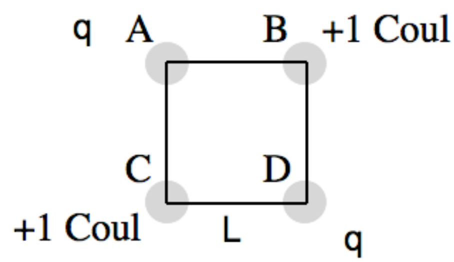
COMMENTS AND REMINDERS: ______________________________

Closed book. No work needs to be shown for multiple-choice questions.

1. Four charges are at the corners of a square, with B and C on opposite corners. Charges A and D, on the other two corners, have equal charge, q, while both B and C have a charge of +1.0 C. What is the charge on A so that the force on B is zero?

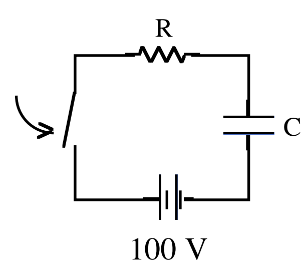


a. –1.0 C
b. –0.50 C
c. –0.35 C
d. –0.71 C
e. –0.24 C

2. A point charge q of 4.0 μC is located at the center of a spherical shell of radius R=2 m that has a charge –q uniformly distributed on its surface. Find the electric field for a point inside of the shell a distance r=1.5 m from the center.

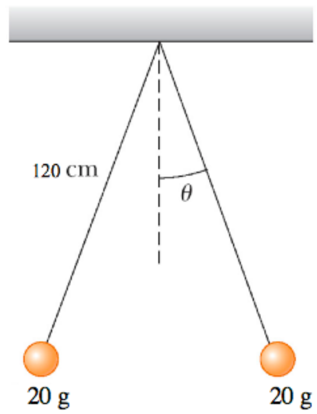
a. 3.6×10^4 N/C
b. 2.4×10^4 N/C
c. 0
d. 1.6×10^4 N/C
e. 0.9×10^4 N/C

3. A 100 V DC battery, a resistor, and a capacitor are connected in series. The RC time constant for the circuit is 0.334 s. The charge on the capacitor is observed to be 6.85 x10^{-3}C at 0.200 s after the switch is closed. What is the capacitance of the capacitor?



a. 200 μF.
b. 90.9 μF.
c. 152 μF.
d. 114 μF.
e. 182 μF.

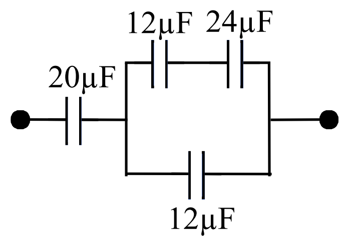
4. Two identical conducting balls of mass 20 grams are hung from thin threads of length 120 cm and carry the same charge q. Assume the angle the threads make from the vertical is $\theta = 20^{\circ}$. What is the value of each charge?



a. 4.1×10^{-7} C.
b. 2.3×10^{-6} C.
c. 4.5×10^{-6} C.
d. 8.2×10^{-7} C.
e. Not enough information is given to solve this problem.

5. What is the equivalent capacitance of this system of capacitors?

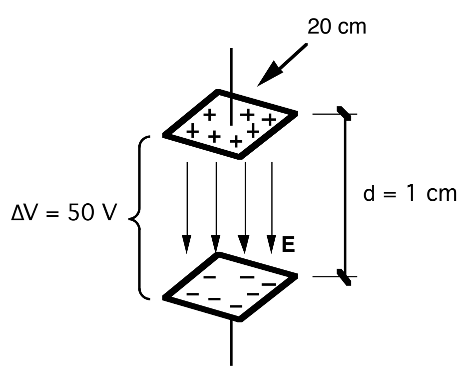
a. 29 μF.
b. 10 μF.
c. 40 μF.
d. 25 μF.
e. 16 μF.



