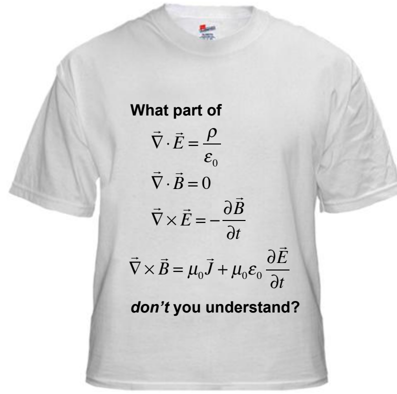
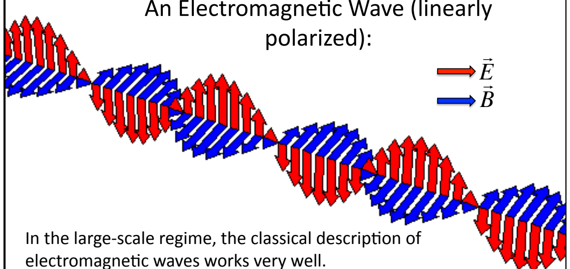
PHY385-H1F Introductory Optics

Class 2 – Outline: Ch.2

- One dimensional wave function $\psi(x,t) = f(x - vt)$
- The differential wave equation: $\dfrac{\partial^2\psi}{\partial x^2} = \dfrac{1}{v^2}\dfrac{\partial^2\psi}{\partial t^2}$
- Harmonic Waves
- Phasors
- Plane waves
- 3-D Wave equation
- Spherical waves
- Cylindrical Waves (if time)



An Electromagnetic Wave (linearly polarized):



In the large-scale regime, the classical description of electromagnetic waves works very well.

In the subatomic domain, the quantum mechanical treatment must be applied.

Both the classical and quantum-mechanical treatments of light make use of the mathematical description of waves.

5-minute In-Class Task

- Please take out a piece of paper that you don't mind handing to me at the end (I have some at the front if you want).
- WRITE YOUR NAME at the top of the piece of paper
- Discussion with your friends or me during this task is ***encouraged!***
- Consider the function: $\psi(x,t) = f(x - vt)$
- Where: $f(y) = \dfrac{1}{y^2 + 1}$

1. Consider the time $t = 0$. At what value of x is $\psi(x,0)$ a minimum? At what value of x is $\psi(x,0)$ a maximum?
2. Consider the time $t = +1$ second. At what value of x is $\psi(x,1)$ a maximum?

Some math identities

Cartesian Laplacian: $\Delta f = \dfrac{\partial^2 f}{\partial x^2} + \dfrac{\partial^2 f}{\partial y^2} + \dfrac{\partial^2 f}{\partial z^2}.$

Cylindrical Laplacian: $\Delta f = \dfrac{1}{\rho}\dfrac{\partial}{\partial\rho}\left(\rho\dfrac{\partial f}{\partial\rho}\right) + \dfrac{1}{\rho^2}\dfrac{\partial^2 f}{\partial\theta^2} + \dfrac{\partial^2 f}{\partial z^2}.$

Spherical Laplacian: $\Delta f = \dfrac{1}{r^2}\dfrac{\partial}{\partial r}\left(r^2\dfrac{\partial f}{\partial r}\right) + \dfrac{1}{r^2\sin\varphi}\dfrac{\partial}{\partial\varphi}\left(\sin\varphi\dfrac{\partial f}{\partial\varphi}\right) + \dfrac{1}{r^2\sin^2\varphi}\dfrac{\partial^2 f}{\partial\theta^2}.$

Curl of the curl: $\nabla\times(\nabla\times\mathbf{A}) = \nabla(\nabla\cdot\mathbf{A}) - \nabla^2\mathbf{A}$