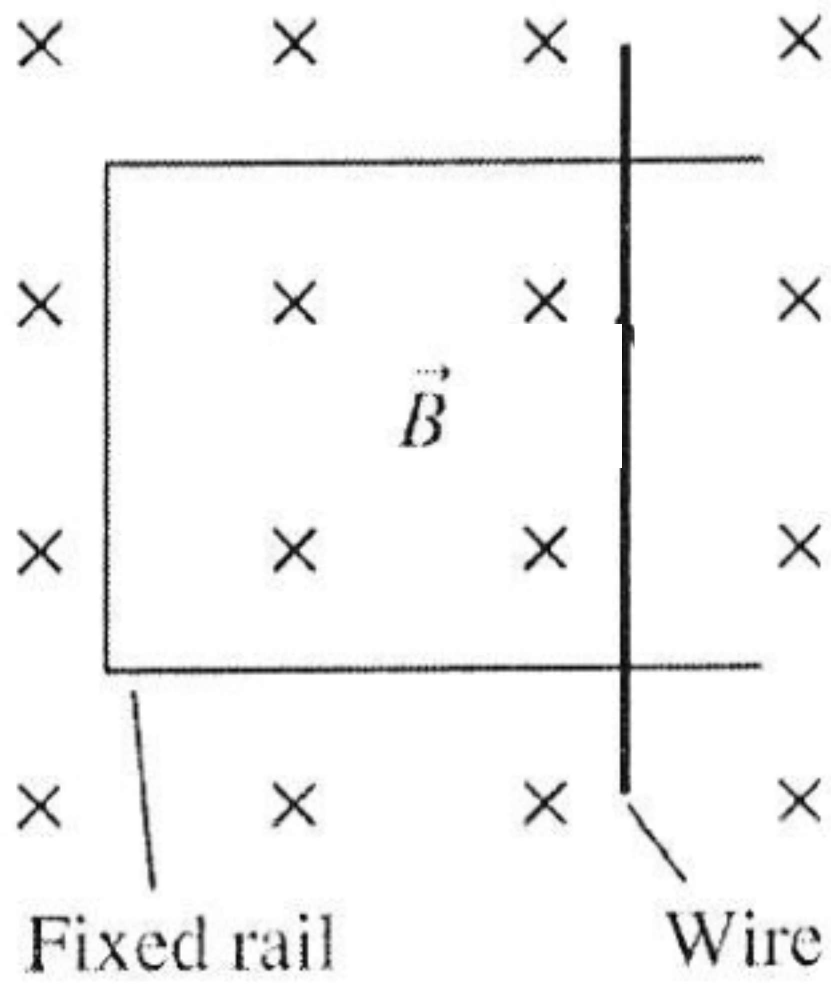

PH 220
Lance Nelson

Question #1

If the magnetic field is increasing in strength, does the wire:

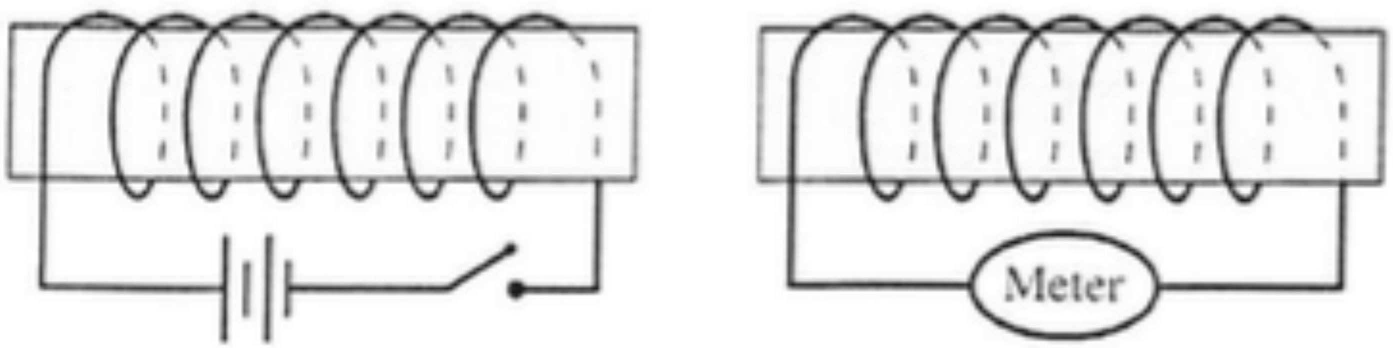
a) remain in place?
b) move to the left?
c) move to the right?
d) move up the page?
e) move down the page?



Question #2

Just after the switch on the left coil is closed, does the current flow right to left or left to right through the current meter of the right coil?

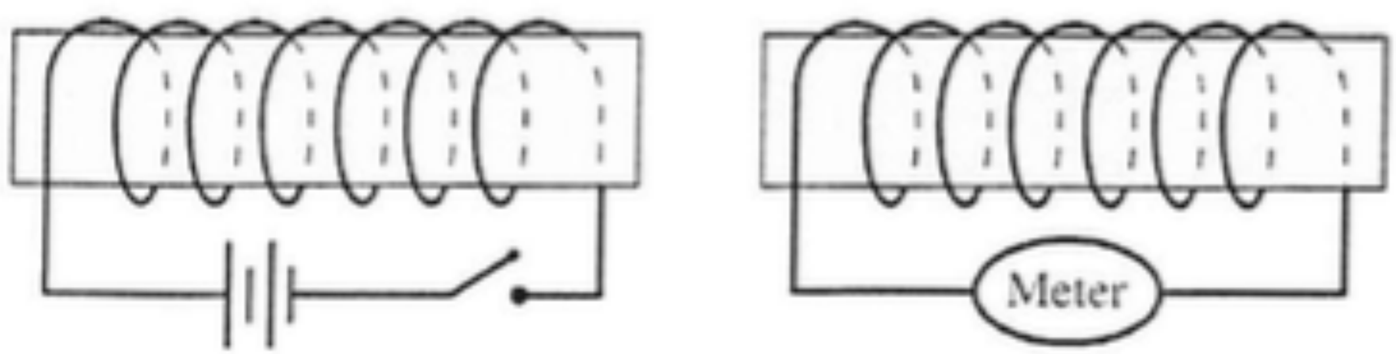
a) right to left
b) left to right



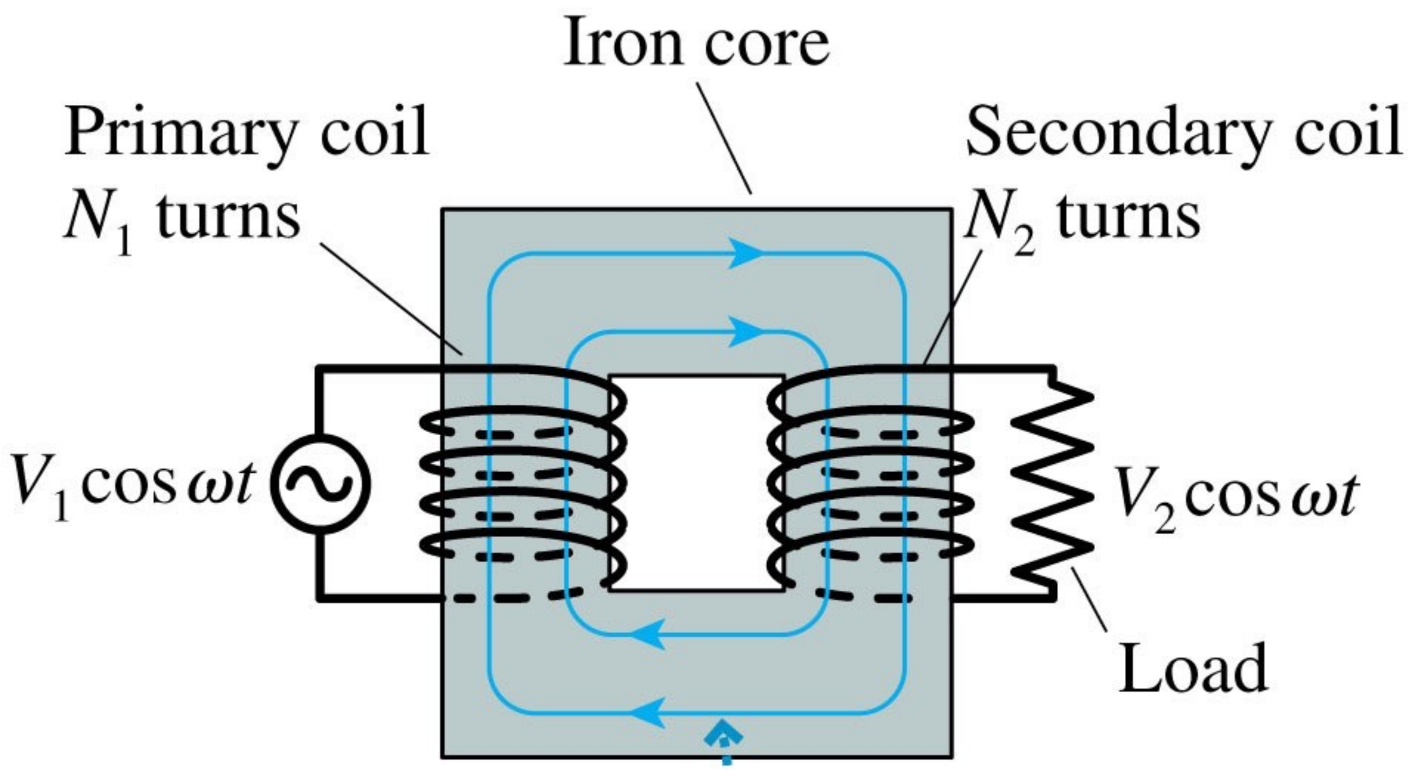
Question #2

Just after the switch on the left coil is closed, does the current flow right to left or left to right through the current meter of the right coil?

a) right to left
b) left to right



Long after the switch on the left coil is closed, does the current flow right to left or left to right through the current meter of the right coil?

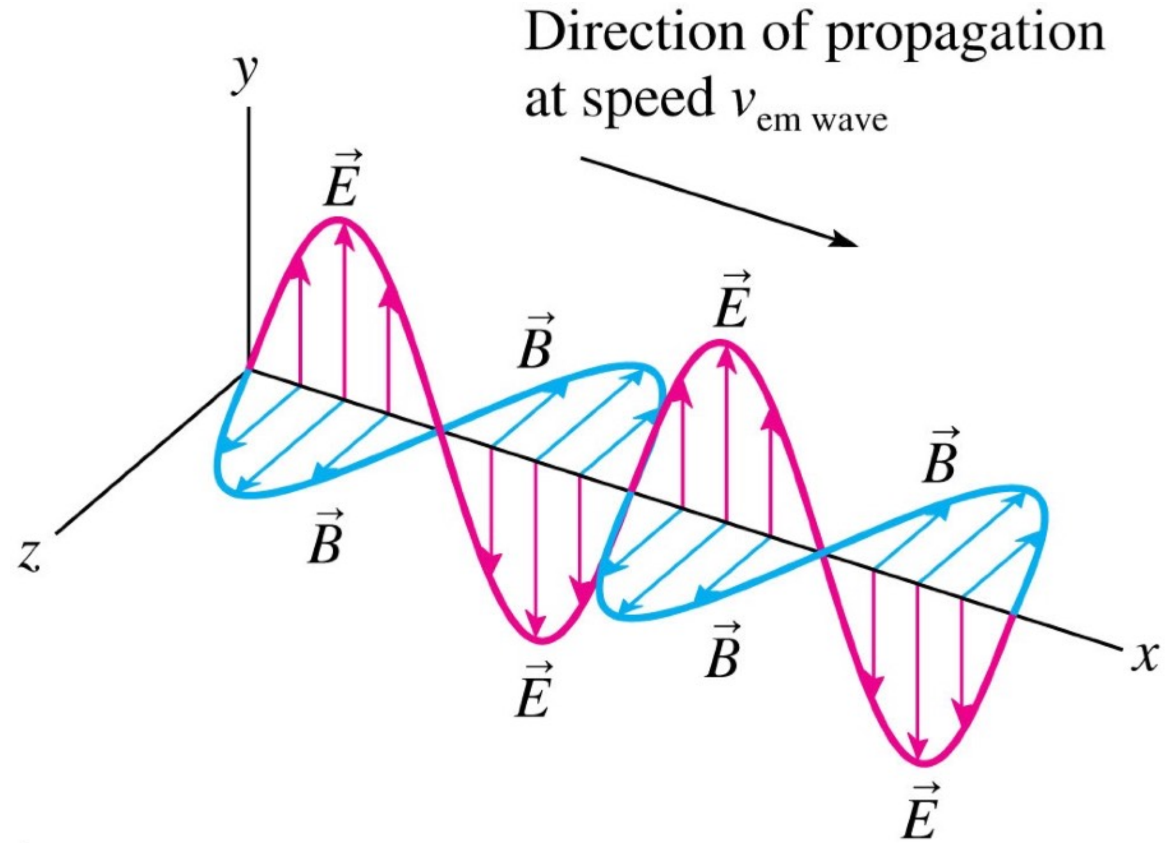


$$\frac{\Phi_2}{N_2} = \frac{\Phi_1}{N_1}$$

$$\Phi_2 = \Phi_1 \frac{N_2}{N_1}$$

$$V_2 = \frac{N_2}{N_1} V_1$$

E-M waves



$$v_{\text{em wave}} = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

Inductors

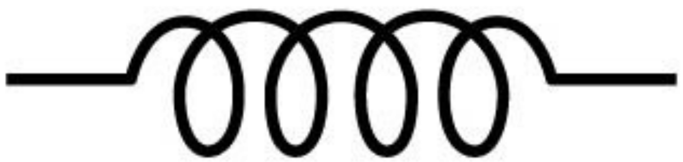
a. Capacitors store energy in the form of an electric field.
b. Resistors dissipate thermal energy.
c. Inductors store energy in the form of a magnetic field.

