Circle the letter that corresponds to your choice for the correct answer to each problem.

1. A square loop of wire lies in the plane of the page. A decreasing magnetic field is directed into the page. The induced current in the loop is:

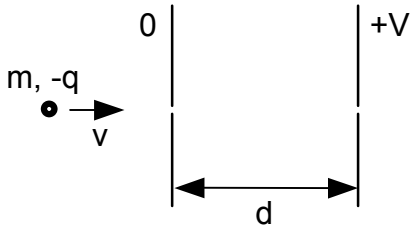
   A) counterclockwise.
   B) clockwise.
   C) zero.
   D) depends upon whether or not B is decreasing at a constant rate.
   E) clockwise in two of the loop sides and counterclockwise in the other two.

2. A point charge, -3q, lies at the center of a conducting, cubical shell with sides of length 2d. The shell has a net charge of -3q. The net charge on the outer surface of the shell is:

   A) 6q B) 3q C) zero D) -3q E) -6q

3. A particle (mass m, charge -q) with speed v enters the region between two parallel plates through a very small hole, as shown. The potential difference between the two plates is V and their separation is d. The change in kinetic energy of the particle after it traverses this region is best given by:

   A) -qV/d
   B) $2qV/mv^2$
   C) qV
   D) ½ mv^2
   E) none of these



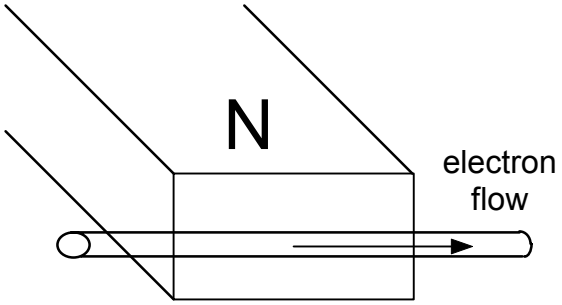
4. Charge is distributed uniformly on the surface of a large flat plate. The electric field 2 cm from the plate is 30 N/C. The electric field 4 cm from the plate is:

   A) 120 N/C B) 80 N/C C) 30 N/C D) 15 N/C E) 7.5 N/C

5. Two small charged objects repel each other with a force F when separated by a distance d. If the charge on each object is reduced to one-fourth of its original value and the distance between is reduced to d/2, the force becomes:

   A) F/16 B) F/8 C) F/4 D) F/2 E) F

6. The figure shows the motion of *electrons* in a wire which is near the North pole of a magnet. The wire will be pushed:



A) toward the magnet
B) away from the magnet
C) downwards
D) upwards
E) along its length

7. 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.

8. In the formula $\mathbf{F} = q\mathbf{v}\times\mathbf{B}$:

A) **F** must be perpendicular to **v** but not necessarily to **B**.
B) **F** must be perpendicular to **B** but not necessarily to **v**.
C) **v** must be perpendicular to **B** but not necessarily to **F**.
D) all three vectors must be mutually perpendicular.
E) none of the above.

9. Two point charges, 8×10^{-9} C and -2×10^{-9} C are separated by 4 m. The electric field magnitude (in units of V/m) midway between them is:

A) 9×10^{9} B) 13,500 C) 135,000 D) 36×10^{-9} E) 22.5

10. Two point charges, q_1 and q_2, are placed a distance r apart. The electric field is zero at a point P between the charges on the line segment connecting them. We conclude that:

A) q_1 and q_2 must have the same magnitude and sign
B) P must be midway between q_1 and q_2
C) q_1 and q_2 must have the same sign but may have different magnitudes
D) q_1 and q_2 must have equal magnitudes and opposite signs
E) q_1 and q_2 must have opposite signs and may have different magnitudes

11. Resistances of 2.0 Ω, 4.0 Ω, and 6.0 Ω, and a 24 V battery are all in series. The current in the 2.0 Ω resistor is:

A) 12 A B) 4.0 A C) 2.4 A D) 2.0 A E) 0.50 A

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

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

13. Let Q denote charge, V denote potential difference, and U denote stored energy. Of these quantities, capacitors in series must have the same:

