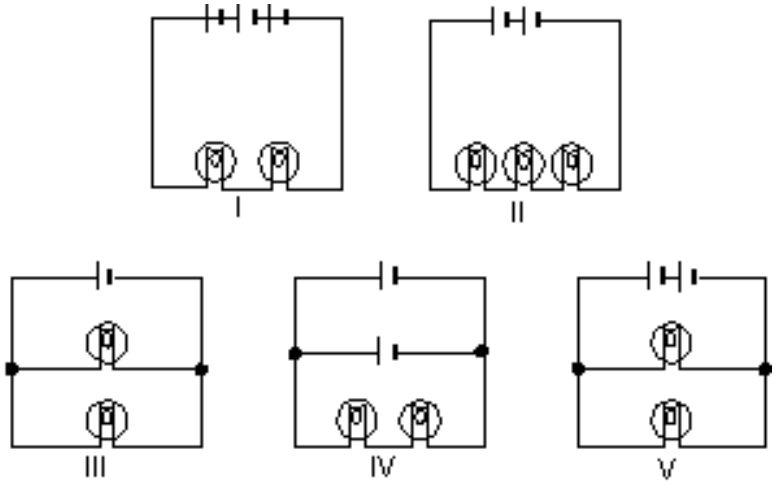
1. A certain sample carries a current of 4 A when the potential difference is 2 V and a current of 10 A when the potential difference is 4 V. This sample:

   A) obeys Ohm's law
   B) has a resistance of 0.5 Ω at 2 V
   C) has a resistance of 2.5 Ω at 2 V
   D) has a resistance of 25 Ω at 2 V
   E) does not have a resistance

2. A 3-Ω and a 1.5-Ω resistor are wired in parallel and the combination is wired in series to a 4-Ω resistor and a 10-V emf device. The current in the 3-Ω resistor is:

   A) 0.33 A
   B) 0.67 A
   C) 2.0 A
   D) 3.3 A
   E) 6.7 A

3. In the diagrams, all light bulbs are identical and all emf devices are identical. In which circuit (I, II, III, IV, V) will the bulbs be dimmest?

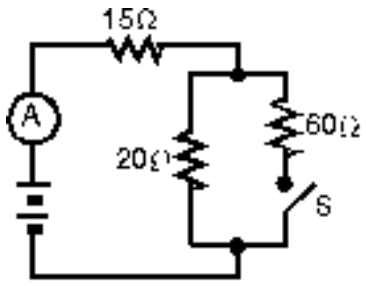


   A) I
   B) II
   C) III
   D) IV
   E) V

4. Five cylindrical wires are made of the same material. Their lengths and radii are
   wire 1: length E , radius r
   wire 2: lenth $3E/2$, radius $r/2$
   wire 3: length $E/2$, radius $r/2$
   wire 4: length E , radius $r/2$
   wire 5: length $5E$, radius $r/2$
   Rank the wires according to their resistances, least to greatest.

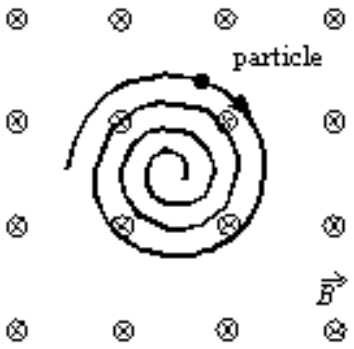
   A) 1, 2, 3, 4, 5
   B) 5, 4, 3, 2, 1
   C) 1 and 2 tie, then 5, 3, 4
   D) 1, 3, 4, 2, 5
   E) 1, 2, 4, 3, 5

5 When switch S is open, the ammeter in the circuit shown reads 2.0 A. When S is closed, the ammeter reading:



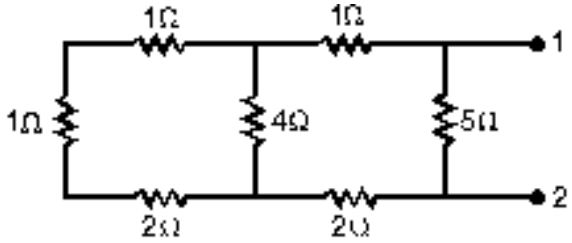
   A) increases slightly
   B) remains the same
   C) decreases slightly
   D) doubles
   E) halves

6. A uniform magnetic field is directed into the page. A charged particle, moving in the plane of the page, follows a clockwise spiral of decreasing radius as shown. A reasonable explanation is:



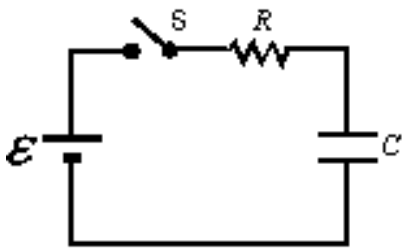
A) the charge is positive and slowing down
B) the charge is negative and slowing down
C) the charge is positive and speeding up
D) the charge is negative and speeding up
E) none of the above

7. The equivalent resistance between points 1 and 2 of the circuit shown is:



A) 3 Ω
B) 4 Ω
C) 5 Ω
D) 6 Ω
E) None of the above

8. Four circuits have the form shown in the diagram. The capacitor is initially uncharged and the switch S is open.



The values of the emf $\mathcal{E}$, resistance R, and the capacitance C for each of the circuits are
circuit 1: $\mathcal{E}$ = 18 V, R = 3 Ω, C = 1 μF
circuit 2: $\mathcal{E}$ = 18 V, R = 6 Ω, C = 9 μF
circuit 3: $\mathcal{E}$ = 12 V, R = 1 Ω, C = 7 μF
circuit 4: $\mathcal{E}$ = 10 V, R = 5 Ω, C = 7 μF

Rank the circuits according to the time after switch S is closed for the capacitors to reach half their final charges, least to greatest.