Inductance

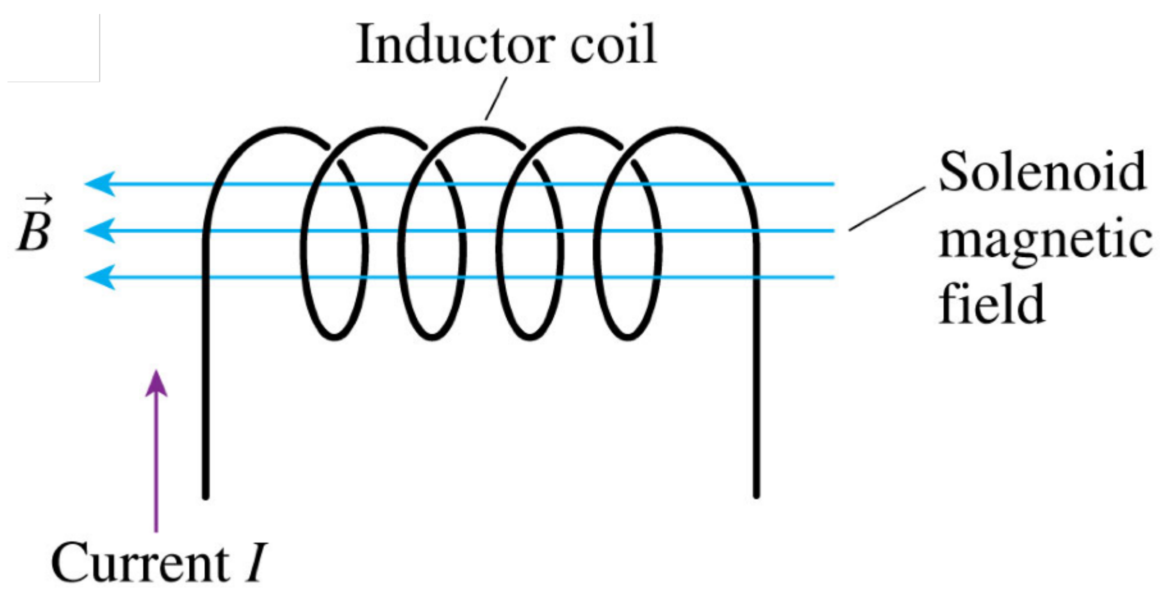
$$L_{\text{solenoid}} = \frac{\Phi_{\text{m}}}{I} = \frac{\mu_0 N^2 A}{l}$$

- The SI unit of inductance is the henry, defined as:

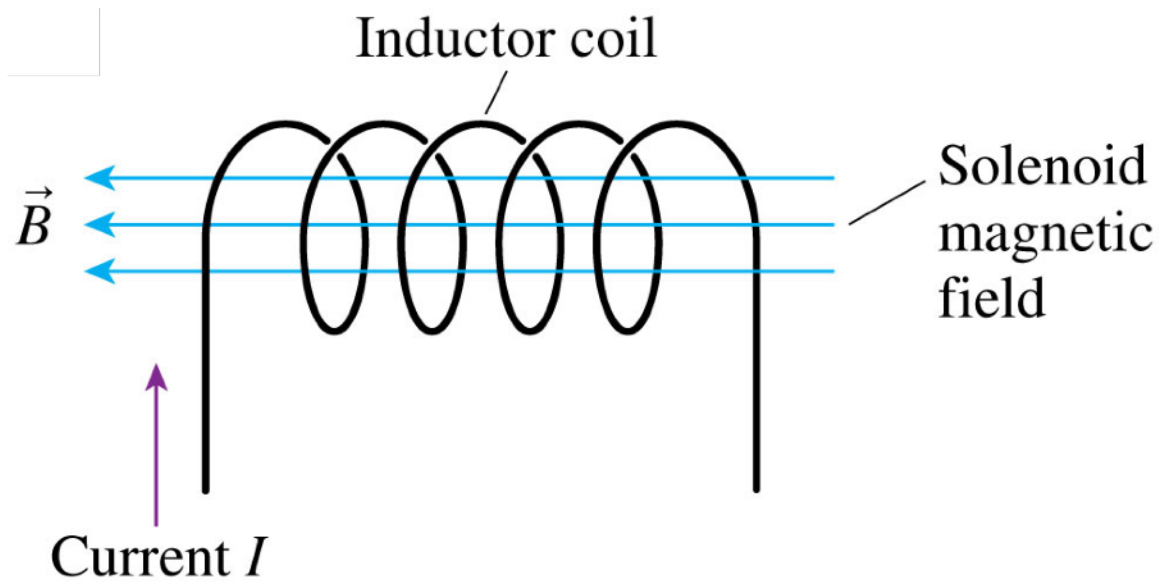
  1 henry = 1 H = 1 Wb/A = 1 T m2/A



Inductors

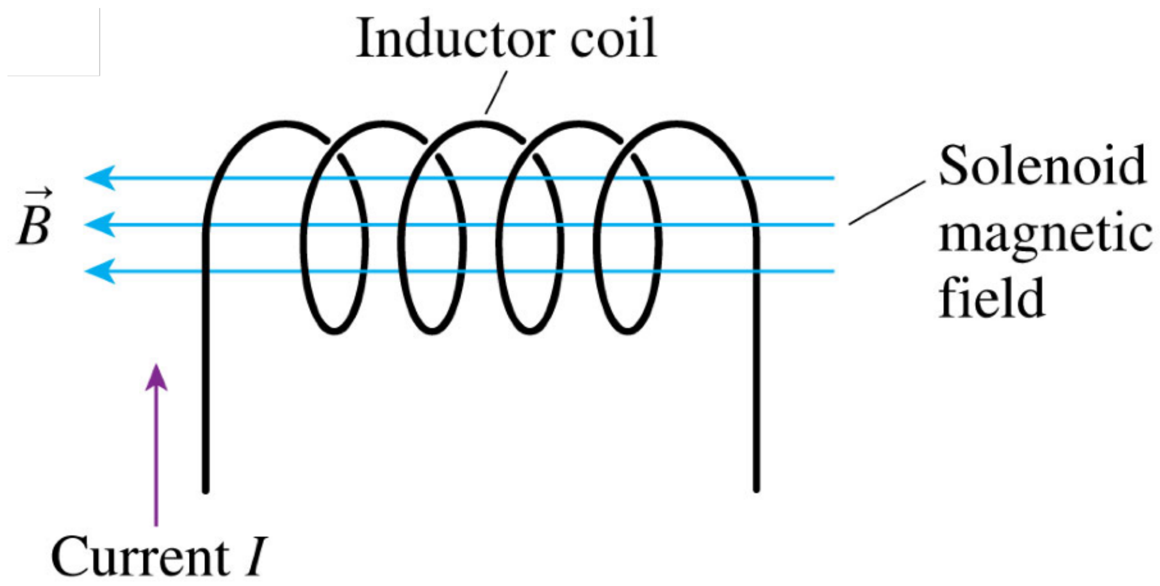


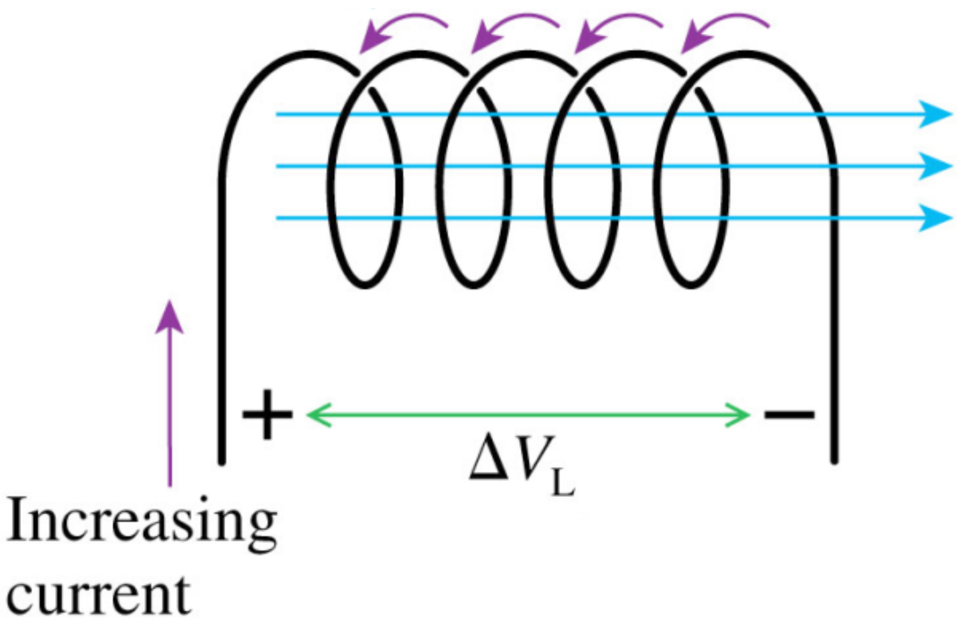
Inductors



What if I steadily increase the current? What will happen?

