- Here is our model of electrostatics

$$
\begin{tikzcd}[column sep=huge, row sep=huge]
 & \rho \arrow[dl, shift right, "{dq=\rho\, d\tau,\ V=\int \frac{k\,dq}{r}}"'] \arrow[dr, shift left, "{\oint \vec{E}\cdot d\vec{a}=\int\frac{dq}{\epsilon_0},\ \vec{E}=\int \frac{k\,dq}{r^2}\hat{r}}"] & \\
V \arrow[ur, shift right, "{\nabla^2 V=-\rho/\epsilon_0}"'] \arrow[rr, shift left, "{\vec{E}=-\vec{\nabla}V}"] & & \vec{E} \arrow[ul, shift left, "{\vec{\nabla}\cdot\vec{E}=\rho/\epsilon_0}"] \arrow[ll, shift left, "{\Delta V=-\int \vec{E}\cdot d\vec{r}}"]
\end{tikzcd}
$$

$\vec{\nabla}\times\vec{E}=0$

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

$W_{nc}=\Delta(KE+PE)$ To assemble a charge distribution

$W_{me}=\int V\,dq=\Delta PE$ or $=\frac{1}{2}\int V\,dq$

$W=\frac{\epsilon_0}{2}\left[\int E^2 d\tau+\oint V\vec{E}\cdot d\vec{a}\right]$

$\sigma_b=\vec{P}\cdot\hat{n}$ $\quad\rho_b=-\vec{\nabla}\cdot\vec{P}$

$\vec{D}=\epsilon_0\vec{E}+\vec{P}$ $\quad\vec{\nabla}\cdot\vec{D}=\rho_f$

$\vec{P}=\epsilon_0\chi_e\vec{E}$ $\quad\epsilon=\epsilon_0(1+\chi_e)$

$$\frac{dW}{dt}=-\frac{d}{dt}\int\frac{1}{2}\left(\epsilon_0E^2+\frac{B^2}{\mu_0}\right)d\tau-\frac{1}{\mu_0}\oint(\vec{E}\times\vec{B})\cdot d\vec{a}$$

$U=-\vec{p}\cdot\vec{E}$ $\quad\vec{F}=(\vec{p}\cdot\vec{\nabla})\vec{E}$ $\quad V_{dipole}=\frac{1}{4\pi\epsilon_0}\frac{\vec{p}\cdot\hat{r}}{r^2}$

$\vec{p}=\alpha\vec{E}$

Here is our model of magnetostatics:

$$
\begin{tikzcd}[column sep=huge, row sep=huge]
 & \vec{J} \arrow[dl, shift right, "{\vec{A}=\frac{\mu_0}{4\pi}\int\frac{\vec{J}}{r}d\tau}"'] \arrow[dr, shift left, "{\oint\vec{B}\cdot d\vec{r}=\mu_0\underbrace{\int\vec{J}\cdot d\vec{a}}_{I_{enclosed}},\ B=\frac{\mu_0}{4\pi}\int\frac{\vec{J}\times\hat{r}}{r^2}d\tau}"] & \\
\vec{A} \arrow[ur, shift right, "{\nabla^2\vec{A}=-\mu_0\vec{J}}"'] \arrow[rr, "{\vec{B}=\vec{\nabla}\times\vec{A}}"'] & & \vec{B} \arrow[ul, shift left, "{\vec{\nabla}\times\vec{B}=\mu_0\vec{J},\ \vec{\nabla}\cdot\vec{B}=0}"]
\end{tikzcd}
$$

$\vec{F}=q\vec{E}+q\vec{v}\times\vec{B}$

$\mu=m=I\,\text{area}$ $\quad\vec{\nabla}\cdot\vec{A}=0$ $\quad W=\frac{1}{2\mu_0}\left[\int_{vol}B^2d\tau-\int_{surface}(\vec{A}\times\vec{B})\cdot d\vec{a}\right]$

$U=-\vec{\mu}\cdot\vec{B}$ $\quad\vec{J}_b=\vec{\nabla}\times\vec{M}$ $\quad\vec{H}=\frac{\vec{B}}{\mu_0}-\vec{M}$ $\quad\vec{\nabla}\times\vec{H}=\vec{J}_f$ $\quad\vec{M}=\chi_m\vec{H}$

$\vec{A}_{dipole}=\frac{\mu_0}{4\pi}\frac{\vec{\mu}\times\hat{r}}{r^2}$ $\quad\vec{K}_b=\vec{M}\times\hat{n}$ $\quad\vec{B}=\mu\vec{H}$ $\quad\mu=\mu_0(1+\chi_m)$

$$\vec{\nabla}\times\vec{B}=\mu_0\vec{J}+\mu_0\epsilon_0\frac{\partial\vec{E}}{\partial t}\ ;\quad\vec{\nabla}\cdot\vec{F}=\frac{1}{r^2\sin\theta}\frac{\partial}{\partial r}(r^2F_r)+\frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta F_\theta)+\frac{1}{r\sin\theta}\frac{\partial F_\phi}{\partial\phi}$$

$\vec{\nabla}\times\vec{E}=-\frac{\partial\vec{B}}{\partial t}$