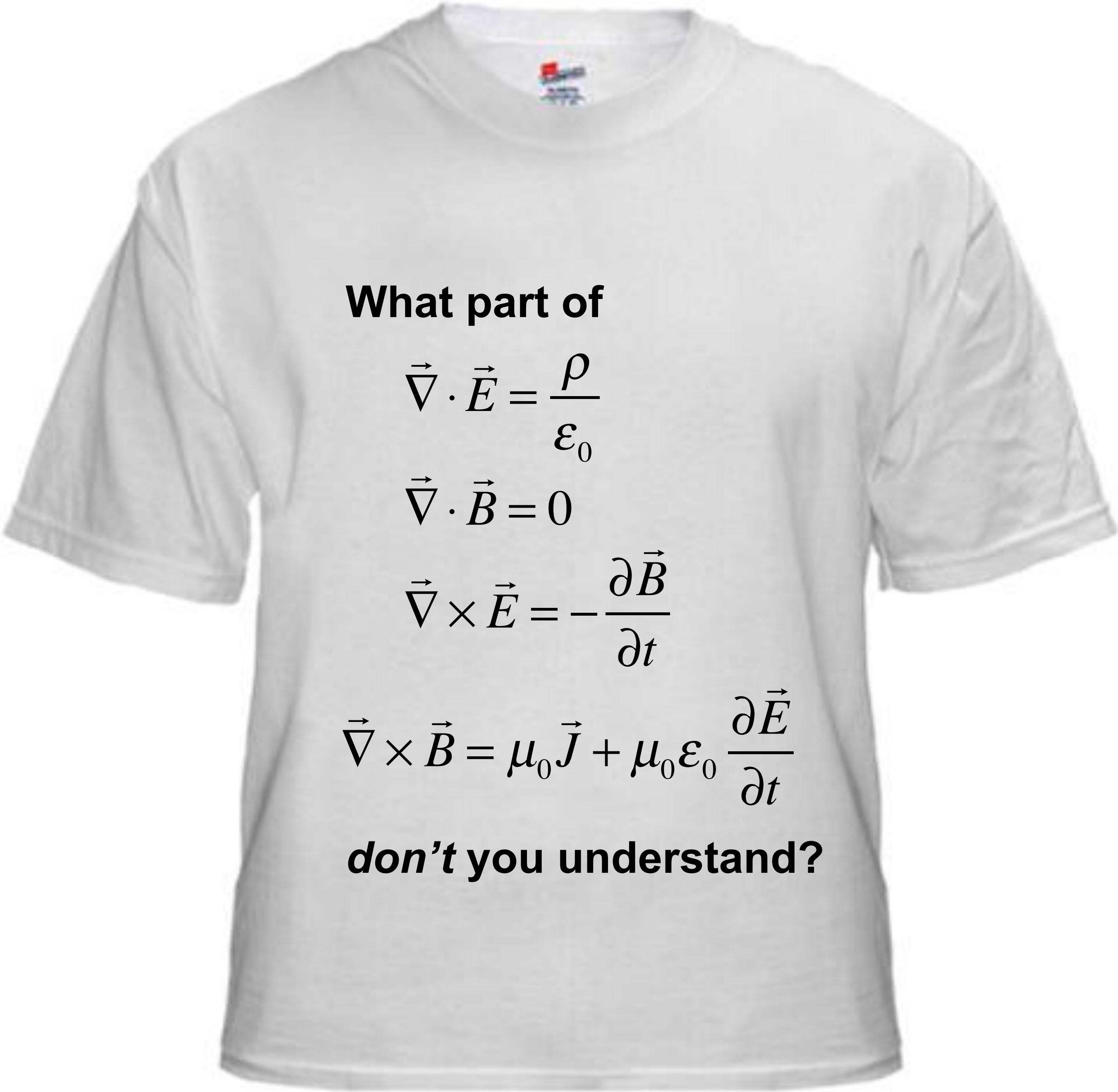
