1. The specific heat of lead is 0.030 cal/g · °C. 300 g of lead shot at 100°C is mixed with 100 g of water at 70°C in an insulated container. The final temperature of the mixture is:
   A) 100°C
   B) 85.5°C
   C) 79.5°C
   D) 72.5°C
   E) None of these

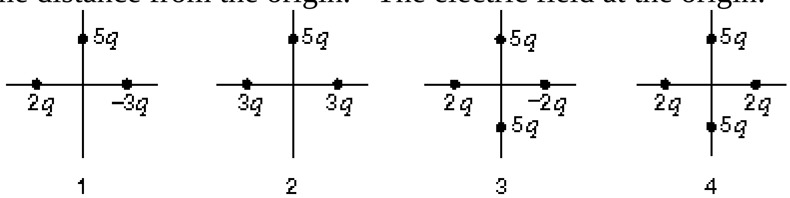
2. The rate of heat flow through a slab is R If the slab thickness is doubled, its cross-sectional area is halved, and the temperature difference across it is doubled, then the rate of heat flow becomes:
   A) $2R$
   B) $R/2$
   C) R
   D) $R/8$
   E) None of these

3. A particle with a charge of 5×10^{-6} C and a mass of 20 g moves uniformly with a speed of 7 m/s in a circular orbit around a stationary particle with a charge of -5×10^{-6} C. The radius of the orbit is:
   A) 0
   B) 0.23 m
   C) 0.62 m
   D) 1.6 m
   E) None of these

4. A particle with charge 2μC charge is placed at the origin, an identical particle, with the same charge, is placed 2 m from the origin on the x axis, and a third identical particle, with the same charge, is placed 2 m from the origin on the y axis. The magnitude of the force on the particle at the origin is:
   A) 9.0×10^{-3} N
   B) 6.4×10^{-3} N
   C) 1.3×10^{-2} N
   D) 1.8×10^{-2} N
   E) None of these

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 them is reduced to $d/2$ the force becomes:
   A) F/16
   B) F/8
   C) F/4
   D) F/2
   E) None of these

6. The diagrams below depict four different charge distributions. The charged particles are all the same distance from the origin. The electric field at the origin:



   A) is greatest for situation 1
   B) is greatest for situation 3
   C) is zero for situation 4 (Either A or C is correct.)
   D) is downward for situation 1
   E) is downward for situation 3

7. An isolated point charged point particle produces an electric field with magnitude E at a point 2 m away from the charge. A point at which the field magnitude is $E/4$ is:
   A) 1 m away from the charge
   B) 0.5 m away from the charge
   C) 2 m away from the charge
   D) 4 m away from the charge
   E) None of these

8. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A particle with charge q is placed at the center of the cavity. The magnitude of the electric field at a point in the cavity, a distance r from the center, is:
   A) kQ/R_1^2
   B) $kQ/(R_1^2-r^2)$
   C) kq/r^2
   D) $k(q+Q)/r^2$
   E) $k(q+Q)/(R_1^2-r^{2)}$

9. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A point charge q is placed at the center of the cavity. The magnitude of the electric field at a point r from the center, where $R_1 < r < R_2$, is:
   A) $Q/4\pi\varepsilon_0 R_1^2$
   B) $Q/4\pi\varepsilon_0 (R_1^2 - r^2)$
   C) $q/4\pi\varepsilon_0 r^2$
   D) $(q + Q)/4\pi\varepsilon_0 r^2$
   E) 0

10. Charge is distributed uniformly along a long straight wire. The electric field 2 cm from the wire is 20 N/C. The electric field 4 cm from the wire is:
   A) 120 N/C
   B) 80 N/C
   C) 40 N/C
   D) 10 N/C
   E) None of these

11. A 3.5-cm radius hemisphere contains a total charge of 6.6×10^{-7} C. The flux through the rounded portion of the surface is 9.8×10^4 N · m²/C. The flux through the flat base is:
   A) 0
   B) $+2.3 \times 10^4$ N · m²/C
   C) -2.3×10^4 N · m²/C
   D) -9.8×10^4 N · m²/C
   E) $+9.8 \times 10^4$ N · m²/C

