Exercise 30.4 - Enhanced - with Feedback

Complete

Review | Constants

A solenoidal coil with 25 turns of wire is wound tightly around another coil with 350 turns. The inner solenoid is 21.0 cm long and has a diameter of 2.30 cm. At a certain time, the current in the inner solenoid is 0.150 A and is increasing at a rate of 1800 $\mathrm{A/s}$.

Part A

For this time, calculate the average magnetic flux through each turn of the inner solenoid.

Express your answer in webers.

Φ_B = 1.3×10^{-7} Wb

Submit   Previous Answers

Correct

Part B

For this time, calculate the mutual inductance of the two solenoids.

Express your answer in henries.

M = 2.2×10^{-5} H

Part C

For this time, calculate the emf induced in the outer solenoid by the changing current in the inner solenoid.

Express your answer in volts.

Exercise 30.11 - Enhanced - with Solution

A metallic laboratory spring is typically 5.00 cm long and 0.150 cm in diameter and has 50 coils.

For related problemsolving tips and strategies, you may want to view a Video Tutor Solution of Calculating self-induced emf.

Review | Constants

Part A

If you connect such a spring in an electric circuit, how much self-inductance must you include for it if you model it as an ideal solenoid?

Express your answer with the appropriate units.

μÅ ?

L = Value Units

Exercise 30.19 - Enhanced - with Solution

Complete

Review | Constants

In a proton accelerator used in elementary particle physics experiments, the trajectories of protons are controlled by bending magnets that produce a magnetic field of 4.30 T.

For related problemsolving tips and strategies, you may want to view a Video Tutor Solution of Storing energy in an inductor.

Part A

What is the magnetic-field energy in a 15.0 cm^3 volume of space where B = 4.30 T?

Express your answer with the appropriate units.

U = 110 J

Exercise 30.30 - Enhanced - with Feedback

An inductor with an inductance of 6.00 H and a resistance of 8.00 Ω is connected to the terminals of a battery with an emf of 5.00 V and negligible internal resistance.

Review | Constants

Part A

Just after the circuit is completed, at what rate is the battery supplying electrical energy to the circuit?

Express your answer with the appropriate units.

P = Value Units

Submit Request Answer

Part B

When the current has reached its final steady-state value, how much energy is stored in the inductor?

Express your answer with the appropriate units.

U_L = Value Units

Part C

What is the rate at which electrical energy is being dissipated in the resistance of the inductor?

Express your answer with the appropriate units.

P_R = Value Units

Submit Request Answer

Part D

What is the rate at which the battery is supplying electrical energy to the circuit?

Express your answer with the appropriate units.

P_ε = Value Units

The minimum capacitance of a variable capacitor in a radio is 4.11 pF.

Review | Constants

Part A

What is the inductance of a coil connected to this capacitor if the oscillation frequency of the *L*-*C* circuit is 1.68 MHz, corresponding to one end of the AM radio broadcast band, when the capacitor is set to its minimum capacitance?

Express your answer in henries.

L = H

Submit Request Answer

Part B

The frequency at the other end of the broadcast band is 0.538 MHz. What is the maximum capacitance of the capacitor if the oscillation frequency is adjustable over the range of the broadcast band?

Express your answer in farads.

C = F

Exercise 30.40

Review | Constants

An L-R-C series circuit has L = 0.800 H, C = 3.00 $\mu\mathrm{F}$, and R = 350.0 Ω. At t = 0 the current is zero and the initial charge on the capacitor is 2.80×10^{-4} C.

Part A

What is the value of the constant A in the following equation?

$$q = Ae^{-(R/2L)t} \cos\left(\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}\,t + \phi\right)$$

Express your answer with the appropriate units.

A = Value Units

Submit Previous Answers Request Answer

Incorrect; Try Again

Part B

What is the value of the constant ϕ?

Express your answer in radians.

Part C

How much time does it take for each complete current oscillation after the switch in this circuit is closed?

Express your answer with the appropriate units.

μÅ ?

t = Value Units

Submit Request Answer

Part D

What is the charge on the capacitor after the first complete current oscillation?

Express your answer with the appropriate units.

μÅ ?

q = Value Units

Problem 30.45

Magnetic fields within a sunspot can be as strong as $0.4\ \mathrm{T}$. (By comparison, the earth's magnetic field is about 1/10,000 as strong.) Large sunspots can be as much as $25,000\ \mathrm{km}$ in radius. The material in a sunspot has a density of about $3 \times 10^{-4}\ \mathrm{kg/m^3}$.

Review | Constants

Part A

If 100% of the magnetic field energy stored in a sunspot could be used to eject the sunspot's material away from the sun's surface, at what speed would that material be ejected? (Hint: Calcualte the kinetic energy the magnetic field could supply to $1\ \mathrm{m^3}$ of sunspot material.)

