Problems for Capacitors and Inductors

After LC1a Introduction (Capacitors)

1. Determine the charge stored on a 2.2 μF capacitor if the capacitor's voltage is 5 V.
   Answer: 11 μF,

2. In some integrated circuits, the insulator or dielectric is silicon dioxide, which has a relative permittivity of 4. If a square capacitor measuring 10 μm on edge, has a capacitance of 100 fF, what is the separation distance between the capacitor's plates, in μm?
   Answer: 35.4 nm.

After LC1c Example (Capacitors)

1. If the voltage across a 47 mF capacitor is found to be +10 V at an instant in time, what is the current flowing into the capacitor's positive terminal?
   a. 470 mA Wrong - the current depends on the derivative of the voltage.
   b. 0 A Wrong - the current depends on the derivative of the voltage.
   c. 213 A Wrong - the current depends on the derivative of the voltage.
   d. insufficient information Right - the current depends on the derivative of the voltage.

2. If a constant current of 440 μA charges a capacitor of value 2.2 mF, with an initial voltage of 1.25 V, what is the capacitor's final voltage after 10 seconds?
   Answer: 3.25 V

After LC1d Power (Capacitor)

1. When the charge on a capacitor is doubled, the stored energy;
   a. decreases by a factor of 4 Answer: Wrong
   b. decreases by a factor of 2 Answer: Wrong
   c. stays the same Answer: Wrong
   d. increases by a factor of 2 Answer: Wrong
   e. increases by a factor of 4 Answer: Correct

2. If the voltage on a 15 mF capacitor changes from 3 V to 4 V, how much additional energy is stored on the capacitor?
Answer: 52.5 mJ

After LC2a Introduction (Inductors)

1. If the current through a 5 mH inductor is increasing at 3 A/s, what is the voltage across the inductor? Answer: 15 mV

2. The current in an 8 μH inductor is given by $i(t) = 3t + 2$ A. What is the value of the inductors voltage at $t = 2$ s? Answer: 24 μV

After LC2b Symbol I-V (Inductors)

1. If the voltage across a 10 mH inductor is found to be zero;
   a. What is the current?
      a: 10 mA Wrong: insufficient information.
      b: 0 mA Wrong: insufficient information.
      c: -10 mA Wrong: insufficient information.
      d: none of the above Wrong: insufficient information.
      e: unknown Correct: We only know the rate of change of the current is zero.
   b. What is the magnitude of the rate of change of the current?
   Answer: 1 mA/s

2. The current through a 5 μH inductor is $3\sin(12{,}000t)$ mA, What is the voltage across the inductor? Answer: 180 μV

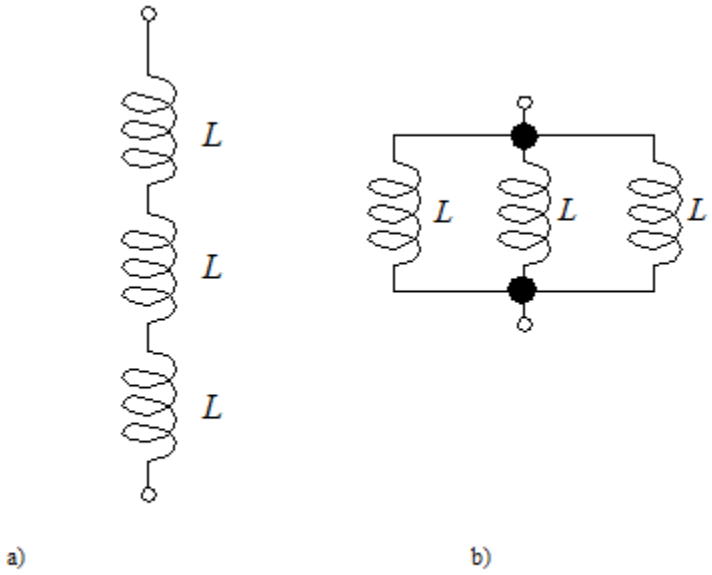
After LC2d Example (inductor)

1. If the voltage across an inductor is zero, it contains stored energy.
   a) True Wrong - the energy stored in an inductor is determined by the current.
   b) Unknown Correct - the current determines the stored energy
   c) False Wrong - until we know the current, logically, we cannot make this claim.

