Chapter 17

Properties of Charges

- Like charges repel
- Unlike charges attract
- Conservation of charge: charge can't be created or destroyed however it can be transferred from on object to another
- In conductors the charge carriers (electrons) are free to move about and will do so when exposed to an electric field. The charges will position themselves at the edges and will induce an opposing E field. This is why the E field inside a conductor is zero when equilibrium is reached.
- Even though the charge carriers inside an insulator are not free to move a charge can be I induced in an insulator via the polarization of the atoms or molecules. In insulators the E field inside doesn't have to be zero.

$$\vec{E} = \frac{\vec{F}_{electric}}{q_{test}}$$ Definition of Electric Field

$$\vec{E} = k\frac{|q_{source}|}{r^2}\hat{r}$$ The electric field due to a point source or spherical charge distribution

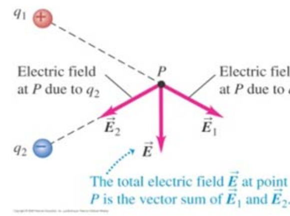
Coulomb's Law

$$\vec{F} = k\frac{|q_1 q_2|}{r^2}\hat{r}$$

$$k = \frac{1}{4\pi\varepsilon_0} = 8.987\times10^{9}\ \frac{N\cdot m^2}{C^2}$$

$$\varepsilon_0 = 8.854\times10^{-12}\ \frac{C^2}{N\cdot m^2}$$

r hat is a unit vector pointing in the direction of the force. Its direction is determined by the signs of the two charges but runs parallel to a line btw the them, r^2 is the distance btw the charges squared

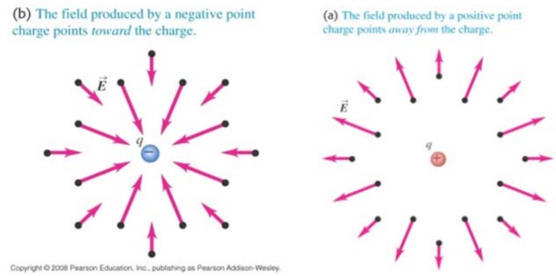


The Principle of Superposition

The total force or total electric field is the vector sum of the forces or electric fields of each charged source. Remember that to add vectors first resolve them into components and then add the components

The mass & charge of particles

$$m_e = 9.11\times10^{-31}\,kg$$
$$q_e = -1.60\times10^{-19}\,C$$
$$m_p = 1.67\times10^{-27}\,kg$$
$$q_e = +1.60\times10^{-19}\,C$$



Chapter 18

$$W_{a\to b} = F\Delta s\cos\theta = -\Delta U = U_a - U_b = \Delta K$$

The work-energy theorem states that change in kinetic energy is equal to the work done on the particle or the negative of the change in potential energy

$$W_{a\to b} = kq\,q'\left(\frac{1}{r_a} - \frac{1}{r_b}\right)$$ This is the work done on a test charge *q'* that starts at point *a* and ends at point *b* in the vicinity of the electric field caused by point *q.*

$$U = k\frac{q\,q'}{r}$$ This is the potential energy *U* of a system that consists of a point charge *q'* in the vicinity of the field due to point *q* and a distance *r* away from *q.*

$$U_{total} = kq'\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \cdots\right)$$ This is the total potential energy of a system consisting of a point charge *q'* in the vicinity of n number of charges q_i each a distance r_i from *q'*

$$V = \frac{U}{q'},\quad V_{total} = k\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \cdots\right)$$ The definition of potential and the total potential due to n charges

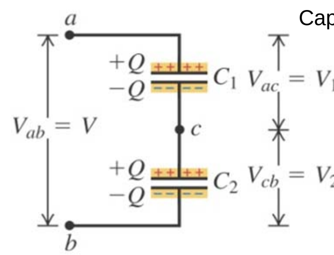
$$\Delta V = E\Delta x$$
$$W = qE\Delta x$$
In a constant E field he change in potential and work are related by

$$C_K = KC_0,\ V_K = \frac{V_0}{K},\ E_K = \frac{E_0}{K}$$ Where K is the dielectric constant, C_0, V_0, E_0 are the original quantities

$$U_{cap} = W_{total} = \frac{VQ}{2} = \frac{Q^2}{2C} = \frac{1}{2}CV^2$$ The energy stored in a capacitor

