# Electrostatics summary

- Like charges repel and unlike charges attract
- The total charge in the universe is conserved
- Charge is quantized. Total charge in an object q = ne where n = 0,1,2,3… and e is electron charge.
- Coulomb's law in vector form: $\vec{F} = \frac{1}{4\pi\varepsilon_\circ}\frac{q_1 q_2}{r^2}\hat{r}$ ($\hat{r}$ is unit vector along joining $q_1$, $q_2$)
- For continuous charge distributions, integration methods can be used.
- Electrostatic force obeys the superposition principle.
- Electric field at a distance r from a point charge: $\vec{E} = \frac{1}{4\pi\varepsilon_\circ}\frac{q}{r^2}\hat{r}$
- Electric field lines starts at a positive charge and end at a negative charge or at infinity
- Electric field due to electric dipole at points on the axial line : $\vec{E}_{tot} = \frac{1}{4\pi\varepsilon_\circ}\left(\frac{2\vec{p}}{r^3}\right)$
- Electric field due to electric dipole at points on the equatorial line: $\vec{E}_{tot} = -\frac{1}{4\pi\varepsilon_\circ}\left(\frac{\vec{p}}{r^3}\right)$
- Torque experienced by a dipole in a uniform electric field: $\vec{\tau} = \vec{p}\times\vec{E}$
- Electrostatic potential at a distance r from the point charge: $V = \frac{1}{4\pi\varepsilon_\circ}\frac{q}{r}$
- Electrostatic potential due to an electric dipole: $V = \frac{1}{4\pi\varepsilon_\circ}\frac{\vec{p}\cdot\hat{r}}{r^2}$
- The electrostatic potential is the same at all points on an equipotential surface.
- The relation between electric field and electrostatic potential:

$$\vec{E} = -\left(\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right)$$

- Electrostatic potential energy for system of charges is equal to the work done to arrange the charges in the given configuration.
- Electrostatic potential energy stored in a dipole system in a uniform electric field: $U = -\vec{p}\cdot\vec{E}$
- The total electric flux through a closed surface : $\Phi_E = \frac{Q}{\varepsilon_\circ}$ where Q is the net charge enclosed by the surface
- Electric field due to a charged infinite wire : $\vec{E} = \frac{1}{2\pi\varepsilon_\circ}\frac{\lambda}{r}\hat{r}$
- Electric field due to a charged infinite plane : $\vec{E} = \frac{\sigma}{\varepsilon_\circ}\hat{n}$ ($\hat{n}$ is normal to the plane)
- Electric field inside a charged spherical shell is zero. For points outside: $\vec{E} = \frac{Q}{4\pi\varepsilon_\circ r^2}\hat{r}$

- Electric field inside a conductor is zero. The electric field at the surface of the conductor is normal to the surface and has magnitude $E = \frac{\sigma}{\varepsilon_\circ}$.
- The surface of the conductor has the same potential, at all points on the surface.
- Conductor can be charged using the process of induction.
- A dielectric or insulator has no free electrons. When an electric field is applied, the dielectric is polarised.
- Capacitance is given by $C = \frac{Q}{V}$.
- Capacitance of a parallel plate capacitor: $C = \frac{\varepsilon_\circ A}{d}$
- Electrostatic energy stored in a capacitor: $U = \frac{1}{2}CV^2$
- The equivalent capacitance for parallel combination is equal to the sum of individual capacitance of capacitors.
- For a series combination: The inverse of equivalent capacitance is equal to sum of inverse of individual capacitances of capacitors.
- The distribution of charges in the conductors depends on the shape of conductor. For sharper edge, the surface charge density is greater. This principle is used in the lightning arrestor
- To create a large potential difference, a Van de Graaff generator is used.