

Inventory of Basic Conceptions in DC Circuits

Dear Student:

The Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET) at Arizona State University (ASU) is conducting a research study to determine how student performance in particular courses compares across instructional settings, schools, colleges and universities. We are requesting that you participate by taking the attached test following the instructions given below.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty (it will not affect your grade). The results of the research study may be published, but your identity will never be disclosed to any party.

*If you have any questions concerning the research study, please contact CRESMET at:
(480) 965-7820.*

Return of the questionnaire will be considered your consent to participate.

Please:

*Do **not write** anything on this questionnaire.*

*Mark your answers on the NCS Pearson **answer sheet**, and follow marking instructions given on the back side of this sheet.*

*Follow instructions given by your teacher to fill in your **Name and/or other personal information** on the left side of the front page of the answer sheet.*

*Mark **only one** answer per test item, starting with Item 1 on the answer sheet.*

*Answer **all questions** to the best of your knowledge. Do not skip any question.*

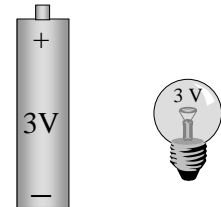
*Avoid guessing. Your answers should reflect what **you** actually and honestly think.*

*For efficient performance, read first the stem of an item and answer the question the way you know it **before** reading the provided alternatives marked (A) through (E). Once you have answered the question your way, read the provided alternatives and choose the one that best matches your own answer.*

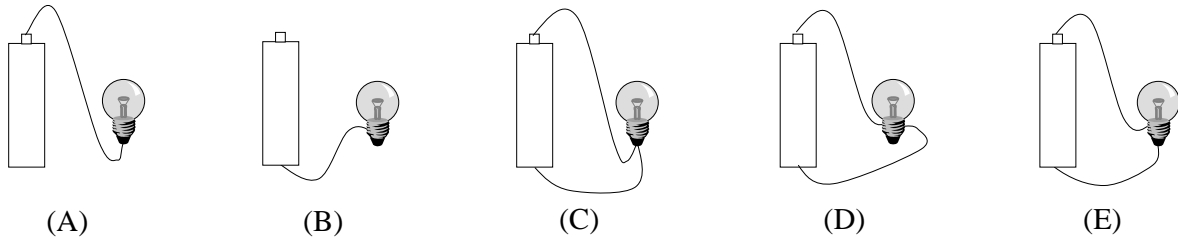
Plan to finish the test in 25 minutes.

Thank You.

The figure at right shows a real 3-V incandescent light bulb and a real 3-V dry cell battery.



1. Which of the figures below shows the most appropriate wiring for the bulb to light up?



2. Which of the following filament features affect(s) the brightness of the bulb in question 1:
- (A) The material that the filament is made of.
 - (B) The length of the filament.
 - (C) The thickness of the filament.
 - (D) (A) and (B).
 - (E) (A), (B) and (C).

* * *

The light bulb of question 1 is replaced by another 3-V real bulb of greater internal resistance. The new bulb is appropriately connected to the same 3-V dry cell battery so that it may light up if possible.

3. By comparison to the original light bulb of question 1, the new bulb:
- (A) does not light up at all.
 - (B) lights up with less brightness.
 - (C) lights up with about the same brightness.
 - (D) lights up with more brightness.
 - (E) (A) or (B), depending on the internal resistance of the new bulb.
4. By comparison to the original light bulb of question 1, the electric power consumed by the new bulb is:
- (A) zero.
 - (B) smaller.
 - (C) the same.
 - (D) bigger.
 - (E) (A) or (B), depending on the internal resistance of the new bulb.
5. By comparison to the original light bulb of question 1, the electric potential difference (voltage) across the new bulb is:
- (A) zero.
 - (B) smaller.
 - (C) the same.
 - (D) bigger.
 - (E) (A) or (B), depending on the internal resistance of the new bulb.
6. By comparison to the original light bulb of question 1, the electric current that flows through the new bulb is:
- (A) zero.
 - (B) smaller.
 - (C) the same.
 - (D) bigger.
 - (E) (A) or (B), depending on the internal resistance of the new bulb.

* * *

7. The 3-V bulb of question 1 is connected to a 1.5-V dry cell battery instead of the original 3-V battery. By comparison to the situation in question 1, the bulb will now:
- (A) light up weaker than before.
 - (B) light up as strong as before.
 - (C) light up stronger than before.
 - (D) eventually burn up (the filament inside breaks apart).
 - (E) not light up (without burning up).

