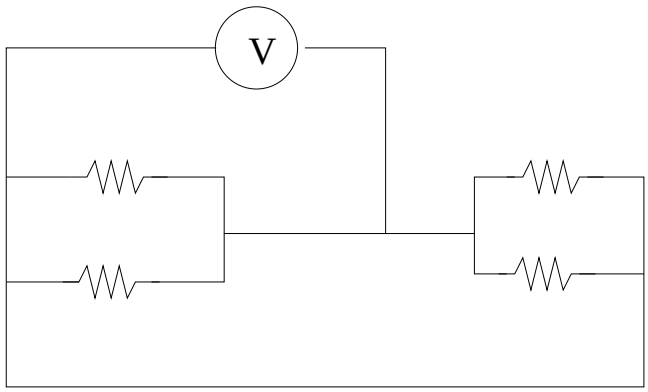
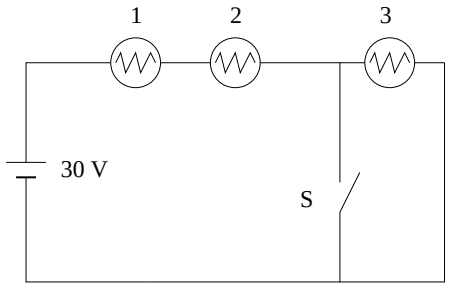
1. If each of the four resistors below has a resistance of 1 $\mu\Omega$, what is the equivalent resistance of the combination?



(a) 0.25 $\mu\Omega$
(b) 1 $\mu\Omega$
(c) 2 $\mu\Omega$
(d) 4 $\mu\Omega$
(e) none of these

2. Three identical lamps are connected in series as shown. When the switch is closed



(a) lamps 1 and 2 turn off; lamp 3 gets brighter
(b) lamps 1 and 2 turn off; lamp 3 gets dimmer
(c) lamps 1 and 2 get brighter; lamp 3 turns off
(d) lamps 1 and 2 get dimmer; lamp 3 turns off
(e) all the lamps get brighter
(f) all the lamps get dimmer

3. Fill in the blanks with the choices below. (Some answers could be used more than once.) A large capacitor and a small capacitor are wired in series and connected to a battery. The charge on the large cap is _____ the charge on the small cap. The voltage across the large cap is _____ the voltage across the small cap. The potential energy stored in the large cap is _____ the potential energy stored in the small cap.

   (a) greater than

   (b) smaller than

   (c) equal to

4. Fill in the blanks with the choices below. (Some answers could be used more than once.) A large capacitor and a small capacitor are wired in parallel and connected to a battery. The charge on the large cap is _____ the charge on the small cap. The voltage across the large cap is _____ the voltage across the small cap. The potential energy stored in the large cap is _____ the potential energy stored in the small cap.

   (a) greater than

   (b) smaller than

   (c) equal to

5. What maximum power can be generated from an 18-V battery using any combination of a 6.0-Ω resistor and a 9.0-Ω resistor?

   (a) 22 W
   (b) 54 W
   (c) 71 W
   (d) 80 W
   (e) 90 W

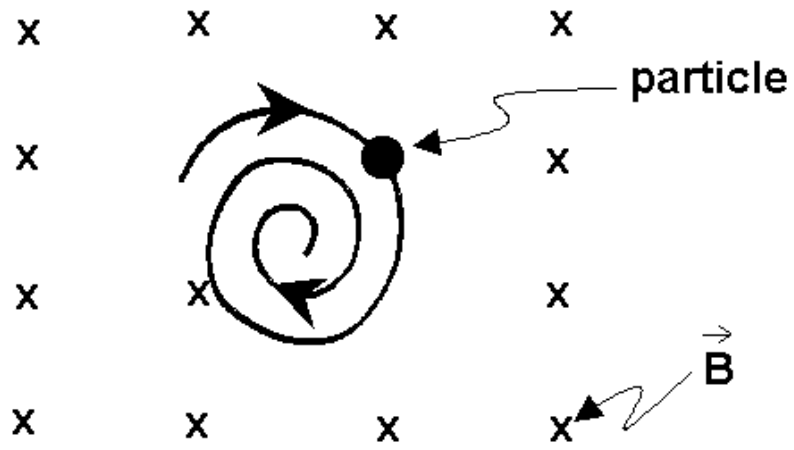
6. An unknown resistor dissipates 0.5 W when connected to a 3 V potential difference. When connected to a 1 V potential difference, this resistor will dissipate:

   (a) 0.5 W
   (b) 0.167 W
   (c) 1.5 W
   (d) 0.056 W
   (e) none of these

7. In general, the magnetic field lines are in the direction of:

   (a) the magnetic force on a moving positive charge
   (b) the magnetic force on a moving negative charge
   (c) the velocity of a moving positive charge
   (d) the velocity of a moving negative charge
   (e) perpendicular to both the force and the velocity
   (f) none of the above