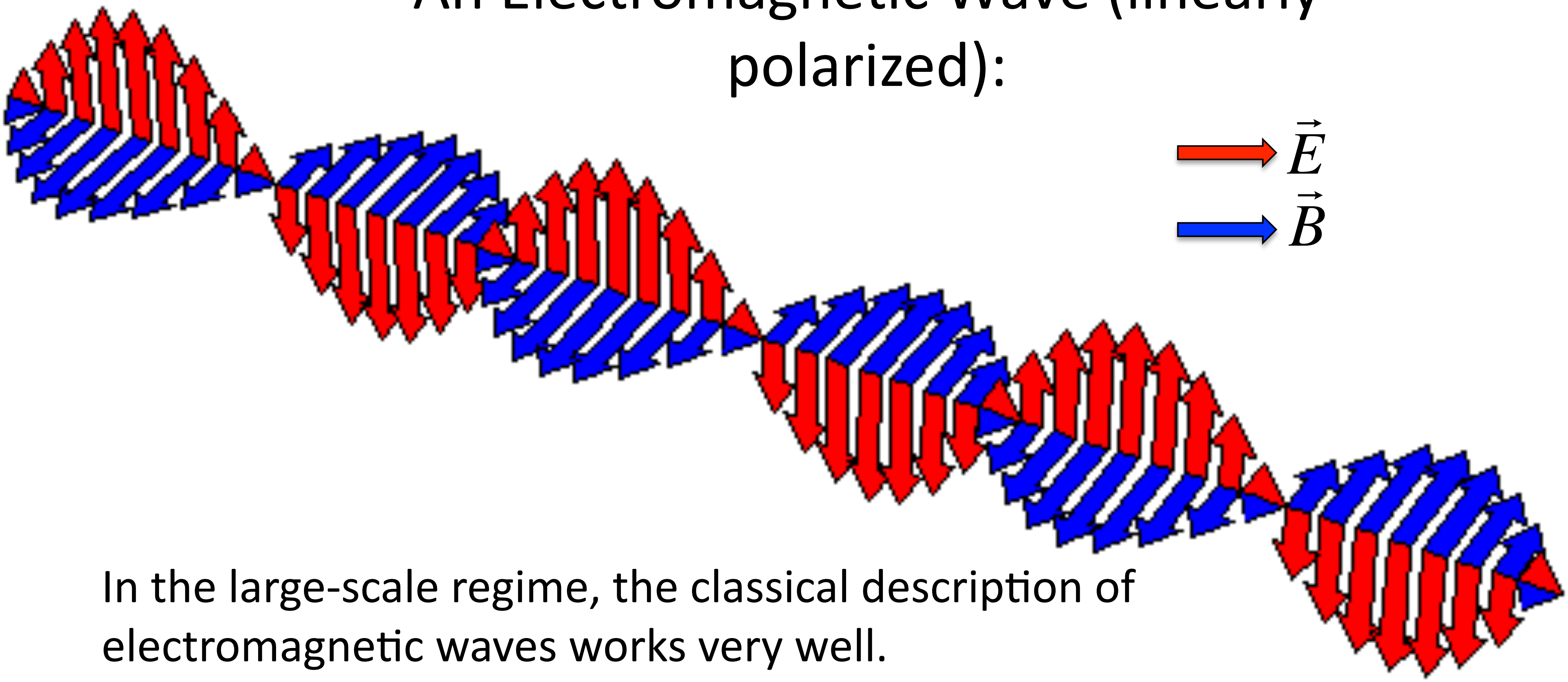
PHY385-H1F Introductory Optics

