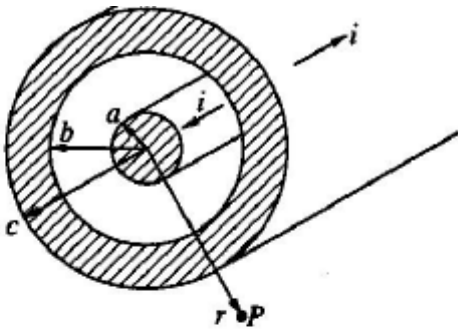


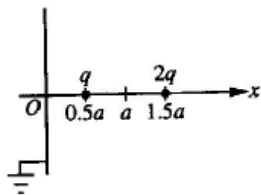
Electricity & Magnetism – Problem Set # 1

Rest mass of the electron	$m_e = 9.11 \times 10^{-31}$ kilogram = 9.11×10^{-28} gram
Magnitude of the electron charge	$e = 1.60 \times 10^{-19}$ coulomb = 4.80×10^{-10} statcoulomb (esu)
Avogadro's number	$N_0 = 6.02 \times 10^{23}$ per mole
Universal gas constant	$R = 8.32$ joules/(mole · K)
Boltzmann's constant	$k = 1.38 \times 10^{-23}$ joule/K = 1.38×10^{-16} erg/K
Speed of light	$c = 3.00 \times 10^8$ m/s = 3.00×10^{10} cm/s
Planck's constant	$h = 6.63 \times 10^{-34}$ joule · second = 4.14×10^{-15} eV · second $\hbar = h/2\pi$
Vacuum permittivity	$\epsilon_0 = 8.85 \times 10^{-12}$ coulomb ² /(newton · meter ²)
Vacuum permeability	$\mu_0 = 4\pi \times 10^{-7}$ weber/(ampere · meter)
Universal gravitational constant	$G = 6.67 \times 10^{-11}$ meter ³ /(kilogram · second ²)
Acceleration due to gravity	$g = 9.80$ m/s ² = 980 cm/s ²
1 atmosphere pressure	1 atm = 1.0×10^5 newton/meter ² = 1.0×10^5 pascals (Pa)
1 angstrom	1 Å = 1×10^{-10} meter
	1 weber/m ² = 1 tesla = 10^4 gauss



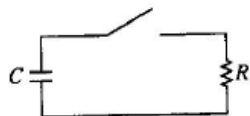
9. A coaxial cable having radii a , b , and c carries equal and opposite currents of magnitude i on the inner and outer conductors. What is the magnitude of the magnetic induction at point P outside of the cable at a distance r from the axis?

- (A) Zero (B) $\frac{\mu_0 i r}{2\pi a^2}$ (C) $\frac{\mu_0 i}{2\pi r}$
(D) $\frac{\mu_0 i}{2\pi r} \frac{c^2 - r^2}{c^2 - b^2}$ (E) $\frac{\mu_0 i}{2\pi r} \frac{r^2 - b^2}{c^2 - b^2}$
-



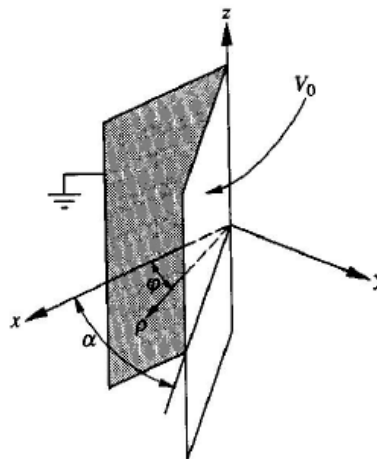
10. Two positive charges of q and $2q$ coulombs are located on the x -axis at $x = 0.5a$ and $1.5a$, respectively, as shown above. There is an infinite, grounded conducting plane at $x = 0$. What is the magnitude of the net force on the charge q ?

- (A) $\frac{1}{4\pi\epsilon_0} \frac{q^2}{a^2}$
 (B) $\frac{1}{4\pi\epsilon_0} \frac{3q^2}{2a^2}$
 (C) $\frac{1}{4\pi\epsilon_0} \frac{2q^2}{a^2}$
 (D) $\frac{1}{4\pi\epsilon_0} \frac{3q^2}{a^2}$
 (E) $\frac{1}{4\pi\epsilon_0} \frac{7q^2}{2a^2}$



11. The capacitor in the circuit shown above is initially charged. After closing the switch, how much time elapses until one-half of the capacitor's initial stored energy is dissipated?