A) Q only
B) V only
C) U only
D) Q and U only
E) V and U only

14. Choose the correct statement:

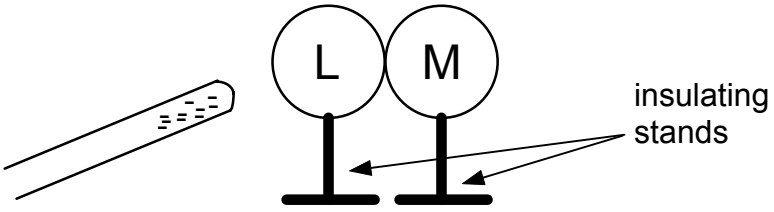
A) A proton tends to go from a region of low potential to a region of high potential
B) The potential of a negatively charged conductor must be negative
C) If E=0 at a point P, then V must be zero at P
D) If V=0 at a point P, then E must be zero at P
E) None of the above are correct

15. If 500 J of work are required to carry a 40 C charge form one point to another, the potential difference between these two points is:

A) 12.5 V
B) 20,000 V
C) 0.08 V
D) depends on the path
E) none of these

16. Two uncharged metal spheres, L and M, are in contact. A negatively charged rod is brought close to L, but not touching it, as shown. The two spheres are slightly separated and the rod is then withdrawn. As a result:

A) both spheres are neutral.
B) both spheres are positive.
C) both spheres are negative.
D) L is negative and M is positive.
E) L is positive and M is negative.



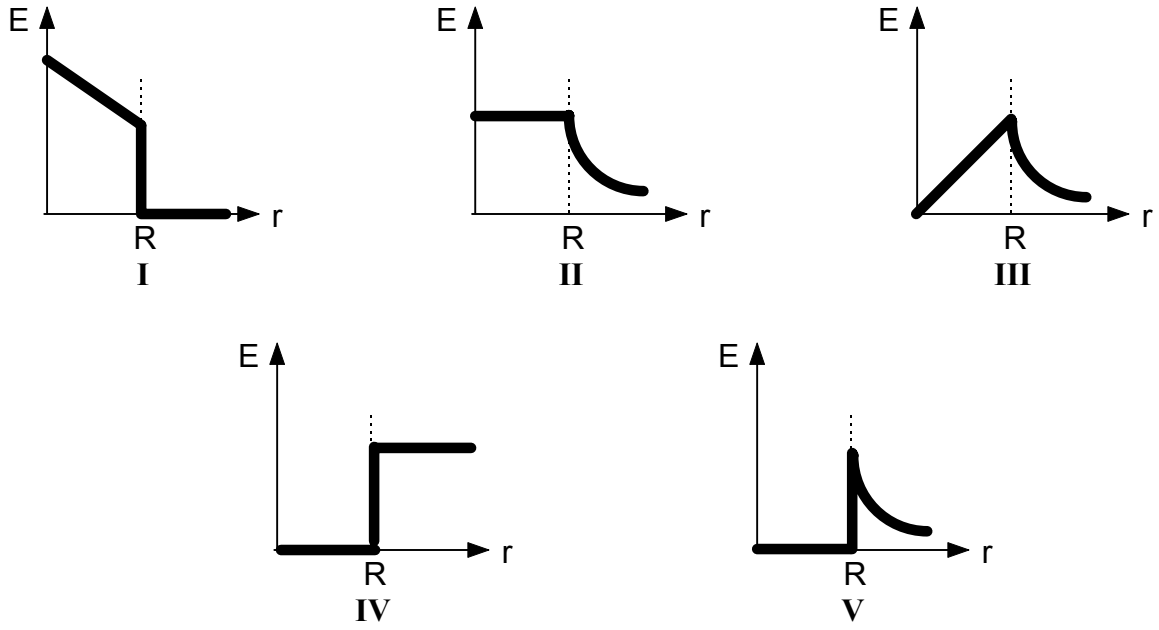
17. Each plate of a capacitor stores a charge of magnitude 1×10^{-3} C when a 100 V potential difference is applied. The capacitance is:

A) 5 μF
B) 10 μF
C) 50 μF
D) 100 μF
E) none of these

18. Two wires made of the same material have the same length but different diameters. They are connected in parallel to a battery. The quantity that is NOT the same for the wires is:

A) the end-to-end potential difference
B) the current
C) the current density
D) the electric field
E) the electron drift velocity

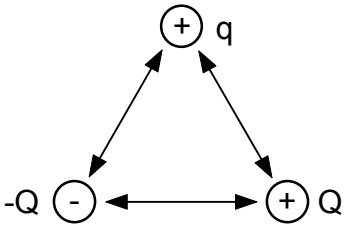
19. A solid insulating sphere of radius R contains a uniform volume distribution of positive charge. Which of the graphs below correctly gives the magnitude E of the electric field as a function of r?



