PHY 3107, Spring 2018, Homework #1

due Thursday, Jan. 11, at 9:30 am (beginning of class)

This should be easy if you took class with me in the fall. It is very similar to your first homework set from then, and I am hoping this will take you only 10 or 15 minutes.. On all homework assignments, please show your work and explain your reasoning. This homework is a review of math (and a little physics from PHY 3106). Feel free to use any notes or texts, or talk to other students. In the end, all your work must be your own.

Homework problems must be neatly done, with each problem begun on a fresh page. Multiple problems on the same sheet or sheets with multiple solutions to the same problem will not be accepted. No pages with scratched-out work will be accepted -- if you spoil the page, begin with a clean sheet.

1.) Consider the complex number $z = -3 + 3i$. What is the value of $|z|^2 = z^* \cdot z$? Plot this number in the complex plane (y-axis = Im, x-axis = Re). If we rewrite z in the form $z = Ae^{i\theta}$, what is the value of *A*? What is the value of θ? What is $\left|e^{i\theta}\right|$?

2.) Given matrices $A = \begin{pmatrix} 2 & 4 \\ 3 & 5 \end{pmatrix}$ and $B = \begin{pmatrix} 1 & 0 \\ 0 & 4 \end{pmatrix}$, what is their product: $A \cdot B =$?

3.) Find $\int_{-1}^{12}(x-6)\delta(x-4)dx$, explaining clearly (i.e., use words). ["δ" is a Dirac delta function]

4.) Sketch a graph of $y = 2e^{-(\frac{x}{a})^2}$ vs. x for *a=10*. Indicate the x and y scales. Is the function symmetric? What is the limit for $x \to \pm\infty$? What is the significance of *a* in the exponent?

5.) What is the relation between the energy, E, and the frequency, f, of a photon? What is the approximate energy of a photon of red light? (both in Joules and eV)

6.) What is the relation between a particle's wavelength, λ, and momentum, p? Roughly what energy does an electron have for its wavelength to be roughly an "atomic" distance scale? Re-express this as the number of volts to accelerate that electron from rest to this energy. Would you call this a high-voltage device?

7.) Write down an equation describing a sinusoidal traveling wave (in 1-D). Tell us (words and/or equations) what in your equation tells us the *speed* and *direction* of the wave?

8.) What does it mean for two functions to be "orthogonal"? Then, give a *specific example* of two orthogonal functions.