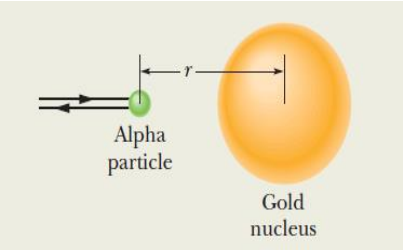
Home Assignment-2 : Spring 2021

Introduction to Coulomb's Law and Electric Field

1. What must be the distance between point charge q_1 = 26.0 μC and point charge q_2 = 47.0 μC for the electrostatic force between them to have a magnitude of 5.70 N?
2. Two equally charged particles are held 3.2×10^{-3} m apart and then released from rest. The initial acceleration of the first particle is observed to be 7.0 m/s^2 and that of the second to be 9.0 m/s^2. If the mass of the first particle is 6.3×10^{-7} kg, what are (a) the mass of the second particle and (b) the magnitude of the charge of each particle?
3. Two point charges +4q and +q are placed 30 cm apart. At what point on the line joining them the electric field is zero?
4. A uniform electric field of magnitude E =3.0 mN/C is passing through a circular area of radius, a = 11 cm. The rim of the circular area is aligned perpendicular to the field. The net contains no net charge. Find the electric flux through the netting.

Electric Potential

5. Fair weather atmospheric electricity 100 N/C is acting downward 100 km high in the ionosphere. What is the ionosphere voltage required?
6. An alpha particle (two protons, two neutrons) moves into a stationary gold atom (79 protons, 118 neutrons), passing through the electron region that surrounds the gold nucleus like a shell and headed directly toward the nucleus (Fig. below). The alpha particle slows until it momentarily stops when its center is at radial distance r =9.23 fm from the nuclear center. Then it moves back along its incoming path. **What was the kinetic energy *Ki* of the alpha particle when it was initially far away**? Assume that the only force acting between the alpha particle and the gold nucleus is the (electrostatic) Coulomb force and treat each as a single charged particle.



7. Hydrogen sulfide (H_2S) is a molecule that has a permanent dipole moment with dipole charge q=$|\pm 18e|$. The dipole distance of H_2S molecule is 1.12 pm. What is the dipole moment?
8. A Sodium (mass *23g*, charge +11*e*) atom and an alpha particle (mass 4g, charge +2*e*) approach one another with the same initial speed v=10^6 m/s from an initially large distance. How close will these two particles get to one another before turning around? **[**Given, k=8.99x10^9 Nm^{2}C^{-2} and q_e= 1.6x10^{-19} C**]**

Capacitance:

9. A plane-parallel capacitor has circular plates of radius r = 10 cm, separated by a distance d =1 mm. How much charge is stored on each plate when their electric potential difference has the value V = 100 V?
10. How much charge is stored in a capacitor consisting of two concentric spheres of radii 30 and 31 cm if the potential difference is 500 V?
11. What is the capacitance of the Earth, viewed as an isolated conducting sphere of radius 6370 km?
12. The space between the conductors of a long coaxial cable, used to transmit TV signals, has an inner radius a = 0.15 mm and an outer radius b = 2.1 mm. What is the capacitance per unit length of this cable?
13. In Fig. 25-30, the battery has a potential difference of V = 10.0 V and the five capacitors each have a capacitance of 10.0 µF. What is the charge on (a) capacitor 1 and (b) capacitor 2?

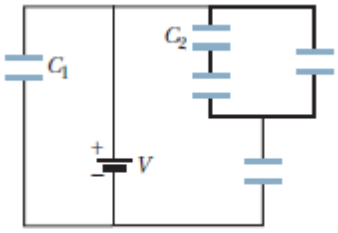


Figure 25-30 Problem 14.

14. In Fig. 25-51, V =9.0 V, C_1=C_2 =30 µF, and C_3=C_4 =15 µF. What is the (i) charge on capacitor 4? (ii) charge on capacitor 2? (iii) voltage drop across C_3, and (iv) voltage drop across C_1 ?