* * *

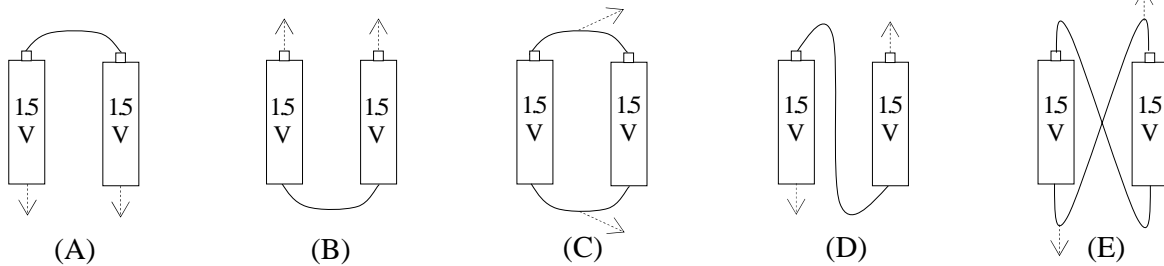
8. The 3-V bulb of question 1 is connected to a 9-V dry cell battery instead of the original 3-V battery. By comparison to the situation in question 1, the bulb will now:
- (A) light up weaker than before.
 - (B) light up as strong as before.
 - (C) light up stronger than before.
 - (D) eventually burn up (the filament inside breaks apart).
 - (E) not light up (without burning up).

* * *

9. The 3-V bulb of question 1 is now connected to two dry cell batteries, each rated 1.5 V, instead of the single 3-V battery.

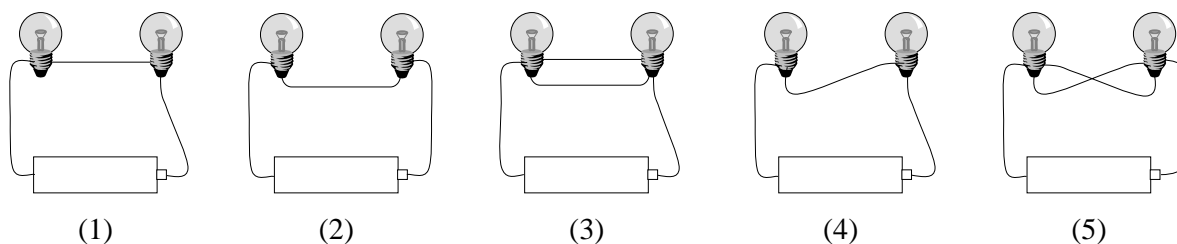
Which of the figures below shows best how to connect the two replacement batteries so that the 3-V bulb lights up as bright as it did in question 1?

(Dashed arrows represent electric wires that you may choose from to connect the light bulb)



* * *

Two identical light bulbs are connected in five different ways to a single dry cell battery as shown below.

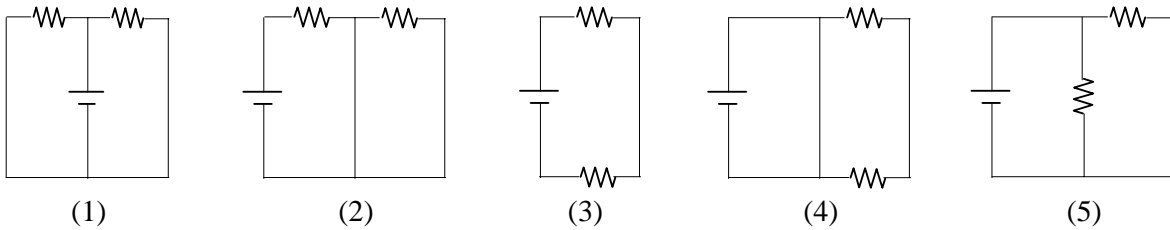


10. Which of the above diagrams show(s) the two bulbs connected in series with the battery?
- (A) 1.
 - (B) 4.
 - (C) 1 and 4.
 - (D) 2 and 4.
 - (E) 1, 2 and 4.

11. Which of the above diagrams show(s) the two bulbs connected in parallel with the battery?
 (A) 2.
 (B) 3
 (C) 2 and 3.
 (D) 3 and 5.
 (E) 2, 3 and 5.

