1. (6 points) The figure shows two connected wires that are made of the same material. The current entering the wire on the left is 2.0 A and in that wire the electron drift speed is v_d. What is the electron drift speed in the wire on the right side?

   The concepts necessary to solve this problem correctly: Relationship between current and current density, Definition of elements being in series

   (A) $4v_d$

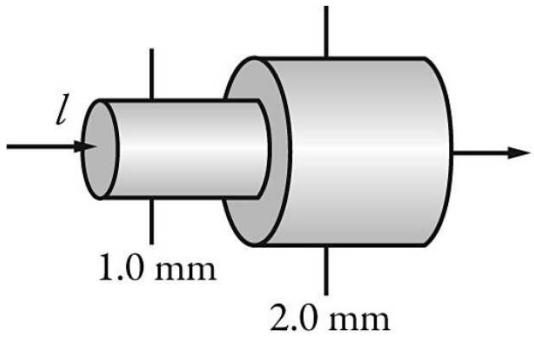
   (B) $2v_d$

   (C) v_d

   (D) $\frac{1}{2}v_d$

   (E) $\frac{1}{4}v_d$

   Points Per Response:
   A: 2
   B:
   C:
   D: 2
   E: 6



2. (4 points) You are given a copper bar of dimensions 3 cm × 5 cm × 8 cm and asked to attach leads to it in order to make a resistor. If you want to achieve the *smallest* possible resistance, you should attach the leads to the opposite faces that have which measurements?

   The concepts necessary to solve this problem correctly: Definition of resistance

   (A) 3 cm × 5 cm

   (B) 3 cm × 8 cm

   (C) 5 cm × 8 cm

   (D) Any pair of faces will produce the same resistance since the resistivity is the same.

   Points Per Response:
   A:
   B:
   C: 4
   D:

3. (8 points) The figure shows a 2.0-cm diameter roller that turns at 90 rpm. A 4.0-cm wide plastic film is being wrapped onto the roller, and this plastic carries an excess electric charge having a uniform surface charge density of 5.0 nC/cm^2. What is the current of the moving film?

The concepts necessary to solve this problem correctly: Definition of current and charge density

(A) 188 nA

(B) 377 nA

(C) 47.1 nA

(D) 11300 nA

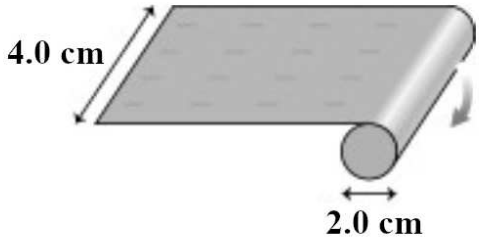
(E) 8130 nA

(F) 7100 nA

(G) 4800 nA

(H) 1370 nA

Points Per Response:
A: 8
B: 6
C: 5
D: 6
E:
F:
G:
H:



4. (6 points) An aluminum cylinder is 10.0 cm long and has a cross-sectional area of 2.00×10^{-4} m^2. When a voltage difference 3 V is applied, what is power dissipated through it? (the resistivity of aluminum is 2.82×10^{-8} Ωm).

The concepts necessary to solve this problem correctly: Definition of resistance, Ohm's Law

(A) 2.1×10^5 W

(B) 6.4×10^5 W

(C) 1.1×10^5 W

(D) 7.8×10^5 W

(E) 5.5×10^5 W

Points Per Response:
A: 4
B: 6
C:
D:
E:

5. (6 points) In the circuit below you are given the current through the two indicated resistors. What is the current through the 6 V battery?

The concepts necessary to solve this problem correctly: Kirchoff's Loop and Junction Rules

(A) 0.26 A

(B) 0.62 A

(C) 0.36 A

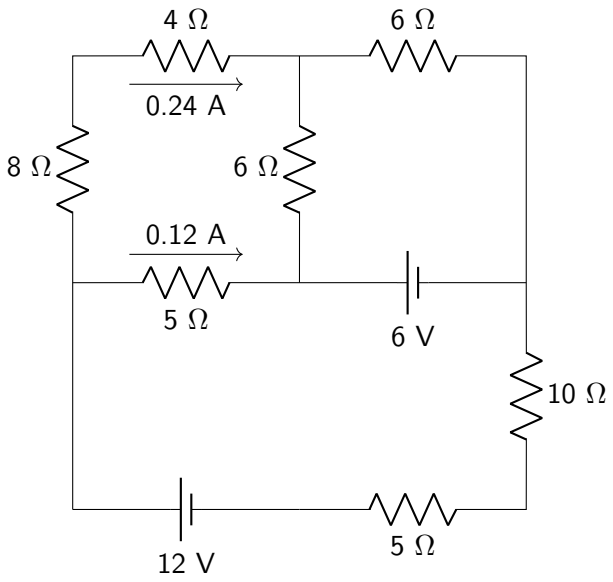
(D) 0.12 A

(E) 0.40 A

(F) 0.22 A

Points Per Response:

A: 6
B: 4
C: 4
D:
E:
F:



6. (6 points) The emf and the internal resistance of a battery are as shown in the figure. If a current of 8.30 A is drawn from the battery when a hair dryer is connected across the terminals ab of the battery, what is the power dissipated by the dryer?

