$$
\begin{aligned}
\vec{a}\times(\vec{b}\times\vec{c}) &= \vec{b}(\vec{a}\cdot\vec{c})-\vec{c}(\vec{a}\cdot\vec{b}),\\
\vec{a}\cdot(\vec{b}\times\vec{c}) &= \vec{b}\cdot(\vec{c}\times\vec{a})=\vec{c}\cdot(\vec{a}\times\vec{b}),\\
(\vec{a}\times\vec{b})\cdot(\vec{c}\times\vec{d}) &= (\vec{a}\cdot\vec{c})(\vec{b}\cdot\vec{d})-(\vec{a}\cdot\vec{d})(\vec{b}\cdot\vec{c}),\\
\vec{\nabla}\times(\vec{\nabla}\psi) &= 0,\\
\vec{\nabla}\cdot(\vec{\nabla}\times\vec{a}) &= 0,\\
\vec{\nabla}\times(\vec{\nabla}\times\vec{a}) &= \vec{\nabla}(\vec{\nabla}\cdot\vec{a})-\nabla^2\vec{a},\\
\vec{\nabla}\cdot(\psi\vec{a}) &= \vec{a}\cdot\vec{\nabla}\psi+\psi\vec{\nabla}\cdot\vec{a},\\
\vec{\nabla}\times(\psi\vec{a}) &= \vec{\nabla}\psi\times\vec{a}+\psi\vec{\nabla}\times\vec{a},\\
\vec{\nabla}(\vec{a}\cdot\vec{b}) &= (\vec{a}\cdot\vec{\nabla})\vec{b}+(\vec{b}\cdot\vec{\nabla})\vec{a}+\vec{a}\times(\vec{\nabla}\times\vec{b})+\vec{b}\times(\vec{\nabla}\times\vec{a}),\\
\vec{\nabla}\cdot(\vec{a}\times\vec{b}) &= \vec{b}\cdot(\vec{\nabla}\times\vec{a})-\vec{a}\cdot(\vec{\nabla}\times\vec{b}),\\
\vec{\nabla}\times(\vec{a}\times\vec{b}) &= \vec{a}(\vec{\nabla}\times\vec{b})-\vec{b}(\vec{\nabla}\times\vec{a})+(\vec{b}\cdot\vec{\nabla})\vec{a}-(\vec{a}\cdot\vec{\nabla})\vec{b},\\
\vec{\nabla}\cdot\vec{r} &= 3,\\
\vec{\nabla}\times\vec{r} &= 0,\\
\vec{\nabla}\cdot\hat{r} &= 2/r,\\
\vec{\nabla}\times\hat{r} &= 0,\\
\vec{\nabla}r &= \hat{r},\\
\vec{\nabla}\frac{1}{r} &= -\frac{\hat{r}}{r^2},\\
\vec{\nabla}\cdot(\hat{r}f(r)) &= \frac{2}{r}f+\frac{df}{dr},\\
(\vec{a}\cdot\vec{\nabla})\hat{r} &= \frac{1}{r}[\vec{a}-\hat{r}(\vec{a}\cdot\hat{r})]=\frac{\vec{a}_\perp}{r},\\
\vec{\nabla}^2\left(\frac{1}{r}\right) &= -4\pi\delta(\vec{r}),\\
\int_V d^3r\ \vec{\nabla}\cdot\vec{A} &= \int_S d\vec{S}\cdot\vec{A},\\
\int_V d^3r\ \vec{\nabla}\psi &= \int_S \psi\ d\vec{S},\\
\int_V d^3r\ \vec{\nabla}\times\vec{A} &= \int_S d\vec{S}\times\vec{A},\\
\int_V d^3r\ (\phi\nabla^2\psi+\vec{\nabla}\phi\cdot\vec{\nabla}\psi) &= \int_S \phi\ d\vec{S}\cdot\vec{\nabla}\psi,\\
\int_V d^3r\ (\phi\nabla^2\psi-\psi\nabla^2\phi) &= \int_S(\phi\vec{\nabla}\psi-\psi\vec{\nabla}\phi)\cdot d\vec{S},\\
\int_S(\vec{\nabla}\times\vec{A})\cdot d\vec{S} &= \oint d\vec{\ell}\cdot\vec{A},\\
\int_S d\vec{S}\times\vec{\nabla}\psi &= \oint_C d\vec{\ell}\ \psi.
\end{aligned}
$$

