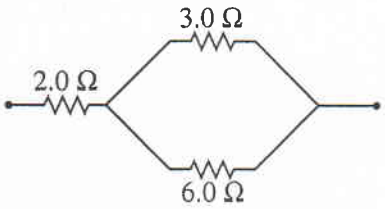
Unit 7

8. How much current flows through a 5 Ω resistor that is dissipating heat at a rate of 500 J/s?

(A) 0.01 A
(B) 0.1 A
(C) 1 A
(D) 10 A
(E) 100 A

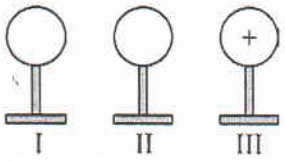


10. What is the equivalent resistance of the combination of resistors shown above?

(A) 1.0 Ω
(B) 4.0 Ω
(C) 5.0 Ω
(D) 6.5 Ω
(E) 11.0 Ω

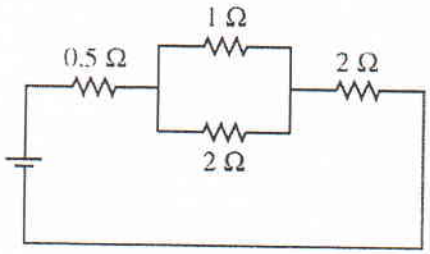
14. A small metal sphere X is charged by losing 500 electrons. An identical metal sphere Y is charged by gaining 1000 electrons. The two spheres are first put in contact with each other and then separated. If $-e$ is the charge on an electron, what is the charge on each sphere after separation?

	Sphere X	Sphere Y
(A)	$+500e$	$+500e$
(B)	$+250e$	$+250e$
(C)	$-250e$	$+250e$
(D)	$-250e$	$-250e$
(E)	$-500e$	$-500e$



46. Three identical conducting spheres, I, II, and III, are mounted on insulating stands and placed as shown above. Spheres I and II are each uncharged, and III carries a positive charge. Spheres I and II are connected to each other by a conducting wire. After the wire is removed, sphere III is moved far away. Which of the following statements about the subsequent charges on spheres I and II is correct?

(A) They are each still uncharged.
(B) They are charged with equal positive charges.
(C) They are charged with equal negative charges.
(D) Sphere I is positively charged and sphere II is negatively charged.
(E) Sphere I is negatively charged and sphere II is positively charged.

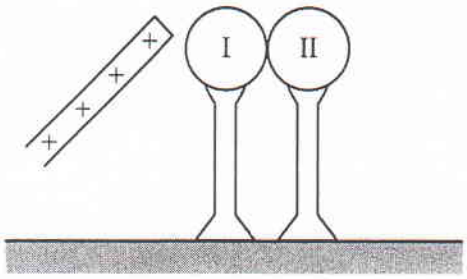


40. In the circuit represented above, the current in the 1 Ω resistor is 4 A. What is terminal voltage V of the battery?

(A) 6 V
(B) 12 V
(C) 18 V
(D) 19 V
(E) 30 V

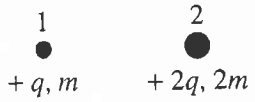
19. If the charge of each of two particles is doubled and the separation between them is also doubled, the force between the two particles is

(A) quadrupled
(B) doubled
(C) the same as before
(D) halved
(E) quartered



13. Two initially uncharged metal spheres are mounted on insulating stands and placed in contact with each other, as shown above. A student brings a positively charged insulating rod near sphere I. Sphere II is then removed, and finally the rod is moved away. What is the net charge on sphere I?