Express your answer in meters per second.

ΑΣφ ?

v = $\mathrm{m/s}$

Submit

Request Answer

A small solid conductor with radius a is supported by insulating, nonmagnetic disks on the axis of a thin-walled tube with inner radius b. The inner and outer conductors carry equal currents i in opposite directions.

Review | Constants

Part A

Use Ampere's law to find the magnetic field at any point at the distance r from the axis of the cable in the volume between the conductors.

Express your answer in terms of some or all of the variables a, b, i, r, and constants μ_0, π.

$B = \frac{\mu_0 i}{2\pi r}$

Submit Previous Answers

Correct

Part B

Write the expression for the flux $d\Phi_B$ through a narrow strip of length l parallel to the axis, of width dr, at a distance r from the axis of the cable and lying in a plane containing the axis.

Express your answer in terms of some or all of the variables a, b, i, l, r, dr, and constants μ_0, π.

$d\Phi_B = \frac{\mu_0 i l dr}{2\pi r}$

Submit Previous Answers

Part C

Integrate your expression from part B over the volume between the two conductors to find the total flux produced by a current i in the central conductor.

Express your answer in terms of some or all of the variables a, b, i, l, and constants μ_0, π.

$$\Phi_B = \frac{\mu_0 i l}{2\pi} \ln\left(\frac{b}{a}\right)$$

Submit   Previous Answers

Correct

Part D

Find the inductance of a length l of the cable.

Express your answer in terms of some or all of the variables a, b, i, l, and constants μ_0, π.

ΑΣφ ?

L =

Submit   Request Answer

Part E

Use equation $U = \frac{1}{2}LI^2$ to calculate the energy stored in the magnetic field for a length l of the cable.

Express your answer in terms of some or all of the variables a, b, i, l, and constants μ_0, π.

ΑΣφ ?

U =

Submit

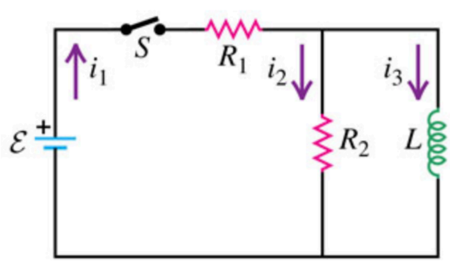
Request Answer

Review | Constants

An inductor with inductance L = 0.400 H and negligible resistance is connected to a battery, a switch S, and two resistors, R_1 = 8.00 Ω and R_2 = 5.00 Ω (Figure 1). The battery has emf 48.0 V and negligible internal resistance. S is closed at $t = 0$.

Figure

1 of 1



Part A

What is the current i_1 just after S is closed?

Express your answer with the appropriate units.

i_1 = Value Units

Submit Request Answer

Part B

What is the current i_2 just after S is closed?

Express your answer with the appropriate units.

i_2 = Value Units

Part C

What is the current i_3 just after S is closed?

Express your answer with the appropriate units.

i_3 = Value Units

Submit Request Answer

Part D

What is i_1 after S has been closed a long time?

Express your answer with the appropriate units.

i_1 = Value Units

Submit Request Answer

Part E

What is i_2 after S has been closed a long time?

Express your answer with the appropriate units.

μÅ ?

i_2 = Value Units

Submit Request Answer

Part F

What is i_3 after S has been closed a long time?

Express your answer with the appropriate units.

μÅ ?

i_3 = Value Units

Submit Request Answer

Review | Constants

Part G

Apply Kirchhoff s rules to the circuit and obtain a differential equation for $i_3(t)$. Integrate the equation to obtain an equation for i_3 as a function of the time t that has elapsed since S was closed.

Express your answer in terms of the variables R_1, R_2, L, $\mathcal{E}$, and t.

ΑΣφ ?

i_3 =

Submit Request Answer

Part H

Use the equation that you derived in part G to calculate the value of t for which i_3 has half of the final value that you calculated in part F.

Express your answer with the appropriate units.

μÅ ?

t = Value Units

Submit Request Answer

Part I

When i_3 has half of its final value, what is i_2?

Express your answer with the appropriate units.

i_2 = Value Units

Submit Request Answer

Part J

When i_3 has half of its final value, what is i_1?

Express your answer with the appropriate units.

i_1 = Value Units

Submit Request Answer

In the circuit shown in (Figure 1), S_1 has been closed for a long enough time so that the current reads a steady 3.50 A. Suddenly, S_2 is closed and S_1 is opened at the same instant.

Review | Constants

Part A

What is the maximum charge that the capacitor will receive?

Express your answer in millicoulombs.

Q_{max} = 0.350 mC

Submit Previous Answers

Correct

Part B

What is the current in the inductor at this time?