6. Two point charges of values +3.4 μC and +6.6 μC are separated by 0.10 m. What is the electrical potential at the point midway between the two point charges?

a. $+1.8 \times 10^{6}$ V
b. -0.90×10^{6} V
c. $+0.90 \times 10^{6}$ V
d. $+3.6 \times 10^{6}$ V
e. $+8.8 \times 10^{6}$ V

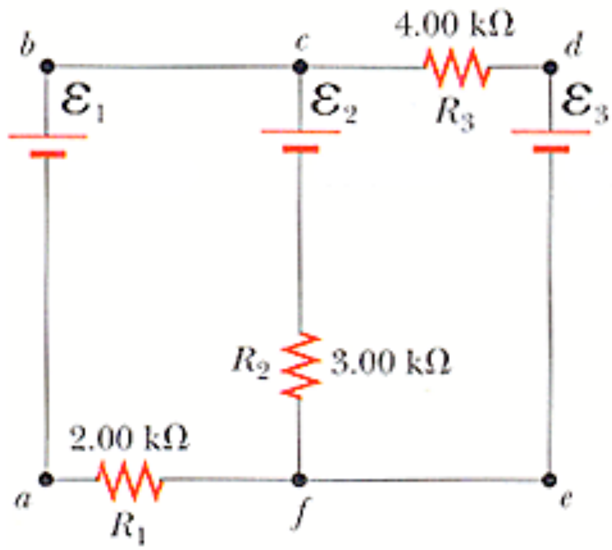
7. A parallel plate capacitor is made from two square plates, 20 cm on a side. The plates are spaced 1.0 cm apart and connected to a 50 V battery. How much energy is stored in the capacitor?



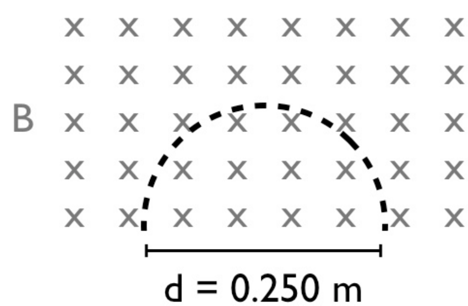
a. 8.9×10^{-8} J.
b. 2.2×10^{-7} J.
c. 3.5×10^{-11} J.
d. 8.9×10^{-10} J.
e. 4.4×10^{-8} J.

8. For the circuit below the $\varepsilon_1 = 28V$, $\varepsilon_2 = 6V$ and $\varepsilon_3 = 40V$. What is the value of the current flowing through R_2?

a. 2.0 mA.
b. 6.0 mA.
c. 4.0 mA.
d. 3.0 mA.
e. 8.0 mA.

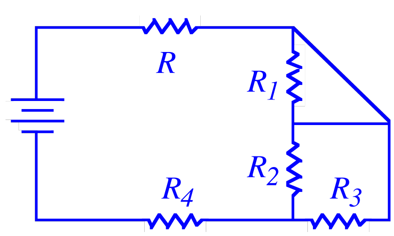


9. A particle with charge $+2.25 \times 10^{-15}$ C enters a uniform magnetic field of 0.500 T in a direction perpendicular to the field. Its velocity when it enters the magnetic field is 5.00×10^5 m/s. The particle exits the magnetic field 0.250 m from where it entered. Its path is shown with a dotted line in the picture to the right. What is the particle's mass?



a) 1.41×10^{-11} kg.
b) 2.81×10^{-22} kg.
c) 5.62×10^{-22} kg.
d) 9.00×10^{-27} kg.
e) 1.67×10^{-27} kg.

10. Which two resistors are in parallel with each other?



a. R and R_4
b. R_2 and R_3
c. R_2 and R_4
d. R and R_1
e. R_3 and R_4

11. If an electron is accelerated from rest through a potential difference of 1,200 V, find its approximate velocity at the end of this process.

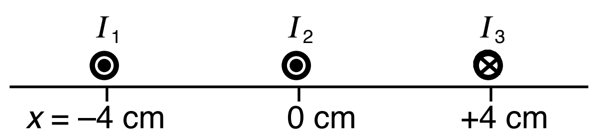
a. 1.0×10^7 m/s
b. 1.4×10^7 m/s
c. 2.1×10^7 m/s
d. 2.5×10^7 m/s
e. 2.3×10^8 m/s

12. A 12.0 μF capacitor is connected to an AC voltage source with a voltage maximum of 170 V and a frequency of 60.0 Hz. What is the rms current in the capacitor?

a. 1.41 A.
b. 0.768 A.
c. 0.543 A.
d. 0.384 A.
e. 0 A.

13. Three parallel wires all with the same magnitude of current ($I_1 = I_2 = I_3 = 10$ A) are perpendicular to the plane of this page. In two of the wires, the current is directed out of the page, while in the remaining wire the current is directed into the page. What is the value of magnetic field at $x = 2$ cm?

a. 33 μT.
b. 200 μT.
c. 233 μT.
d. 133 μT.
e. 117 μT.



14. A flat coil of wire consisting of 20 turns, each with an area of 50 cm^2, is positioned perpendicularly to a uniform magnetic field that increases its magnitude at a constant rate from 2.0 T to 6.0 T in 2.0 s. If the coil has a total resistance of 0.40 Ω, what is the magnitude of the induced current?

a. 70 mA
b. 140 mA
c. 500 mA
d. 800 mA
e. 250 mA

15. What is the current required in the windings of a long solenoid that has 500 turns uniformly distributed over a length of 0.200 m in order to produce a magnetic field of magnitude of 2.00×10^{-4} T at the center of the solenoid?

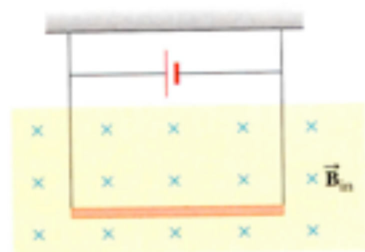
a. 20.0 mA.
b. 399 mA.
c. 39.9 mA.
d. 80.0 mA.
e. 63.5 mA.

16. How far apart should two 1.0 μC charges be placed so each exerts a force of 4.0 N on the other?

a. 4.7cm.
b. 5.5 cm.
c. 13.5 cm.
d. 16.5 cm.
e. 47.5 cm.

17. A conductor suspended by two flexible wires as shown in the figure has a mass for unit length of 0.040 kg/m. What current must exist in the conductor for the tension in the supporting wires to be zero when the magnetic field is 3.6 T into the page?

a. 0.11 A to the left.
b. 0.11 A to the right.
c. 0.011 A to the left.
d. 0.011 A to the right.
e. zero.



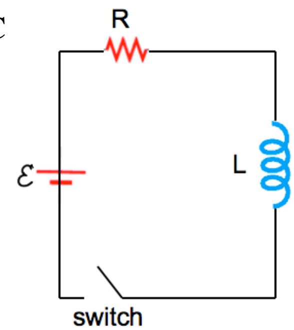
18. A 0.20-m-long conducting wire has a radius of 1.0 cm and a resistance of 3.2×10^{-5} Ω. What is the resistivity of the wire?

a. 1.6×10^{-8} Ω·m
b. 5.0×10^{-8} Ω·m
c. 16×10^{-8} Ω·m
d. 160×10^{-8} Ω·m
e. 1.0×10^{-7} Ω·m

19. A uniform 4.50 T magnetic field passes through the plane of a wire loop 0.100 m^2 in area. What magnetic flux passes through the loop when the direction of the 4.50 T field is at a 30.0° angle to the normal of the loop plane?

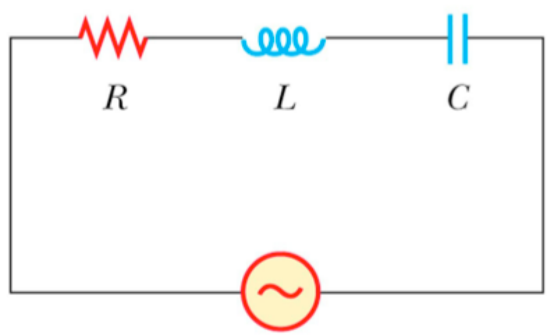
a. 5.00 $T\cdot m^2$.
b. 0.520 $T\cdot m^2$.
c. 0.390 $T\cdot m^2$.
d. 0.225 $T\cdot m^2$.
e. 1.22 $T\cdot m^2$.

20. A resistor, an inductor, and a switch are hooked up in series to a 24 V DC battery. The resistor has a resistance of 6.0 Ω and the inductive time constant, τ_L, of the circuit is 4.0×10^{-4} s. What energy is stored in the inductor when the current through it is 2.0 A? (It is easy if you think what is the intermediate step!)



a. 4.8×10^{-3} J.
b. 9.6×10^{-3} J.
c. 1.4×10^{-2} J.
d. 2.9×10^{-2} J.
e. 1.2×10^{-3} J.

