

$$W = \frac{q^2}{2C}\bigg|_0^6$$

Given,

$$C = 30\mu F$$

Hence,

$$W = \frac{36 * 10^{-6}}{2 * 30 * 10^{-6}}$$

Hence, after simplification

$$W = \frac{18}{30}J = \frac{3}{5}J = 0.6J$$

So, 0.6 J is the total energy initially stored in the circuit.If we assume that there is no loss of energy from both capacitor and inductor i.e, they are both ideal then we can conclude that total energy in the circuit at a later time is also 0.6 J .