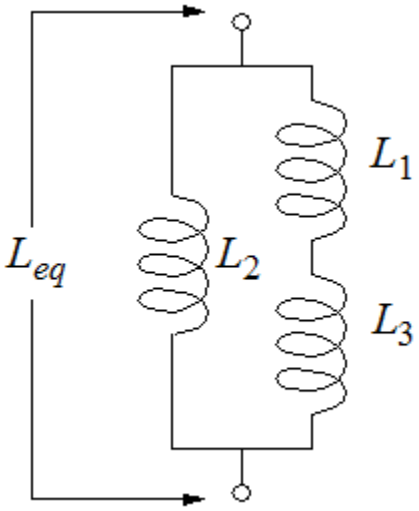
2. If the current flowing through a 6 H inductor is given by $i(t) = 4\cos(2\pi 60t)$ A, How much energy is stored in the inductor at time $t = 5$ s.? Answer 48 J

After LC3d Inductors in Parallel

1. If L = 420 μH, determine the equivalent inductance of each network shown below.
   Answers: a) 1.26 mH b) 140 μH

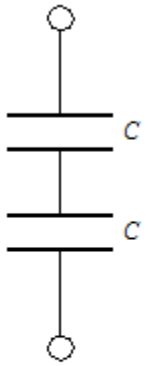


2. If L_1 = 8 H, L_2 = 5 H and L_3 = 12 H, determine the equivalent capacitance of the network shown to the right. Answer: 4 H

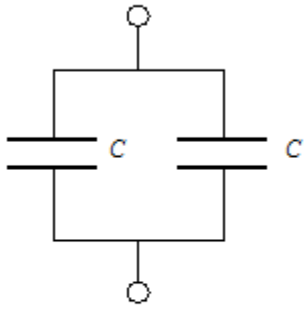


After LC3e Capacitors in Parallel

1. If C = 90 F, find the equivalent capacitance of each network shown below:
   a) C_{eq} = 45 F, b) C_{eq} = 180 F



a)



b)

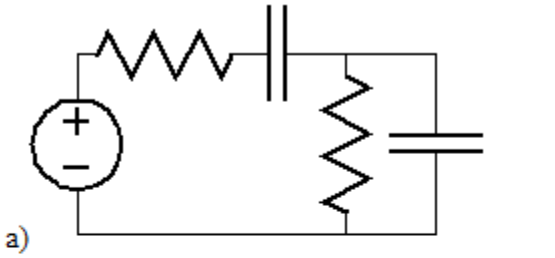
Problems for First Order RC and RL Circuits

