

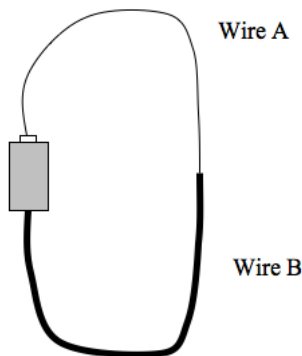
Numeric answers must include units. Sketches must be labeled. All short-answer questions must include your reasoning, for full credit. A correct answer with no reasoning will only receive partial credit.

Resistance of a wire: $R = \frac{\rho L}{A}$

Section 1. Multiple Choice

1. A current of 0.5 A flows through a resistor. How many electrons flow through the resistor in 1 second?
 - (a) 1 electron
 - (b) 1.6×10^{-19} electrons
 - (c) 6.25×10^{18} electrons
 - (d) 3.125×10^{18} electrons
 - (e) 1.6×10^{19} electrons

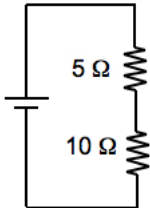
Questions 2-3: Two wires of the same length are connected in series to a battery, as shown below. Wire B has a cross-sectional area that is twice the cross-sectional area of Wire A.



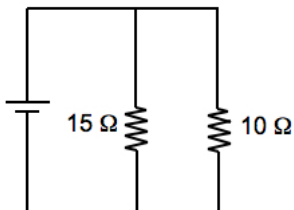
2. Which wire has a greater resistance?
 - (a) Wire A
 - (b) Wire B
 - (c) Neither. They have the same resistance since they have the same length.
3. The current through Wire B is
 - (a) twice the current through Wire A.
 - (b) half the current through Wire A.
 - (c) four times the current through Wire A.
 - (d) one-fourth the current through Wire A.
 - (e) equal to the current through Wire A.
4. A 5Ω bulb and a 10Ω bulb are connected in series with a 1.5 V battery. Which bulb will be brighter?
 - (a) 5Ω bulb
 - (b) 10Ω bulb
 - (c) Neither; they will have the same brightness

5. A $5\ \Omega$ bulb and a $10\ \Omega$ bulb are connected in parallel with a $1.5\ \text{V}$ battery. Which bulb will be brighter?
- (a) $5\ \Omega$ bulb
 - (b) $10\ \Omega$ bulb
 - (c) Neither; they will have the same brightness

6. What is the equivalent resistance of the resistors shown below?

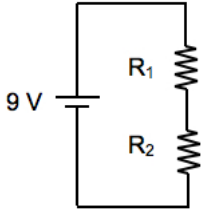


- (a) $0.3\ \Omega$
 - (b) $5\ \Omega$
 - (c) $3.3\ \Omega$
 - (d) $15\ \Omega$
 - (e) $25\ \Omega$
7. For the circuit in the previous question, if you add a third resistor in series with those shown, the current through the battery will
- (a) be more than with the two resistors
 - (b) be less than with the two resistors
 - (c) stay the same as with the two resistors
8. What is the equivalent resistance of the resistors shown below?

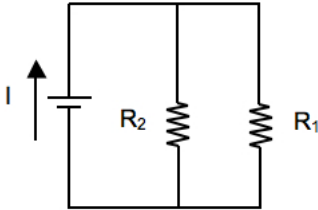


- (a) $1/6\ \Omega$
 - (b) $5\ \Omega$
 - (c) $6\ \Omega$
 - (d) $15\ \Omega$
 - (e) $25\ \Omega$
9. For the circuit in the previous question, if you add a third resistor in parallel with those shown, the current through the battery will
- (a) be more than with the two resistors
 - (b) stay the same as with the two resistors
 - (c) be less than with the two resistors

10. For the resistors in the circuit below, $\Delta V_2 = 2.0$ V. What is ΔV_1 ?

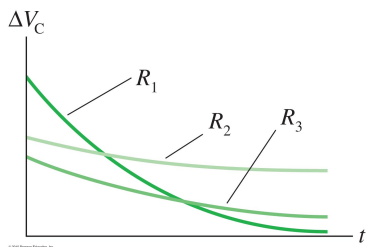


- (a) 11.0 V
(b) 2.0 V
(c) 9.0 V
(d) 7.0 V
(e) 4.0 V
11. For the circuit in the previous question, if the current through R_1 is 0.1 A, then the current through R_2 is
- (a) less than 0.1 A
(b) greater than 0.1 A
(c) 0.1 A
12. For the resistors in the circuit below, the current flowing through the battery is 0.05 A. If the current through R_2 is 0.02 A, what is the current through R_1 ?