$$\mathscr{L} = -\frac{1}{4\mu_0} F_{\mu\nu} F^{\mu\nu} - J_\mu A^\mu$$
$$L = \frac{1}{\gamma}(-mc^2 - qA_\mu u^\mu)$$
$$\frac{dp^\mu}{d\tau} = qF^{\mu\nu} u_\nu$$
$$\partial_\mu F^{\mu\nu} = \mu_0 J^\nu$$
$$\partial_\mu \tilde{F}^{\mu\nu} = 0$$
$$\partial_\mu J^\mu = 0$$
$$(g_{\mu\nu}) = \mathrm{diag}(1, -1, -1, -1),$$
$$\vec{\beta} = \vec{v}/c,$$
$$\gamma = 1/\sqrt{1-\beta^2},$$
$$x'^\mu = \Lambda^\mu{}_\nu x^\nu$$
$$(\Lambda^\mu{}_\nu) = \begin{pmatrix} \gamma & -\beta\gamma & 0 & 0 \\ -\beta\gamma & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix},$$

$$x^\mu = (ct, x, y, z),$$
$$\partial^\mu = ((1/c)\partial/\partial t, -\vec{\nabla})$$
$$k^\mu = (\omega/c, \vec{k}),$$
$$u^\mu = (\gamma c, \gamma \vec{v}),$$
$$p^\mu = (E/c, \vec{p}),$$
$$A^\mu = (\phi/c, \vec{A}),$$
$$J^\mu = (c\rho, \vec{j}),$$
$$F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu,$$
$$\tilde{F}^{\mu\nu} = \frac{1}{2}\epsilon^{\mu\nu\alpha\beta} F_{\alpha\beta}$$
$$\vec{E}'_\parallel = \vec{E}_\parallel$$
$$\vec{B}'_\parallel = \vec{B}_\parallel$$
$$\vec{E}'_\perp = \gamma(\vec{E}_\perp + c\vec{\beta} \times \vec{B})$$
$$\vec{B}'_\perp = \gamma(\vec{B}_\perp - \frac{1}{c}\vec{\beta} \times \vec{E})$$

$$\vec{\nabla} \cdot \vec{E} = \frac{1}{\epsilon_0}\rho, \qquad \vec{\nabla} \cdot \vec{B} = 0,$$
$$\vec{\nabla} \times \vec{B} - \frac{1}{c^2}\frac{\partial \vec{E}}{\partial t} = \mu_0 \vec{j}, \qquad \vec{\nabla} \times \vec{E} + \frac{\partial \vec{B}}{\partial t} = 0, \qquad \epsilon_0 \mu_0 = \frac{1}{c^2}$$

$$\frac{d\vec{p}}{dt} = q(\vec{E} + \vec{v} \times \vec{B}), \qquad 0 = \frac{\partial \rho}{\partial t} + \vec{\nabla} \cdot \vec{j}$$
$$\vec{E} = -\vec{\nabla}\phi - \frac{\partial \vec{A}}{\partial t}, \qquad \vec{j}(\vec{r}, t) = q\vec{v}(t)\,\delta(\vec{r} - \vec{r}_0(t)), \qquad I = \frac{dq}{dt}$$
$$\vec{B} = \vec{\nabla} \times \vec{A}, \qquad I = \int_S \vec{j} \cdot d\vec{A}, \qquad I d\vec{l} = dq\,\vec{v}$$

$$(\vec{E}_{\text{out}} - \vec{E}_{\text{in}}) \cdot \hat{n} = \sigma/\epsilon_0$$