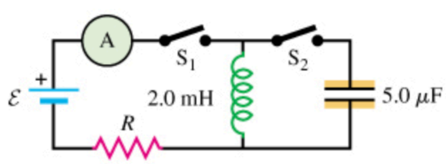
Express your answer in amperes.

i = A

Submit Request Answer

Figure

1 of 1

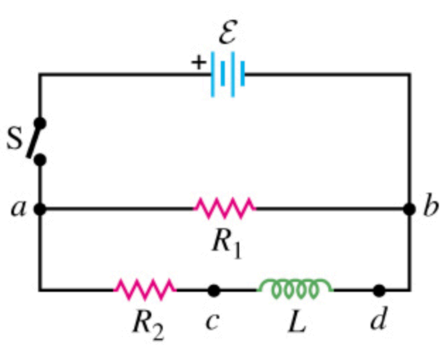


Review | Constants

In the circuit shown in (Figure 1), $\mathcal{E}$ = 65.0 V, R_1 = 45.0 Ω, R_2 = 26.0 Ω, and L = 0.291 H. Switch S is closed at t = 0.

Figure

1 of 1



Part A

Just after the switch is closed, what is the magnitude of the potential difference v_{ab} across the resistor R_1?

Express your answer in volts.

v_{ab} = V

Submit Request Answer

Part B

Which point, a or b, is at a higher potential?

- point a
- point b

Submit Request Answer

Part C

What is the magnitude of the potential difference v_{cd} across the inductor L?

Express your answer in volts.

v_{cd} = V

Submit Request Answer

Part D

Which point, c or d, is at a higher potential?

- point c
- point d

Submit Request Answer

Part E

The switch is left closed a long time and then opened. Just after the switch is opened, what is the magnitude of the potential difference v_{ab} across the resistor R_1?

Express your answer in volts.

ΑΣφ ?

v_{ab} = V

Submit Request Answer

Part F

Which point, a or b, is at a higher potential?

- point a
- point b

Submit Request Answer

Part G

What is the magnitude of the potential difference v_{cd} across the inductor L?

Express your answer in volts.

v_{cd} = V

Submit

Request Answer

Part H

Which point, c or d, is at a higher potential?

- point c
- point d

Submit

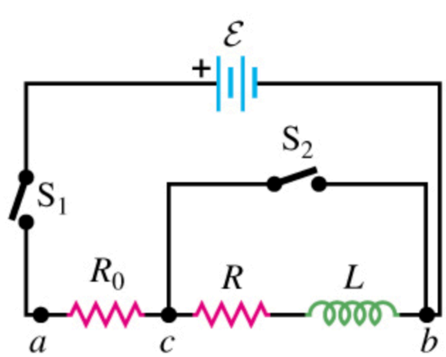
Request Answer

Review | Constants

Consider the circuit shown in (Figure 1). Let $\mathcal{E}$ = 36.0 V, R_0 = 50.0 Ω, R = 150 Ω, and L = 4.00 H.

Figure

1 of 1



Part A

Switch S_1 is closed and switch S_2 is left open. Just after S_1 is closed, what is the current i_0 through R_0?

Express your answer in amperes.

i_0 = 0 A

Submit Previous Answers

Correct

Part B

Switch S_1 is closed and switch S_2 is left open. Just after S_1 is closed, what is the potential difference V_{ac}?

Express your answer in volts.

V_{ac} = 0 V

Submit Previous Answers

Correct

Part C

Switch S_1 is closed and switch S_2 is left open. Just after S_1 is closed, what is the potential difference V_{cb}?

Express your answer in volts.

ΑΣφ ?

V_{cb} = V

Submit Request Answer

Part D

After S_1 has been closed a long time (S_2 is still open) so that the current has reached its final, steady value, what is i_0?

Express your answer in amperes.

ΑΣφ ?

i_0 = A

Submit Request Answer

Part E

After S_1 has been closed a long time (S_2 is still open) so that the current has reached its final, steady value, what is V_{ac}?

Express your answer in volts.

V_{ac} = V

Submit

Request Answer

Part F

After S_1 has been closed a long time (S_2 is still open) so that the current has reached its final, steady value, what is V_{cb}?

Express your answer in volts.

V_{cb} = V

Part G

Find the expression for i_0 as functions of the time t since S_1 was closed. Your results should agree with part A when t = 0 and with part D when $t \to \infty$.

- $0.180\left(1 - e^{-0.020t}\right)$
- $0.180\left(1 + e^{-t/0.010}\right)$
- $0.180\left(1 + e^{-t/0.020}\right)$
- $0.180\left(1 - e^{-t/0.020}\right)$

Submit

Request Answer

Part H

Find the expression for V_{ac} as functions of the time t since S_1 was closed. Your results should agree with part B when t = 0 and with part E when $t \to \infty$.

