EXERCISES 5

Section A

1. Explain the difference between load resistance in a circuit and internal resistance in a battery.

2. Under what condition does the potential difference across the terminals of a battery equal its emf? Can the terminal voltage ever exceed the emf? Explain. Is the direction of current through a battery always from the negative terminal to the positive terminal? Explain.

4. How would you connect resistors so that the equivalent resistance is larger than the greatest individual resistance? Give an example involving three resistors.

5. How would you connect resistors so that the equivalent resistance is smaller than the least individual resistance? Give an example involving three resistors.

6. Given three lightbulbs and a battery, sketch as many different electric circuits as you can.

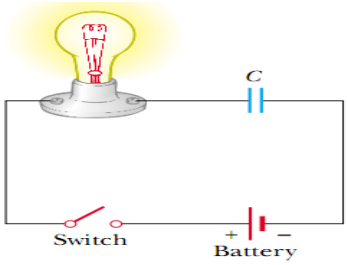
7. When resistors are connected in series, which of the following would be the same for each resistor: potential difference, current, power?

8. When resistors are connected in parallel, which of the following would be the same for each resistor: potential difference, current, power?

9. What advantage might there be in using two identical resistors in parallel connected in series with another identical parallel pair, rather than just using a single resistor?

10. When can the potential difference across a resistor be positive?

11. Referring to Figure, describe what happens to the lightbulb after the switch is closed. Assume that the capacitor has a large capacitance and is initially uncharged, and assume that the light illuminates when connected directly across the battery terminals.



12. What is the internal resistance of an ideal ammeter? Of an ideal voltmeter? Do real meters ever attain these ideals?

13. Embodied in Kirchhoff's rules are two conservation laws. What are they?

14. A series combination of three lightbulbs, all rated at 120 V with power ratings of 60 W, 75 W, and 200 W. Why is the 60W lamp the brightest and the 200W lamp the dimmest? Which bulb has the greatest resistance? How would their intensities differ if they were connected in parallel?

Section B

1. What is the voltage at terminals of a battery of emf 3V and internal resistance 0.3 Ω when sending a current of 1.5 A in a circuit?

2. Knowing that the voltage at terminals of a cell is 1.5V and the current crossing the circuit is 1.2 A. Find its emf if its internal resistance is of 0.4 Ω.

3. A generator of internal resistance 2Ω sends a current of 4A in a resistor of resistance 10Ω. Calculate its power.

4. An external resistance of 4Ω is connected to an electric cell of emf 1.5V and internal resistance 2Ω. Calculate the intensity of the current flowing the external resistance.

5. An electric cell of emf 1.5V and internal resistance 2Ω is connected in series with a resistance of 28Ω. Calculate the power dissipated as heat in the cell.

6. A certain number of cells of emf 1.5V and internal resistance 2Ω are connected in series. When connected this combination to an external resistance of 10Ω, a current of 500m. A flows in this resistance. Find the number of cells used.

7. Six cells of unknown emf and internal resistance of 2Ω are associated in parallel. When an external resistance of 1Ω is connected to this combination a current of 1.5A is produced. Calculate the emf.

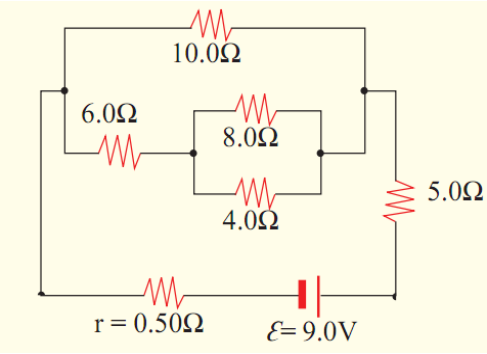
8. A battery has an emf of 12.0V and an internal resistance of 0.05Ω. Its terminals are connected to a load resistance of 3.00Ω.

a) Find the current in the circuit and the terminal voltage of the battery.

b) Calculate the power delivered to the load resistor, the power delivered to the internal resistance of the battery, and the power delivered by the battery.

9. Calculate the terminal voltage for a battery with an internal resistance of 0.9Ω and an emf of 8.5V when the battery is connected in series with (a) an 81Ω resistor, and (b) 810Ω.

10. A 9V battery whose internal resistance r is 0.5Ω is connected in the circuit shown in the figure.



a) How much current is drawn from the source?

b) What is the terminal voltage of the battery?

c) What is the current in the 6Ω resistor?

11. What is the internal resistance of a 12V car battery whose terminal voltage drops to 8.4V when the starter draws 75A? What is the resistance of the starter?