$$\phi(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int_V d^3r'\,\rho(\vec{r}')G(\vec{r}, \vec{r}') - \frac{1}{4\pi}\int_S dA'\phi(\vec{r}')\frac{\partial G(\vec{r}, \vec{r}')}{\partial n'}$$
$$\phi(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int_V d^3r'\,\rho(\vec{r}')G(\vec{r}, \vec{r}') + \frac{1}{4\pi}\int_S dA'\frac{\partial \phi(\vec{r}')}{\partial n'}G(\vec{r}, \vec{r}') + \langle\phi\rangle_S$$
$$\phi = \sum_{l=0}^{\infty}\left(a_l r^l + b_l/r^{l+1}\right)P_l(\cos\theta)$$
$$\phi = \sum_{l=0}^{\infty}\sum_{m=-l}^{l}\left[A_{lm}r^l + B_{lm}/r^{l+1}\right]Y_{lm}(\theta, \varphi)$$
$$\phi = a_0 + b_0 \ln s + \sum_{n=1}^{\infty}\left[s^n(a_n\cos(n\varphi) + b_n\sin(n\varphi)) + s^{-n}(c_n\cos(n\varphi) + d_n\sin(n\varphi))\right]$$

$$
\begin{aligned}
P_0(\cos\theta) &= 1\\
P_1(\cos\theta) &= \cos\theta\\
P_2(\cos\theta) &= \frac{1}{2}(3\cos^2\theta - 1)
\end{aligned}
$$

$$
\begin{aligned}
Y_{0,0} &= \frac{1}{\sqrt{4\pi}}\\
Y_{1,0} &= \sqrt{\frac{3}{4\pi}}\cos\theta, \quad Y_{1,\pm 1} = \mp\sqrt{\frac{3}{8\pi}}\sin\theta\, e^{\pm i\varphi}\\
Y_{2,0} &= \sqrt{\frac{5}{16\pi}}\left(3\cos^2\theta - 1\right), \quad Y_{2,\pm 1} = \mp\sqrt{\frac{15}{8\pi}}\sin\theta\cos\theta\, e^{\pm i\varphi}, \quad Y_{2,\pm 2} = \sqrt{\frac{15}{32\pi}}\sin^2\theta\, e^{\pm 2i\varphi}
\end{aligned}
$$

$$
\begin{aligned}
P_l^m(x) &= \frac{(-1)^m}{2^l l!}(1-x^2)^{m/2}\frac{d^{l+m}}{dx^{l+m}}(x^2-1)^l\\
Y_{lm}(\theta,\varphi) &= \sqrt{\frac{(2l+1)(l-m)!}{4\pi(l+m)!}}e^{im\varphi}P_l^m(\cos\theta)\\
\frac{1}{|\vec{r}-\vec{r}\,'|} &= \sum_{l=0}^{\infty}\sum_{m=-l}^{l}\left(\frac{4\pi}{2l+1}\right)\frac{r_<^l}{r_>^{l+1}}Y_{lm}^*(\theta',\varphi')Y_{lm}(\theta,\varphi) = \sum_{l=0}^{\infty}\frac{r_<^l}{r_>^{l+1}}P_l(\cos\gamma)\\
\phi &= \frac{1}{4\pi\epsilon_0}\sum_{l=0}^{\infty}\sum_{m=-l}^{l}\left(\frac{4\pi}{2l+1}\right)\frac{q_{lm}}{r^{l+1}}Y_{lm}(\theta,\varphi)\\
q_{lm} &= \int d^3r'\,\rho(\vec{r}\,')r'^l Y_{lm}^*(\theta,\varphi)\\
\phi &= \frac{1}{4\pi\epsilon_0}\left(\frac{Q_{\rm tot}}{r} + \frac{p_i\hat{r}_i}{r^2} + \frac{1}{2!}Q_{ij}\frac{\hat{r}_i\hat{r}_j}{r^3} + \dots\right)\\
p_i &= \int d^3\,r'\rho(\vec{r}\,')\,r_i'\\
Q_{ij} &= \int d^3r'\,\rho(\vec{r}\,')\,(3r_i'r_j' - \delta_{ij}r'^2)\\
U &= Q_{\rm tot}\phi(\vec{r}) - p_iE_i(\vec{r}) - \frac{1}{6}Q_{ij}\partial_iE_j + \dots
\end{aligned}
$$