- $9.0\left(1 - e^{-0.020t}\right)$
- $9.0\left(1 - e^{-t/0.020}\right)$
- $9.0\left(1 + e^{-t/0.010}\right)$
- $9.0\left(1 + e^{-t/0.020}\right)$

Part I

Find the expression for V_{cb} as functions of the time t since S_1 was closed. Your results should agree with part C when t = 0 and with part F when $t \to \infty$.

- $9.0\left(3.00 - e^{-t/0.010}\right)$
- $9.0\left(3.00 - e^{-t/0.020}\right)$
- $9.0\left(3.00 + e^{-0.020t}\right)$
- $9.0\left(3.00 + e^{-t/0.020}\right)$

Submit   Previous Answers

Correct

In the circuit shown in (Figure 1), neither the battery nor the inductors have any appreciable resistance, the capacitors are initially uncharged, and the switch S has been in position 1 for a very long time.

Review | Constants

Part A

What is the current in the circuit?

Express your answer in amperes.

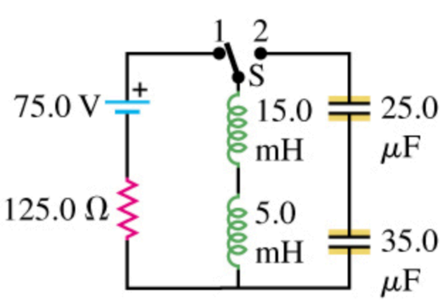
$I =$ 0.600 A

Submit Previous Answers

Correct

Figure

1 of 1



Part B

The switch is now suddenly flipped to position 2. Find the maximum charge that the $25.0\ \mu F$ capacitor will receive.

Express your answer in coulombs.

$q =$ C

Part C

The switch is now suddenly flipped to position 2. Find the maximum charge that the $35.0\ \mu\text{F}$ capacitor will receive.

Express your answer in coulombs.

q = C

Submit

Request Answer

Part D

How much time after the switch is flipped will it take the capacitors to acquire this charge?

Express your answer in seconds.

t = s

Submit

Request Answer

Challenge Problem 30.71

Review | Constants

Consider the circuit shown in (Figure 1). Switch S is closed at time $t = 0$, causing a current i_1 through the inductive branch and a current i_2 through the capacitive branch. The initial charge on the capacitor is zero, and the charge at time t is q_2.

Part A

Derive expression for i_1 as function of time.

Express your answer in terms of some or all of the variables $\mathcal{E}$, L, C, R_1, R_2, and t.

i_1 =

Submit Request Answer

Part B

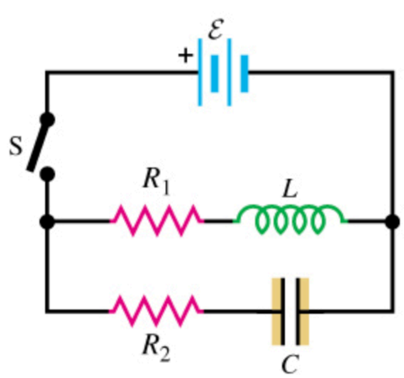
Derive expression for i_2 as function of time.

Express your answer in terms of some or all of the variables $\mathcal{E}$, L, C, R_1, R_2, and t.

i_2 =

Figure

1 of 1



Part C

Derive expression for q_2 as function of time.

Express your answer in terms of some or all of the variables $\mathcal{E}$, L, C, R_1, R_2, and t.

q_2 =

Submit

Request Answer

Part D

For the remainder of the problem let the circuit elements have the following values: $\mathcal{E}$ = 43 V, L = 7.5 H, C = 27 $\mu\mathrm{F}$, R_1 = 29 Ω, and R_2 = 4600 Ω. What is the initial current through the inductive branch?

Express your answer in amperes.

$i_L(0)$ = A

Part E

What is the initial current through the capacitive branch?

Express your answer in amperes.

$i_C(0)$ = A

Submit Request Answer

Part F

What is the current through the inductive branche a long time after the switch has been closed?

Express your answer in amperes.

$i_L(\infty)$ = A

Part G

What is the current through capacitive branche a long time after the switch has been closed?

Express your answer in amperes.

$i_C(\infty)$ = A

Submit Request Answer

Part H

At what time t_1 (accurate to two significant figures) will the currents i_1 and i_2 be equal? (*Hint:* You might consider using series expansions for the exponentials.)

Express your answer in seconds.

t_1 = s

Part I

For the conditions given in part I, determine i_1.

Express your answer in amperes.

i_1 = A

Submit

Request Answer

Part J

The total current through the battery is $i = i_1 + i_2$. At what time t_2 (accurate to two significant figures) will i equal one-half of its final value? (*Hint:* The numerical work is greatly simplified if one makes suitable approximations. A sketch of i_1 and i_2 versus t may help you decide what approximations are valid.

Express your answer in seconds.

t_2 = s