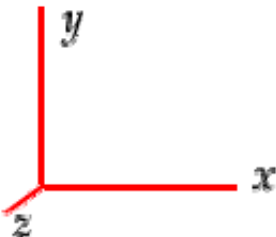
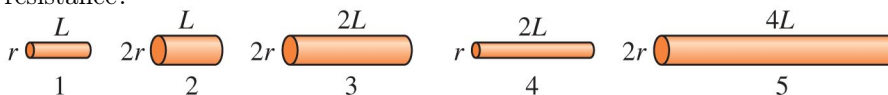


To specify directions, use the coordinate system shown below where  $+x$  is to the right,  $+y$  is toward the top of the page, and  $+z$  is out of the page.



Section 1. Multiple Choice

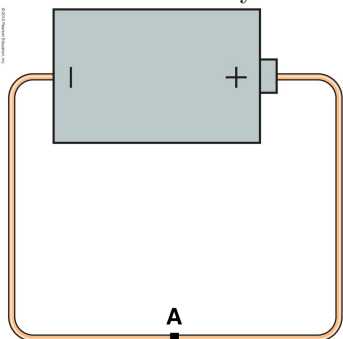
1. The wires shown below copper wires of varying length and diameter. Which wire has the largest resistance?



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- (a) Wire 1
- (b) Wire 2
- (c) Wire 3
- (d) Wire 4
- (e) Wire 5

Questions 2-4: A battery is connected to a copper wire as shown below.

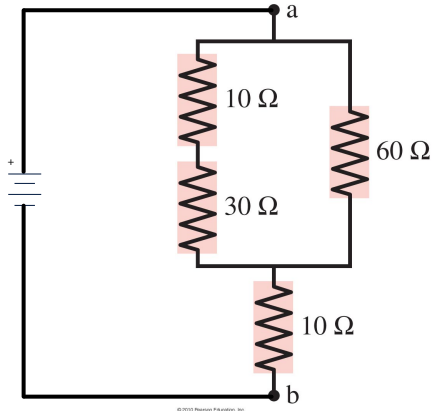


- 2. At point A in the wire, what is the direction of the velocity of a mobile electron in the wire?
  - (a) to the left
  - (b) to the right
  - (c) neither, because its velocity is zero
- 3. At point A, what is the direction of the electric field within the wire (due to surface charge on the wire) that pushes electrons through the wire?
  - (a) to the left
  - (b) to the right
  - (c) neither, because the electric field is zero

4. If 2 A of current flows past point A, how many mobile electrons flow past point A in one second?
- (a) 2 electrons
  - (b) 0.5 electrons
  - (c)  $3.2 \times 10^{-19}$  electrons
  - (d)  $6.25 \times 10^{18}$  electrons
  - (e)  $1.25 \times 10^{19}$  electrons

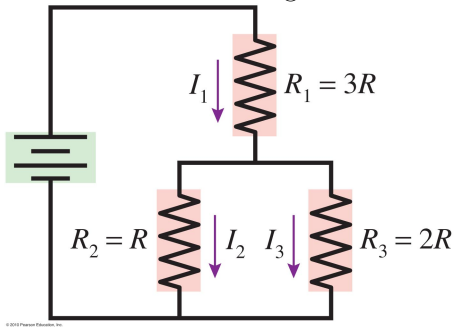
Questions 5–6:

5. What is the equivalent resistance in the following circuit?



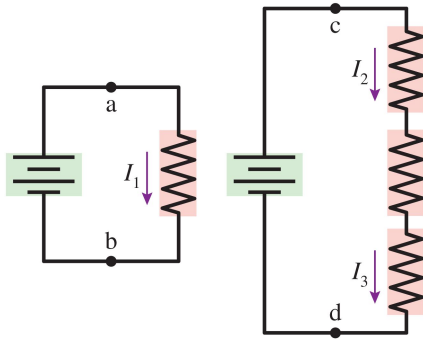
- (a) 110  $\Omega$
  - (b) 9.1  $\Omega$
  - (c) 25  $\Omega$
  - (d) 78  $\Omega$
  - (e) 34  $\Omega$
6. Through which resistor(s) is the current the greatest?
- (a) the 30  $\Omega$  resistor and the 10  $\Omega$  resistor that is connected to point a
  - (b) the 60  $\Omega$  resistor
  - (c) 10  $\Omega$  resistor that is connected to point b
  - (d) Both (a) and (b)
  - (e) The current is the same through all of them.
7. Which of these laws is a result of Conservation of Energy?
- (a) Kirchhoff's Current Law
  - (b) Kirchhoff's Voltage Law
  - (c) Both (a) and (b)
  - (d) Neither (a) nor (b)

8. Which current is the largest?



- (a)  $I_1$
- (b)  $I_2$
- (c)  $I_3$
- (d)  $I_2 = I_3$  which are greater than  $I_1$
- (e) None of the above because they are all equal.

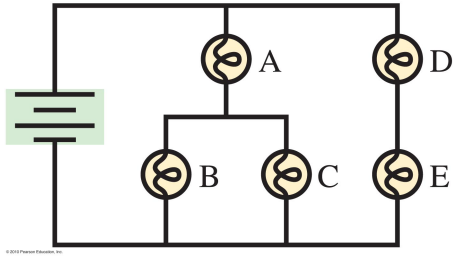
9. In the following two circuits, the batteries are identical, and the resistors are identical.



Which current is the smallest?