12. A 1.5V dry cell can be tested by connecting it to a low-resistance Ammeter. It should be able to supply at least 22A. What is the internal resistance of the cell in this case, assuming it is much greater than that of the Ammeter?

13. A cell whose terminals are connected to a wire in nickel silver o resistivity 30 x 10^{-6}Ωcm and cross sectional area 0.25mm^2 and length 5m sends a current of 160mA. When the length is reduced to a half, the intensity of the current is of 300mA. Calculate:

a) The internal resistance.

b) The emf of the cell.

14. A cell (E = 1.5V, r = 1.3Ω) sends a current in an external resistance of 3Ω. Calculate:

a) The intensity of the current in the circuit.

b) The p.d at terminals of the cell.

c) The power of generator.

d) The efficiency of the cell.

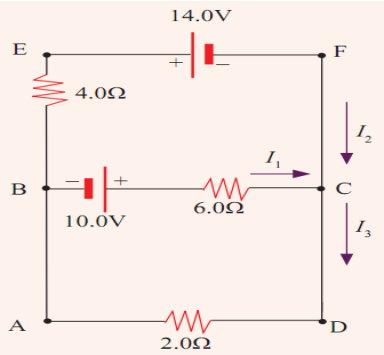
15. A battery is composed by 120 cells in series. Each element has an emf of 2V and an internal resistance of 0.001Ω. The combination is connected to an external resistance of 4.8Ω. Calculate:

a) The intensity of the current in the circuit.

b) The voltage at terminals of the battery.

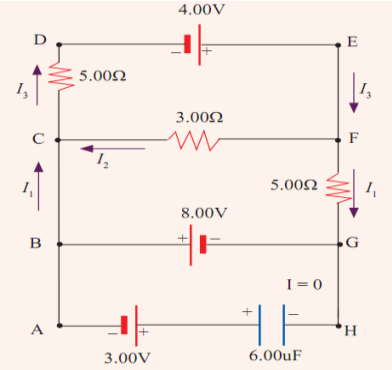
c) The energy dissipated by joule effect when the current flows in the circuit in one hour.

16. Find the currents I_1, I_2, and I_3 in the circuit shown in Figure

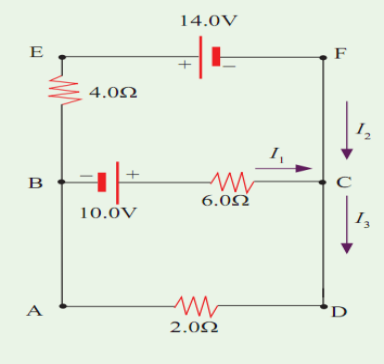


17. (a) Under steady-state conditions, find the unknown currents I_1, I_2, and I_3 in the multi loop circuit shown in the figure

b) What is the charge on the capacitor?

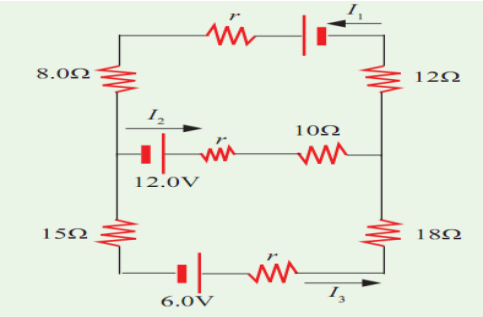


18. In the following circuit, using the Kirchhoff's rules find the currents I_1, I_2 and I_3.

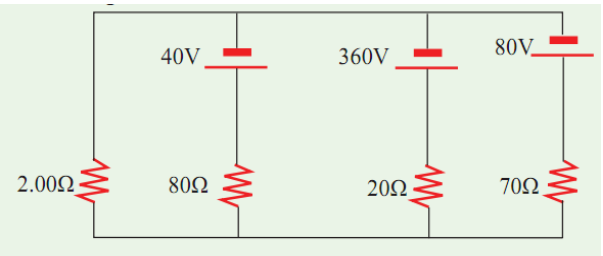


19. (a) Determine the currents I_1, I_2 and I_3 in the figure below. Assume the internal resistance of each battery is r = 1Ω.

(b) What is the terminal voltage of the 6V battery?

