Physics 3034 – Spring 2024
Due Thursday February 1.

Homework 02 – Rev A

SPN 2–01 [10 pts] – Fun with EM units.
In part "f" of problem 5 from homework 1 you hopefully arrived at the expression $J_{conduct}/J_{maxwell} = \sigma/\epsilon\omega = 1$. Since this is a ratio of currents (or current densities) it should be dimensionless. Beginning with the following units, show that the ratio above really IS dimensionless.

$$\sigma : ([\Omega]\cdot[m])^{-1} \tag{1}$$
$$\omega : [s]^{-1} \tag{2}$$
$$\epsilon : [C]^2/[m^2]\cdot[N] \tag{3}$$

SPN 2–02 [10 pts] – More fun with EM units.
You probably know that $c = \sqrt{\frac{1}{\epsilon_0\mu_0}}$. Plug in the values for ϵ_0 and μ_0 to show this comes out correctly. Then show that the units are correct also. Begin with the units for ϵ_0 as in problem 1. Begin with the units for μ_0 as $[T]\cdot[m]/[A]$.

SPN 2–03 – Mechanical Waves.
Physicists measured some guitar strings. A high-E string had a diameter of 0.25 mm while a G-string had a diameter of about 0.4 mm. Both were made of steel with density $\rho = 7000\ kg/m^3$.

[a] Both strings were tensioned to about 60 N. What are their respective wave speeds?
[b] The strings is attached to a guitar that it is 80 cm long. What is the wavelength of the fundamental and the first harmonic for each string? (You might need to look up standing waves on strings with fixed ends if you do not remember this.) Write an equation in the form $f(z,t) = Re\ \tilde{A}\ exp(ikz - \omega t)$ using the appropriate k for the fundamental notes on each string. Fill in the constants correctly. You can make up an amplitude that seems reasonable for a plucked guitar string.

SPN 2–04 – Wave Equation.
Do Griffith's 9.1.

SPN 2–05 – Standing Waves.
Do Griffith's 9.2.

SPN 2–06 [15 pts] – Electromagnetic Wave Equation.
Begin with the following two equations.

$$\nabla \times \vec{E} = -d\vec{B}/dt \tag{4}$$
$$\nabla \times \vec{B} = \epsilon_0\mu_0 d\vec{E}/dt \tag{5}$$

[a] Take the cross product of both sides of equation 4 and use the vector identity for the curl of a curl to arrive at a wave equation for $\vec{B}$. Justify your steps.
[b] Do the same for $\vec{E}$. Justify your steps.

SPN 2–07 [15 pts] – Poynting Vector.
Do Griffiths 8.1. I will work these partially in class.

SPN 2–08 [15 pts] – Poynting Vector.
Do Griffiths 8.2.