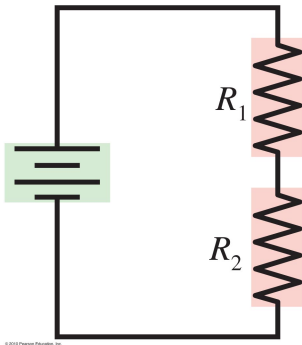
- (a)  $I_1$
- (b)  $I_2$
- (c)  $I_3$
- (d)  $I_2 = I_3$ , which is less than  $I_1$
- (e) None of the above because they are all equal.

10. Which of these identical bulbs will be brightest?



- (a) A
- (b) B
- (c) C
- (d) D
- (e) D and E are equally bright and are the brightest
- (f) B and C are equally bright and are the brightest
- (g) All bulbs have the same brightness.

Questions 11–12: In the circuit below, the voltage across the battery is 5 V,  $R_1 = 10 \Omega$ , and  $R_2 = 15 \Omega$ .



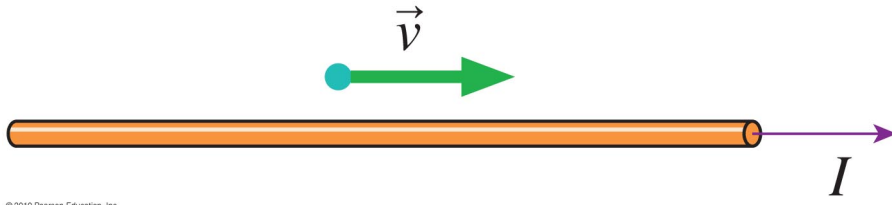
11. What is the voltage across  $R_1$ ?

- (a) 1.5 V
- (b) 2.0 V
- (c) 2.5 V
- (d) 3.0 V
- (e) 5.0 V

12. What is the current through  $R_1$ ?

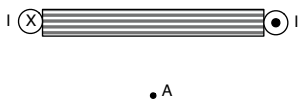
- (a) 0.08 A
- (b) 0.12 A
- (c) 0.2 A
- (d) 0.33 A
- (e) 0.5 A

Questions 13–15: Current flows through a wire as shown below. Near the wire, a positively charged ion travels in the direction shown.



13. What is the direction of the magnetic field due to the wire at the location of the ion?
- $+x$
  - $-x$
  - $+y$
  - $-y$
  - $+z$
  - $-z$
14. What is the direction of the magnetic force on the ion due to the wire?
- $+x$
  - $-x$
  - $+y$
  - $-y$
  - $+z$
  - $-z$
15. If the ion is 1 cm from the wire and 2 A of current flows in the wire, what is the magnitude of the magnetic field at the location of the ion?
- $4.0 \times 10^{-7}$  T
  - $1.6 \times 10^{-8}$  T
  - $4.0 \times 10^{-5}$  T
  - $1.6 \times 10^{-6}$  T
  - $1.3 \times 10^{-4}$  T
16. The magnetic field at the center of a 1.0-cm diameter loop is 2.5 mT. What is the current in the loop?
- $2.0 \times 10^4$  A
  - 250 A
  - 63 A
  - 4000 A
  - 20 A

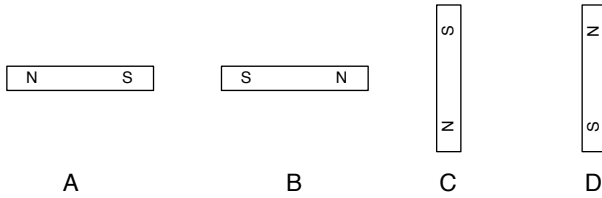
Questions 17–18: A constant current flows through the coil shown in a top view below.



17. What is the direction of the magnetic field at location A that is along the axis of the coil?

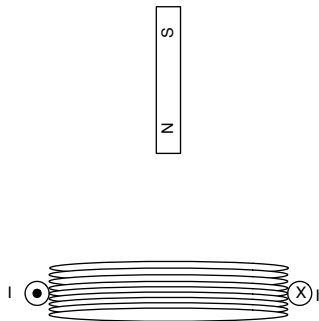
- (a)  $+x$
- (b)  $-x$
- (c)  $+y$
- (d)  $-y$
- (e)  $+z$
- (f)  $-z$

18. If you model the electromagnet above as a magnetic dipole, which picture below shows the orientation of the poles of the coil?



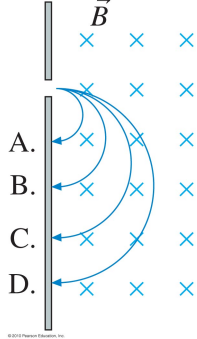
- (a) A
- (b) B
- (c) C
- (d) D

19. A current-carrying coil and magnet are shown below. The coil is shown from a top view, and the magnet lies along the axis of the coil. Will the coil and magnet attract or repel?



- (a) attract
- (b) repel
- (c) neither; they will not exert forces on each other

20. The figure below shows four particles moving to the right as they enter a region of uniform magnetic field. All particles move at the same speed and have the same charge.



Are the particles negatively charged or positively charged?

- (a) negatively charged
- (b) positively charged
- (c) neither; they are neutral
- (d) It cannot be determined from the picture alone.

# Answer Key for Exam A

## Section 1. Multiple Choice

- |         |         |
|---------|---------|
| 1. (d)  | 11. (b) |
| 2. (b)  | 12. (c) |
| 3. (a)  | 13. (e) |
| 4. (e)  | 14. (d) |
| 5. (e)  | 15. (c) |
| 6. (c)  | 16. (e) |
| 7. (b)  | 17. (d) |
| 8. (a)  | 18. (c) |
| 9. (d)  | 19. (b) |
| 10. (a) | 20. (a) |