The concepts necessary to solve this problem correctly: Kirchoff's Loop Rule, Electrical Power

(A) 444 W

(B) 700 W

(C) 622 W

(D) 538 W

(E) 791 W

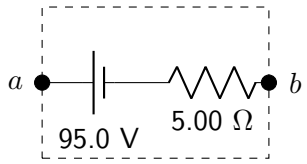
(F) 1130 W

(G) 42.0 W

(H) 789 W

Points Per Response:

A: 6
B:
C:
D:
E:
F: 4
G: 3
H: 3



7. (6 points) In the circuits given below, all bulbs are identical. Which of the following correctly indicates the relative brightness of the bulbs? (D>B implies that D is brighter than B.)

The concepts necessary to solve this problem correctly: Kirchoff's Loop Rule, Electrical Power (as it relates to brightness).

(A) D>A>B>C

(B) D=A>B=C

(C) D=B=C>A

(D) D=A=B=C

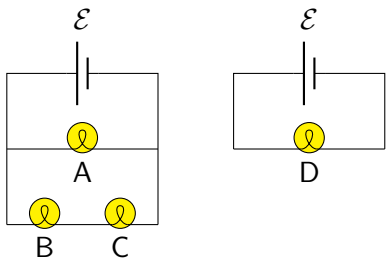
(E) D<A<B<C

(F) D=A<B=C

(G) D<B<C<A

Points Per Response:

A:
B: 6
C:
D:
E:
F: 2
G:



8. (6 points) In the diagram below, find current through the 6.0 Ω resistor?

The concepts necessary to solve this problem correctly: Effective Resistance, Kirchoff's Loop Rule, Ohm's Law

(A) 2.0 A

(B) 0.67 A

(C) 1.3 A

(D) 3.0 A

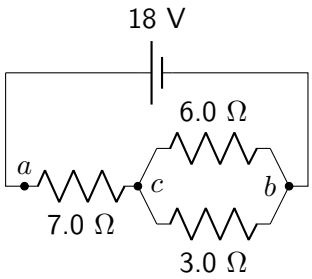
(E) 4.6 A

(F) 1.5 A

(G) 2.3 A

Points Per Response:

A:
B: 6
C: 3
D:
E:
F: 2
G:



9. (6 points) In the circuit diagram below, you know there is a 1.0 A current passing through the 1.0 Ω resistor moving to the left. The rectangular box represents an unknown battery with emf $\mathcal{E}$. What is the unknown emf and which side of it is the positive terminal?

The concepts necessary to solve this problem correctly: Kirchoff's Loop and Junction Rules

(A) 5.0 V with the positive terminal on the left

(B) 5.0 V with the positive terminal on the right

(C) 9.0 V with the positive terminal on the left

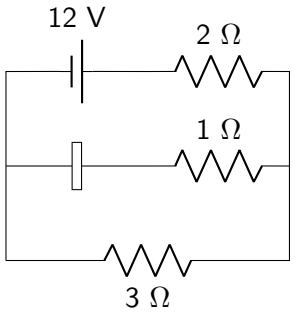
(D) 9.0 V with the positive terminal on the right

(E) 7.0 V with the positive terminal on the left

(F) 7.0 V with the positive terminal on the right

Points Per Response:

A: 4
B: 6
C: 1
D: 2
E:
F:



10. (6 points) Assume the switch below is closed. After a long time, which of the following will affect the final voltage across the capacitor?

The concepts necessary to solve this problem correctly: Time dependence of RC-circuits, Kirchoff's Loop and Junction Rules

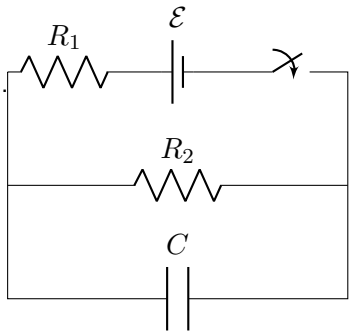
(A) The emf, $\mathcal{E}$, and only the resistance R_1.

(B) The emf, $\mathcal{E}$, and only the resistance R_2.

(C) The emf, $\mathcal{E}$, and only the capacitance C.

(D) The emf, $\mathcal{E}$, and both resistances R_1 and R_2.

(E) The emf, $\mathcal{E}$, the capacitance C and both the resistances R_1 and R_2.