* * *

Each of the five diagrams below shows two resistors connected in a special way to a dry cell battery. W represents a resistor; — represents a battery.



12. Which of the above diagrams represent(s) two resistors in series with the battery?
 (A) 1 and 2.
 (B) 3
 (C) 3 and 4.
 (D) 3 and 5.
 (E) 3, 4 and 5.

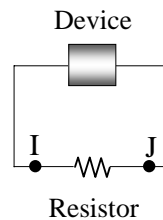
13. Which of the above diagrams represent(s) two resistors in parallel with the battery?
 (A) 1 and 2.
 (B) 5.
 (C) 1 and 5.
 (D) 2 and 5.
 (E) 1, 2 and 5.

14. Aside from a resistor, the symbol W in the above five diagrams may represent:
 (A) a light bulb.
 (B) a battery operated toy.
 (C) a portable radio set.
 (D) any of the above three objects.
 (E) none of the above three objects.

* * *

The figure at right shows a resistor connected to an electric device. I and J are two points on the connection wires located on opposite sides of the resistor. The device may bring about any of the following situations:

- (1) Let electrons go in but not out of the resistor.
 (2) Let electrons go in and out of the resistor.
 (3) Have the same electric potential at points I and J.
 (4) Have an electric potential difference (voltage) between points I and J.

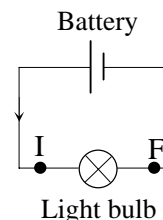


15. Which of the situations above may cause an electric current to flow through the resistor?
 (A) 1 and 3.
 (B) 2 and 3.
 (C) 2 and 4.
 (D) 1, 2 and 3.
 (E) 2, 3, and 4.

16. The situation that you chose in question 15 is maintained so as to keep the electric current flowing through the resistor. After a long while, the device is shut off. The current then:
- (A) keeps flowing at a constant rate through the resistor.
 - (B) keeps flowing at a constant rate for awhile, it then starts gradually dropping off to zero.
 - (C) immediately stops flowing through the resistor.
 - (D) starts gradually dropping off to zero.
 - (E) cannot be determined from the given information.

* * *

The figure at right shows a light bulb connected to a dry cell battery. I and F are two points on the connection wires located on opposite sides of the bulb. The arrow indicates the direction in which electric current flows.

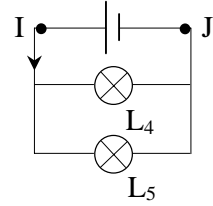
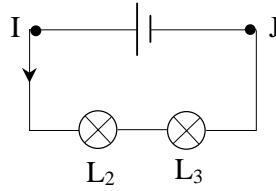
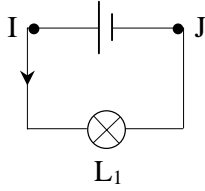


17. Which of the statements below describes best the electric current and electric potential at points I and F?
- (A) Both electric current and electric potential are smaller at F than at I.
 - (B) The electric current is about the same at F and I; the electric potential is smaller at F than at I.
 - (C) The electric current is about the same at F and I; the electric potential is greater at F than at I.
 - (D) The electric current is smaller at F than at I; the electric potential is about the same at these two points.
 - (E) Both electric current and electric potential are about the same at F and I.
18. When the bulb is connected to the battery as shown in the above diagram:
- (A) electrons flow in the circuit almost as fast as light.
 - (B) protons flow in the circuit almost as fast as light.
 - (C) electrons flow in the circuit considerably slower than light.
 - (D) protons flow in the circuit considerably slower than light.
 - (E) electrons and protons flow in the circuit considerably slower than light.
19. Charged particles identified in question 18 (electrons and/or protons):
- (A) are discharged from one end of the battery and into the bulb where all such charges are stored.
 - (B) are discharged from one end of the battery and into the bulb where all such charges are used up.
 - (C) are discharged from one end of the battery and into the bulb; some of these charges are stored in the bulb and the rest flow out in the circuit.
 - (D) are discharged from one end of the battery and into the bulb; some of these charges get used up in the bulb and the rest flow out in the circuit.
 - (E) flow continuously between the two ends of the battery and through the bulb; they are virtually neither stored nor used up in the bulb.