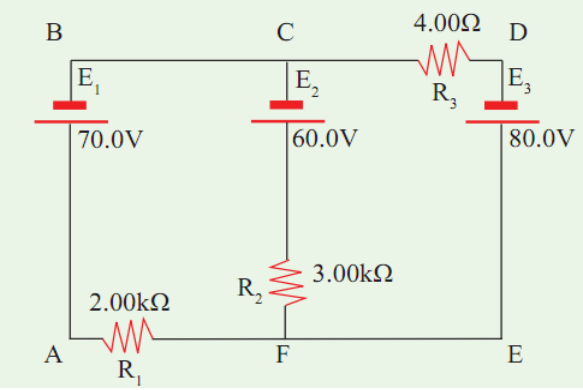


20. In the circuit of the figure, determine the current in each resistor and the voltage across the 200Ω resistor.

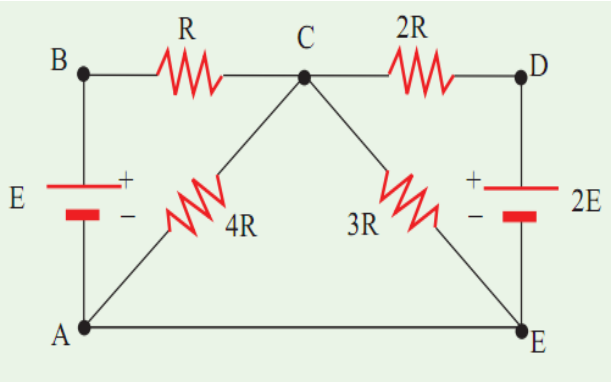


21. Using Kirchhoff's rules,(a) Find the current in each resistor in the figure bellow.

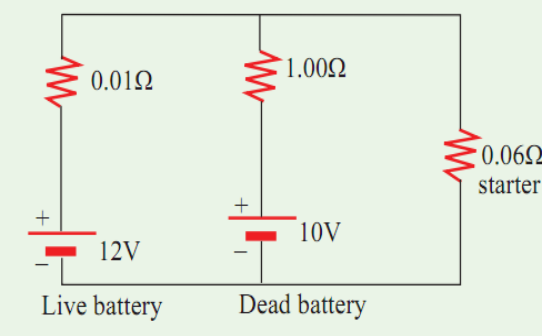
(b) Find the potential difference between points C and F. Which point is at the higher potential?



22. Taking R = 1.00kΩ and E = 250V in the figure below, determine the direction and magnitude of the current in the horizontal wire between A and E.



23. A dead battery is charged by connecting it to the live battery of another car with jumper cables as shown in the figure. Determine the current in the starter and in the dead battery.



Section 1 .Electromotive Force

1. A battery has an emf of 15.0 V. The terminal voltage of the battery is 11.6 V when it is delivering 20W of power to an external load resistor R.

(a) What is the value of R? (b) What is the internal resistance of the battery?

2. a)What is the current in a 5.6Ω resistor connected to a battery that has a 0.2Ω internal resistance if the terminal voltage of the battery is 10V?

(b) What is the emf of the battery?

3. Two 1.5V batteries with their positive terminals in the same direction are inserted in series into the barrel of a flashlight.One battery has an internal resistance of 0.255 Ω ,the other an internal resistance of 0.153 Ω. When the switch is closed, a current of 600 mA occurs in the lamp.

(a) What is the lamp's resistance?

(b) What fraction of the chemical energy transformed appears as internal energy in the batteries?

4. An automobile battery has an emf of 12.6 V and an internal resistance of 0.08 Ω.The headlights together present equivalent resistance 5Ω (assumed constant).What is the potential difference across the headlight bulbs

(a) When they are the only load on the battery

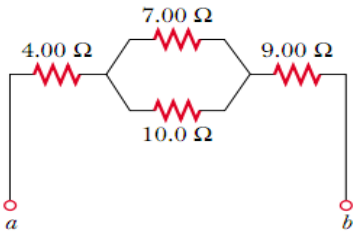
(b) When the starter motor is operated, taking an additional 35A from the battery?

Section 2. Resistors in Series and Parallel

5. The current in a loop circuit that has a resistance of R_1 is 2A. The current is reduced to 1.6A when an additional resistor R_2= 3Ω is added in series with R_1.What is the value of R_1?

6. (a) Find the equivalent resistance between points a and b

(b) A potential difference of 34.0 V is applied between points a and b. Calculate the current in each resistor.

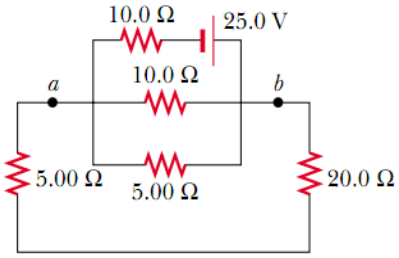


7. A lightbulb marked "75 W [at] 120 V" is screwed into a socket at one end of a long extension cord, in which each of the two conductors has resistance 0.8 Ω.The other end of the extension cord is plugged into a 120V outlet. Draw a circuit diagram and find the actual power delivered to the bulb in this circuit.