(A) No charge
(B) A positive charge
(C) A negative charge
(D) Either a positive or a negative charge, depending on the sizes of the spheres
(E) Either a positive or a negative charge, depending on the amount of charge on the rod

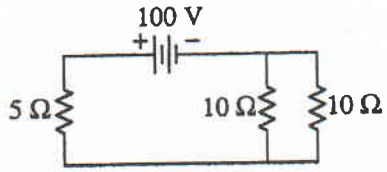


67. An isolated system consists of the two particles shown above. Particle 1 has charge $+q$ and mass m. Particle 2 has charge $+2q$ and mass $2m$. The ratio of the magnitude of the electrical force on particle 1 to the magnitude of the electrical force on particle 2 is

(A) $\frac{1}{4}$
(B) $\frac{1}{2}$
(C) 1
(D) 2
(E) 4

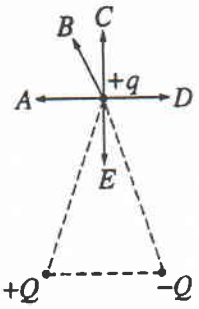
17. A 60 W, 120 V lightbulb has a resistance of

(A) 0.5 Ω
(B) 2.0 Ω
(C) 120 Ω
(D) 240 Ω
(E) 480 Ω



20. In the circuit shown above, what is the current in the 5 Ω resistor?

(A) 40 A
(B) 25 A
(C) 20 A
(D) 10 A
(E) 4 A



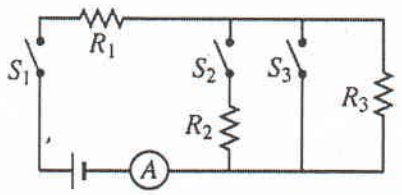
45. Three point charges, $+q$, $+Q$, and $-Q$, are fixed at the corners of an isosceles triangle in the plane of the page, as shown above. Which arrow in the figure represents the direction of the net electrostatic force on charge $+q$ due to the other two equal and opposite charges?

(A) *A*
(B) *B*
(C) *C*
(D) *D*
(E) *E*

29. Two cables can be used to wire a circuit. Cable *A* has a lower resistivity, a larger diameter, and a different length than cable *B*. Which cable should be used to minimize heat loss if the same current is maintained in either cable?

(A) Cable *A*
(B) Cable *B*
(C) The heat loss is the same for both.
(D) It cannot be determined without knowing the length of each cable.
(E) It cannot be determined without knowing the materials contained in each cable.

Questions 26-28



In the circuit above, the resistors all have the same resistance. The battery, wires, and ammeter have negligible resistance. A closed switch also has negligible resistance.

26. Closing which of the switches will produce the greatest power dissipation in R_2?

(A) S_1 only
(B) S_2 only
(C) S_1 and S_2 only
(D) S_1 and S_3 only
(E) S_1, S_2, and S_3

27. Closing which of the switches will produce the greatest reading on the ammeter?

(A) S_1 only
(B) S_2 only
(C) S_3 only
(D) S_1 and S_2
(E) S_1 and S_3

28. Closing which of the switches will produce the greatest voltage across R_3?

(A) S_1 only
(B) S_2 only
(C) S_1 and S_2 only
(D) S_1 and S_3 only
(E) S_1, S_2, and S_3

63. If three resistors with unequal resistance are connected in parallel in a DC circuit, which of the following is true of the total resistance?

(A) It is higher than the value of the highest resistance.
(B) It is equal to the middle resistance.
(C) It is equal to the average of the three resistances.
(D) It is lower than the value of the lowest resistance.
(E) It cannot be determined without knowing the emf applied across the combination.

17. A wire of length L and radius r has a resistance R. What is the resistance of a second wire made from the same material that has a length $L/2$ and a radius $r/2$?

