- Here is our model of electrostatics

$$dq = \rho\, d\tau \qquad V = \int \frac{k\, dq}{r}$$

$$\oint \vec{E}\cdot d\vec{a} = \int \frac{dq}{\epsilon_0} \qquad \vec{E} = \int \frac{k\, dq}{r^2}\hat{r}$$

$$\nabla^2 V = -\rho/\epsilon_0 \qquad \vec{\nabla}\cdot\vec{E} = \rho/\epsilon_0$$

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

$$\rho \qquad V \qquad \vec{E}$$

$$\vec{E} = -\vec{\nabla} V$$

$$\Delta V = -\int \vec{E}\cdot d\vec{r}$$

$$\vec{F} = q\vec{E} \qquad W_{nc} = \Delta(KE + PE)$$

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

To assemble a charge distribution

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

Here is our model of magnetostatics:

$$\oint \vec{B}\cdot d\vec{r} = \mu_0 \underbrace{\int \vec{J}\cdot d\vec{a}}_{I_{enclosed}}$$

$$B = \frac{\mu_0}{4\pi}\int \frac{\vec{J}\times\hat{r}}{r^2}\, d\tau$$

$$\vec{A} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}}{r}\, d\tau \qquad \nabla^2\vec{A} = -\mu_0\vec{J}$$

$$\vec{J} \qquad \vec{A} \qquad \vec{B}$$

$$\vec{\nabla}\times\vec{B} = \mu_0\vec{J} \qquad \vec{\nabla}\cdot\vec{B} = 0$$

$$\vec{B} = \vec{\nabla}\times\vec{A}$$

$$\vec{\nabla}\cdot\vec{A} = 0$$

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

$$W = \frac{1}{2\mu_0}\left[\int_{vol} B^2\, d\tau - \int_{surface} (\vec{A}\times\vec{B})\cdot d\vec{a}\right]$$