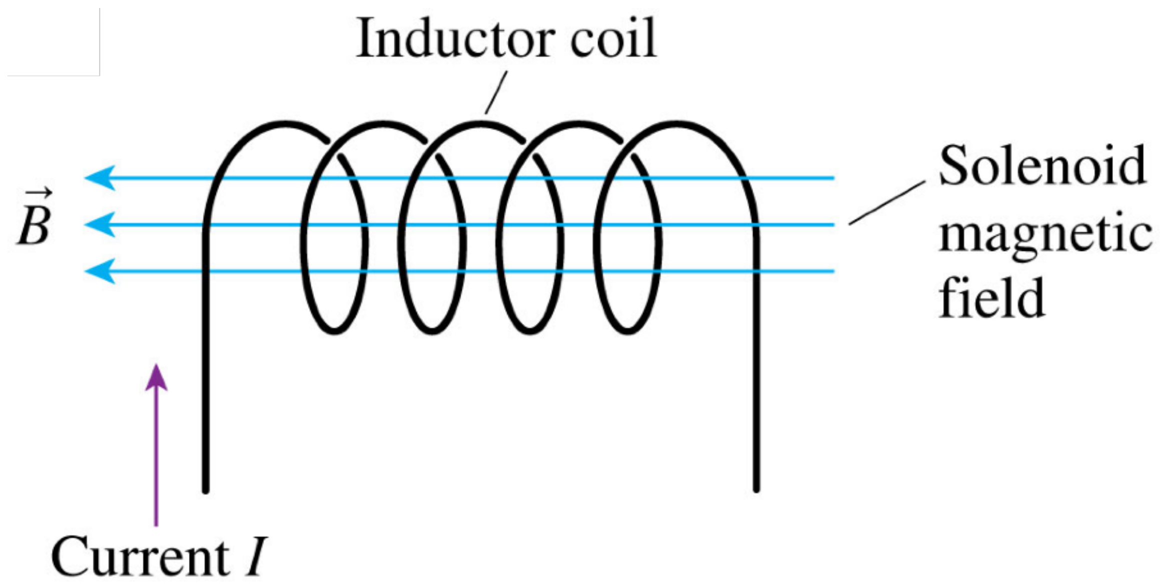
Inductors

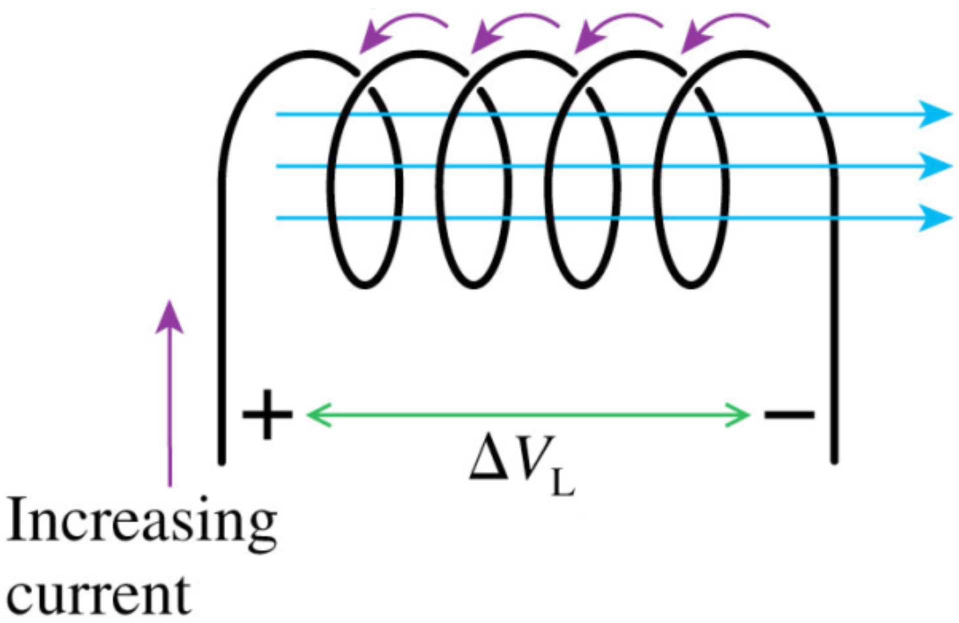




What if I steadily increase the current? What will happen?

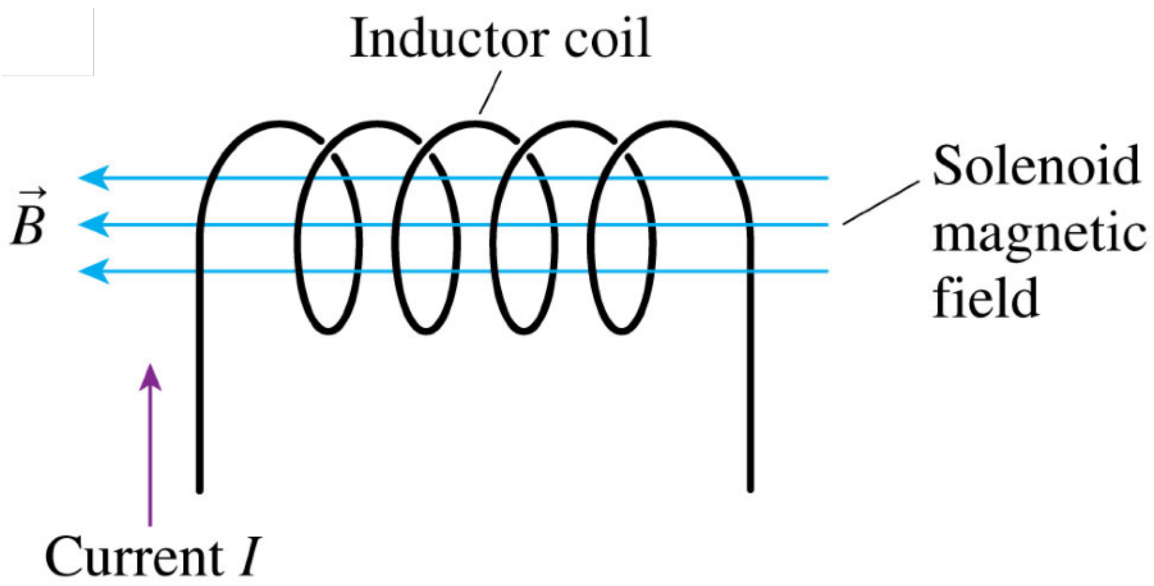
Inductors

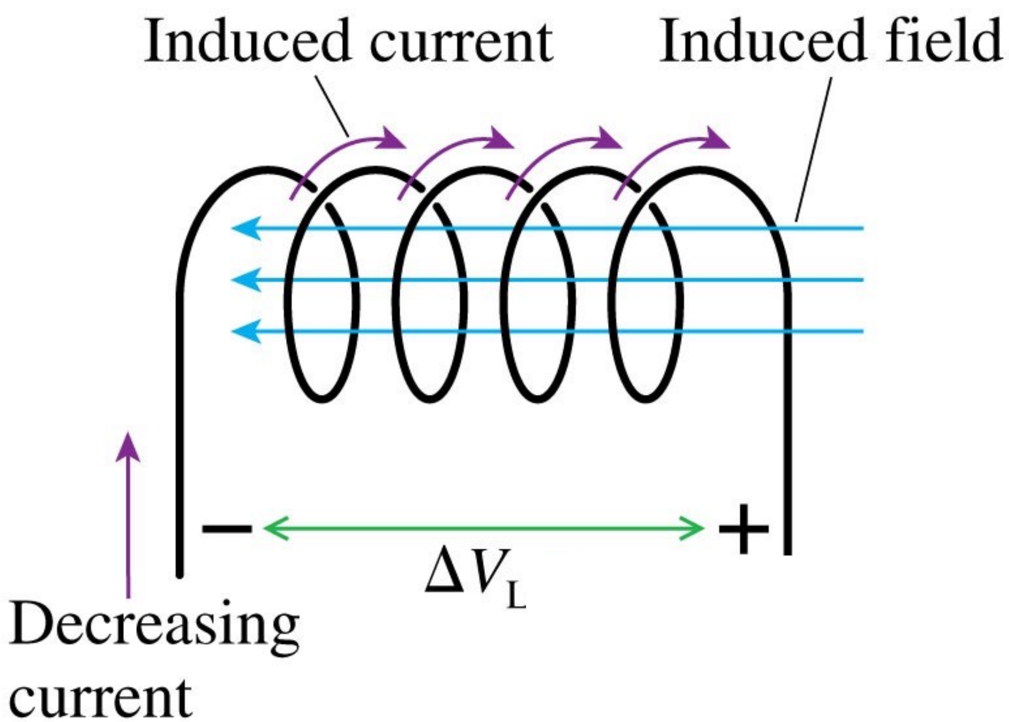




What if I steadily decrease the current? What will happen?

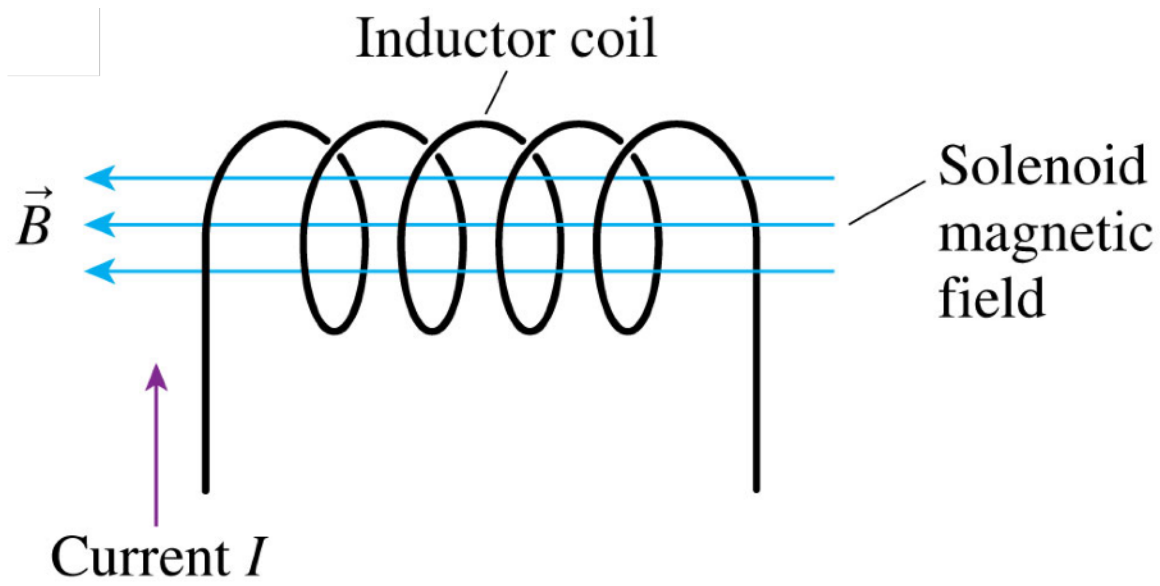
Inductors

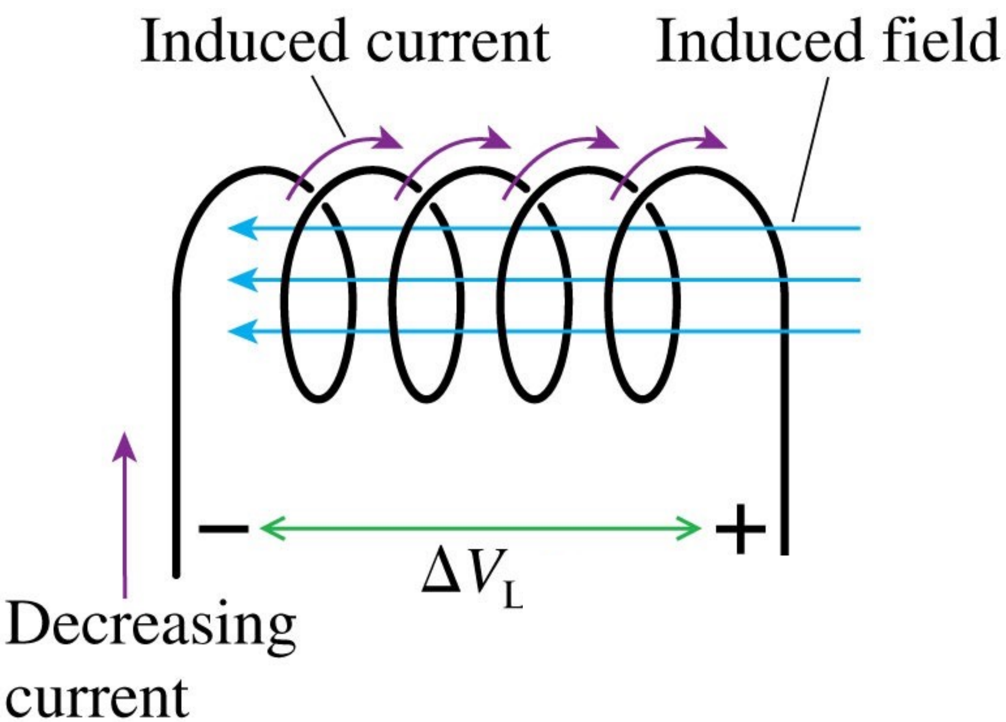




What if I steadily decrease the current? What will happen?