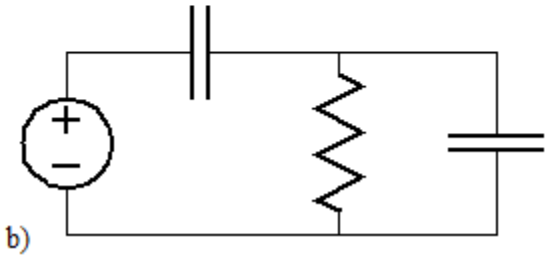
After Step1a Introduction

1. Identify which of the following circuits are first order RC circuits.

   a. Yes ○ No Answer: No

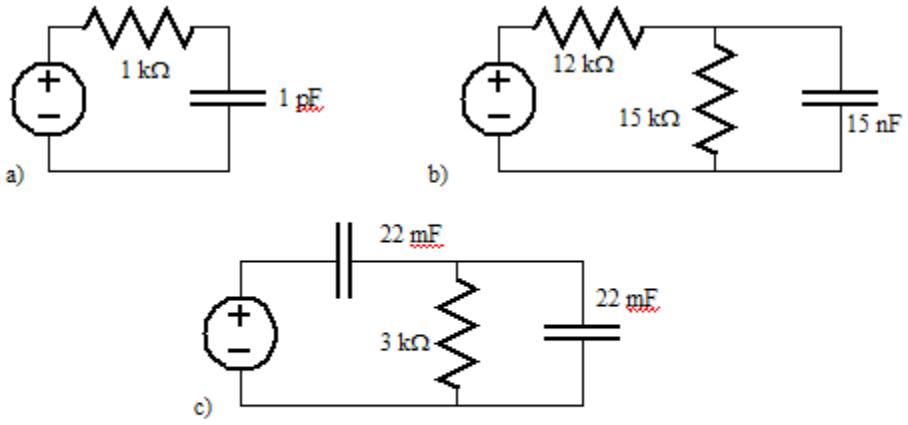
   b. Yes ○ No Answer: Yes





After Step 1b Time Constant

1. Find the time constant for the following circuits;
   Answers: a) 1 ns, b) 100 μs, c) 132 s.

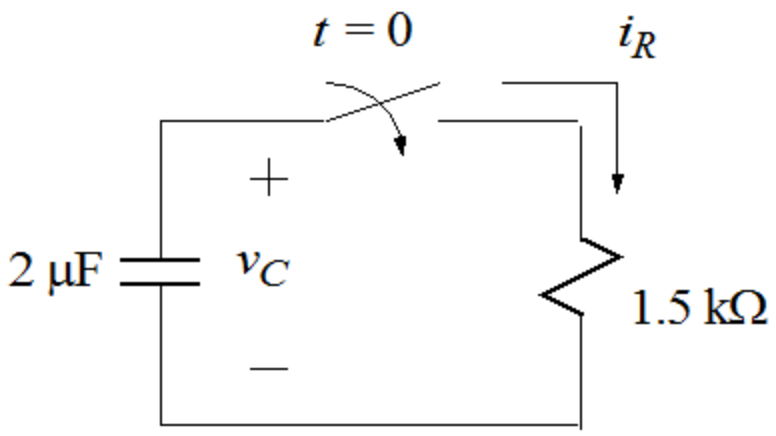


2. If $x(t) = 16e^{-t/10\ \text{ns}}$, at what time is the value of x half its value at $t = 0$?
   Answer: 6.9 ns.

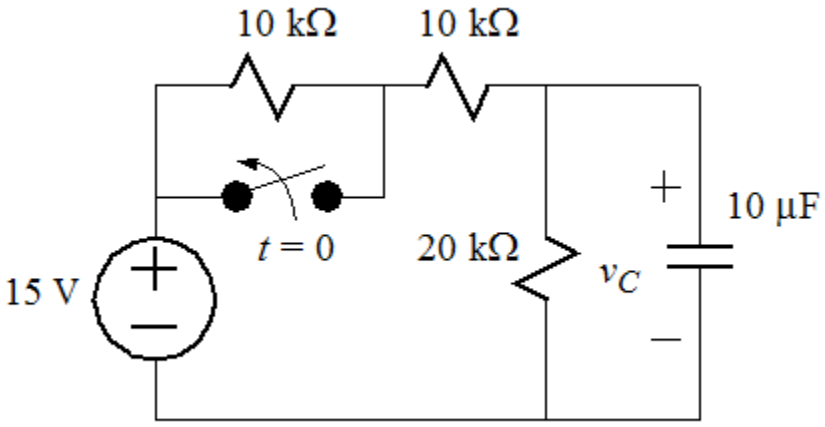
3. If $v(t) = 5 - 5e^{-t/2\ \text{ms}}\text{V}$;
   a. What is the value of v when t is infinite? Answer: 5 V
   b. At what time is the value of v equal to half of its final value? Answer: 1.4 ms.

