EQUATION SHEET

$$\vec{F} = q\vec{E}$$

$$\vec{E} = \frac{q}{4\pi\epsilon_o |r|^2}\hat{r} \quad \text{point charge}$$

Electric field due to a uniformly charged spherical shell: outside shell, like point charge; inside shell, 0.

$\left|\vec{E}_{rod}\right| = \frac{1}{4\pi\varepsilon_o}\left[\frac{Q}{r\sqrt{r^2+(L/2)^2}}\right]$ a perpendicular distance r from the center; $\left|\vec{E}_{rod}\right| \approx \frac{1}{4\pi\varepsilon_o}\frac{2(Q/L)}{r}$ if $r << L$

$\left|\vec{E}_{ring}\right| = \frac{1}{4\pi\varepsilon_o}\frac{qz}{\left(z^2+R^2\right)^{3/2}}$ a distance z along the axis

$\left|\vec{E}_{disk}\right| = \frac{Q/A}{2\varepsilon_o}\left[1-\frac{z}{\left(z^2+R^2\right)^{1/2}}\right]$ a distance z along the axis; $\left|\vec{E}_{disk}\right| = \frac{Q/A}{2\varepsilon_o}\left[1-\frac{z}{R}\right]$ if $z << R$

$\left|\vec{E}_{capacitor}\right| = \frac{Q/A}{\varepsilon_o}$ for $+Q$ and $-Q$ disks; $\left|\vec{E}_{fringe}\right| = \frac{Q/A}{\varepsilon_o}\left(\frac{s}{2R}\right)$ just outside capacitor

$\left|\vec{E}_{dipole,x}\right| \approx \frac{1}{4\pi\varepsilon_o}\frac{2qs}{x^3}$ along dipole axis, where $x >> s$; $\left|\vec{E}_{dipole,y}\right| \approx \frac{1}{4\pi\varepsilon_o}\frac{qs}{y^3}$ along perpendicular axis, for $y >> s$

electric dipole moment $p = qs$

Physical constants

$\frac{1}{4\pi\varepsilon_o} = 9x10^9 \frac{N\cdot m_2}{C^2}$ $\varepsilon_0 = 9x10^{-12} \frac{C^2}{N\cdot m^2}$

$c = 3x10^8$ *m/s* $e = 1.6x10^{-19}$ coulomb

$m_{\text{proton}} \approx m_{\text{neutron}} \approx m_{\text{hydrogen atom}} = 1.7x10^{-27}$ kg $m_{\text{electron}} = 9x10^{-31}$ kg $g = 9.8$ N/kg

$6.02x10^{23}$ molecules/mole Atomic radius $\approx 10^{-10}$ m Proton radius $\approx 10^{-15}$ m

Electric field necessary to ionize air, about $3x10^6$ N/C

Geometry

area of circle = πr^2 circumference of circle = $2\pi r$ area of curved surface of cylinder = $2\pi rL$

surface area of sphere = $4\pi r^2$ volume of sphere = $\frac{4}{3}\pi r^3$ arc length = $r\Delta\theta$