21. An RLC series circuit is used to tune a radio to an FM station broadcasting at 105.0 MHz. The resistance of the circuit is 50 Ω and the capacitance is 2 pF. What inductance should be present at the circuit and what is the impedance at this frequency?



a. L= 2.29 μH and R=75 Ω.
b. L= 1.15 μH and R=75 Ω.
c. L= 1.15 μH and R=50 Ω.
d. L= 45.4 μH and R=75 Ω.
e. L= 45.4 μH and R=50 Ω.

22. In an AC series circuit the inductive reactance, X_L, is 50 Ω and the frequency is 100 Hz. What is the inductance in the circuit?

a. 80 mH.
b. 240 mH.
c. 500 mH.
d. 740 mH.
e. 5.0 H.

Recall that

$F = k_e \frac{|q_1||q_2|}{r^2}$; $k_e = 8.99\times 10^9\ \frac{\mathrm{N\cdot m^2}}{\mathrm{C^2}}$; $e = 1.60\times 10^{-19}\mathrm{C}$; $\varepsilon_o = 8.85\times 10^{-12}\ \frac{\mathrm{C^2}}{\mathrm{N\cdot m^2}}$;

$m_e = 9.11\times 10^{-31}$ kg; $m_p = 1.673\times 10^{-27}$ kg; $m_n = 1.675\times 10^{-27}$ kg; $1\ \mathrm{eV} = 1.602\times 10^{-19}\ \mathrm{J}$;

$1\ \mathrm{kWh} = 3.60\times 10^6\ \mathrm{J}$; $\vec{\mathbf{F}} = q_o\vec{\mathbf{E}}$; $E = k_e \frac{|q|}{r^2}$; $\Phi_E = EA\cos\theta$; $\Phi_E = \frac{Q_{inside}}{\varepsilon_0}$; $PE_{elec,\mathrm{point}} = k_e \frac{qq_0}{r}$;

$V_{point\ charge} = k_e \frac{q}{r}$; $\Delta PE_{elec} = q_0\Delta V$; $C = \frac{Q}{\Delta V}$; $C_{parllel\ plate} = \varepsilon_0 \frac{A}{d}$; $C_{dielectric} = \kappa\varepsilon_0 \frac{A}{d}$;

$\frac{1}{C_{series\ eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$; $C_{parallel\ eq} = C_1 + C_2 + C_3 + \ldots$; $I = \frac{\Delta Q}{\Delta t}$;

$R = \frac{\Delta V}{I} = \rho\frac{L}{A}$; $\rho = \rho_o[1+\alpha(T-T_o)]$; $R = R_o[1+\alpha(T-T_o)]$; $Power = I(\Delta V) = I^2R = \frac{(\Delta V)^2}{R}$;

$\rho_{Silver} = 1.59\times 10^{-8}\,\Omega\cdot\mathrm{m}$; $\rho_{Copper} = 1.7\times 10^{-8}\,\Omega\cdot\mathrm{m}$

$I_{in} = I_{out}$; $\frac{1}{R_{parallel\ eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$; $R_{series\ eq} = R_1 + R_2 + R_3 + \ldots$; $\sum \Delta V_{loop} = 0$;

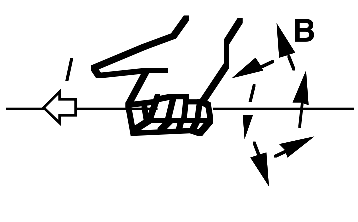
$\tau = RC$; $q_{\mathrm{charge}} = Q_{final}\left(1 - e^{-t/RC}\right)$; $q_{\mathrm{discharge}} = Q_0 e^{-t/RC}$;

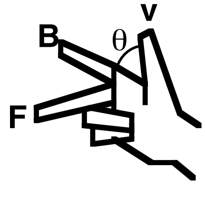
$\oint \vec{B}\times d\vec{l} = \mu_o I_{cross}$; $\mu_o = 4\pi\times 10^{-7}\,\frac{\mathrm{N}}{A^2}$;