Points Per Response:
A: 4
B:
C:
D: 6
E: 2

11. (6 points) In the circuit below all capacitors are uncharged and the switch has been open for a long time. At $t = 0$ the switch is closed. What is the potential difference $V_a - V_b$ between a and b after the switch has been closed for a long time.

The concepts necessary to solve this problem correctly: Effective Capacitance, Time dependence of RC-circuits, Potential difference between points in a circuit

(A) +8 V

(B) -8 V

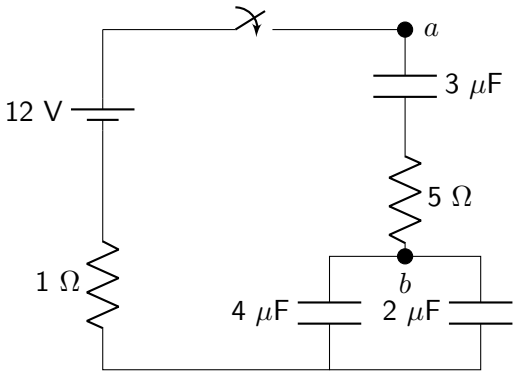
(C) +4 V

(D) -4 V

(E) +12 V

(F) -12 V

(G) 0 V



Points Per Response:
A: 6
B: 4
C:
D:
E:
F:
G:

12. (4 points) Two identically shaped parallel plate capacitors are connected in parallel to a battery and stay connected to that battery. One is filled with a dielectric with constant κ, the other is filled with air. What is the change in charge collected on C_1 if the dielectric is removed from C_1 and inserted into C_2?

The concepts necessary to solve this problem correctly: Capacitors with dielectrics, definition of capacitance, Definition of elements in parallel

(A) The charge on C_1 increases by a factor of κ

(B) The charge on C_1 decreases by a factor of κ

(C) The charge on C_1 increases by a factor of κ^2

(D) The charge on C_1 decreases by a factor of κ^2

(E) The amount of charge on C_1 will not change

Points Per Response:

A: 1
B: 4
C:
D:
E:

13. (4 points) In the previous problem, what is the change in the *total charge* delivered by the battery to the circuit?

The concepts necessary to solve this problem correctly: Capacitors with dielectrics, definition of capacitance, Definition of elements in parallel

(A) The total charge increases by a factor of κ

(B) The total charge decreases by a factor of κ

(C) The total charge increases by a factor of κ^2

(D) The total charge decreases by a factor of κ^2

(E) The total charge will not change

Points Per Response:

A:
B:
C:
D:
E: 4

14. (6 points) A 5.0 μF capacitor is fully charged by a 12 V battery and then disconnected from the battery. The capacitor is then connected in parallel to an unknown capacitor that is initially uncharged. After reaching equilibrium, it is found that the potential difference across this unkonwn capacitor is 3.0 V. What is the capacitance of the unknown capacitor?

The concepts necessary to solve this problem correctly: Capacitors with dielectrics, definition of capacitance, Definition of elements in parallel

(A) 15 μF

(B) 5 μF

(C) 10 μF

(D) 20 μF

(E) 25 μF

Points Per Response:
A: 6
B:
C: 2
D: 2
E:

15. (8 points) A bar has a radius of 1.00 cm and a length of 50.0 cm. It was constructed so that it is entirely copper at one end, zinc at the other and linearly changes composition along the way. The resistivity can be given by the function $\rho(x) = \rho_0 + ax$ where $\rho_0 = 1.68 \times 10^{-8}$ Ωm and $a = 8.44 \times 10^{-8}$ Ω. What is the resistance of this bar?

The concepts necessary to solve this problem correctly: Resistance with varying resistivity

(A) 6.03×10^{-5} Ω

(B) 1.90×10^{-8} Ω

(C) 9.39×10^{-5} Ω

(D) 5.90×10^{-8} Ω

Points Per Response:
A: 8
B: 4
C: 4
D:

16. (6 points) The current through the cross section of a conductor is given by the formula $I_0 e^{-\alpha t}$ where $I_0 = 8.00$ mA and $\alpha = 0.200$ s^{-1}. What is the magnitude of charge that passes through this cross section between $t = 3.00$ and $t = 9.00$ s?

The concepts necessary to solve this problem correctly: Definition of current

(A) 15.3 mC

(B) 3.07 mC

(C) 2.41 mC

(D) 9.91 mC

(E) 4.89 mC

(F) 12.7 mC

Points Per Response:
A: 6
B: 4
C: 3
D:
E:
F:

17. (6 points) In the previous problem, assume that the provided function is the current in a simple RC series circuit. If the battery was supplying an emf of 24.0 V, what was the effective capacitance of the circuit?

The concepts necessary to solve this problem correctly: Time dependence of RC-circuits

(A) 1670 μF

(B) 66.7 μF

(C) 114 μF

(D) 4.85 μF

Points Per Response:
A: 6
B: 4
C:
D: