Q1. A sinusoidal string wave has a speed of 250 m/s and a frequency of 100 Hz. what is the phase difference between two elements of the string that are 0.20 m apart?

A) 0.50 rad.
B) 0.20 rad.
C) 3.14 rad.
D) 29 rad.
E) 0 rad.

Q2. By what factor the intensity of a sound source increased if its sound level is increased by 20 dB?

A) 100.
B) 10.
C) 20.
D) 7.4.
E) 480.

Q3. A 300-g metallic block is placed with 300 g of water in an insulated container. When they reach equilibrium, the temperature of the block decreases by 50^o and the temperature of water changes from 30^o C to 40^o. What is the specific heat of the metal? The specific heat of water is 1.0 cal/g·C^o.

A) 0.20 cal/g·C^o.
B) 0.015 cal/g·C^o.
C) 0.10 cal/g·C^o.
D) 0.15 cal/g·C^o.
E) 0.50 cal/g·C^o.

Q4. Five moles of an ideal monatomic gas is initially at 300 K and 1.0 atm. The gas is compressed adiabatically to 3.0 atm. What is the final volume of the gas?

A) 0.064 m^3.
B) 0.041 m^3.
C) 0.020 m^3.
D) 0.050 m^3.
E) 0.045 m^3.

Q5. 100 g of ice at 0 ^oC (System A) is added to 100 g of water at 100 ^oC (system B) in an insulated container. The mixture reaches its equilibrium temperature of 10.3 ^oC. Calculate the change in entropy of system A.

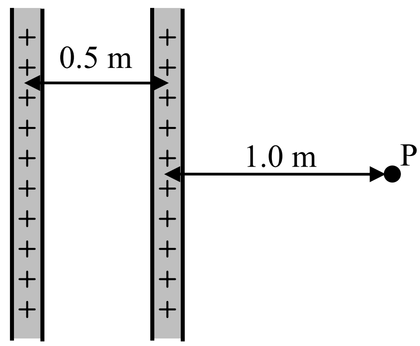
A) 0.14 kJ/K.
B) 0.84 kJ/K.
C) 0.016 kJ/K.
D) 0.11 kJ/K.
E) Zero.

Q6. An electric dipole consists of charges +2e and -2e separated by 0.78×10^{-9} m. It is placed in an electric field of strength 3.0×10^{6} N/C such that its dipole moment vector is perpendicular to the field. What is the magnitude of the torque on the dipole?

A) 7.5×10^{-22} N·m.
B) 15×10^{-22} N·m.
C) 3.7×10^{-22} N·m.
D) 30×10^{-22} N·m.
E) Zero.

Q7. The figure shows two infinite insulating sheets each of which has a positive surface charge density of 1.0 μC/m^2. Find the magnitude of the electric field at a point P.

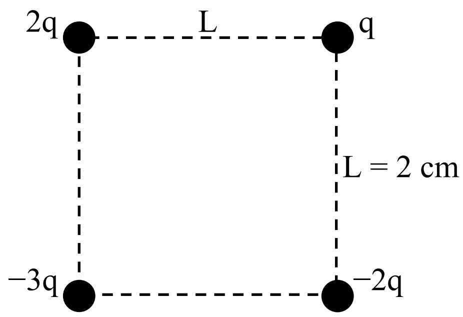
Fig#



A) 110 kV/m.
B) 220 kV/m.
C) 56 kV/m.
D) Zero.
E) 28 kV/m.

Q8. Consider the four charges shown in the figure. How much work is required by an external agent to move the charge q to infinity? q = 1.0 μC.

Fig#

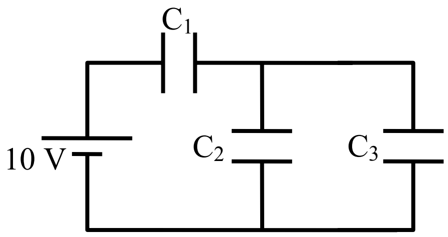


A) 0.95 J.
B) -0.95 J.
C) -0.48 J.
D) -3.0 J.