(A) $4R$
(B) $2R$
(C) R
(D) $R/2$
(E) $R/4$

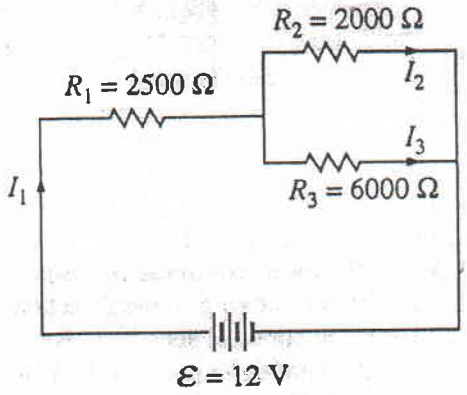
18. The operating efficiency of a 0.5 A, 120 V electric motor that lifts a 9 kg mass against gravity at an average velocity of 0.5 m/s is most nearly

(A) 7%
(B) 13%
(C) 25%
(D) 53%
(E) 75%

20. A certain coffeepot draws 4.0 A of current when it is operated on 120 V household lines. If electrical energy costs 10 cents per kilowatt-hour, how much does it cost to operate the coffeepot for 2 hours?

(A) 2.4 cents
(B) 4.8 cents
(C) 8.0 cents
(D) 9.6 cents
(E) 16 cents

Questions 48-49 relate to the following circuit diagram.



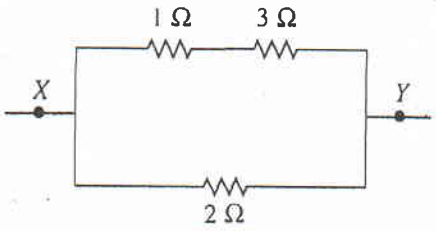
48. What is the current I_1 ?

(A) 0.8 mA
(B) 1.0 mA
(C) 2.0 mA
(D) 3.0 mA
(E) 6.0 mA

49. How do the currents I_1, I_2, and I_3 compare?

(A) $I_1 > I_2 > I_3$
(B) $I_1 > I_3 > I_2$
(C) $I_2 > I_1 > I_3$
(D) $I_3 > I_1 > I_2$
(E) $I_3 > I_2 > I_1$

Questions 15-16 refer to the following diagram that shows part of a closed electrical circuit.



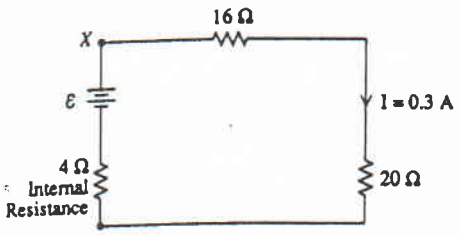
15. The electrical resistance of the part of the circuit shown between point X and point Y is

(A) $1\frac{1}{3}\ \Omega$
(B) $2\ \Omega$
(C) $2\frac{3}{4}\ \Omega$
(D) $4\ \Omega$
(E) $6\ \Omega$

16. When there is a steady current in the circuit, the amount of charge passing a point per unit of time is

(A) the same everywhere in the circuit
(B) greater at point X than at point Y
(C) greater in the 1 Ω resistor than in the 2 Ω resistor
(D) greater in the 1 Ω resistor than in the 3 Ω resistor
(E) greater in the 2 Ω resistor than in the 3 Ω resistor

13. Which of the following will cause the electrical resistance of certain materials known as superconductors to suddenly decrease to essentially zero?
(A) Increasing the voltage applied to the material beyond a certain threshold voltage
(B) Increasing the pressure applied to the material beyond a certain threshold pressure
(C) Cooling the material below a certain threshold temperature
(D) Stretching the material to a wire of sufficiently small diameter
(E) Placing the material in a sufficiently large magnetic field



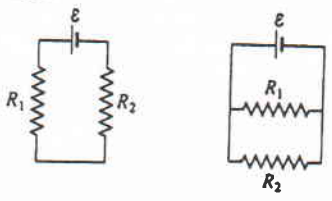
Questions 20-22 relate to the following circuit diagram which shows a battery with an internal resistance of 4.0 ohms connected to a 16-ohm and a Ω- ohm resistor in series. The current in the 20-ohm resistor is 0.3 amperes