8. A uniform magnetic field is directed into the page. A charged particle, moving in the plane of the page, follows a clockwise spiral of decreasing radius as shown. A reasonable explanation is:



   (a) the charge is positive and slowing down
   (b) the charge is negative and slowing down
   (c) the charge is positive and speeding up
   (d) the charge is negative and speeding up
   (e) none of the above

9. A large resistor and a small resistor are connected in parallel. The equivalent resistance of the combination

   (a) is always larger than the large resistor

   (b) is always smaller than the small resistor

   (c) is always between the large and small resistor values

   (d) can be larger than, smaller than, or between the given resistor values depending on their specific numerical values

10. Aluminum wire has been used to replace copper wire during times of high copper prices. If 20-gauge (diameter 0.81 mm) copper wire has a resistance of 33 Ω per kilometer of length, determine the diameter of an aluminum wire with the same resistance.

    (a) 0.50 mm

    (b) 0.60 mm

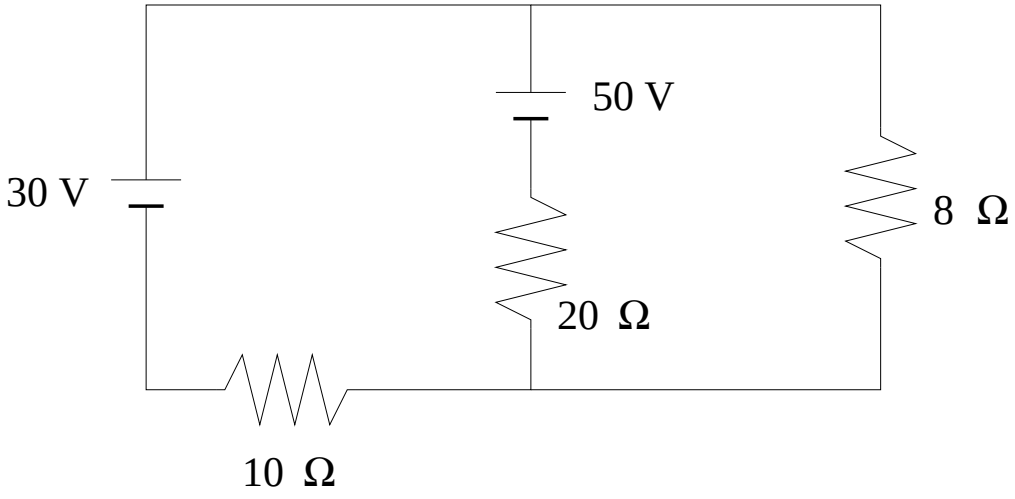
    (c) 0.81 mm

    (d) 1.0 mm

    (e) 3.3 mm

Partial Credit Section (30 points)
It would be prudent to use variables as much as possible and only substitute numbers in at the very end of each part. SHOW YOUR WORK!

Find the currents, including directions, through all the resistors.

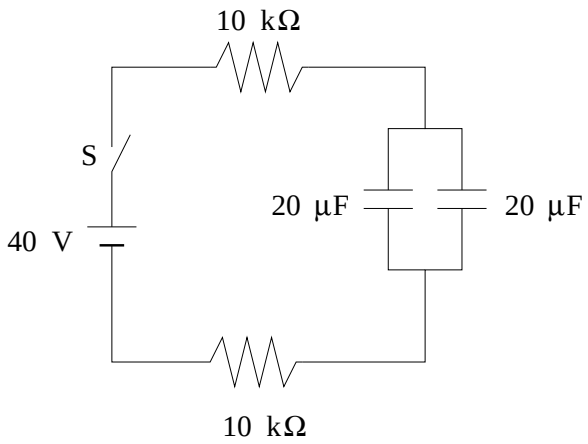


A real battery is modeled as an ideal emf in series with a small internal resistance. If a voltmeter is placed across a real D-cell flashlight battery with no external load resistor, the open-circuit terminal voltage (from the positive end to the negative end) reads 1.5 volts. If the positive and negative terminals of the battery are short-circuited, the resulting current is measured to be 15 amps.
What is the internal resistance of the battery?

What power is dissipated in a 2 ohm external load resistor connected to this battery?

What is the voltage across the 2 ohm external load resistor?

What is the capacitive time constant for the circuit shown?



If the caps are initially uncharged and the switch is closed at time zero, what is the battery current at time t=0?

What is the battery current at $t = \infty$.

When the caps are fully charged, what is the charge on one plate of one cap?