Class 2 – Outline: Ch.2

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


What part of
$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$
$\vec{\nabla} \cdot \vec{B} = 0$
$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$
$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$
don't you understand?

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:

$$\Delta f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}.$$

Cylindrical Laplacian:

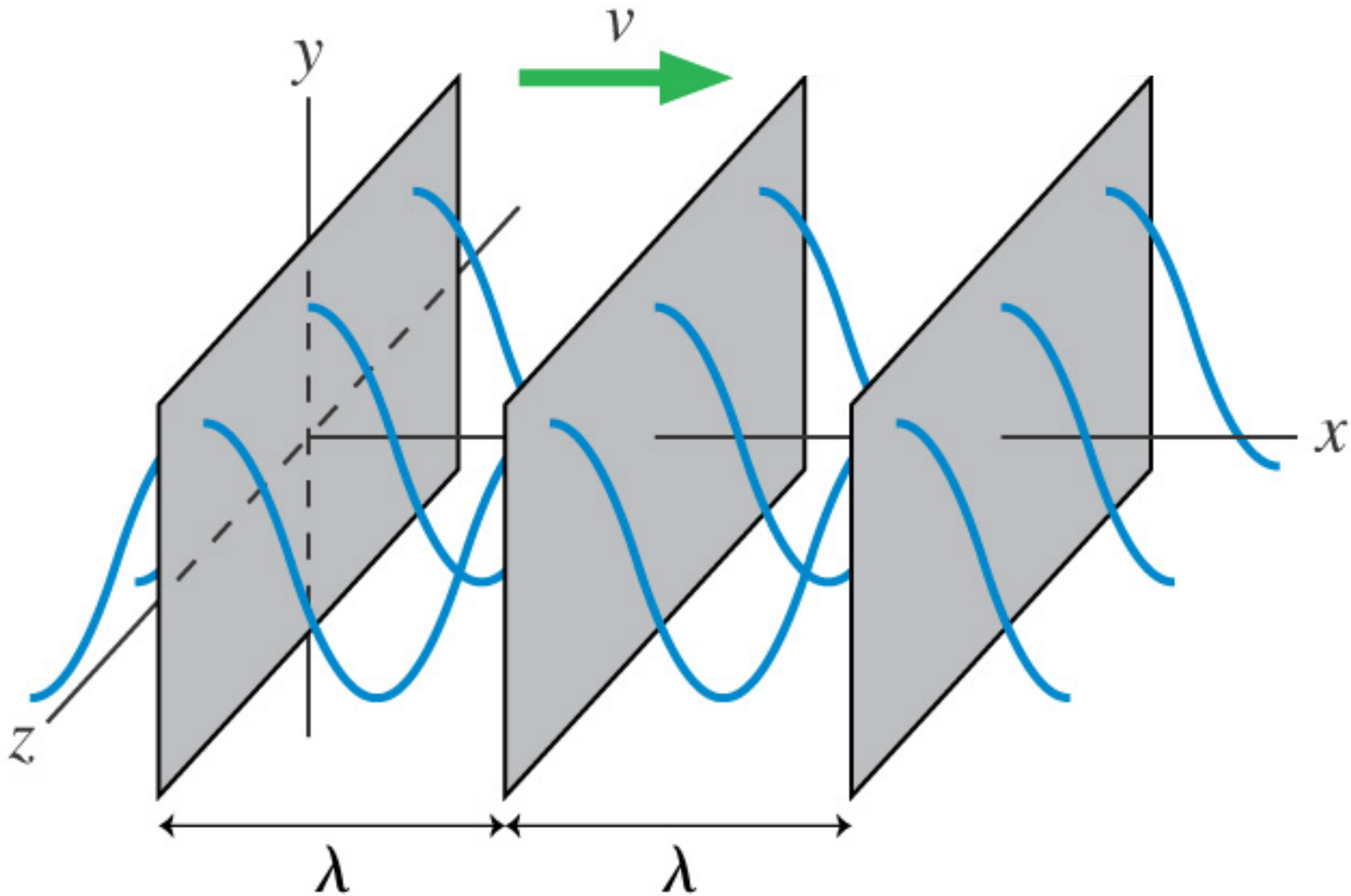
$$\Delta f = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \frac{\partial f}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 f}{\partial \theta^2} + \frac{\partial^2 f}{\partial z^2}.$$

Spherical Laplacian:

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

Curl of the curl:

$$\nabla \times (\nabla \times \mathbf{A}) = \nabla(\nabla \cdot \mathbf{A}) - \nabla^2 \mathbf{A}$$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