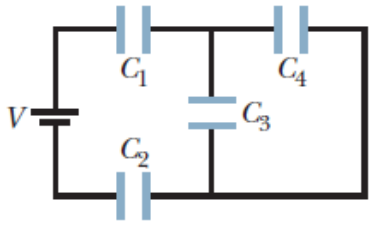


Figure 25-51 Problem 57.

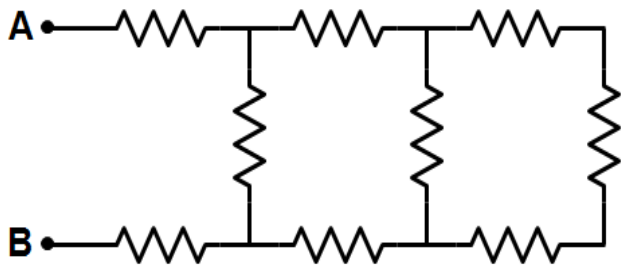
15. In open heart surgery, a much smaller amount of energy will defibrillate the heart. (a) What voltage is applied to the 8.00 µF capacitor of a heart defibrillator that stores 40.0 J of energy? (b) Find the amount of stored charge.

Current, Resistance, & EMF:

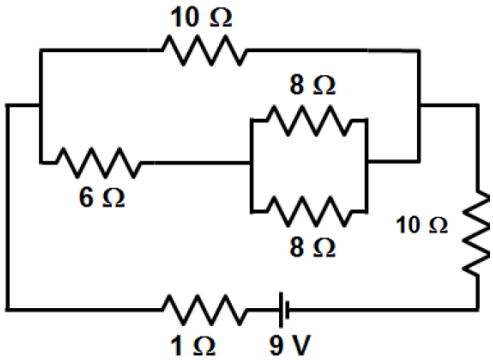
16. A copper wire of 3.2 mm in diameter and 4 m length carries a certain amount of current. The conduction electron density in copper is 8.49×10^{28} electrons/m^3. A 75.0-Ω resistor is connected with the copper wire to the terminals of a battery whose emf is 11.0 V and whose internal resistance is 0.8 Ω. Calculate (a) the current in the circuit, (b) the current density in the wire, (c) the terminal voltage of the battery, V_{ab}, and (d) the power dissipated in the

resistor R, (e) the power dissipated in the battery's internal resistance r, (f) the resistivity of the wire, (g) the drift velocity of the free electrons, and (h) Estimate the rms speed of electrons assuming they behave like an ideal gas at 20°C. Assume that one electron per Cu atom is free to move (the others remain bound to the atom).

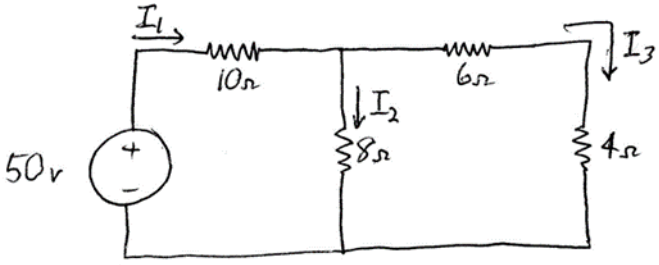
17. Calculate the equivalent resistance of the resistor "ladder" shown. All resistors have the same resistance R.



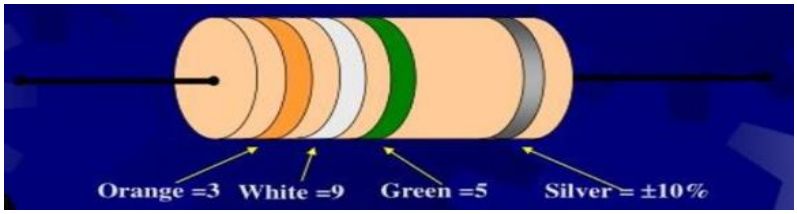
18. For the circuit below, calculate the current drawn from the battery and the current in the 6Ω resistor.



19. Find the voltage and current using KVL and KCL.



20. Determine the (i) nominal value, tolerance, and maximum-minimum resistance value of following resistor



and (ii) specify the color code of a resistor with nominal value of 1.5KΩ and a tolerance of ±5% and the color code of a resistor with nominal value of 2.5MΩ and a tolerance of ±1%.