324 formula sheet

Maxwell's Equations: Everything we need when working in vacuum.

	vacuum	matter	or
1. Gauss's Law	$\nabla \cdot \vec{E} = \frac{1}{\epsilon_0}\rho$	$\nabla \cdot \vec{E} = \frac{1}{\epsilon}(\rho_f - \nabla \cdot \vec{P})$	$\nabla \cdot \vec{D} = \rho_f$ if $\vec{D} \equiv \epsilon_0 \vec{E} + \vec{P}$
2. No mag monopoles	$\nabla \cdot \vec{B} = 0$	1: $\nabla \cdot \vec{E} = \frac{\rho_{free}}{\epsilon}$	
3. Faraday's Law	$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$	4: $\nabla \times \vec{B} = \mu \vec{J}_{free} + \mu\sigma\vec{E} + \mu\epsilon\frac{\partial \vec{E}}{\partial t}$	
4. Ampere's Law	$\nabla \times \vec{B} = \mu_0 \vec{J} + \mu_0\epsilon_0\frac{\partial \vec{E}}{\partial t}$	$\nabla \times \vec{B} = \mu_0(\vec{J}_f + \nabla \times \vec{M} + \frac{\partial \vec{P}}{\partial t}) + \mu_0\epsilon_0\frac{\partial \vec{E}}{\partial t}$	$\nabla \times \vec{H} = \vec{J}_f + \frac{\partial \vec{D}}{\partial t}$ if $\vec{H} = \frac{1}{\mu_0}\vec{B} - \vec{M}$
0. Continuity	$\nabla \cdot \vec{J} = -\frac{\partial \rho}{\partial t} = -\nabla \cdot (\epsilon_0 \frac{\partial \vec{E}}{\partial t})$	Vac, no charges or currents: $\nabla^2 \vec{E}$	$= \mu_0\epsilon_0\frac{\partial^2 \vec{E}}{\partial t^2}$ and $\nabla^2 \vec{B} = \mu_0\epsilon_0\frac{\partial^2 \vec{B}}{\partial t^2}$

Boundary Conditions: $\epsilon_1 E_1^{\perp} = \epsilon_2 E_2^{\perp}$ $\quad B_1^{\perp} = B_2^{\perp}$ $\quad E_1^{\parallel} = E_2^{\parallel}$ $\quad \frac{1}{\mu_1}B_1^{\parallel} = \frac{1}{\mu_2}B_2^{\parallel}$

Wave Equation: $\frac{\partial^2 f}{\partial z^2} = \frac{1}{v^2}\frac{\partial^2 f}{\partial t^2}$ Standing Wave to sum of waves: $A \sin kz \cos kvt = \frac{A}{2}(\sin kz + kvt + \sin kz - kvt)$

Standing Wave: $kL = n\pi$ for $n = 1, 2, 3...$ And frequency: $V = \frac{1}{T} = \frac{kv}{2\pi} = \frac{nv}{nL}$

String boundary conditions: Position cannot change across boundary, and neither can first derivative.

2 connected strings, $\omega_1 = \omega_2$ must be, $v = \frac{\omega}{k}$, then $r = \frac{A_R}{A_I} = \frac{k_1 - k_2}{k_1 + k_2} = \frac{v_2 - v_1}{v_1 + v_2}$ and $t = \frac{A_T}{A_I} = \frac{2k_1}{k_1 + k_2} = \frac{2v_2}{v_1 + v_2}$

Monochromatic plane waves: $\vec{E} = E_0 \hat{n} e^{i(\vec{k}\cdot\vec{r} - \omega t)}$ and $\vec{B} = \frac{E_0}{c}\hat{k} \times \hat{n} e^{i(\vec{k}\cdot\vec{r} - \omega t)}$