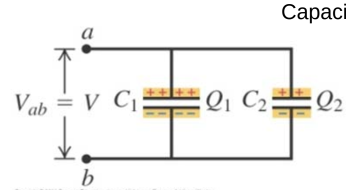
$$C = \frac{Q}{V}$$ Definition of Capacitance

Capacitors in Series



$$V_{ab} = V_1 + V_2$$
$$Q_{ab} = Q_1 = Q_2$$
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Capacitors in Parallel



$$V_{ab} = V_1 = V_2$$
$$Q_{ab} = Q_1 + Q_2$$
$$C_{eq} = C_1 + C_2$$

$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$$ The electric field stored in a parallel plate capacitor with no dielectric

$$C_0 = \varepsilon_0\frac{A}{d}$$ The capacitance of a parallel plate capacitor without a dielectric

Chapter 19

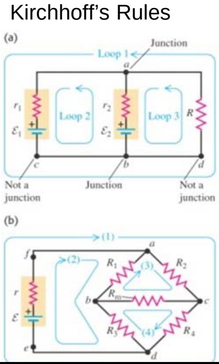
$$I = \frac{\Delta Q}{\Delta t},$$ defintion of current I. The current always flows from + to -

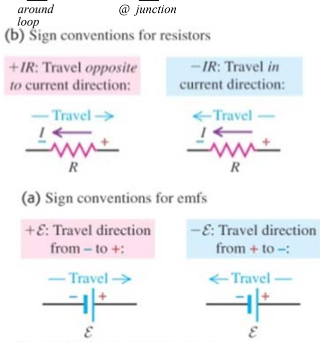
$$R = \frac{V}{I},$$ definition of resistance R $\quad R_T = R_0\left[1 + \alpha\left(T - T_0\right)\right]$, the temperature dependence of the resistance

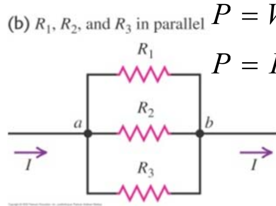
$$R = \rho\frac{L}{A},$$ definition of resistivity ρ where L is the length of the conductor and A is the cross-sectional area

Kirchhoff's Rules

$$\sum_{\substack{around\\loop}} V_i = 0,\quad \sum_{@\ junction} I_i = 0$$



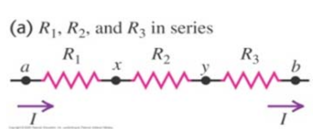




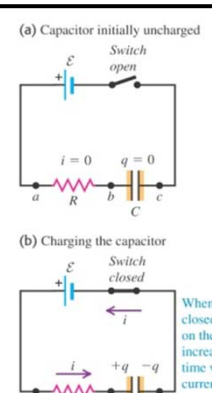
$$P = VI = \mathcal{E}I$$ Power supplied to a circuit

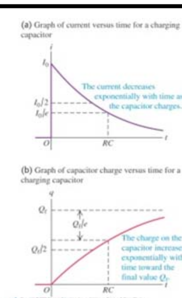
$$P = I^2R$$ Power dissipated by a resistor

$$V_{ab} = V_1 = V_2 = V_3$$
$$I_{ab} = I_1 + I_2 + I_3$$
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$



$$V_{ab} = V_1 + V_2 + V_3$$
$$I_{ab} = I_1 = I_2 = I_3$$
$$R_{eq} = R_1 + R_2 + R_3$$





$$i(t) = I_{max}e^{-t/RC},\quad q(t) = Q_{max}\left(1 - e^{-t/RC}\right)$$
$$I_{max} = \mathcal{E}/R,\quad Q_{max} = C\mathcal{E},\quad \tau = RC$$

The formulas describing the time dependence of the current, and charge for an RC circuit, τ is the time constant of the circuit