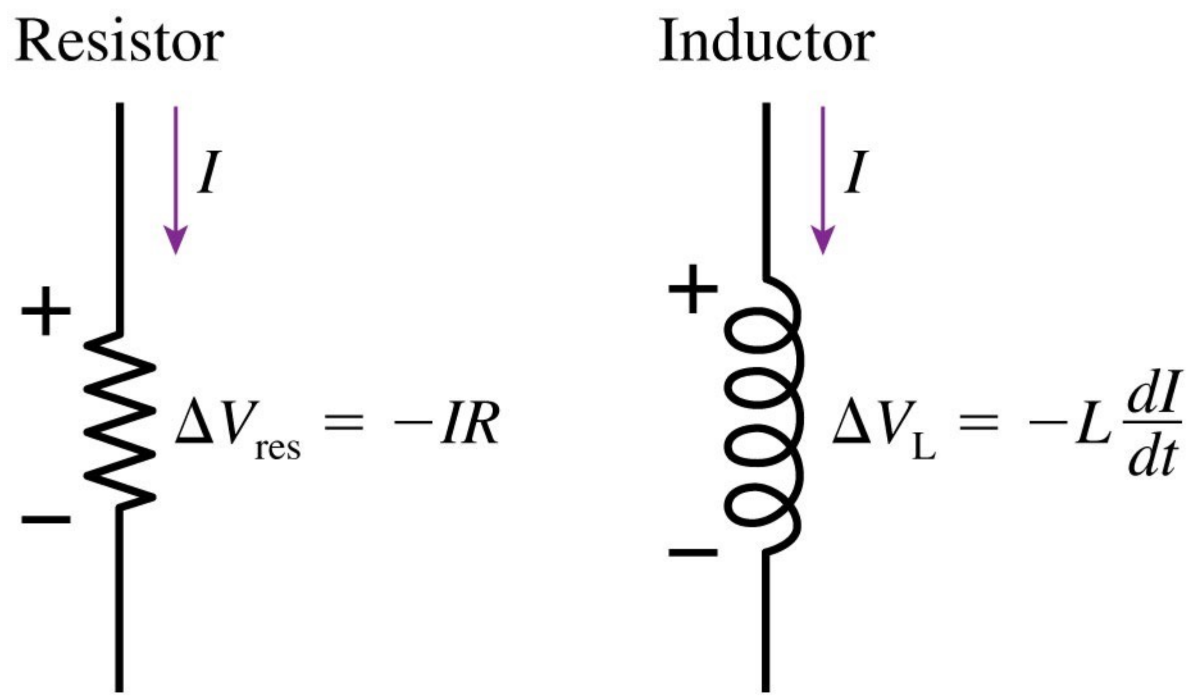
Inductors





What if I steadily decrease the current? What will happen?

$$\Delta V_L = -L\frac{dI}{dt}$$



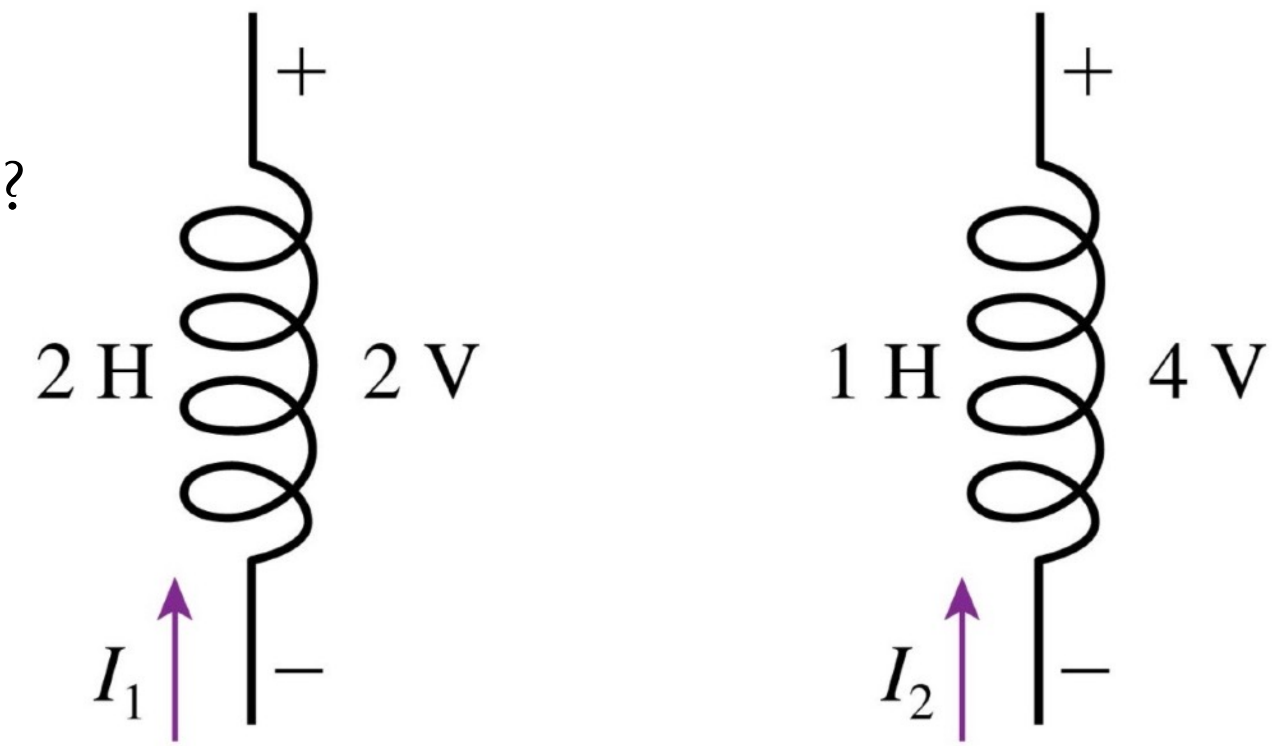
The potential always decreases.

The potential decreases if the current is increasing.

The potential increases if the current is decreasing.

Question #3

Which current is changing more rapidly?



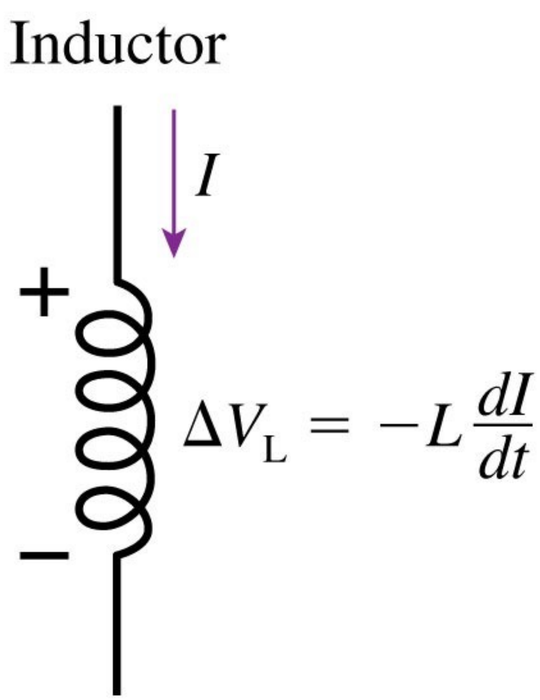
B. They are changing at the same rate.

C. Current I_1.

D. Current I_2.

$$P = \frac{dU}{dt} = I\Delta V$$

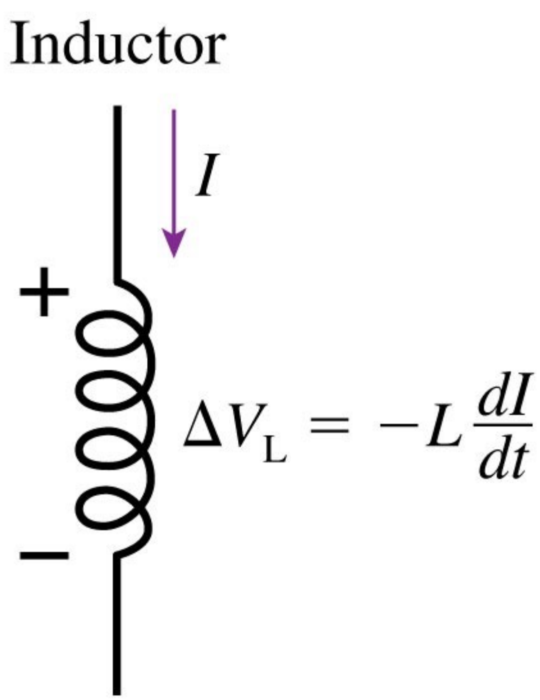
Substitute in what we just learned for voltage across an inductor



$$\frac{dU_L}{dt} =$$

$$P = \frac{dU}{dt} = I\Delta V$$

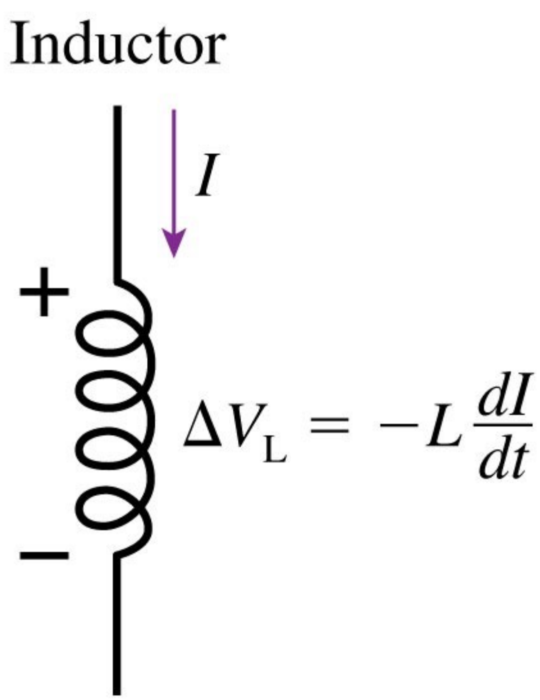
Substitute in what we just learned for voltage across an inductor



$$\frac{dU_L}{dt} = +LI\frac{dI}{dt}$$

$$P = \frac{dU}{dt} = I\Delta V$$

Substitute in what we just learned for voltage across an inductor

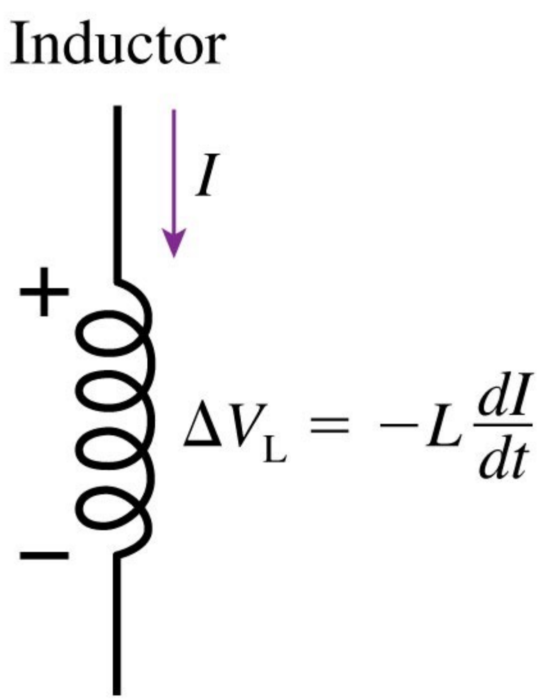


$$\frac{dU_L}{dt} = +LI\frac{dI}{dt}$$

Integrate both sides to find the energy stored in an inductor.