$F_{on\ q} = qvB\sin\theta$; $F_{on\ I} = ILB\sin\theta$; OR $\vec{F}_{on\ q} = q\vec{v}\times\vec{B}$; $\vec{F}_{on\ I} = I\vec{L}\times\vec{B}$

$\tau = BIAN\sin\theta$; $\tau = |\vec{r}||\vec{F}|\sin\theta$; $\tau = \mu B\sin\theta$; $\mu = NIA$; $r = \frac{mv}{qB}$; $p = mv$; $F_{cent} = \frac{\mathrm{m}v^2}{r}$;

$B_{wire} = \frac{\mu_o I}{2\pi r}$; $B_{coil} = N\frac{\mu_o I}{2R}$; $B_{solenoid} = \mu_o\left(N/\ell\right)I$; $\frac{F_1}{\ell} = \frac{\mu_o I_1 I_2}{2\pi d}$;





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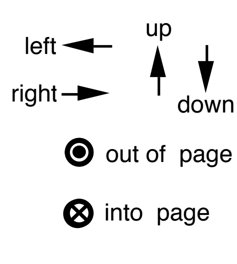

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$\Phi_B = BA\cos\theta$; $\mathcal{E} = -N\frac{d\Phi_B}{dt}$; $|\mathcal{E}| = B_\perp \ell v$; $\mathcal{E} = NAB\omega\sin(\omega t)$; $\omega = 2\pi f$; $\mathcal{E}_L = -L\frac{dI}{dt}$;

$L = \frac{N\Phi_B}{I}$; $L = \frac{\mu_o N^2 A}{\ell}$; $\tau_L = \frac{L}{R}$; $I = \frac{\mathcal{E}}{R}\left(1 - e^{-Rt/L}\right)$; $PE_L = \frac{1}{2}LI^2$.

$I_{rms} = \frac{I_{\max}}{\sqrt{2}}$; $\Delta V_{rms} = \frac{\Delta V_{\max}}{\sqrt{2}}$; $P_{avg} = I_{rms}^2 R$; $X_C = \frac{1}{2\pi f C}$; $\Delta V_{C,rms} = I_{rms}X_C$; $X_L = 2\pi f L$;

$\Delta V_{L,rms} = I_{rms}X_L$; $\Delta V_{\max} = \sqrt{\Delta V_R^2 + \left(\Delta V_L - \Delta V_C\right)^2}$; $Z = \sqrt{R^2 + \left(X_L - X_C\right)^2}$; $\Delta V_{\max} = I_{\max}Z$;

$\tan\phi = \frac{X_L - X_C}{R}$; $P_{avg} = I_{rms}\Delta V_{rms}\cos\phi$; $I_{rms} = \frac{\Delta V_{rms}}{Z} = \frac{\Delta V_{rms}}{\sqrt{R^2 + \left(X_L - X_C\right)^2}}$; $f_o = \frac{1}{2\pi\sqrt{LC}}$

<u>p</u>ico- = $\times 10^{-12}$; <u>n</u>ano- = $\times 10^{-9}$; <u>μ</u> = micro- = $\times 10^{-6}$; <u>m</u>illi- = $\times 10^{-3}$; <u>c</u>enti- = $\times 10^{-2}$ <u>M</u>ega- = $\times 10^{6}$;

$A_{circle} = \pi r^2$; $A_{sphere} = 4\pi r^2$; $A_{square} = L^2$; $g = 9.80$ m/s^2; 100 cm = 1 m; 1,000 mA = 1 A;

2.54 cm = 1 in; 12 in = 1 ft; 5,280 ft = 1 mi; 1,609 m = 1 mi; 0.3048 m = 1 ft; $A_{circle} = \pi r^2$;

$A_{cyl.side} = 2\pi rh$; $A_{sphere} = 4\pi r^2$; $g = 9.80$ m/s^2; $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$; 100 cm = 1 m;

1 μF = 1.0×10^{-6}F; 1 MW = 1.0×10^{6}W; 1,000 W = 1 kW; 60 s = 1 min; 60 min = 1 hr;

2.54 cm = 1 in; 12 in = 1 ft; 5,280 ft = 1 mi; 1,609 m = 1 mi; 0.3048 m = 1 ft