- (A) RC
 (B) $\frac{RC}{2}$
 (C) $\frac{RC}{4}$
 (D) $2RC \ln(2)$
 (E) $\frac{RC \ln(2)}{2}$



12. Two large conducting plates form a wedge of angle α as shown in the diagram above. The plates are insulated from each other; one has a potential V_0 and the other is grounded. Assuming that the plates are large enough so that the potential difference between them is independent of the cylindrical coordinates z and ρ , the potential anywhere between the plates as a function of the angle ϕ is

- (A) $\frac{V_0}{\alpha}$
 (B) $\frac{V_0\phi}{\alpha}$
 (C) $\frac{V_0\alpha}{\phi}$
 (D) $\frac{V_0\phi^2}{\alpha}$
 (E) $\frac{V_0\alpha}{\phi^2}$

GO ON TO THE NEXT PAGE.

13. Listed below are Maxwell's equations of electromagnetism. If magnetic monopoles exist, which of these equations would be INCORRECT?

I. $\text{Curl } \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$

II. $\text{Curl } \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$

III. $\text{div } \mathbf{D} = \rho$

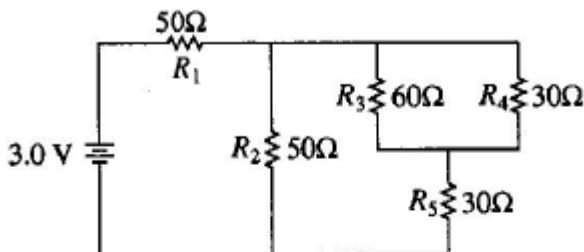
IV. $\text{div } \mathbf{B} = 0$

- (A) I only
(B) I and II
(C) I and III
(D) II and IV
(E) III and IV
-

18. In transmitting high frequency signals on a coaxial cable, it is important that the cable be terminated at an end with its characteristic impedance in order to avoid

- (A) leakage of the signal out of the cable
(B) overheating of the cable
(C) reflection of signals from the terminated end of the cable
(D) attenuation of the signal propagating in the cable
(E) production of image currents in the outer conductor
-

Questions 32-33

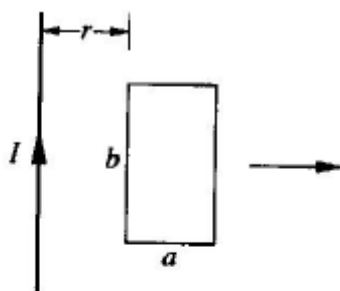


In the circuit shown above, the resistances are given in ohms and the battery is assumed ideal with emf equal to 3.0 volts.

32. The resistor that dissipates the most power is
(A) R_1 (B) R_2 (C) R_3
(D) R_4 (E) R_5
33. The voltage across resistor R_4 is
(A) 0.4 V
(B) 0.6 V
(C) 1.2 V
(D) 1.5 V
(E) 3.0 V
-
34. A conducting cavity is driven as an electromagnetic resonator. If perfect conductivity is assumed, the transverse and normal field components must obey which of the following conditions at the inner cavity walls?
(A) $E_n = 0, B_n = 0$
(B) $E_n = 0, B_t = 0$
(C) $E_t = 0, B_t = 0$
(D) $E_t = 0, B_n = 0$
(E) None of the above
-

36. A plane-polarized electromagnetic wave is incident normally on a flat, perfectly conducting surface. Upon reflection at the surface, which of the following is true?
- (A) Both the electric vector and magnetic vector are reversed.
- (B) Neither the electric vector nor the magnetic vector is reversed.
- (C) The electric vector is reversed; the magnetic vector is not.
- (D) The magnetic vector is reversed; the electric vector is not.
- (E) The directions of the electric and magnetic vectors are interchanged.

Questions 54-55



A rectangular loop of wire with dimensions shown above is coplanar with a long wire carrying current I . The distance between the wire and the left side of the loop is r . The loop is pulled to the right as indicated.

54. What are the directions of the induced current in the loop and the magnetic forces on the left and the right sides of the loop as the loop is pulled?

<u>Induced Current</u>	<u>Force on Left Side</u>	<u>Force on Right Side</u>
(A) Counterclockwise	To the left	To the right
(B) Counterclockwise	To the left	To the left
(C) Counterclockwise	To the right	To the left
(D) Clockwise	To the right	To the left
(E) Clockwise	To the left	To the right