12. A point particle with charge q is placed inside a cube at its center. The electric flux through any one side of the cube:
   A) is zero
   B) is q/ε_0
   C) is $q/4\varepsilon_0$
   D) is $q/6\varepsilon_0$
   E) cannot be computed using Gauss' law

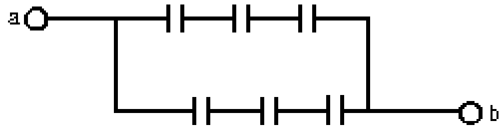
13. Positive charge is spread along a line of length L=1 meter on the x-axis. The left end of the line of charge is at the origin, and the linear charge density, λ, varies according to the equation, $\lambda(x) = 2 \times 10^{-9} x$, where x is measured in meters, and λ coulombs per meter. What is the electric potential (in volts) at a point located a distance d = 2 meters from the right end of the line of charge? (Use $k = 9 \times 10^{9}$ N-m^2/C^2.)
    A) 2.86
    B) 3.90
    C) 4.12
    D) 5.17
    E) None of these

14. A particle with a charge of 5.5×10^{-8}C charge is fixed at the origin. A particle with a charge of -2.3×10^{-8}C charge is moved from $x = 3.5$ cm on the x axis to $y = 3.5$ cm on the y axis. The change in the potential energy of the two-charge system is:
    A) 3.2×10^{-4} J
    B) -3.2×10^{-4} J
    C) 9.3×10^{-3} J
    D) -9.3×10^{-3} J
    E) 0

15. 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

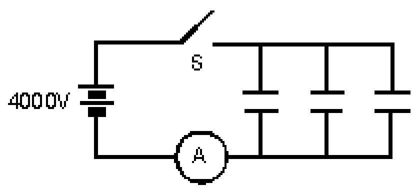
16. A certain capacitor has a capacitance of 5.0 μF. After it is charged to 5 μC and isolated, the plates are brought closer together so its capacitance becomes 10 μF. The work done by the agent is about:
    A) 0
    B) 1.25×10^{-6} J
    C) -1.25×10^{-6} J
    D) 8.3×10^{-7} J
    E) None of these

17. The diagram shows six 6-μF capacitors. The capacitance between points a and b is:



A) 3 μF
B) 4 μF
C) 6 μF
D) 9 μF
E) None of these

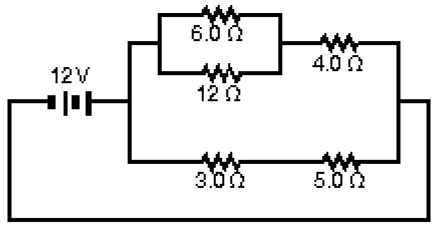
18. Each of the three 25-μF capacitors shown is initially uncharged. How many coulombs of charge pass through the ammeter A after the switch S is closed?



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

19. An ordinary light bulb is marked "60 watt, 120 volt". Its resistance is:
A) 60 Ω
B) 120 Ω
C) 180 Ω
D) 240 Ω
E) None of these

20. 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) None of these

21. A battery is connected across a parallel combination of two identical resistors. If the potential difference across the terminals is *V* and the current in the battery is I, then:
A) the potential difference across each resistor is V and the current in each resistor is I.
B) the potential difference across each resistor is V/2 and the current in each resistor is I/2.
C) the potential difference across each resistor is V and the current in each resistor is I/2.
D) the potential difference across each resistor is V/2 and the current in each resistor is I.
E) none of the above are true

22. Four 20-Ω resistors are connected in parallel and the combination is connected to a 20-V emf device. The current in the device is:
A) 0.25 A
B) 1.0 A
C) 4.0 A
D) 5.0 A
E) None of these