$$P = \frac{dU}{dt} = I\Delta V$$

Substitute in what we just learned for voltage across an inductor

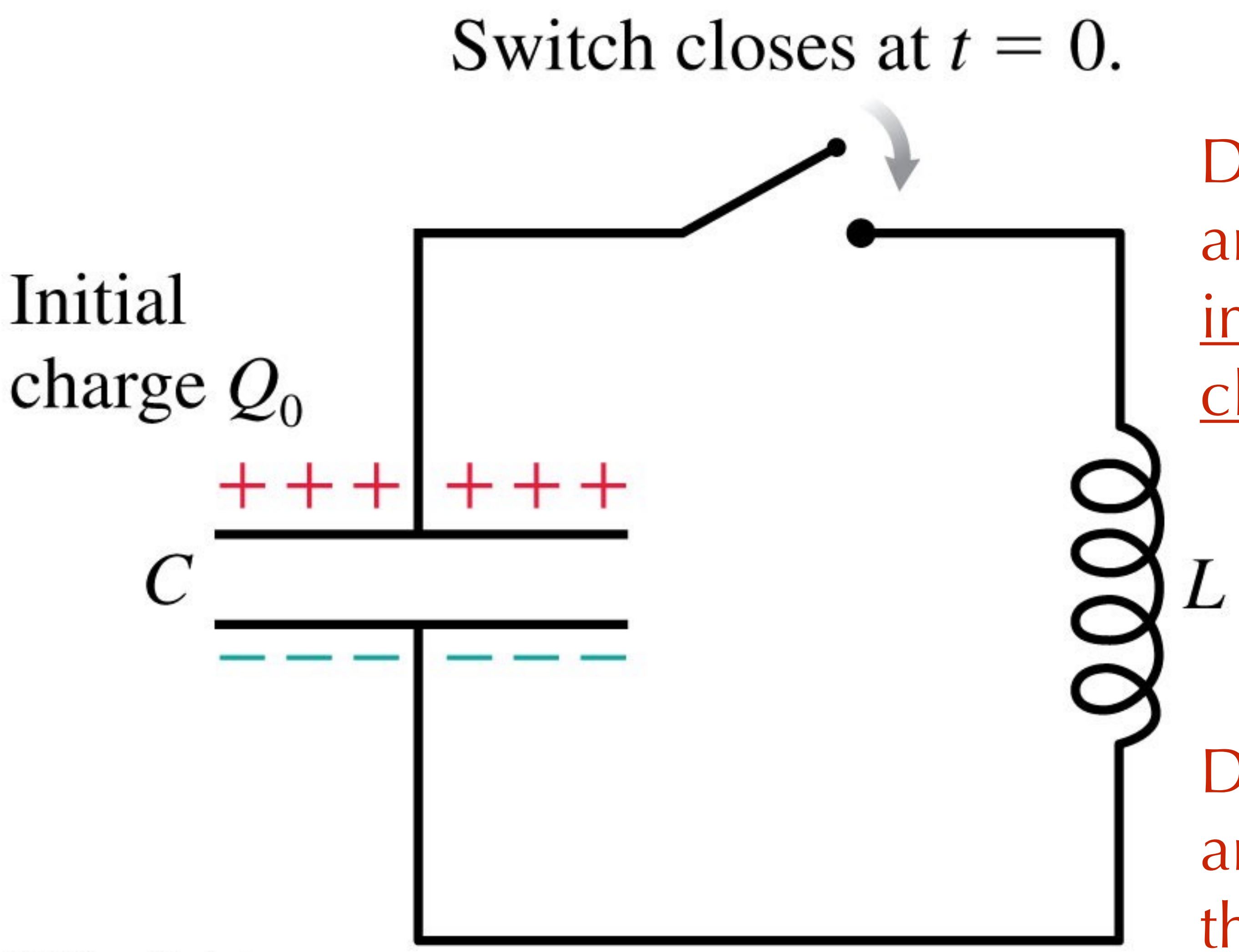


$$\frac{dU_L}{dt} = +LI\frac{dI}{dt}$$

Integrate both sides to find the energy stored in an inductor.

$$U_L = L\int_0^I I\,dI = \frac{1}{2}LI^2$$

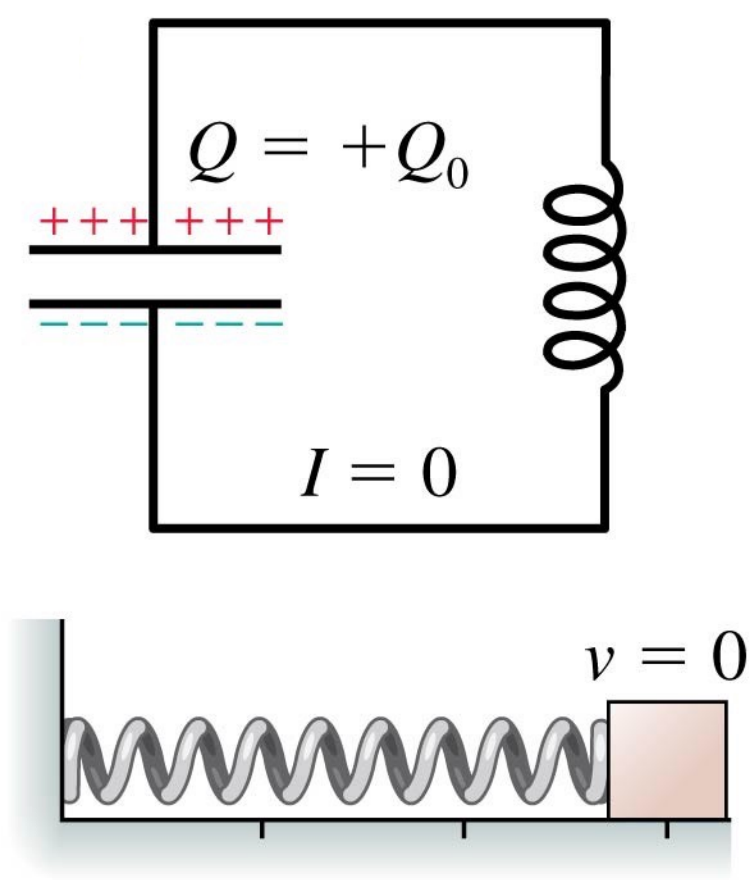
LC circuits



Describe the current in the circuit and voltages across each element <u>immediately after the switch is closed</u>.

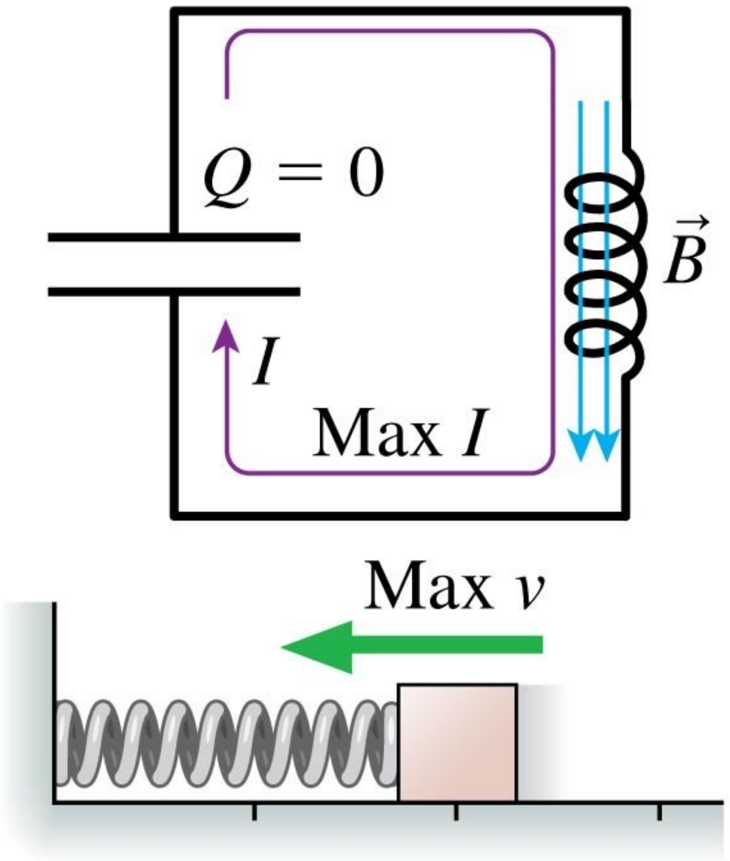
Describe the current in the circuit and voltages across each element <u>at the moment when the capacitor has no charge on it</u>.

An analogy



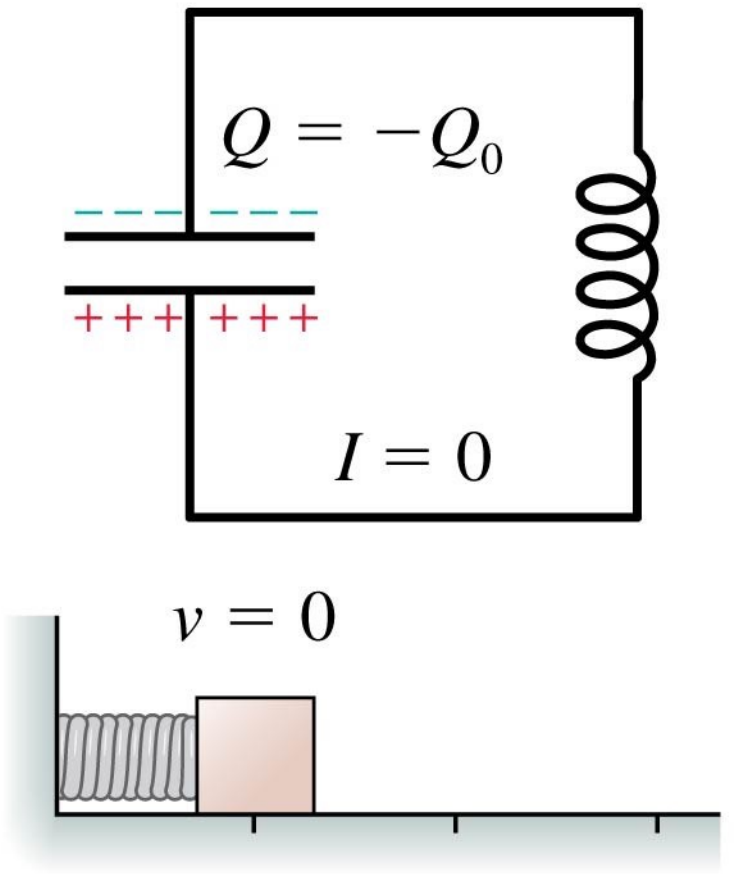
Maximum capacitor charge is
like a fully stretched spring.

An analogy

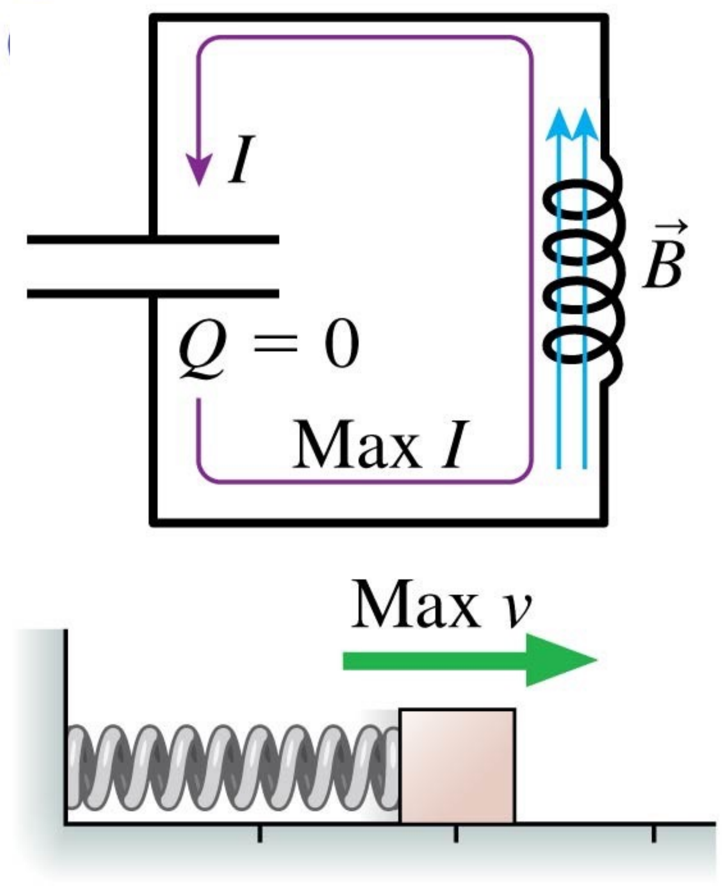


Maximum current is like the block having maximum speed.