20. What is the emf of the battery?
(A) 1..2 V (B) 6.0 V (C) 10.8 V (D) 12.0 V (E) 13.2 V

21. What is the potential difference across the terminals X and Y of the battery?
(A) 1.2 V (B) 6.0 V (C) 10.8 V (D) 12.0 V (E) 13.2 V

22. What power is dissipated by the 4-ohm internal resistance of the battery?
(A) 0.36 W (B) 1.2 W (C) 3.2 W (D) 3.6 W (E) 4.8 W

42. Forces between two objects which are inversely proportional to the square of the distance between the objects include which of the following?
I. Gravitational force between two celestial bodies
II. Electrostatic force between two electrons
III. Nuclear force between two neutrons
(A) I only (B) III only (C) I and II only (D) II and III only (E) I, II, and III



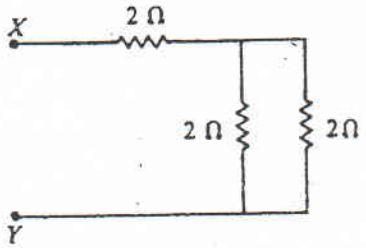
Series Connection

Parallel Connection

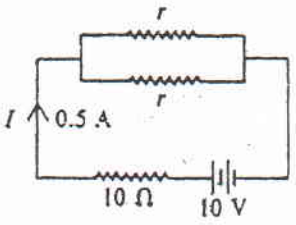
50. In the diagrams above, resistors R_1 and R_2 are shown in two different connections to the same source of emf ε that has no internal resistance. How does the power dissipated by the resistors in these two cases compare?
(A) It is greater for the series connection.
(B) It is greater for the parallel connection.
(C) It is the same for both connections.
(D) It is different for each connection, but one must know the values of R_1 and R_2 to know which is greater.
(E) It is different for each connection, but one must know the value of ε to know which is greater.

51. The product 2 amperes x 2 volts x 2 seconds is equal to
(A) 8 coulombs (B) 8 newtons (C) 8 joules (D) 8 calories (E) 8 newton-amperes

56. In the Bohr model of the atom, the postulate stating that the orbital angular momentum of the electron is quantized can be interpreted in which of the following ways?
(A) An integral number of electron wavelengths must fit into the electron's circular orbit.
(B) Only one electron can exist in each possible electron state.
(C) An electron has a spin of 1/2.
(D) The atom is composed of a small, positively charged nucleus orbited by electrons.
(E) An incident photon is completely absorbed when it causes an electron to move to a higher energy state.



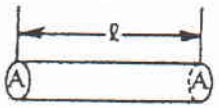
15. The total equivalent resistance between points X and Y in the circuit shown above is
(A) 3 Ω
(B) 4 Ω
(C) 5 Ω
(D) 6 Ω
(E) 7 Ω



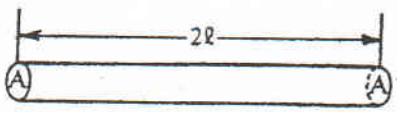
68. In the circuit shown above, the value of r for which the current I is 0.5 ampere is
(A) 0 Ω
(B) 1 Ω
(C) 5 Ω
(D) 10 Ω
(E) 20 Ω

10. The five resistors shown below have the lengths and cross-sectional areas indicated and are made of material with the same resistivity. Which resistor has the least resistance?

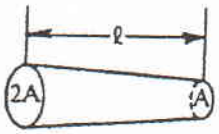
(A)



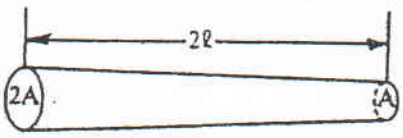
(B)



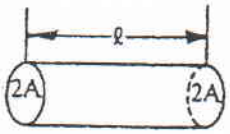
(C)



(D)



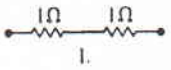
(E)



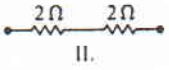
54. Two isolated charges, $+q$ and $-2q$, are 2 centimeters apart. If F is the magnitude of the force acting on charge $-2q$, what are the magnitude and direction of the force acting on charge $+q$?