23. Two identical batteries, each with an emf of 18 V and an internal resistance of 1 Ω, are wired in parallel by connecting their positive terminals together and connecting their negative terminals together. The combination is then wired across a 4-Ω resistor. The current in the 4-Ω resistor is:
A) 1.0 A
B) 2.0 A
C) 4.0 A
D) 3.6 A
E) None of these

24. 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) None of these

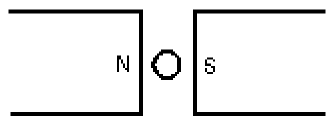
25. A charged capacitor is being discharged through a resistor. At the end of one time constant the charge has been reduced by $(1 - 1/e) = 63\%$ of its initial value. At the end of two time constants the charge has been reduced by what percent of its initial value?
   A) 82%
   B) 86%
   C) 100%
   D) between 90% and 100%
   E) None of these

26. 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) 2.32 ms
   C) 6.93 ms
   D) 14.43 ms
   E) None of these

27. A current of 20 amperes is being drawn from a battery whose emf is 24 volts. The internal resistance of the battery is 0.3 ohms. By how many volts is the battery "loaded down"?
   A) 2
   B) 3
   C) 5
   D) 4
   E) None of these

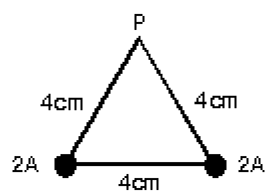
28. A loop of wire carrying a current of 2.0 A is in the shape of a right triangle with two equal sides, each 15 cm long. A 0.7 T uniform magnetic field is in the plane of the triangle and is perpendicular to the hypotenuse. The resultant magnetic force on the two sides has a magnitude of:
A) 0
B) 0.21 N
C) 0.30 N
D) 0.41 N
E) None of these

29. The diagram shows a straight wire carrying a flow of electrons into the page. The wire is between the poles of a permanent magnet. The direction of the magnetic force exerted on the wire is:



A) ↑
B) ↓
C) ←
D) →
E) into the page

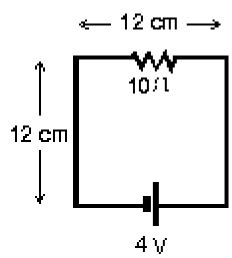
30. Two long straight wires pierce the plane of the paper at vertices of an equilateral triangle as shown below. They each carry 2 A, out of the paper. The magnetic field at the third vertex (P) has magnitude (in T):



A) 1.0×10^{-5}
B) 1.7×10^{-5}
C) 2.0×10^{-5}
D) 5.0×10^{-6}
E) None of these

31. A long, cylindrical straight wire carries a current density J that varies with respect to the distance r from the axis according to the equation, $J = 3r^2$, where J is in A/m^2, and r is in meters Use Ampere's Law to find the magnetic field inside the wire at a distance d from the axis.
    A) $3\mu_0 d^3/4$
    B) $4\mu_0 d$
    C) $2\mu_0/d^2$
    D) μ_0
    E) None of these

32. A 10 ohm resistor is connected to a 4 volt battery, as shown in the figure. the arrangement of circuit elements and the wires forms a square, each side of which is 12 cm. The circuit is in a uniform magnetic field that is into the page. The current in the circuit is 0.20 A. At what approximate rate (in T/s) is the magnitude of the magnetic field changing?



    A) zero
    B) 140
    C) 160
    D) 420
    E) None of these

33. A 6.0-mH inductor and a 3.0-Ω resistor are wired in series to a 12-V ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. 2.0 ms later the energy stored in the inductor is:
    A) 0
    B) 2.5×10^{-2} J
    C) 1.9×10^{-2} J
    D) 3.8×10^{-2} J
    E) None of these

34. How many calories are required to change one gram of 0°C ice to 100°C steam? The latent heat of fusion is 80 cal/g and the latent heat of vaporization is 540 cal/g. The specific heat of water is 1.00 cal/g · K.
    A) 100
    B) 540
    C) 620
    D) 720
    E) None of these