An analogy



An analogy



Now the math…

$$\Delta V_C + \Delta V_L = 0$$

Now the math…

$$\Delta V_C + \Delta V_L = 0$$

$$\frac{Q}{C} - L\frac{dI}{dt} = 0$$

Now the math…

$$\Delta V_C + \Delta V_L = 0$$

$$\frac{Q}{C} - L\frac{dI}{dt} = 0$$

$$I = -\frac{dQ}{dt}$$

Now the math...

$$\Delta V_C + \Delta V_L = 0$$

$$\frac{Q}{C} - L\frac{dI}{dt} = 0$$

$$I = -\frac{dQ}{dt}$$

$$\frac{Q}{C} - L\frac{d}{dt}(-\frac{dQ}{dt}) = 0$$

Now the math…

$$\Delta V_C + \Delta V_L = 0$$

$$\frac{Q}{C} - L\frac{dI}{dt} = 0$$

$$I = -\frac{dQ}{dt}$$

$$\frac{Q}{C} - L\frac{d}{dt}(-\frac{dQ}{dt}) = 0$$

$$\frac{Q}{C} + L\frac{d^2Q}{dt^2} = 0$$

Now the math…

$$\Delta V_C + \Delta V_L = 0$$

$$\frac{Q}{C} - L\frac{dI}{dt} = 0$$

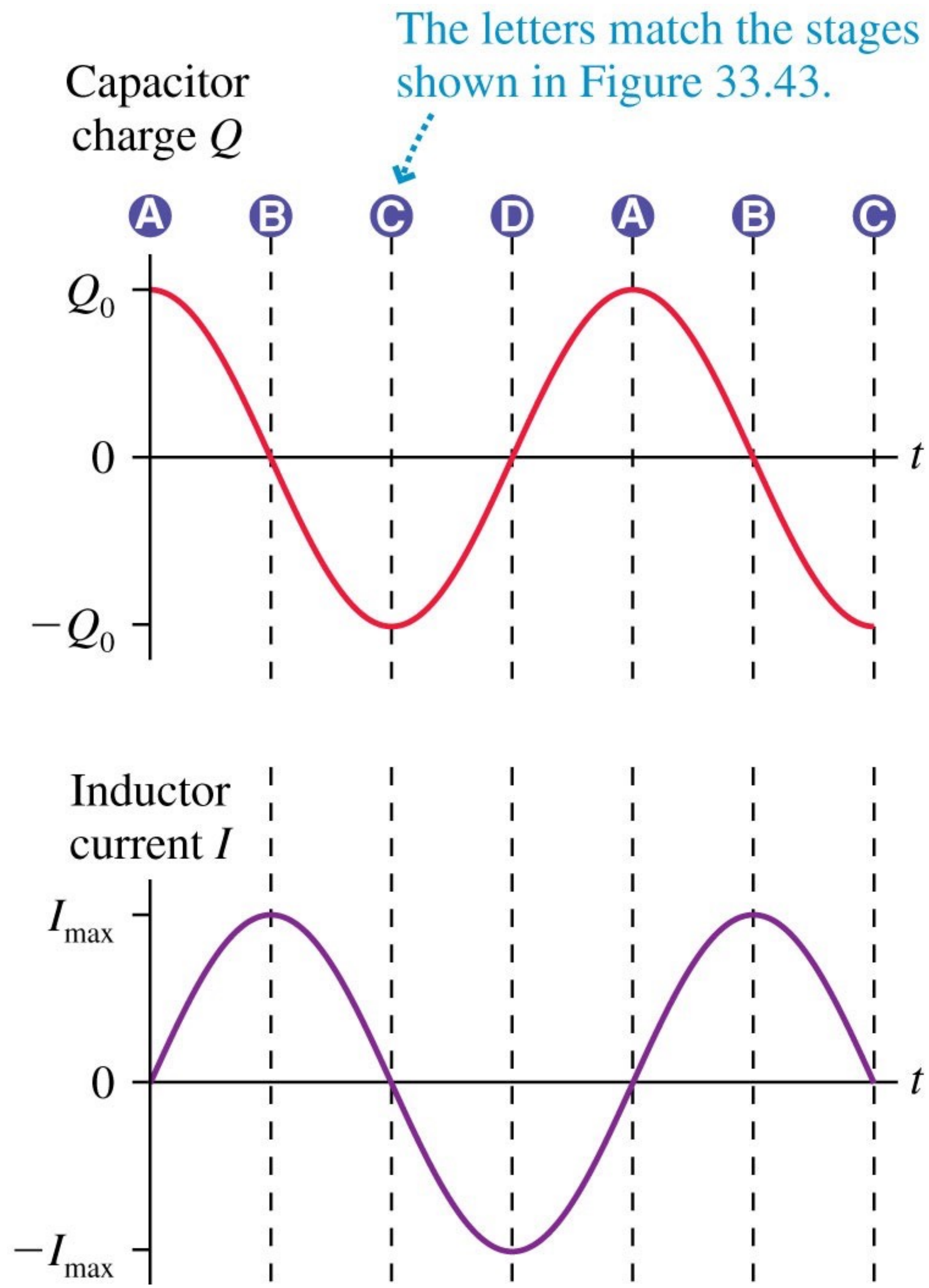
$$I = -\frac{dQ}{dt}$$

$$\frac{Q}{C} - L\frac{d}{dt}(-\frac{dQ}{dt}) = 0$$

$$\frac{Q}{C} + L\frac{d^2Q}{dt^2} = 0$$

What function satisfies this equation?

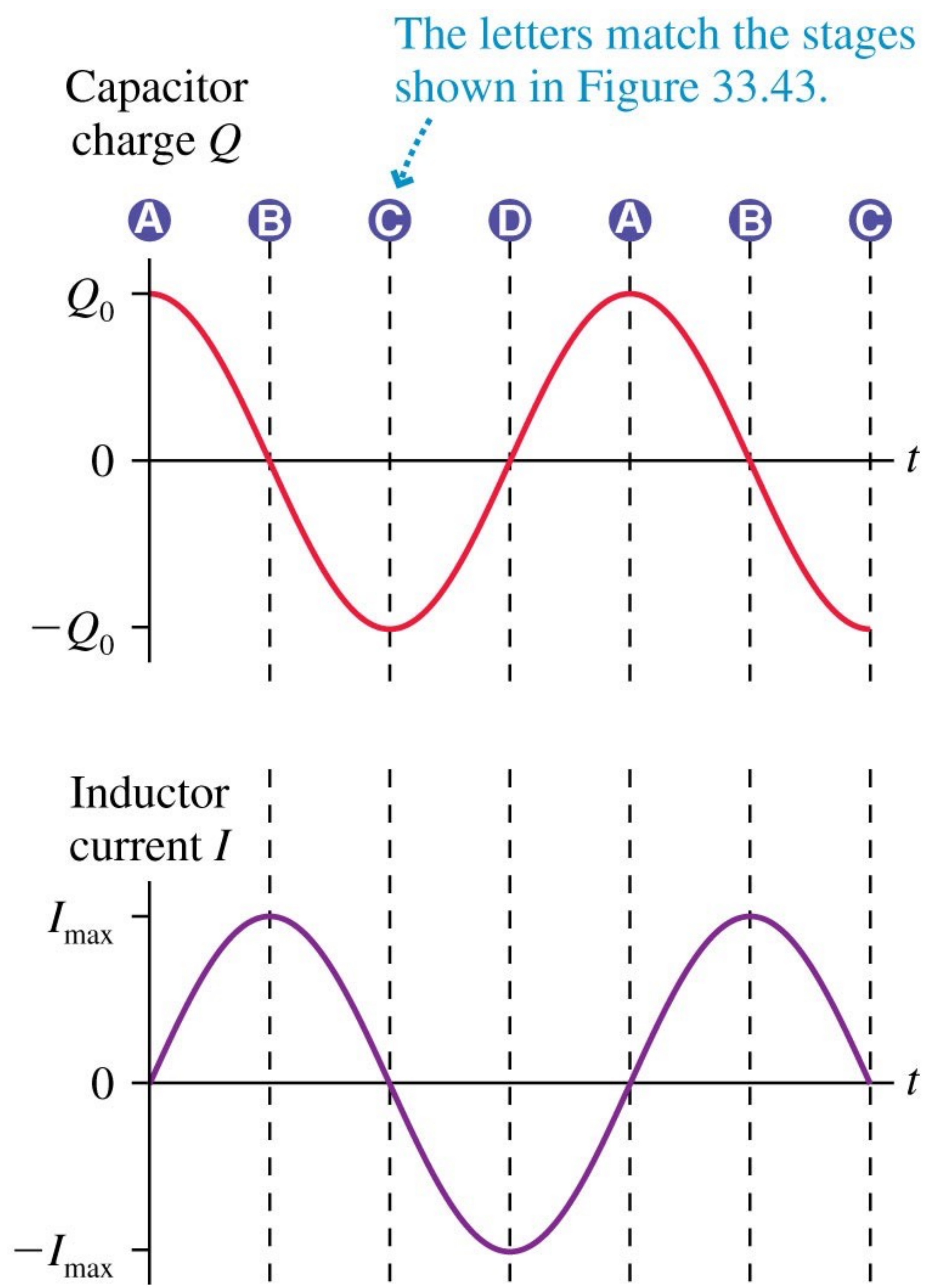
Now the math…



$$= -\frac{dQ}{dt}$$

What function satisfies this equation?

Now the math…



$$Q = Q_0 \cos \omega t$$

$$= -\frac{dQ}{dt}$$

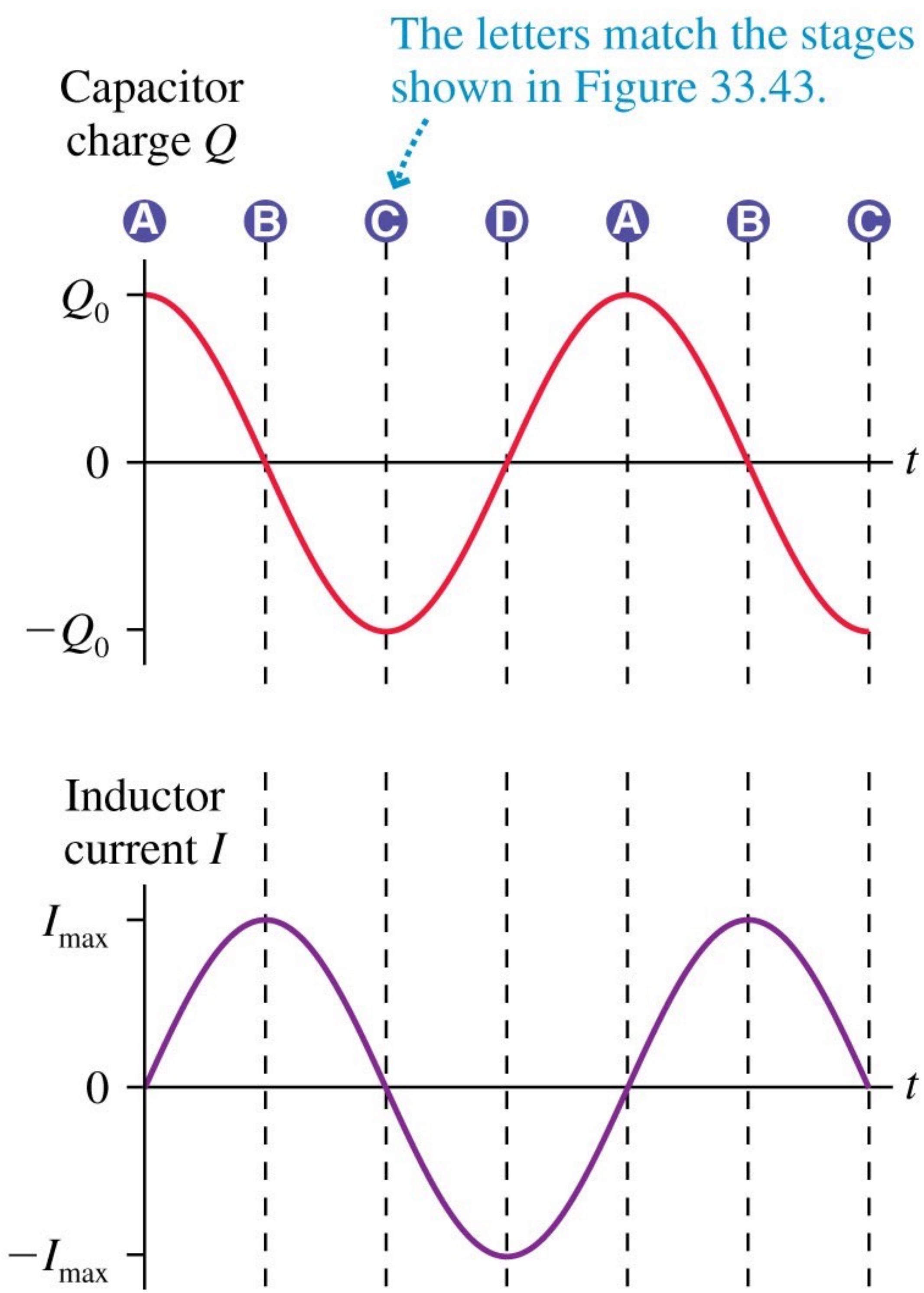
$$\omega = \sqrt{\frac{1}{LC}}$$

What function satisfies this equation?