9. Consider the circuit shown in Figure Find

(a) The current in the 20A resistor and

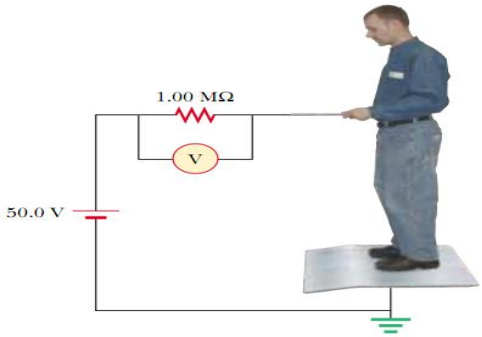
(b) The potential difference between points a and b



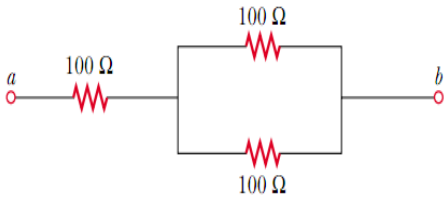
10. For the purpose of measuring the electric resistance of shoes through the body of the wearer to a metal ground plate, the American National Standards Institute (ANSI) specifies the circuit shown in Figure. The potential difference ΔV across the 1MΩ resistor is measured with a high-resistance voltmeter.

a) Show that the resistance of the footwear is given by

b) In a medical test, a current through the human body should not exceed 150 μA. Can the current delivered by the ANSI-specified circuit exceed 150μA? To decide, consider a person standing barefoot on the ground plate.



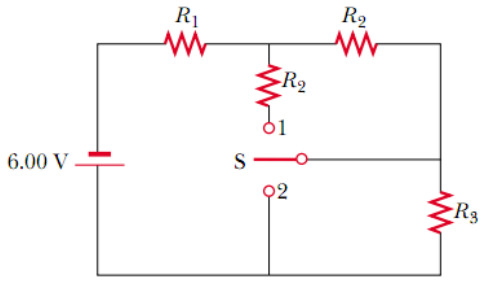
11. Three 100Ω resistors are connected as shown in this Figure.The maximum power that can safely be delivered to any one resistor is 25 W. a) What is the maximum voltage that can be applied to the terminals a and b ? For the voltage determined in part (a), what is the power delivered to each resistor? What is the total power delivered?



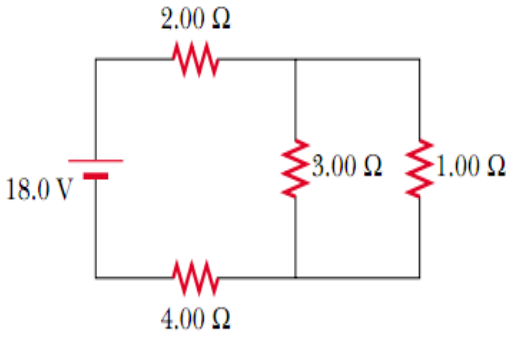
12. Using only three resistors 2Ω, 3Ω, and 4Ω find 17 resistance values that may be obtained by various combinations of one or more resistors. Tabulate the combinations in order of increasing resistance.

13. The current in a circuit is tripled by connecting a 500Ω resistor in parallel with the resistance of the circuit. Determine the resistance of the circuit in the absence of the 500Ω resistor.

14. A 6V battery supplies current to the circuit shown in Figure. When the double-throw switch S is open, as shown in the figure, the current in the battery is 1mA. When the switch is closed in position 1, the current in the battery is 1.2mA. When the switch is closed in position 2, the current in the battery is 2mA. Find the resistances R_1, R_2, and R_3.



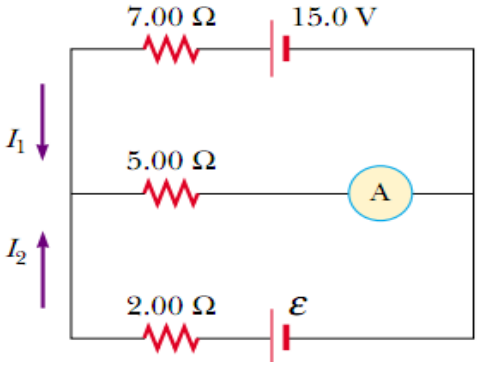
15. Calculate the power delivered to each resistor in the circuit shown in Figure



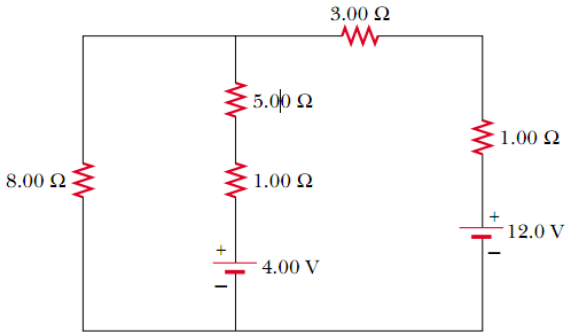
16. Two resistors connected in series have an equivalent resistance of 690Ω.When they are connected in parallel; their equivalent resistance is 150 Ω. Find the resistance of each resistor.