E) 3.0 J.

Q9. For the circuit shown in the figure, what is the charge on C_3? $C_1 = 1.0\ \mu F$, $C_2 = 6.0\ \mu F$ and $C_3 = 3.0\ \mu F$.

Fig#



A) 3.0 μC.
B) 9.0 μC.
C) 6.0 μC.
D) 5.0 μC.
E) 2.0 μC.

Q10. A wire having a resistance of 3 Ω is stretched so that its length becomes three times its original length. Its volume remains unchanged. The resistance of the stretched wire is

A) 27 Ω.
B) 1 Ω.
C) 3 Ω.
D) 1/3 Ω.
E) 9 Ω.

Q11. A battery is connected across a series 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/2 and the current in each resistor is i.
B) the potential difference across each resistor is V and the current in each resistor is i.
C) the potential difference across each resistor is V/2 and the current in each resistor is i/2.
D) the potential difference across each resistor is V and the current in each resistor is i/2.
E) the potential difference across each resistor is V and the current in each resistor is 2 i.

Q12. A 15 Ohm resistor is connected in parallel with 30 Ohm resistor. The combination is connected to a 10 Volt battery. Then the power generated in the 15 Ohm resistor is:

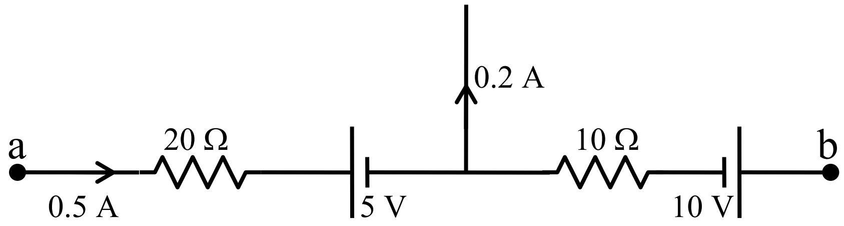
A) 6.7 W.
B) 3.3 W.
C) 5.9 W.
D) 10 W.
E) 15 W.

Q13. The emf of a battery is equal to its terminal potential difference

A) only when there is no current in the battery.
B) under all conditions.
C) only when the battery is being charged.
D) only when a large current is in the battery.
E) only when a small current is in the battery.

Q14. What is the electric potential difference $V_b - V_a$?

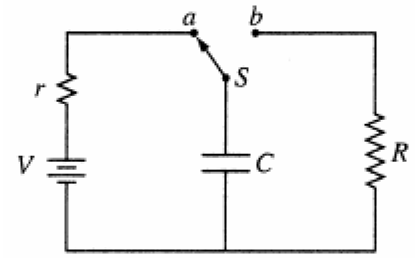
Fig#

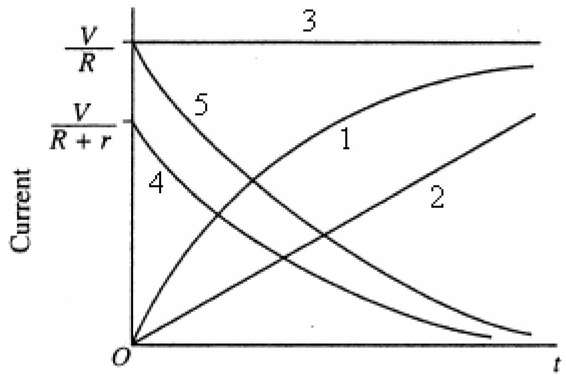


A) – 8 V.
B) – 10 V.
C) + 8 V.
D) + 10 V.
E) + 18 V.

Q15. The capacitor shown in the figure is fully charged by connecting switch S to contact *a*. If switch S is thrown to contact *b* at time t=0, which of the curves represents the magnitude of the current through the resistor R as a function of time?

Fig#





A) 5.
B) 4.
C) 3.
D) 2.
E) 1.