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

20. Charges Q, -Q, and q are placed at the vertices of an equilateral triangle as shown. The total force exerted on the charge q is:

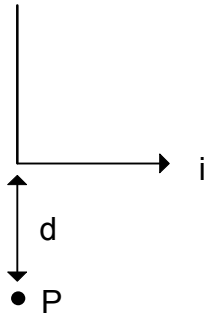
A) toward charge Q.
B) toward charge -Q.
C) away from charge Q.
D) left.
E) right.



21. Three resistors, R_1, R_2, R_3, are in series with each other. $R_1 < R_2 < R_3$. The current through R_1 is i. Which statement is true?

A) R_1 has the largest potential difference across it.
B) R_3 has the largest potential difference across it.
C) The potential difference across each resistor is the same.
D) The power dissipated by each resistor is the same.
E) If the resistors are made of the same material, and have the same cross-sectional area, then R_1 is the longest.

22. A current i goes through a wire that extends from infinitely far up, follows a 90° bend, and continues infinitely far to the right as shown. What is the magnitude of the magnetic field at P, a distance d below?



A) $\frac{2\mu_o i}{\pi d}$ B) $\frac{\mu_o i}{\pi d}$ C) $\frac{\mu_o i}{2\pi d}$
D) $\frac{\mu_o i}{4\pi d}$ E) zero

23. A certain physics textbook shows a region of space in which two electric field lines cross each other. We should conclude that:

A) at least two point charges are present.
B) an electrical conductor is present.
C) an insulator is present.
D) the field points in two directions at the same place.
E) the author of the textbook made a mistake.

24. The capacitance of a parallel-plate capacitor can be increased by:

A) increasing the charge.
B) decreasing the charge.
C) increasing the plate separation.
D) decreasing the plate separation.
E) decreasing the plate area.

25. Charge Q is distributed uniformly throughout a spherical insulating shell. The net electrical flux in Nm^2/C through the outer surface of the shell is:

A) zero B) Q/ε_o C) $2Q/\varepsilon_o$
D) $Q/4\varepsilon_o$ E) $Q/2\pi\varepsilon_o$

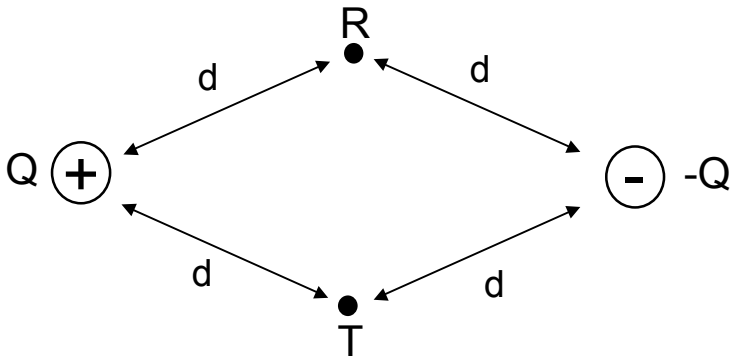
26. A 2 ohm resistor and 4 ohm resistor are connected in parallel to a 6 volt battery. The power dissipated by the 2 ohm resistor is:

A) 8 W
B) 6 W
C) 9 W
D) 18 W
E) None of these

27. A kiloampere - hour is a unit of:

A) current
B) charge per time
C) power
D) charge
E) energy

28. Points R and T are each a distance d from each of two equal and opposite charges as shown. If $k = 1/4\pi\varepsilon_o$, the work required to move a negative charge q from R to T is:



A) zero
B) kqQ/d^2
C) kqQ/d
D) $kqQ/(4d^2)$
E) $kqQ/(2d)$

29. The current is zero in a conductor when no potential difference is applied because:

A) the electrons are not moving.
B) the electrons are not moving fast enough.
C) for every electron with a given velocity, **v**, there is another with velocity, -**v**.
D) equal numbers of electrons and protons are moving together.
E) otherwise Ohm's law would not be valid.