Section 3. Kirchhoff's Rules

20. The ammeter shown in Figure reads 2A. Find I_1, I_2 , and ε



21. Determine the current in each branch of the circuit shown in Figure



23. The circuit considered in Problem 21 and shown in Figure in problem 21 is connected for 2.00 min.

(a) Find the energy delivered by each battery.

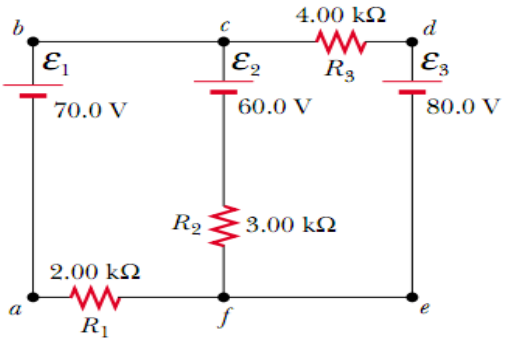
(b) Find the energy delivered to each resistor.

(c) Identify the types of energy transformations that occur in the operation of the circuit and the total amount of energy involved in each type of transformation.

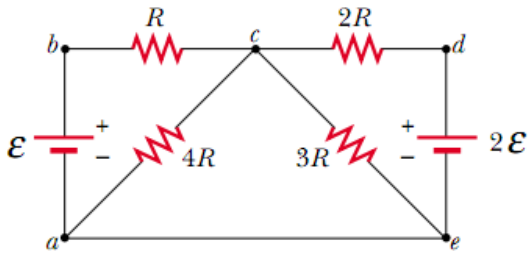
24. Using Kirchhoff's rules,

a) find the current in each resistor in Figure

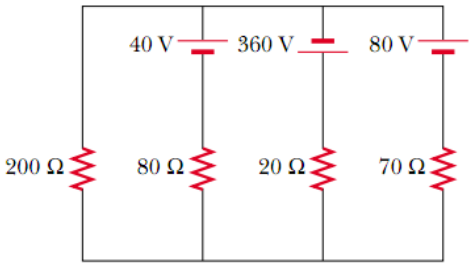
b) Find the potential difference between points c and f. Which point is at the higher potential?



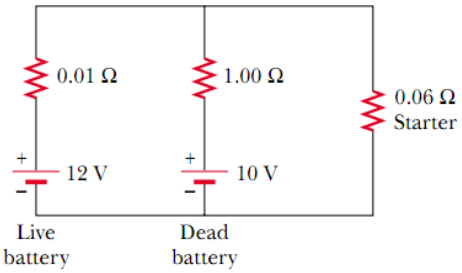
25. Taking R=1kΩ and ε=250V in Figure, determine the direction and magnitude of the current in the horizontal wire between a and e.



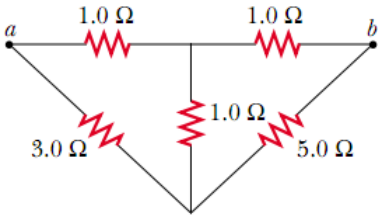
26. In the circuit of Figure, determine the current in each resistor and the voltage across the 200Ω resistor.



27. A dead battery is charged by connecting it to the live battery of another car with jumper cables.Determine the current in the starter and in the dead battery.



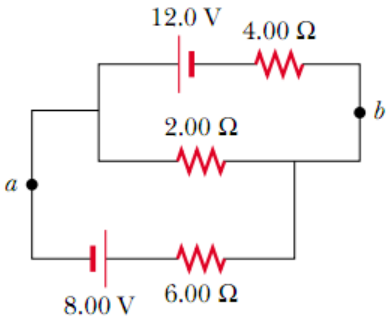
28. For the network shown in Figure P28.28, show that the resistance Rab # (27/17) '.



29. For the circuit shown in Figure, calculate

(a) The current in the 2Ω resistor and

(b) The potential difference between points a and b.



30. Calculate the power delivered to each resistor shown in figure