Q16. A circular loop of radius 10 cm carries a current of 20 A. The magnetic moment of the loop is directed along the unit vector 0.60 **i** + 0.80 **j**. The magnetic field is **B** = (0.20 T) **i** – (0.40 T) **j** T. Find the torque on the loop.

A) (– 0.25 N·m) **k**.
B) (+ 0.25 N·m) **k**.
C) (– 0.050 N·m) **k**.
D) (+ 0.050 N·m) **k**.
E) (+ 0.050 N·m) **j**.

Q17. An electron is accelerated from rest by a potential difference of 500 V. Then, the electron enters a region with a uniform magnetic field and moves in a circular path of radius 6.0 cm. What is the magnitude of the magnetic field?

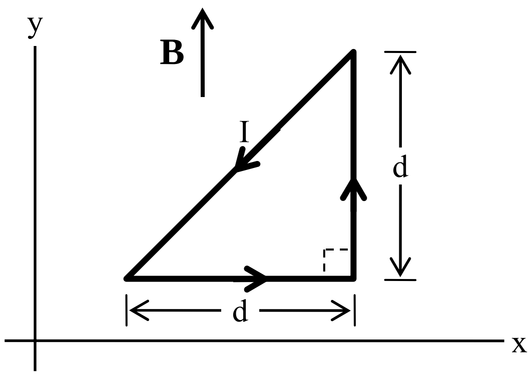
A) 1.3 mT.
B) 3.0 mT.
C) 8.3 mT.
D) 0.45 mT.
E) 4.4 mT.

Q18. An electron enters a region of uniform perpendicular **E** and **B** fields. It is observed that the velocity **v** of the electron is unaffected. A possible explanation is

A) **v** is perpendicular to both **E** and **B** has a magnitude of E/B.
B) **v** is parallel to **E** and has a magnitude of E/B.
C) **v** is parallel to **B**.
D) **v** is perpendicular to both **E** and **B** has a magnitude of B/E.
E) **v** is parallel to **E** and has a magnitude of B/E.

Q19. The current-carrying triangular wire loop shown in the figure is in a uniform magnetic field of (25 mT) **j**. If d = 20 cm and the current in the loop is 0.50 A, what is the resultant force on the loop?

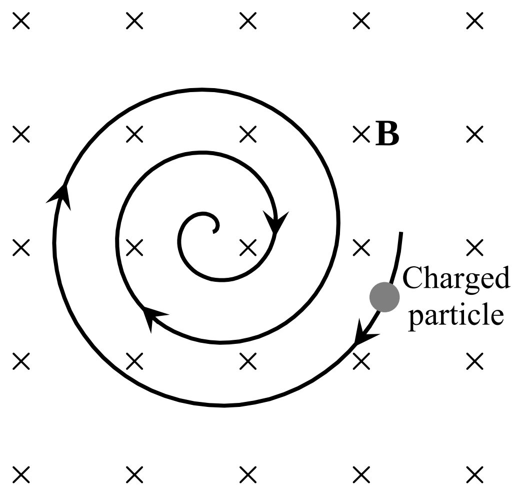
Fig#



A) 0.
B) (+0.50 N) **k**.
C) (–0.50 N) **k**.
D) (–0.25 N) **k**.
E) (+0.25 N) **k**.

Q20. A uniform magnetic field is directed into the page. A particle, moving in the plane of the page, follows a clockwise spiral of decreasing radius as shown in the figure. A reasonable explanation is that the particle has

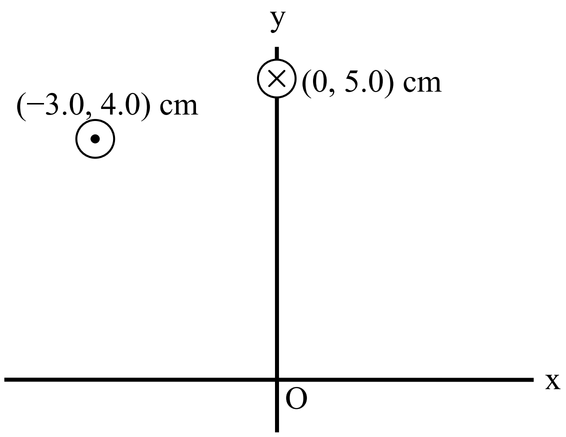
Fig #



A) a negative charge and is slowing down.
B) a positive charge and is slowing down.
C) a positive charge and is speeding up.
D) a negative charge and is speeding up.
E) a positive charge and is moving at constant speed.

