Electric force $\mathbf{F}_E$	**Electrostatic field** $\mathbf{E} = \frac{\mathbf{F}_E}{q_0}$	**Electric potential energy** $\left(U_f - U_i\right)_{q_0} \equiv -q_0 \int_i^f \mathbf{E}_{static}\ \ \mathbf{dl}$	**Electric potential** $V_f - V_i \equiv \frac{U_f - U_i}{q_0} = -\int_i^f \mathbf{E}_{static}\ \ \mathbf{dl}$
$\mathbf{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{\mathbf{r}}_{12}$	$\mathbf{E}_{12} = \frac{\mathbf{F}_{12}}{q_2} = k\frac{q_1}{r_{12}^2}\hat{\mathbf{r}}_{12}$	$U_2(\mathbf{r}_2) - U_2(\infty) = \frac{kq_2 q_1}{\lvert\mathbf{r}_2 - \mathbf{r}_1\rvert}$	$V(\mathbf{r}_2) - V(\infty) = \frac{kq_1}{\lvert\mathbf{r}_2 - \mathbf{r}_1\rvert}$
$\mathbf{F}_0 = \sum_{n=1} k\frac{q_n q_0}{r_{n0}^2}\hat{\mathbf{r}}_{n0}$	$\mathbf{E}_0 = \sum_{n=1} k\frac{q_n}{r_{n0}^2}\hat{\mathbf{r}}_{n0}$	$U_0(\mathbf{r}_0) - U_0(\infty) = q_0\sum_{n=1}\frac{kq_n}{\lvert\mathbf{r}_0 - \mathbf{r}_n\rvert}$	$V(\mathbf{r}_0) - V(\infty) = \sum_{n=1}\frac{kq_n}{\lvert\mathbf{r}_0 - \mathbf{r}_n\rvert}$
$\mathbf{F}_0 = q_0\mathbf{E}_0$ *Cathod-Ray Tube* *Force on eletric dipole **p*** *Torque on electric dipole **p:*** $\tau = \boldsymbol{p}\times\boldsymbol{E}$	*Line segments* *Ring (full and broken)* *Disc and thick ringss* *Electric dipole **p*** *Combination of them:* $\mathbf{E} = \mathbf{E}_1 + \mathbf{E}_2 + \mathbf{E}_3 +$	$U_0(\mathbf{r}_0) = q_0 V(\mathbf{r}_0)$	*Line segments* *Ring (full and broken)* *Disc and thick ringss* *Electric dipole **p*** *Combination of them:* $V = V_1 + V_2 + V_3 +$
	Gauss' law $\oiint_S \mathbf{E}\ \ \mathbf{dA} = \frac{Q_{inside}}{\varepsilon_0}$ *Cylinders/lines/shells* *Spheres/spherical shells* *Flat sheets* *Combination of them:* $\mathbf{E} = \mathbf{E}_1 + \mathbf{E}_2 + \mathbf{E}_3 +$		$V_f - V_i = -\int_i^f \mathbf{E}_{static}\ \ \mathbf{dl}$ $\mathbf{E}(\mathbf{r}) = -\ \ V$ *Cylinders/lines/shells* *Spheres/spherical shells* *Flat sheets* *Combinations of them:* $V = V_1 + V_2 + V_3 +$

Capacitors (C)	**Current** (I) **and Resistors** (R)	**Electro-motive force** (emf)	**DC circuits** (R, C, L, ε)
$C = \frac{Q}{\Delta V}$ *Parallel-plates* *Conducting sphere* *Conducting spherical shells* *Coaxial cylindrical rod and shells*	$I = \frac{\Delta Q}{\Delta t}$ **Ohm's law:** $I = \Delta V/R$ **Power dissipation:** $P = dU/dt = IV = V^2/R = I^2R$	***emf***: *force **K** other than the electrostatic on unit positive charge* $\varepsilon = \oint_C \mathbf{K}\ d\mathbf{l}$ A battery with $r_i = 0$, $V_\varepsilon = -\varepsilon$	**Kirchhoff rules:** 1. $\oint_C \mathbf{E}_{static}\ d\mathbf{l} = 0$ 2. $\sum I^{(in)} = \sum I^{(out)}$ 3. $V_R = IR = R\,dQ/dt$ $V_\varepsilon = -\varepsilon$ $V_c = Q/C$ $V_L = L\,dI/dt$
Capacitor in series: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} +$ **Capacitor in parallel**: $C = C_1 + C_2 + C_3 +$ **Capacitor with dielectrics** (κ): $E = \frac{E_0}{\kappa} \quad C = \kappa C_0$ *Combinations of them*	**Resistance** R: $R = \rho\frac{L}{A}$ **Resistors in series:** $R = R_1 + R_2 + R_3 +$ **Resistors in parallel:** $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} +$ *Combinations of them*	*Chemical (battery)* *Magnetic induction* *Motion emf:* $\varepsilon_m = B\ell v$ *(power generator)* *Back emf:* $\varepsilon_m = L\,dI/dt$ *(LRC circcuits)* *Mutual induction emf :* *(transformer)*	***Resistor network*** ***Resistor-emf circuit*** ***RC circuits:*** *charging* *discharging* $\tau_{RC} = RC$ ***LR circuits***: *"charging"* *"discharging"* $\tau_{LR} = L/R$ ***LRC circuits***
Electrostatic energy density: $\eta_e = \frac{\kappa\varepsilon_0}{2}E^2$			**Magnetic energy density:** $\eta_m = \frac{1}{2\mu_0}B^2$