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The three diagrams below show circuits containing dry cell batteries and light bulbs. The five light bulbs are identical. The batteries maintain the same electric potential at the three points I, as well as at the three points J. Arrows indicate the direction in which electric current flows out of the batteries.

Bulbs L_2 and L_3 in the middle diagram are connected in series. Bulbs L_4 and L_5 in the right-hand diagram are connected in parallel.



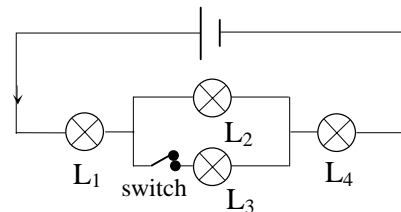
20. How bright bulbs L_2 and L_3 light up relative to each other and to bulb L_1 ?
- (A) L_2 and L_3 light up about as strong as one another, and about as strong as L_1 .
 (B) L_2 and L_3 light up about as strong as one another; L_1 lights up weaker than either L_2 or L_3 .
 (C) L_2 and L_3 light up about as strong as one another; L_1 lights up stronger than either L_2 or L_3 .
 (D) L_2 lights up weaker than L_3 ; L_1 lights up not necessarily as strong as either L_2 or L_3 .
 (E) L_2 lights up stronger than L_3 ; L_1 lights up not necessarily as strong as either L_2 or L_3 .
21. How bright bulbs L_4 and L_5 light up relative to each other and to bulb L_1 ?
- (A) L_4 and L_5 light up about as strong as one another, and about as strong as L_1 .
 (B) L_4 and L_5 light up about as strong as one another; L_1 lights up weaker than either L_4 or L_5 .
 (C) L_4 and L_5 light up about as strong as one another; L_1 lights up stronger than either L_4 or L_5 .
 (D) L_4 lights up weaker than L_5 ; L_1 lights up not necessarily as strong as either L_4 or L_5 .
 (E) L_4 lights up stronger than L_5 ; L_1 lights up not necessarily as strong as either L_4 or L_5 .
22. How are the electric currents through bulbs L_2 and L_3 relative to each other and to the current through bulb L_1 ?
- (A) About the same current flows through L_2 and L_3 ; this current is about the same as the one that flows through L_1 .
 (B) About the same current flows through L_2 and L_3 ; less current flows through L_1 than through either L_2 or L_3 .
 (C) About the same current flows through L_2 and L_3 ; more current flows through L_1 than through either L_2 or L_3 .
 (D) Less current flows through L_2 than through L_3 ; the current that flows through L_1 is not necessarily the same as the one that flows through either L_2 or L_3 .
 (E) More current flows through L_2 than through L_3 ; the current that flows through L_1 is not necessarily the same as the one that flows through either L_2 or L_3 .
23. How are the electric currents through bulbs L_4 and L_5 relative to each other and to the current through bulb L_1 ?
- (A) About the same current flows through L_4 and L_5 ; this current is about the same as the one that flows through L_1 .
 (B) About the same current flows through L_4 and L_5 ; less current flows through L_1 than through either L_4 or L_5 .
 (C) About the same current flows through L_4 and L_5 ; more current flows through L_1 than through either L_4 or L_5 .
 (D) Less current flows through L_4 than through L_5 ; the current that flows through L_1 is not necessarily the same as the one that flows through either L_4 or L_5 .
 (E) More current flows through L_4 than through L_5 ; the current that flows through L_1 is not necessarily the same as the one that flows through either L_4 or L_5 .