Q21. The figure shows, in cross section, two wires that are parallel, straight, and very long. The first wire, located at (0, 5.0) cm, carries a current of 6.0 A into the page and the other wire, located at (–3.0, 4.0) cm, carries a current of 7.5 A out of the page. What magnetic field these two wires produce at the origin O?

Fig#

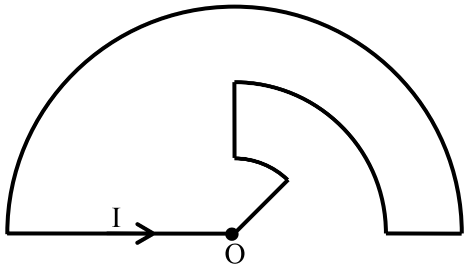


A) (18 μT) **j**.
B) (–18 μT) **j**.
C) (–48 μT) **i** + (–18 μT) **j**.

D) (48 μT) **i** + (18 μT) **j**.
E) (48 μT) **i** + (–18 μT) **j**.

Q22. The figure shows a current-carrying loop. The three circular arcs have radii 1.0, 2.0, and 3.0 cm, and subtend angles 45^o, 90^o, and 180^o, respectively. If the smallest arc alone produces a magnetic field of magnitude 12 μT at point O, what is the magnitude of the total magnetic field produced by the whole loop at point O?

Fig#



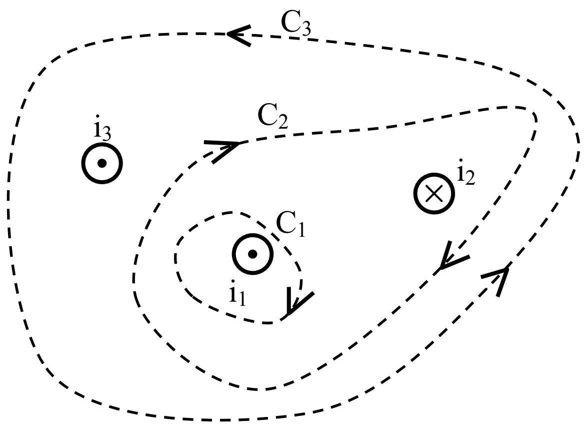
A) 16 μT.
B) 40 μT.
C) 8.0 μT.
D) 10 μT.
E) 0.

Q23. Two long straight parallel wires are separated by a distance of 10 cm. If wire 1 carries a current of 10 A, and exerts a repelling force per unit length of 0.50×10^{-3} N/m on wire 2, what is the current in wire 2?

A) 25 A and opposite in direction to the current in wire 1.
B) 25 A and in the same direction as the current in wire 1.
C) 10 A and opposite in direction to the current in wire 1.
D) 10 A and in the same direction as the current in wire 1.
E) 5.0 A and in the same direction as the current in wire 1.

Q24. Three wires carrying currents of magnitudes i_1, i_2 and i_3 in the directions shown in the figure. Which one of the following integrals is correct?

Fig#



A) $\oint_{C2} \vec{B} \cdot d\vec{s} = \mu_o (i_2 - i_1)$.

B) $\oint_{C2} \vec{B} \cdot d\vec{s} = \mu_o (i_1 + i_3)$.

C) $\oint_{C2} \vec{B} \cdot d\vec{s} = \mu_o (i_1 + i_2 - i_3)$.

D) $\oint_{C3} \vec{B} \cdot d\vec{s} = \mu_o i_3$.

E) $\oint_{C1} \vec{B} \cdot d\vec{s} = \mu_o i_2$.