A) 1, 2, 3, 4
B) 4, 3, 2, 1
C) 1, 3, 4, 2
D) 4, 2, 1, 3
E) 3, 1, 2, 4

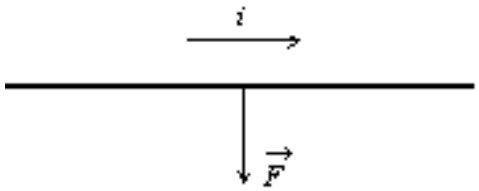
9. Two wires made of different materials have the same uniform current density. They carry the same current only if:

A) their lengths are the same
B) their cross-sectional areas are the same
C) both their lengths and cross-sectional areas are the same
D) the potential differences across them are the same
E) the electric fields in them are the same

10. A magnetic field CANNOT:

A) exert a force on a charge
B) accelerate a charge
C) change the momentum of a charge
D) change the kinetic energy of a charge
E) exist

11. The diagram shows a straight wire carrying current i in a uniform magnetic field. The magnetic force on the wire is indicated by an arrow but the magnetic field is not shown. Of the following possibilities, the direction of the magnetic field is:

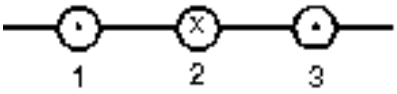


A) to the right
B) opposite the direction of ¢
C) in the direction of ¢
D) into the page
E) out of the page

12. At any point the magnetic field lines are in the direction of:

A) the magnetic force on a moving positive charge
B) the magnetic force on a moving negative charge
C) the velocity of a moving positive charge
D) the velocity of a moving negative charge
E) none of the above

13. The diagram shows three equally spaced wires that are perpendicular to the page. The currents are all equal, two being out of the page and one being into the page. Rank the wires according to the magnitudes of the magnetic forces on them, from least to greatest.



A) 1, 2, 3
B) 2, 1 and 3 tie
C) 2 and 3 tie, then 1
D) 1 and 3 tie, then 2
E) 3, 2, 1

14. Two long parallel straight wires carry equal currents in opposite directions. At a point midway between the wires, the magnetic field they produce is:

    A) zero
    B) non-zero and along a line connecting the wires
    C) non-zero and parallel to the wires
    D) non-zero and perpendicular to the plane of the two wires
    E) none of the above

15. A beam of electrons is sent horizontally down the axis of a tube to strike a fluorescent screen at the end of the tube. On the way, the electrons encounter a magnetic field directed vertically downward. The spot on the screen will therefore be deflected:

    A) upward
    B) downward
    C) to the right as seen from the electron source
    D) to the left as seen from the electron source
    E) not at all

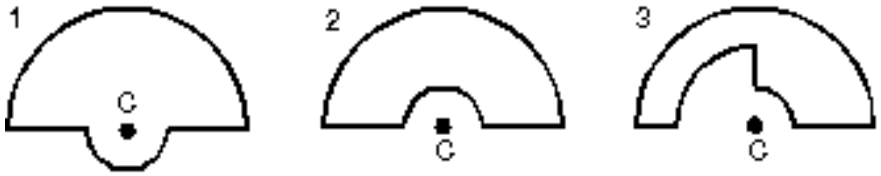
16. A student kept her 60 watt 120 volt study lamp turned on from 2 PM until 2 AM. How many coulombs went through it?

    A) 150
    B) 3,600
    C) 7,200
    D) 9,000
    E) None of the above

17. A current of 0.3 A is passed through a lamp for 2 minutes using a 6 V power supply. The energy dissipated by this lamp during the 2 minutes is:

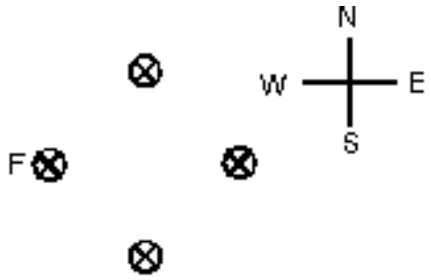
    A) 1.8 J
    B) 12 J
    C) 20 J
    D) 36 J
    E) 216 J

18. The diagrams show three circuits consisting of concentric circular arcs (either half or quarter circles of radii *r*, 2*r*, and 3*r*) and radial lengths. The circuits carry the same current. Rank them according to the magnitudes of the magnetic fields they produce at C, least to greatest.



A) 1, 2, 3
B) 3, 2, 1
C) 1, 3, 2
D) 2, 3, 1
E) 2, 1, 3

19. Four long straight wires carry equal currents into the page as shown. The magnetic force exerted on wire F is:



A) north
B) east
C) south
D) west
E) zero

20. You wish to triple the rate of energy dissipation in a heating device. To do this you could triple:

A) the potential difference keeping the resistance the same
B) the current keeping the resistance the same
C) the resistance keeping the potential difference the same
D) the resistance keeping the current the same
E) both the potential difference and current