	Magnitude	Direction
(A)	$\frac{1}{2}F$	Toward charge $-2q$
(B)	$\frac{1}{2}F$	Away from charge $-2q$
(C)	F	Toward charge $-2q$
(D)	F	Away from charge $-2q$
(E)	$2F$	Toward charge $-2q$

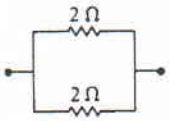
15. The electron volt is a measure of
(A) charge (B) energy (C) impulse (D) momentum (E) velocity



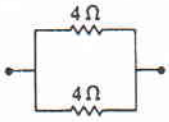
I.



II.

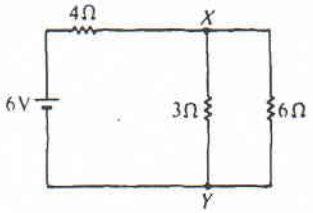


III.

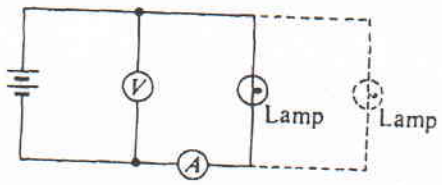


IV.

18. Which two arrangements of resistors shown above have the same resistance between the terminals?
(A) I and II (B) I and IV (C) II and III (D) II and IV (E) III and IV

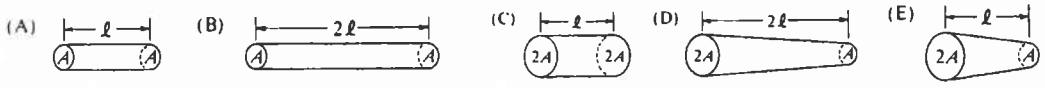


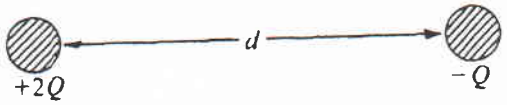
22. In the circuit shown above, what is the value of the potential difference between points X and Y if the 6-volt battery has no internal resistance? (A) 1 V (B) 2 V (C) 3 V (D) 4 V (E) 6V



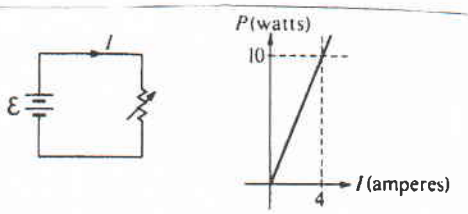
26. A lamp, a voltmeter V, an ammeter A, and a battery with zero internal resistance are connected as shown above. Connecting another lamp in parallel with the first lamp as shown by the dashed lines would
(A) increase the ammeter reading (B) decrease the ammeter reading
(C) increase the voltmeter reading (D) decrease the voltmeter reading
(E) produce no change in either meter reading

57. The five resistors shown below have the lengths and cross-sectional areas indicated and are made of material with the same resistivity. Which has the greatest resistance?





59. Two identical conducting spheres are charged to +2Q and -Q. respectively, and are separated by a distance d (much greater than the radii of the spheres) as shown above. The magnitude of the force of attraction on the left sphere is F_1. After the two spheres are made to touch and then are reseparated by distance d, the magnitude of the force on the left sphere is F_2. Which of the following relationships is correct?
(A) $2F_1 = F_2$ (B) $F_1 = F_2$ (C) $F_1 = 2F_2$ (D) $F_1 = 4F_2$ (E) $F_1 = 8\ F_2$



64. The circuit shown above left is made up of a variable resistor and a battery with negligible internal resistance. A graph of the power P dissipated in the resistor as a function of the current I supplied by the battery is given above right. What is the emf of the battery?
(A) 0.025 V (B) 0.67 V (C) 2.5 V (D) 6.25 V (E) 40 V