Q25. A 342 turns solenoid is 30 cm long, has a radius of 0.50 cm and carries a current of 2.1 A. The magnitude of the magnetic field at the center of the solenoid is

A) 3.0 mT.
B) 2.5 mT.
C) 2.0 mT.
D) 3.5 mT.
E) 4.0 mT.

Q26. Consider a plane square loop made of 1.0 m long wire in a uniform magnetic field of 1.5 T. The magnetic field is directed perpendicular to the yz-plane. If the plane of the loop makes an angle of 30^o with the direction of the magnetic field, find the magnetic flux passing through the loop.

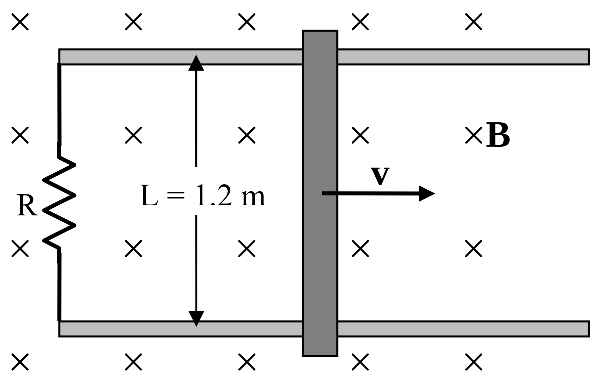
A) 0.047 $T \cdot m^2$.
B) 0.081 $T \cdot m^2$.
C) 0.75 $T \cdot m^2$.
D) 1.3 $T \cdot m^2$.
E) 0.094 $T \cdot m^2$.

Q27. A 20 turn circular coil of radius 5.0 cm and resistance 0.50 Ω is placed in a magnetic field directed perpendicular to the plane of the coil. The magnitude of the magnetic field varies in time as $B = 0.020\, t + 0.050\, t^2$, where t is in seconds and B is in teslas. Calculate the induced emf in the coil at t = 6.0 s.

A) 97 mV.
B) 54 mV.
C) 39 mV.
D) 4.7 mV.
E) 200 mV.

Q28. The figure shows a bar being moved to the right on two parallel rails at a constant speed of 3.0 m/s in a uniform magnetic field of 0.50 T directed into the page. If the induced current is 1.5 A, find the power dissipated in the resistor? Neglect the mass of the bar, friction, and the resistance of the bar and rails.

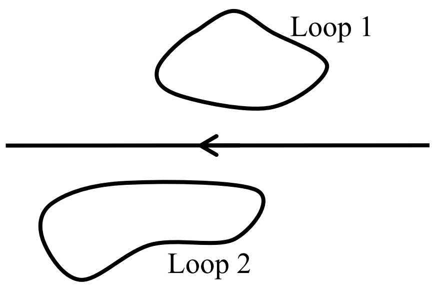
Fig#



A) 2.7 W.
B) 1.2 W.
C) 1.9 W.
D) 0.30 W.
E) 3.2 W.

Q29. The figure shows two loops and a long straight wire lying in the same plane. If the current in the straight wire is increased, then

