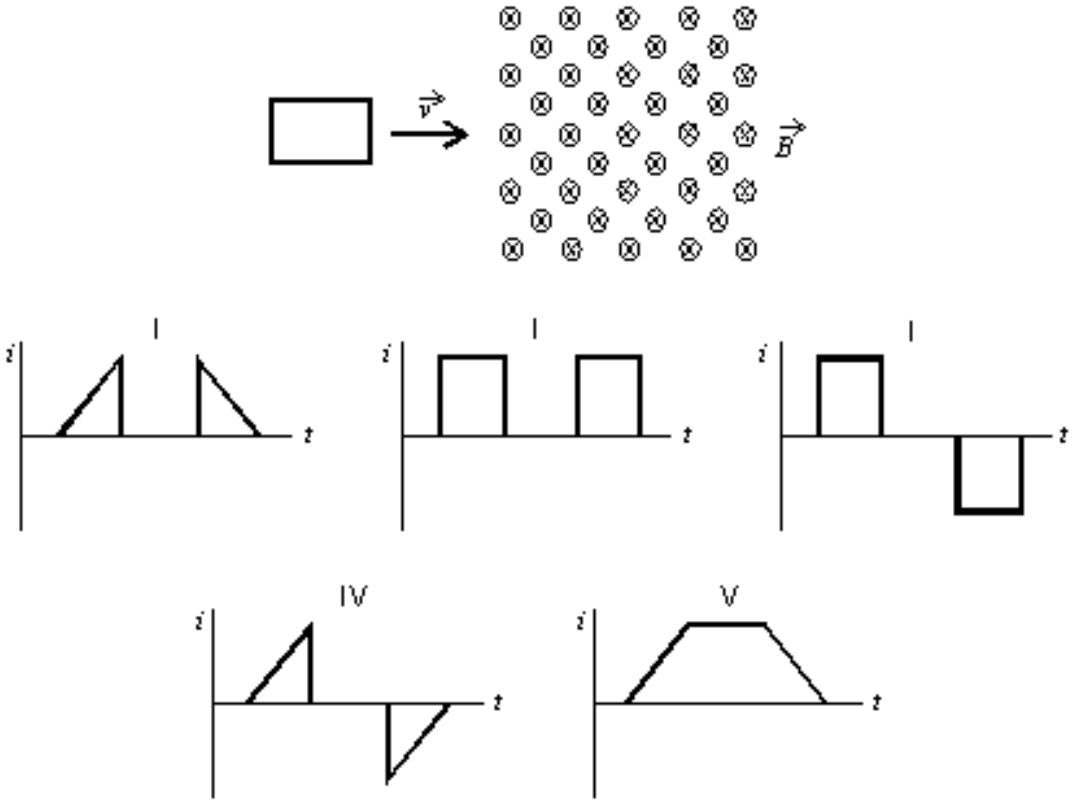
1. A square loop of wire moves with a constant speed v from a field-free region into a region of uniform B field, as shown. Which of the five graphs correctly shows the induced current i in the loop as a function of time t?



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

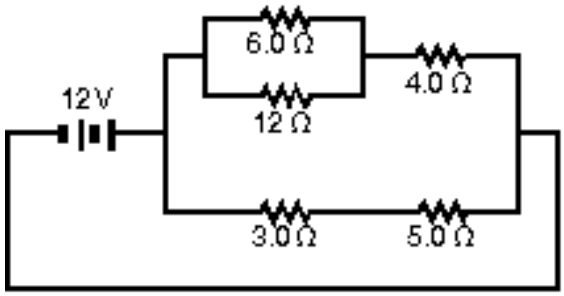
2. A cylinder has a radius of 2.1 cm and a length of 8.8 cm. Total charge 6.1×10^{-7} C is distributed uniformly throughout. The volume charge density is:

A) 5.3×10^{-5} C/m^3
B) 5.3×10^{-5} C/m^2
C) 8.5×10^{-4} C/m^3
D) 5.0×10^{-3} C/m^3
E) 6.3×10^{-2} C/m^3

3. An 8.0-mH inductor and a 2.0-Ω resistor are wired in series to an ideal battery. A switch in the circuit is closed at time 0, at which time the current is 0. The current reaches half its final value at a time of:

   A) 2.8 ms
   B) 4.0 ms
   C) 3 s
   D) 170 s
   E) 250 s

4. The current in the 5.0-Ω resistor in the circuit shown is:



   A) 0.42 A
   B) 0.67 A
   C) 1.5 A
   D) 2.4 A
   E) 3.0 A

5. Capacitors C_1 and C_2 are connected in parallel and a potential difference is applied to the combination. If the capacitor that is equivalent to the combination has the same potential difference, then the charge on the equivalent capacitor is the same as:

   A) the charge on C_1
   B) the sum of the charges on C_1 and C_2
   C) the difference of the charges on C_1 and C_2
   D) the product of the charges on C_1 and C_2
   E) none of the above

6. A total resistance of 3.0 Ω is to be produced by combining an unknown resistor R with a 12 Ω resistor. What is the value of R and how is it to be connected to the 12 Ω resistor?

   A) 4.0 Ω, parallel
   B) 4.0 Ω, series
   C) 2.4 Ω, parallel
   D) 2.4 Ω, series
   E) 9.0 Ω, series

7. A conducting sphere of radius 0.01 m has a charge of 1.0×10^{-9} C deposited on it. The magnitude of the electric field in N/C just outside the surface of the sphere is:

   A) zero
   B) 450
   C) 900
   D) 4500
   E) 90,000

8. Two charged point particle are located at two vertices of an equilateral triangle and the electric field is zero at the third vertex. We conclude:

   A) the two particles have charges with opposite signs and the same magnitude
   B) the two particles have charges with opposite signs and different magnitudes
   C) the two particles have identical charges
   D) the two particles have charges with the same sign but different magnitudes
   E) at least one other charged prticle is present

9. A wire contains a steady current of 2 A. The number of electrons that pass a cross section in 2 s is:

   A) 2
   B) 4
   C) 6.3×10^{18}
   D) 1.3×10^{19}
   E) 2.5×10^{19}

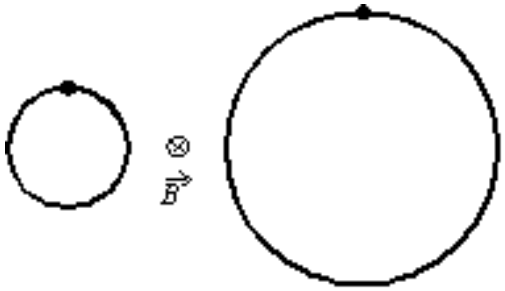
10. The potential difference between its ends of a 2-meter stick that is parallel to a uniform electric field is 400 V. The magnitude of the electric field is:

A) zero
B) 100 V/m
C) 200 V/m
D) 400 V/m
E) 800 V/m

11. A parallel-plate capacitor has a plate area of 0.2 m^2 and a plate separation of 0.1 mm. If the charge on each plate has a magnitude of 4×10^{-6} C the potential difference across the plates is approximately:

A) 0
B) 4×10^{-2} V
C) 1×10^{2} V
D) 2×10^{2} V
E) 4×10^{8} V

12. An electron and a proton both each travel with equal speeds around circular orbits in the same uniform magnetic field, as shown in the diagram (not to scale). The field is into the page on the diagram. Because the electron is less massive than the proton and because the electron is negatively charged and the proton is positively charged:



A) the electron travels clockwise around the smaller circle and the proton travels counterclockwise around the larger circle.
B) the electron travels counterclockwise around the smaller circle and the proton travels clockwise around the larger circle
C) the electron travels clockwise around the larger circle and the proton travels counterclockwise around the smaller circle
D) the electron travels counterclockwise around the larger circle and the proton travels clockwise around the smaller circle
E) the electron travels counterclockwise around the smaller circle and the proton travels counterclockwise around the larger circle

13. A dielectric slab is slowly inserted between the plates of a parallel plate capacitor, while the potential difference between the plates is held constant by a battery. As it is being inserted:

    A) the capacitance, the potential difference between the plates, and the charge on the positive plate all increase
    B) the capacitance, the potential difference between the plates, the charge on the positive plate all decrease
    C) the potential difference between the plates increases, the charge on the positive plate decreases, and the capacitance remains the same
    D) the capacitance and the charge on the positive plate decrease but the potential difference between the plates remains the same
    E) the capacitance and the charge on the plate increase but the potential difference between the plates remains the same

14. A certain capacitor, in series with a resistor, is being charged. At the end of 10 ms its charge is half the final value. The time constant for the process is about:

    A) 0.43 ms
    B) 2.3 ms
    C) 6.9 ms
    D) 10 ms
    E) 14 ms

15. Two long straight wires are parallel and carry current in the same direction. The currents are 8.0 and 12 A and the wires are separated by 0.40 cm. The magnetic field in tesla at a point midway between the wires is:

    A) 0
    B) 4.0×10^{-4}
    C) 8.0×10^{-4}
    D) 12×10^{-4}
    E) 20×10^{-4}

16. Charge Q is distributed uniformly throughout an insulating sphere of radius R. The magnitude of the electric field at a point $R/2$ from the center is:

    A) $Q/4\pi\boldsymbol{5}_0R^2$
    B) $Q/\pi\boldsymbol{5}_0R^2$
    C) $3Q/4\pi\boldsymbol{5}_0R^2$
    D) $Q/8\pi\boldsymbol{5}_0R^2$
    E) none of these

17. Two parallel long wires carry the same current and repel each other with a force F per unit length. If both these currents are doubled and the wire separation tripled, the force per unit length becomes:

A) $2F/9$
B) $4F/9$
C) $2F/3$
D) $4F/3$
E) $6F$

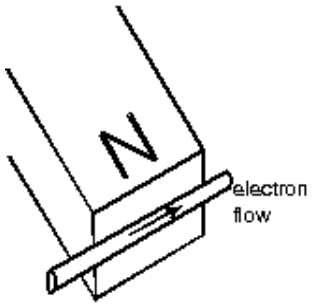
18. A square loop of wire lies in the plane of the page. A decreasing magnetic field is directed into the page. The induced current in the loop is:

A) counterclockwise
B) clockwise
C) zero
D) up the left edge and from right to left alongthe top edge
E) throught the middle of the page

19. A battery is used to charge a parallel-plate capacitor, after which it is disconnected. Then the plates are pulled apart to twice their original separation. This process will double the:

A) capacitance
B) surface charge density on each plate
C) stored energy
D) electric field between the two places
E) charge on each plate

20. The figure shows the motion of electrons in a wire which is near the N 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

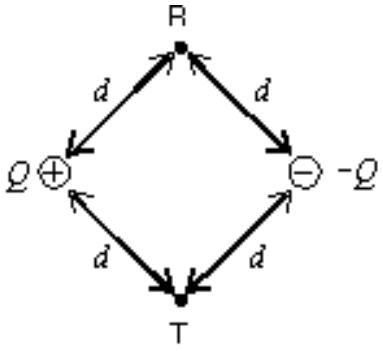
21. A spherical conducting shell has charge Q. A particle with charge q is placed at the center of the cavity. The charge on the inner surface of the shell and the charge on the outer surface of the shell, respectively, are:

A) 0, Q
B) q, $Q - q$
C) Q, 0
D) $-q$, $Q + q$
E) $-q$, 0

22. Of the following the copper conductor that has the least resistance is:

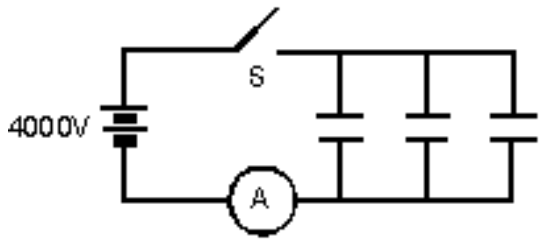
A) thin, long and hot
B) thick, short and cool
C) thick, long and hot
D) thin, short and cool
E) thin, short and hot

23. Points R and T are each a distance d from each of two particles with charges of equal magnitudes and opposite signs as shown. If $k = 1/4\pi\varepsilon_0$, the work required to move a particle with negative charge q from R to T is:



A) zero
B) kqQ/d^2
C) kqQ/d
D) $kqQ/\left(\sqrt{2}d\right)$
E) $kQq/(2d)$

24. Each of the three 25-μF capacitors shown is initially uncharged. How many coulombs of charge pass through the ammeter A after the switch S is closed?



A) 0.10
B) 0.20
C) 10
D) 0.05
E) none of these

25. Particles 1, with charge q_1 and 2, with a charge q_2 are on the x axis, with particle 1 at $x = a$ with and particle 2 at $x = -2a$. For the net force on a third charged particle, at the origin to be zero q_1 and q_2 must be related by q_2=:

A) $2q_1$
B) $4q_1$
C) $-2q_1$
D) $-4q_1$
E) $-q_1/4$