Class 12 - Important Formulas

Chapter 2 - Electric Potential and Capacitance

Electric Potential

S.No.	Term	Description
1	**Electric Potential energy**	**$\Delta U=-W$** Where ΔU = Change in Potential energy and W= Work done by the electric lines of forces For a system of two particles $U(r)=q_1q_2/4\pi\varepsilon r$ where r is the separation between the charges. We assume U to be zero at infinity Similarly for a system of n charges U=Sum of potential energy of all the distinct pairs in the system For example for three charges $U=(1/4\pi\varepsilon)(q_1q_2/r_{12}+q_2q_3/r_{23}+q_1q_3/r_{13})$
2	**Electric PE of a charge**	=qV where V is the potential there
3	**Electric Potential**	Liken Electric field intensity is used to define the electric field; we can also use Electric Potential to define the field. Potential at any point P is equal to the work done per unit test charge by the external agent in moving the test charge from the reference point(without Change in KE) $V_p=W_{ext}/q$ So for a point charge $V_p=Q/4\pi\varepsilon r$ where r is the distance of the point from charge
4	**Some points about Electric potential**	**1**. It is scalar quantity **2**.Potential at point due to system of charges will be obtained by the summation of potential of each charge at that point $V=V_1+V_2+V_3+V_4$ **3**.Electric forces are conservative force so work done by the electric force between two point is independent of the path taken **4**. $V_2-V_1=-\int E.dr$ **5**. In Cartesian coordinates system $dV=-E.dr$ $dV=-(E_xdx+E_ydy+E_zdz)$ So $E_x=\partial V/\partial x$, $E_y=\partial V/\partial y$ and $E_z=\partial V/\partial z$ Also $E=-[(\partial V/\partial x)i+(\partial V/\partial y)j+(\partial V/\partial z)k]$ **6**. Surface where electric potential is same everywhere is call equipotential surface Electric field components parallel to equipotential surface is always zero
5	**Electric dipole**	A combination of two charge +q and -q separated by the distance d **p**=q**d** Where d is the vector joining negative to positive charge
6	**Electric potential due to dipole**	$V=(1/4\pi\varepsilon)(p\cos\theta/r^2)$ where r is the distance from the center and θ is angle made by the line from the axis of dipole
7	**Electric field due to dipole**	$E_\theta=(1/4\pi\varepsilon)(p\sin\theta/r^3)$ $E_r=(1/4\pi\varepsilon)(2p\cos\theta/r^3)$ Total $E=\sqrt{E_\theta^2+E_r^2}$

		$=(p/4\pi\varepsilon r^3)(\sqrt{(3\cos^2\theta+1)})$ Torque on dipole=**p**X**E** Potential Energy U=-**p**.**E**
8	**Few more points**	1. ∫**E**.**dl** over closed path is zero 2.Electric potential in the spherical charge conductor is Q/4πεR where R is the radius of the shell and the potential is same everywhere in the conductor 3. Conductor surface is a equipotential surface

Capacitance

S.No.	Term	Description
1	**Capacitance C of the capacitor**	C=q/V or q=CV -Unit of capacitance is Farads or CV^{-1} capacitance of a capacitor is constant and depends on shape, size and separation of the two conductors and also on insulating medium being used for making capacitor.
2	**Capacitance of parallel plate cap**	$C=(\varepsilon_0A)/d$ where, C= capacitance of capacitor A= area of conducting plate d= distance between plates of the capacitor $\varepsilon_0=8.854\times 10^{-12}$ and is known as electric permittivity in vacuum.
3	**parallel plate air capacitor in presence of dielectric medium**	C=εA/d
4	**Capacitance of spherical capacitor having radii a, b (b>a)**	(a) air as dielectric between them $C=(4\pi\varepsilon_0ab)/(b-a)$ (b) dielectric with relative permittivity ε C=(4πεab)/(b-a)
5	**Parallel combination of capacitors**	$C=Q/V= C_1+C_2+C_3$, resultant capacitance C is greater then the capacitance of greatest individual one.
6	**Series combination of capacitors**	$1/C=1/C_1+1/C_2+1/C_3$, resultant capacitance C is less then the capacitance of smallest individual capacitor.
7	**Energy stored in capacitor**	Energy stored in capacitor is E=QV/2 or $E=CV^2/2$ or $E=Q^2/2C$ factor 1/2 is due to average potential difference across the capacitor while it is charged.
8	**Force between plates of capacitor**	$F=\frac{Q}{2K\varepsilon_0A}$
9	**Force per unit area of plates**	$=\frac{\sigma^2}{2K\varepsilon_0}$ Where σ is charge per unit area.