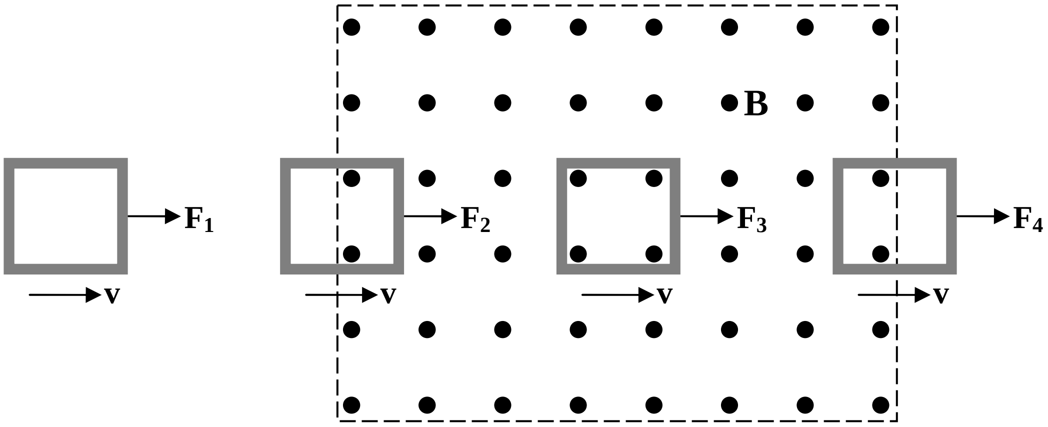
Fig#



A) The induced current in loop 1 is counterclockwise and in loop 2 is clockwise.
B) The induced current in loop 1 is clockwise and in loop 2 is counterclockwise.
C) In both loops, the induced current is clockwise.
D) In both loops, the induced current is counterclockwise.
E) In both loops, there is no induced current.

Q30. A square loop of copper wire is pulled at constant velocity **v** through a region of magnetic field. Which statement about the magnitude of the pulling force $\mathbf{F_1}$, $\mathbf{F_2}$, $\mathbf{F_3}$ and $\mathbf{F_4}$ is true?

Fig#



A) $F_2 = F_4 > F_1 = F_3$.
B) $F_3 > F_2 = F_4 > F_1$.
C) $F_3 > F_4 > F_2 > F_1$.
D) $F_4 > F_2 > F_3 > F_1$.
E) $F_1 = F_2 = F_3 = F_4$.

$v = \sqrt{\frac{\tau}{\mu}}$, $v = \lambda f$ $v = \sqrt{\frac{B}{\rho}}$

$S = S_m \cos(kx - \omega t)$

$I = \frac{\text{Power}}{\text{Area}}$

$y = y_m \sin(kx - \omega t - \varphi)$

$P = \frac{1}{2}\mu\omega^2 y_m^2 v$

$\Delta P = \Delta P_m \sin(kx - \omega t)$

$\Delta P_m = \rho v \omega S_m$

$I = \frac{1}{2}\rho(\omega S_m)^2 v$

$\beta = 10 \log \frac{I}{I_0}$, $I_0 = 10^{-12}\, W/m^2$

$f' = f\left(\frac{v \pm v_D}{v \mp v_s}\right)$

$y = \left(2y_m \cos\frac{\varphi}{2}\right)\sin\left(kx - \omega t - \frac{\varphi}{2}\right)$

$\Delta L = \frac{\lambda}{2\pi}\varphi$

$\Delta L = n\frac{\lambda}{2}$ $n = 0,1,2,3,..$ ...

$\Delta L = m\lambda$

$\Delta L = \left(m + \frac{1}{2}\right)\lambda$

$f_n = \frac{nv}{2L}$, $n = 1,2,3,...$

$f_n = \frac{nv}{4L}$, $n = 1,3,5,...$

$y = 2y_m \sin(kx)\cos(\omega t)$

$\alpha = \frac{\Delta L}{L}\frac{1}{\Delta T}$, $PV = nRT = NkT$

$n = \frac{m}{M} = \frac{N}{N_A}$, $\beta = \frac{1}{V}\frac{\Delta V}{\Delta T}$

$Q = mL$, $W = \int P dV$,

$P = \frac{2}{3}\frac{N}{V}(\frac{1}{2}m\vec{v}^2)$, $C_p - C_v = R$

$Q = m c \Delta T$,

$\Delta E_{int} = Q - W$, $\Delta E_{int} = n c_v \Delta T$

$v_{rms} = \sqrt{\frac{3RT}{M}}$, $\frac{1}{2}m\vec{v}^2 = \frac{3}{2}k_B T$,

$P_{cond} = \frac{Q}{t} = \kappa A\frac{T_H - T_C}{L}$

$Q = n c_p \Delta T$, $Q = n c_v \Delta T$

$P V^{\gamma} = \text{constant}$, $T V^{\gamma-1} = \text{constant}$

$T_F = \frac{9}{5}T_c + 32$, $T_K = T_c + 273$

$W = Q_H - Q_L$, $\varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$

$\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$, $K = \frac{Q_L}{W}$, $\Delta S = \int\frac{dQ_r}{T}$