After Step1c Example

1. The capacitor shown below is initially charged to 12 V. If the switch closes at $t = 0$, determine;
   a. the initial value of the current i_R, after the switch closes. Answer: 8 mA
   b. the time constant for the current after the switch closes. Answer: 3 ms
   c. the value of the current at 4 ms. Answer: 2.1 mA
   d. the time when the current has decreased to 5% of its initial value. Answer: 9 ms

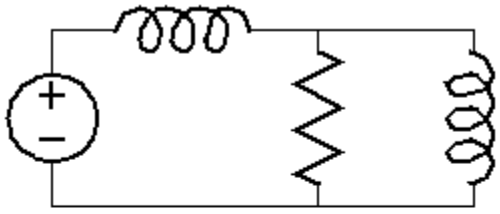


2. If the switch in the circuit shown to the right has been closed a long time and opens at t = 0, determine;
   a. the initial capacitor voltage. Answer: 10 V.
   b. the capacitor voltage after the switch has been open a very long time. Answer: 7.5 V
   c. the capacitor voltage after 0.2 s. Answer: 7.84 V.

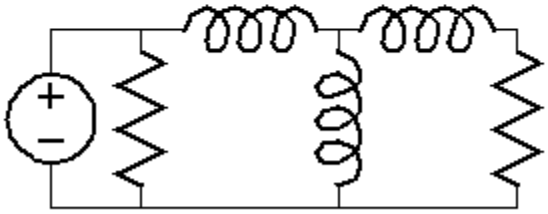


After Step3a RL Natural

1. Identify which of the following circuits are first order RL circuits.
   a. Yes ○ No Answer: Yes
   b. Yes ○ No Answer: No

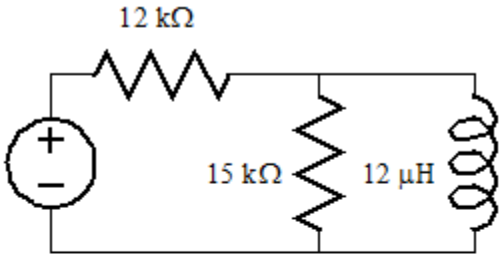


a)

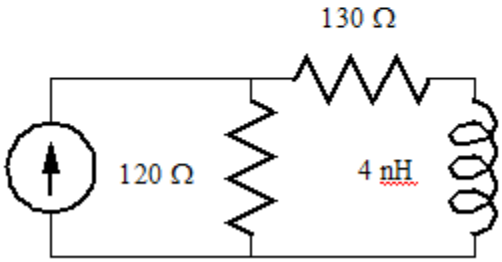


b)

2. Find the time constant for the following circuits;
Answers a) 1.8 ns, b) 16 ps.



a)



b)

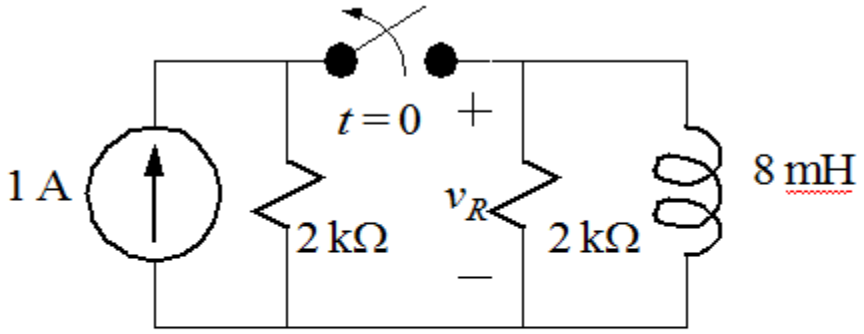
After Step3c RL Step2

1. If the switch in the circuit shown below has been open a long time and closes at $t = 0$, determine;

a. the initial value of the voltage v_R, after the switch closes. Answer: 1 V.

b. the time constant or the current after the switch closes. Answer: 2 μs.

c. the value of the voltage at 5 μs. Answer: 82 mV.



After Step3e RL Example

1. The switch in the circuit shown to the right has been open a long time. If the switch closes at t = 0 and then re-opens at t = 50 ms, determine;

   a. the capacitor's voltage, v_C at t = 50 ms. Answer: 6.1 V.

   b. the capacitor's voltage at t = 100 ms. Answer: 2.7 V.