PHY 3107, Spring 2017, Homework #1
due Tuesday, Jan. 17, at 9:30 am (beginning of class)

On all homework assignments, please show your work and explain your reasoning. This homework set 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. Problems will not be accepted if the solutions are scribbled sideways, upside down, or at the edge of another problem. There should not be multiple columns on a single page. Paper does not need to be ruled, but cannot be torn out of a notebook.

To help better understand where everyone is starting -
On *every question* this week, please put a number in a circle at the end of each question:
(1) - I knew this material, it was fairly trivial for me.
(2) - I knew this material, and didn't look up anything or get help, but it was not "trivial".
(3) - I knew this material, but still needed to look *something* up in a book/notes/web.
(4) - I knew this material, but still needed to get help from a (live) person.
(5) - I did NOT know this, and had to learn it for this homework!

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1.) Consider the complex number $z = -2 + 2i$. 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 $|e^{i\theta}|$?

2.) Given matrices $A = \begin{pmatrix} 6 & 4 \\ 3 & 1 \end{pmatrix}$ and $B = \begin{pmatrix} 3 & 0 \\ 0 & 2 \end{pmatrix}$, what is their product: $A \cdot B =$?

3.) Find $\int_{-2}^{9}(x - 5)\delta(x + 1)dx$, explaining clearly (i.e., use words). ["δ" is the Dirac delta function.]

4.) Sketch a graph of the function $y(x) = 2e^{-\left(\frac{x}{c}\right)^2}$ vs. x for c=5. Indicate the *x* and *y* scales. Is the function symmetric? What is the limit for $x \rightarrow \pm\infty$? What is the significance of *c* 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 yellow 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 approximately an "atomic" distance scale? Re-express this as the number of volts necessary 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.