$$
\begin{aligned}
\vec{A}(\vec{r}) &= \frac{\mu_0}{4\pi}\left(\frac{\vec{m}\times\vec{r}}{r^3} + \dots\right)\\
\vec{B}(\vec{r}) &= \frac{\mu_0}{4\pi}\left(\frac{3(\vec{m}\cdot\hat{r})\hat{r} - \vec{m}}{r^3} + \dots\right)\\
\vec{m} &= \frac{1}{2}\int d^3r'\,\vec{r}\,'\times\vec{j}(\vec{r}\,')\\
U &= -m_iB_i(\vec{r}) + \dots\\
\vec{\tau} &= \vec{m}\times\vec{B} + \vec{r}\times\vec{F} + \dots
\end{aligned}
$$

$$
\begin{aligned}
\vec{A} &= \frac{\mu_0}{4\pi}\left[\frac{1}{r}\left(\dot{\vec{p}}\right) \qquad\qquad + \frac{1}{rc}\left(\dot{\vec{m}} \times \hat{r} \qquad\quad + \frac{1}{6}\ddot{\vec{Q}}\right) + \ldots\right] \\
\vec{B} &= \frac{\mu_0}{4\pi c}\left[\frac{1}{r}\left(\ddot{\vec{p}} \times \hat{r}\right) \qquad + \frac{1}{rc}\left((\ddot{\vec{m}} \times \hat{r}) \times \hat{r} + \frac{1}{6}\dddot{\vec{Q}} \times \hat{r}\right) + \ldots\right] \\
\vec{E} &= \frac{\mu_0}{4\pi}\left[\frac{1}{r}\left((\ddot{\vec{p}} \times \hat{r}) \times \hat{r}\right) + \frac{1}{rc}\left(\ddot{\vec{m}} \times \hat{r} \qquad\quad + \frac{1}{6}(\dddot{\vec{Q}} \times \hat{r}) \times \hat{r}\right) + \ldots\right] \\
\frac{dP}{d\Omega} &= |\vec{S}|r^2 = \frac{c}{\mu_0}|\vec{B}|^2 r^2 \\
P(t) &= \frac{\mu_0}{4\pi c}\left(\frac{2}{3}|\ddot{\vec{p}}|^2 + \frac{2}{3c^2}|\ddot{\vec{m}}|^2 + \frac{1}{180c^2}\dddot{Q}_{ij}\dddot{Q}_{ji}\right) \\
\vec{B} &= i\vec{k} \times \vec{A} \\
\vec{E} &= c\vec{B} \times \hat{r} \\
\vec{E}'_{\parallel} &= \vec{E}_{\parallel}, \qquad \vec{E}'_{\perp} = \gamma(\vec{E}_{\perp} + c\vec{\beta} \times \vec{B}) \\
\vec{B}'_{\parallel} &= \vec{B}_{\parallel}, \qquad \vec{B}'_{\perp} = \gamma(\vec{B}_{\perp} - \frac{1}{c}\vec{\beta} \times \vec{E}) \\
u &= \frac{1}{2}\left(\epsilon_0|\vec{E}|^2 + \frac{1}{\mu_0}|\vec{B}|^2\right) \\
\vec{S} &= \frac{1}{\mu_0}\vec{E} \times \vec{B} \\
0 &= \vec{E} \cdot \vec{j} + \frac{\partial u}{\partial t} + \vec{\nabla} \cdot \vec{S} \\
\vec{g} &= \epsilon_0 \vec{E} \times \vec{B} \\
\sigma_{ij} &= \epsilon_0\left(E_i E_j - \frac{1}{2}\delta_{ij}|\vec{E}|^2\right) + \frac{1}{\mu_0}\left(B_i B_j - \frac{1}{2}\delta_{ij}|\vec{B}|^2\right) \\
0 &= \left(\rho\vec{E} + \vec{j} \times \vec{B} + \frac{\partial}{\partial t}\vec{g}\right)_j - \frac{\partial}{\partial x_i}\sigma_{ij}
\end{aligned}
$$