$F = \frac{kq_1q_2}{r^2}$, $F = q_0 E$

$\varphi = \int_{Surface} \vec{E}.d\vec{A}$, $E = \frac{kq}{r^2}$

$E = \frac{kQ}{R^3}r$, $E = \frac{2k\lambda}{r}$

$\varphi_c = \oint \vec{E}.d\vec{A} = \frac{q_{in}}{\varepsilon_0}$

$E = \frac{\sigma}{2\varepsilon_o}$, $E = \frac{\sigma}{\varepsilon_o}$, $V = \frac{kQ}{r}$,

$\Delta S = nR\ln\frac{V_f}{V_i} + nC_v\ln\frac{T_f}{T_i}$

$\Delta V = V_B - V_A = -\int_A^B \vec{E}.d\vec{S} = \frac{\Delta U}{q_0}$,

$E_x = -\frac{\partial V}{\partial x}$, $E_y = -\frac{\partial V}{\partial y}$, $E_z = -\frac{\partial V}{\partial z}$

$U = \frac{kq_1q_2}{r_{12}}$, $C = \frac{Q}{V}$, $C_o = \frac{\varepsilon_0 A}{d}$

$C = 4\pi\varepsilon_o\frac{ab}{b-a}$, $U = \frac{1}{2}CV^2$

$u = \frac{1}{2}\varepsilon_o E^2$, $C = \kappa C_0$ $E = \frac{E_0}{\kappa}$,

$V = \frac{V_o}{\kappa}$, $I = \frac{dQ}{dt}$, $\vec{\tau} = \vec{p}\times\vec{E}$, $p = qd$

$I = JA$, $R = \frac{V}{I} = \rho\frac{L}{A}$

$\rho = \rho_0[1 + \alpha(T - T_0)]$, $P = IV$

$q(t) = C\varepsilon[1 - e^{-t/RC}]$,

$q(t) = q_o e^{-t/RC}$

$\tau = N i A B \sin\theta$

$\vec{F} = q(\vec{v}\times\vec{B})$, $\vec{F} = i(\vec{L}\times\vec{B})$

$F_{ba} = \frac{\mu_o L i_a i_b}{2\pi d}$, $d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\, d\vec{s}\times\vec{r}}{r^3}$,

$\oint\vec{B}.d\vec{s} = \mu_0 i_{enc}$

$B = \frac{\mu_0 i}{4\pi R}\varphi$, $B = \frac{\mu_0 i}{2\pi r}$,

$B_s = \mu_0 n i$, $\varphi_B = \int_{Surface}\vec{B}.d\vec{A}$

$\varepsilon = -\frac{d\varphi_B}{dt}$, $\varepsilon = BLv$

$v = v_o + at$

$x - x_o = v_o t + \frac{1}{2}at^2$

$v^2 = v_o^2 + 2a(x - x_o)$

$\varepsilon_0 = 8.85 \times 10^{-12}\, C^2/N.m^2$

$k = 9.0 \times 10^9\, N.m^2/C^2$

$q_e = -1.6 \times 10^{-19}\, C$

$m_e = 9.11 \times 10^{-31}\, kg$

$m_p = 1.67 \times 10^{-27}\, kg$

$1\, eV = 1.6 \times 10^{-19}\, J$

$\mu_0 = 4\pi \times 10^{-7}\, Wb/A.\, m$

$k_B = 1.38 \times 10^{-23}\, J/K$

$N_A = 6.02 \times 10^{23}$ molecues/mole

$1\, atm = 1.013 \times 10^5\, N/m^2$

$R = 8.31\, J/mol.\, K$

$g = 9.8\, m/s^2$, $1\, cal = 4.186\, J$,

for water:

$c = 4190\frac{J}{kg.K}$

$L_F = 333\frac{kJ}{kg}$, $L_V = 2256\frac{kJ}{kg}$