- (a) 0.07 A
(b) 0.02 A
(c) 0.05 A
(d) 0.04 A
(e) 0.03 A
13. For the circuit in the previous question, if the voltage across the battery is 3.0 V, the voltage across R_2 is
- (a) less than 3.0 V
(b) greater than 3.0 V
(c) 3.0 V

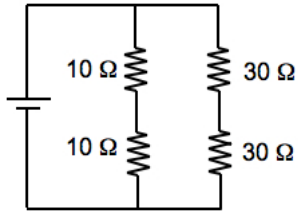
14. In an experiment, the voltage across a discharging capacitor is graphed as a function of time. The resistance in the circuit is changed, and the experiment is repeated. A graph of ΔV_C vs. t for three different resistances is shown below.



- Rank, in order from largest to smallest, the values of the resistances R_1 , R_2 , and R_3 .
- $R_1 > R_2 > R_3$
 - $R_3 > R_2 > R_1$
 - $R_2 > R_1 > R_3$
 - $R_1 > R_3 > R_2$
 - $R_2 > R_3 > R_1$
15. Suppose that you use a $10\ \Omega$ bulb when charging a $1\ \text{F}$ capacitor, and you measure the time required to charge the capacitor. You then disconnect the charged capacitor from the circuit and connect it to a $5\ \Omega$ bulb, and it discharges. The time it takes to discharge through the $5\ \Omega$ bulb will be
- greater than the time it took to charge through the $10\ \Omega$ bulb.
 - less than the time it took to charge through the $10\ \Omega$ bulb.
 - equal to the time it took to charge through the $10\ \Omega$ bulb.

Section 2. Problem Solving

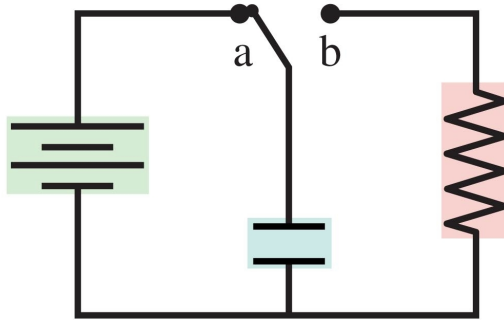
16. (a) What is the equivalent resistance of the circuit below?



- (b) What is the current through the battery if the voltage across the battery is $4.5\ \text{V}$?

- (c) What is the current through each resistor?

17. A 0.5 F capacitor is charged by connecting it in series with a 1.5 V battery (when the switch is in position a). Then, the capacitor is disconnected from the battery and is connected to a $10.0 \text{ }\Omega$ light bulb (when the switch is in position b). The capacitor is fully charged when it is connected to the light bulb. Assume that the light bulb is an ohmic resistor and thus obeys Ohm's law.



(a) Sketch charge on the top plate and on the bottom plate to show which plate is positively charged and which plate is negatively charged.

(b) What is the initial voltage across the capacitor when it is connected to the light bulb?

(c) What is the time constant τ for this circuit?

(d) What is the voltage across the capacitor at $t = 5 \text{ s}$?

Answer Key for Exam A

Section 1. Multiple Choice

- | | |
|--------|---------|
| 1. (d) | 9. (a) |
| 2. (a) | 10. (d) |
| 3. (e) | 11. (c) |
| 4. (b) | 12. (e) |
| 5. (a) | 13. (c) |
| 6. (d) | 14. (e) |
| 7. (b) | 15. (b) |
| 8. (c) | |

Section 2. Problem Solving

16.

17.