Now the math…

$$Q = Q_0 \cos \omega t$$

$$\omega = \sqrt{\frac{1}{LC}}$$

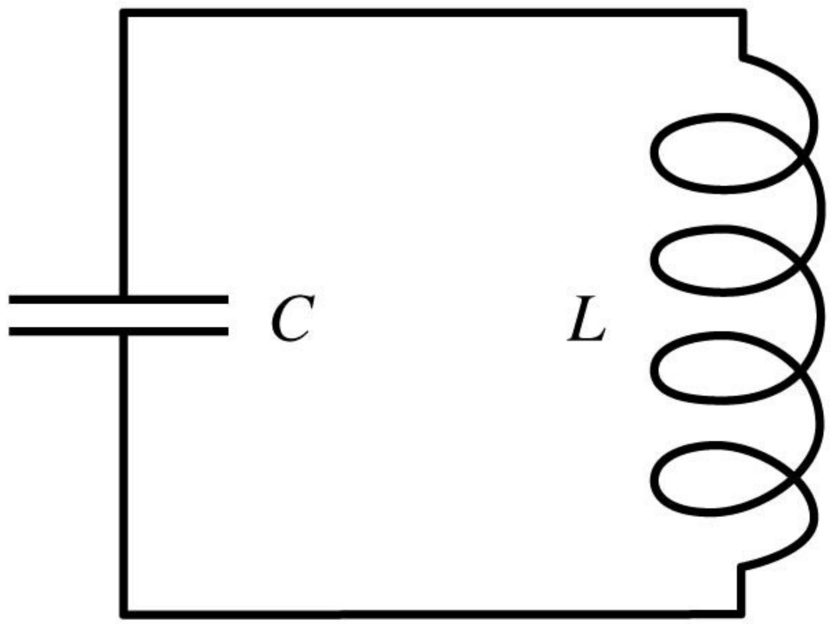


$$= -\frac{dQ}{dt}$$

applet

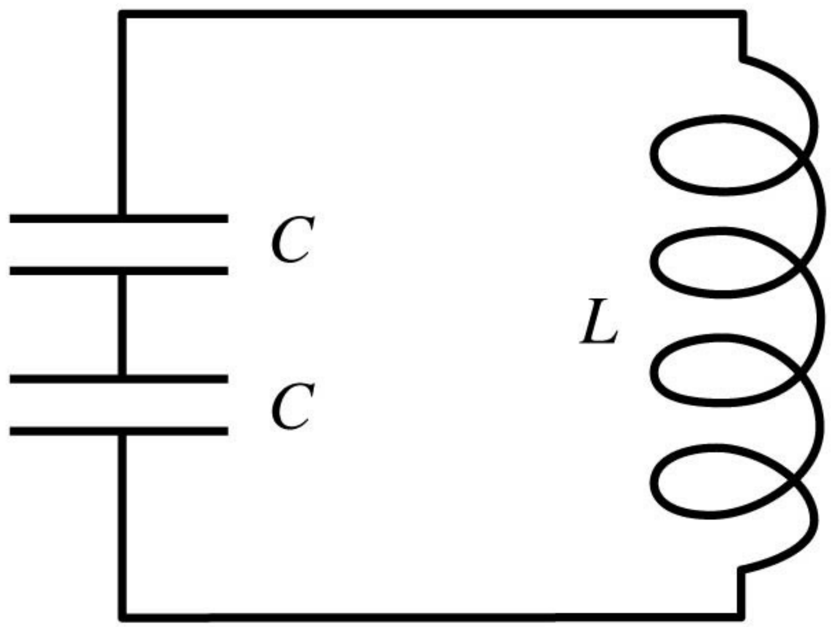
What function satisfies this equation?

Question #4



If the top circuit has an oscillation frequency of 1000 Hz, the frequency of the bottom circuit is

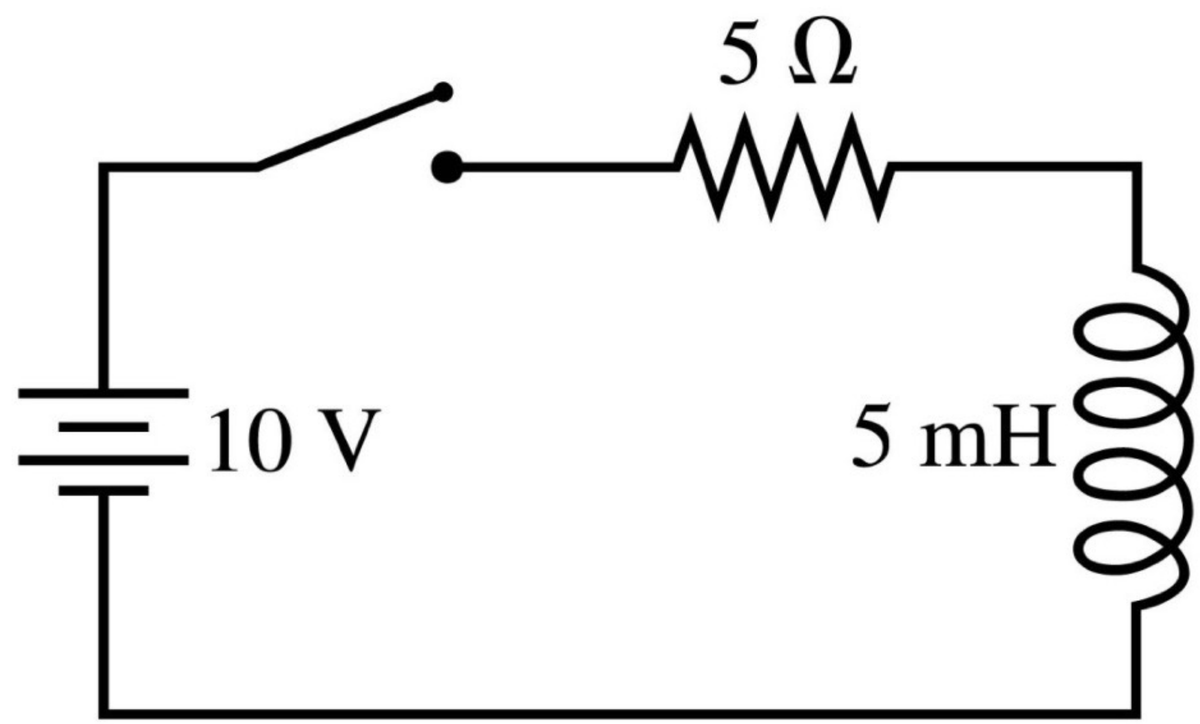
A. 500 Hz.
B. 707 Hz.
C. 1000 Hz.
D. 2000 Hz.
E. 1410 Hz.



Question #5

What is the battery current immediately after the switch has closed?

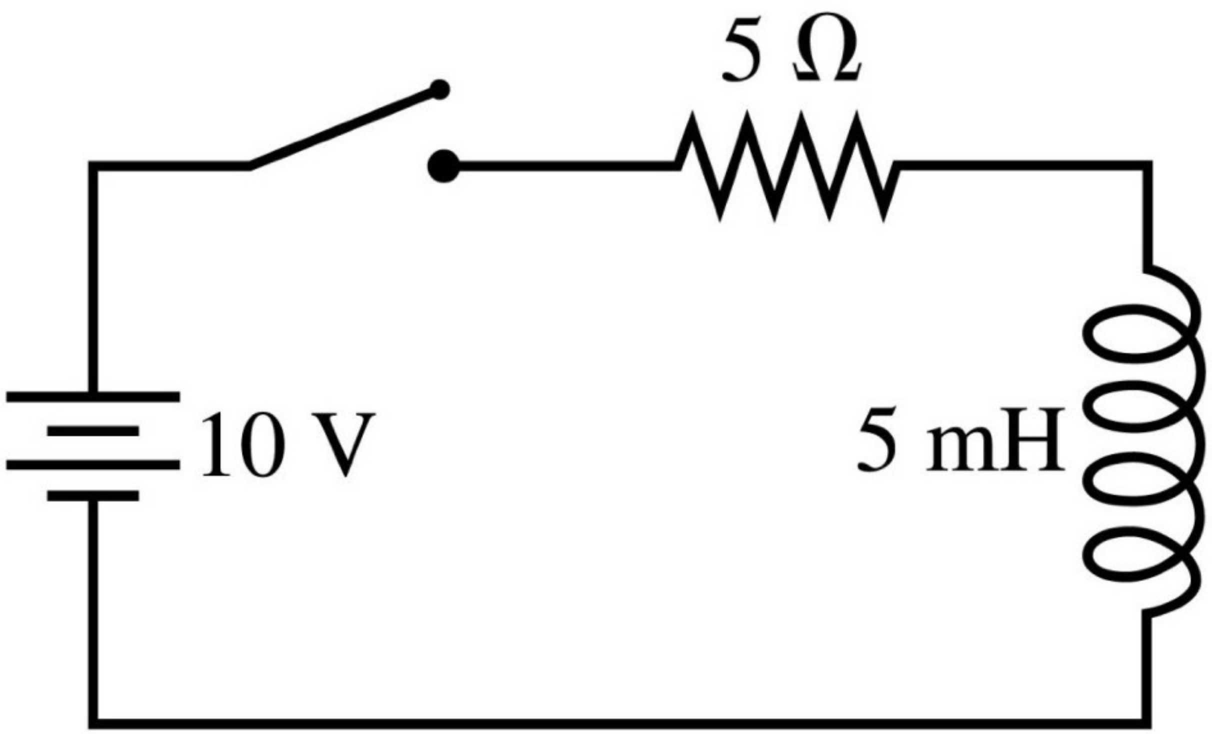
A. 2 A
B. 1 A
C. 0 A
D. Undefined



Question #6

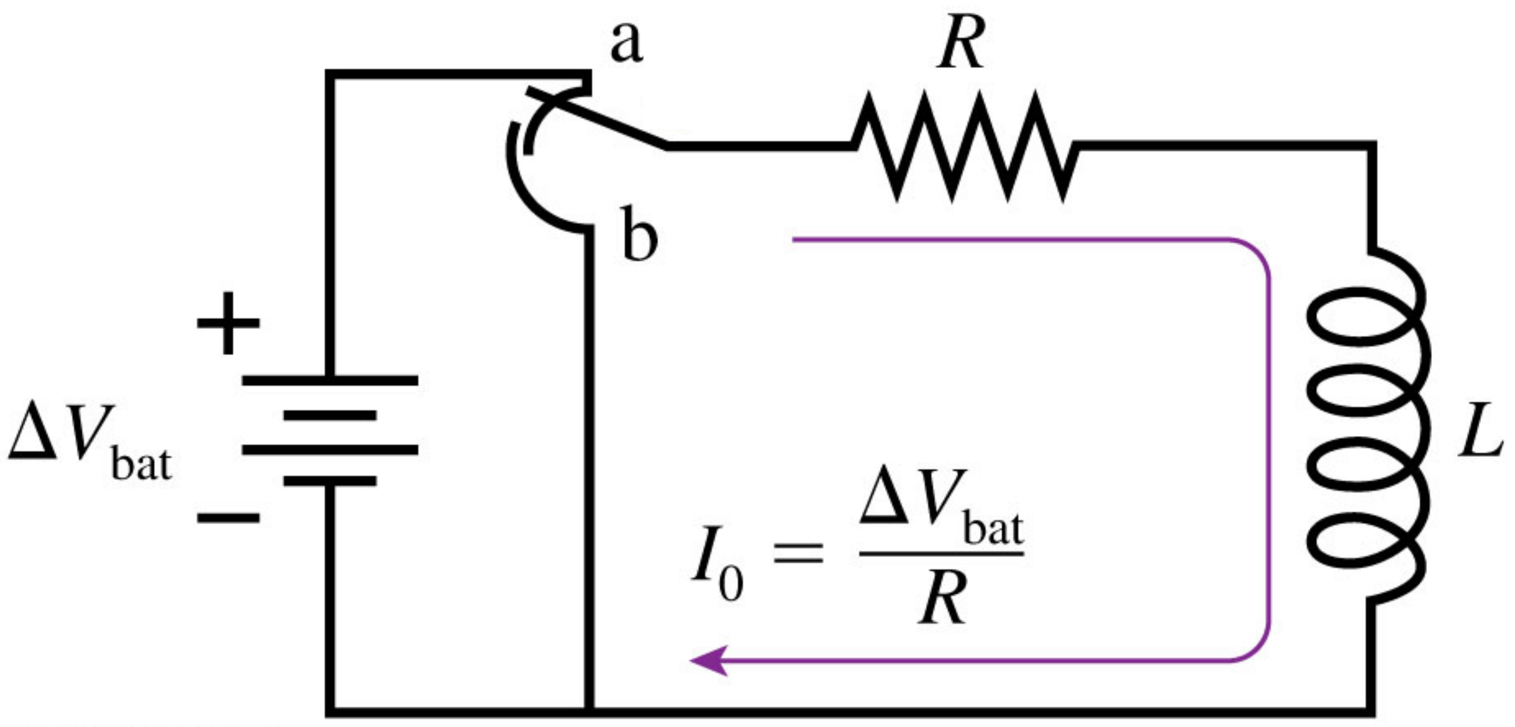
What is the battery current after the switch has been closed for a very long time?

B.
C. 0 A
D. 1 A
E. 2 A



L-R Circuits

What happens to the current in the circuit when the switch is moved to position b?



Now the math…

$$\Delta V_R + \Delta V_L = 0$$

Now the math…

$$\Delta V_R + \Delta V_L = 0$$

$$-IR - L\frac{dI}{dt} = 0$$

Now the math…

$$\Delta V_R + \Delta V_L = 0$$

$$-IR - L\frac{dI}{dt} = 0$$

$$-IR = L\frac{dI}{dt}$$

Now the math…

$$\Delta V_R + \Delta V_L = 0$$

$$-IR - L\frac{dI}{dt} = 0$$

$$-IR = L\frac{dI}{dt}$$

What function satisfies this equation?

Now the math…

$$\Delta V_R + \Delta V_L = 0$$

$$-IR - L\frac{dI}{dt} = 0$$

$$-IR = L\frac{dI}{dt}$$

$$-\frac{R}{L}dt = \frac{dI}{I}$$

What function satisfies this equation?

Now the math…

$$\Delta V_R + \Delta V_L = 0$$

$$-IR - L\frac{dI}{dt} = 0$$

$$I = I_0 e^{-tR/L}$$

$$-IR = L\frac{dI}{dt}$$

$$\tau = \frac{L}{R}$$

$$-\frac{R}{L}dt = \frac{dI}{I}$$

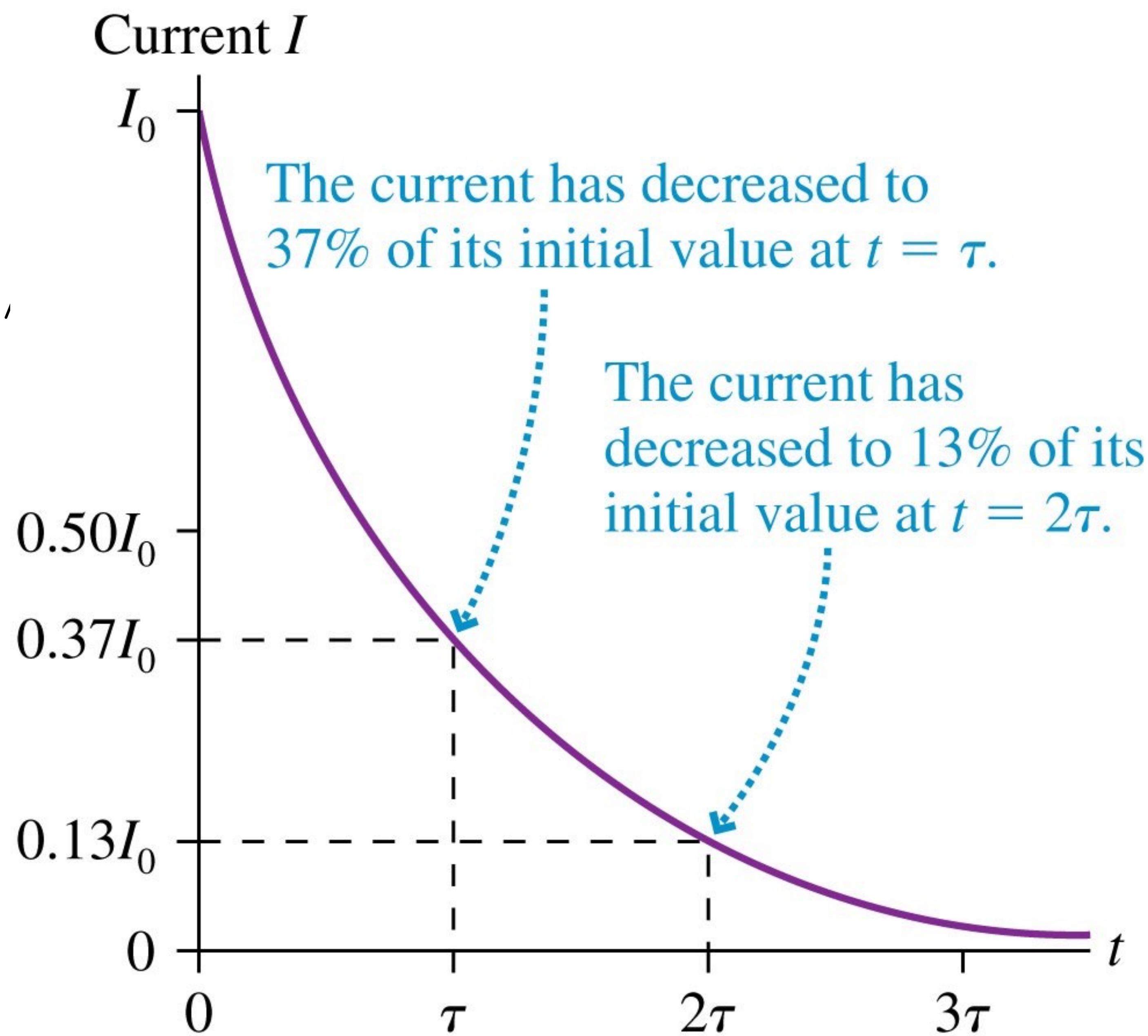
What function satisfies this equation?

Now the math…

$$\Delta V_R + \Delta V_L = 0$$

$$I = I_0 e^{-tR/}$$

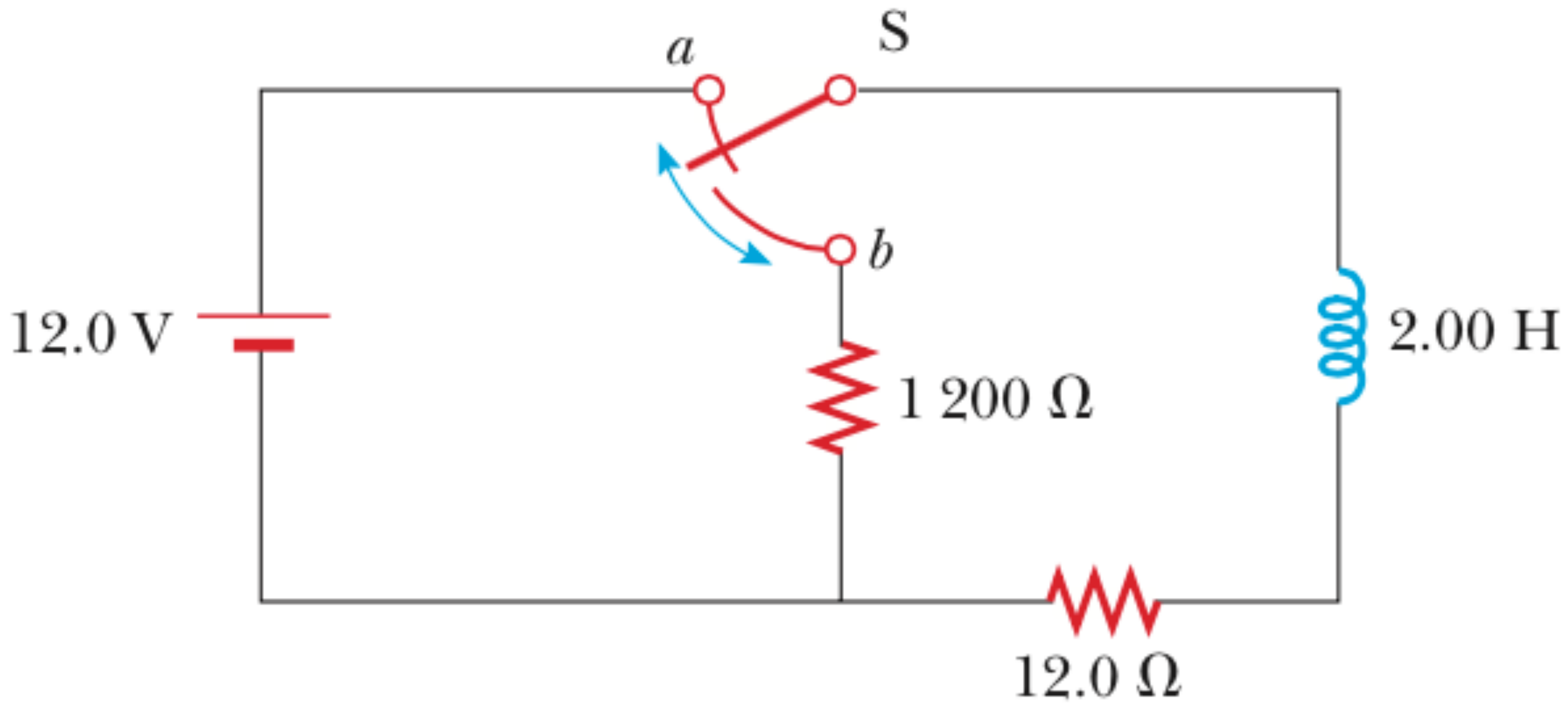
$$\tau = \frac{L}{R}$$

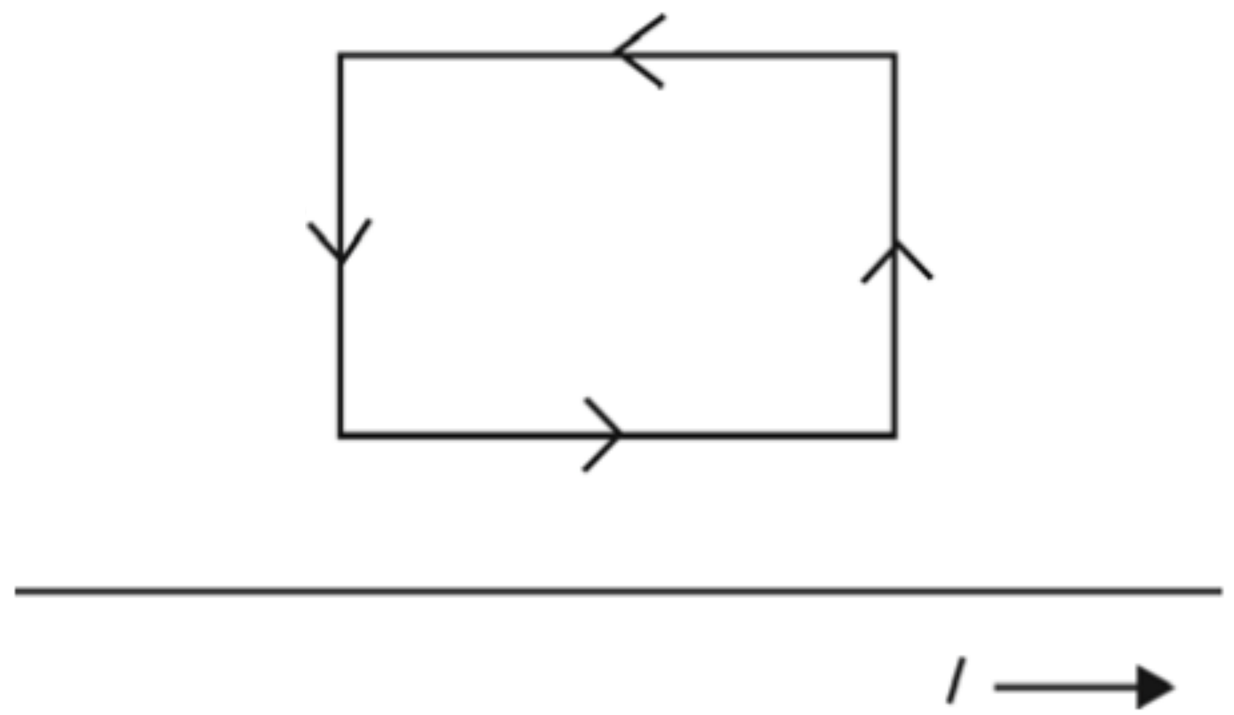


What function satisfies this equation?

Describe what will happen when the switch is placed in position a.

Describe what will happen when the switch is moved from a to b.




I