24. How are the electric potential differences (voltage) across bulbs L_2 and L_3 relative to each other and to the electric potential difference across bulb L_1 ?
- (A) About the same potential difference exists across L_2 and L_3 ; this potential difference is about the same as the one across L_1 .
 - (B) About the same potential difference exists across L_2 and L_3 ; a lower potential difference exists across L_1 than across either L_2 or L_3 .
 - (C) About the same potential difference exists across L_2 and L_3 ; a higher potential difference exists across L_1 than across either L_2 or L_3 .
 - (D) A lower potential difference exists across L_2 than across L_3 ; the potential difference across L_1 is not necessarily the same as the one across either L_2 or L_3 .
 - (E) A higher potential difference exists across L_2 than across L_3 ; the potential difference across L_1 is not necessarily the same as the one across either L_2 or L_3 .
25. How are the electric potential differences (voltage) across bulbs L_4 and L_5 relative to each other and to the electric potential difference across bulb L_1 ?
- (A) About the same potential difference exists across L_4 and L_5 ; this potential difference is about the same as the one across L_1 .
 - (B) About the same potential difference exists across L_4 and L_5 ; a lower potential difference exists across L_1 than across either L_4 or L_5 .
 - (C) About the same potential difference exists across L_4 and L_5 ; a higher potential difference exists across L_1 than across either L_4 or L_5 .
 - (D) A lower potential difference exists across L_4 than across L_5 ; the potential difference across L_1 is not necessarily the same as the one across either L_4 or L_5 .
 - (E) A higher potential difference exists across L_4 than across L_5 ; the potential difference across L_1 is not necessarily the same as the one across either L_4 or L_5 .
26. Which of the following statements best describes the situation in the middle diagram that contains bulbs L_2 and L_3 :
- (A) The electric current at I equals the sum of electric currents through L_2 and L_3 .
 - (B) The electric potential difference (voltage) between I and J equals the sum of electric potential differences across L_2 and L_3 .
 - (C) (A) and (B).
 - (D) The likelihood of either (A) or (B) depends on the internal resistance of each bulb.
 - (E) Neither (A) nor (B).
27. Which of the following statements best describes the situation in the right-hand diagram that contains bulbs L_4 and L_5 :
- (A) The electric current at I equals the sum of electric currents through L_4 and L_5 .
 - (B) The electric potential difference (voltage) between I and J equals the sum of electric potential differences across L_4 and L_5 .
 - (C) (A) and (B).
 - (D) The likelihood of either (A) or (B) depends on the internal resistance of each bulb.
 - (E) Neither (A) nor (B).

28. In order to measure the electric current flowing through L_1 , one can insert an ammeter:
- instead of L_2 in the circuit of the middle diagram that contains L_2 and L_3 .
 - instead of either L_2 or L_3 in the circuit of the middle diagram.
 - instead of L_5 in the circuit of the right-hand diagram that contains L_4 and L_5 .
 - instead of either L_4 or L_5 in the circuit of the right-hand diagram.
 - in none of the places mentioned above.
29. In order to measure the electric potential difference across L_1 , one can insert a voltmeter:
- instead of L_2 in the circuit of the middle diagram that contains L_2 and L_3 .
 - instead of either L_2 or L_3 in the circuit of the middle diagram.
 - instead of L_5 in the circuit of the right-hand diagram that contains L_4 and L_5 .
 - instead of either L_4 or L_5 in the circuit of the right-hand diagram.
 - in none of the places mentioned above.
30. If bulb L_2 burns up (the filament inside breaks apart), bulb L_3 :
- remains lit, almost as bright as before.
 - remains lit, but brighter than before.
 - remains lit, but dimmer than before.
 - starts gradually dimming down until it goes off.
 - does not light up at all.
31. If bulb L_4 burns up (the filament inside breaks apart), bulb L_5 :
- remains lit, almost as bright as before.
 - remains lit, but brighter than before.
 - remains lit, but dimmer than before.
 - starts getting brighter and brighter, and may eventually burn up.
 - does not light up at all.

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Four identical light bulbs are connected as shown to a dry cell battery. All bulbs light up when the switch at the left of bulb L_3 is closed. The arrow indicates the direction in which electric current flows.



32. How is the relative brightness of the four bulbs?
- All four bulbs light up with about the same brightness.
 - L_1 lights up the strongest, followed, and in this order, by L_2 , L_3 , and then L_4 [roughly speaking, in luminosity terms: $L_1 > L_2 > L_3 > L_4$].
 - L_1 lights up the strongest, followed, and in this order, by L_2 , L_4 , and then L_3 [$L_1 > L_2 > L_4 > L_3$].
 - L_1 lights up the strongest, followed by L_2 that lights up almost as strong as L_3 , and then by L_4 that lights up the weakest [$L_1 > (L_2 = L_3) > L_4$].
 - L_1 lights up almost as strong as L_4 ; L_2 lights up almost as strong as L_3 ; L_1 lights up stronger than L_2 [$(L_1 = L_4) > (L_2 = L_3)$].
33. When the switch is open, which bulb(s) will go off?
- L_3 .
 - L_2 and L_3 .
 - L_3 and L_4 .
 - L_2 , L_3 and L_4 .
 - None of the above.

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