PHYS 3220, Fall 09, Homework #1
due Wed, Aug 26, at 2PM (bring in to class)

On all homework assignments this term, please show your work and explain your reasoning. We try to grade for clarity of explanation as much as we do for mere "correctness of final answer". This first homework is meant to be a review of math (and a little physics). Feel free to use any notes or texts, or talk to other students, or come to our homework session (Tuesday 2-4 this week, G2B60). In the end, all your work should be your own.

To help us better understand where everyone is starting -
On *every question* this week, please put a number in a circle at the end of each question:
(i) - I knew this material, it was fairly trivial for me.
(ii) - I knew this material, and didn't need to look up anything or get help, but it was not
      what I would call "trivial" for me.
(iii) - I knew this material, but still needed to look *something* up in a book/notes/web.
(iv) - I knew this material, but still needed to get help from a (live) person.
(v) - I did NOT know this, and had to learn it for this homework!
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1) Consider the complex number $z = -4 + 4i$. 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?

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

3) Evaluate $\int_{-7}^{7} (x-7)\delta(x-5)dx$, explaining clearly (use some words!) your work.

   (Here,"δ" is a Dirac delta function)

4) Sketch a graph of $y = 3e^{-(x^2/a^2)}$ vs. x for *a=10*. (Be sure to indicate the x and y scales you choose). Does the function show any symmetries? What is the limit for $x \rightarrow \pm\infty$? 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 yellow light? (both in Joules and eV)

6) What is the relation between the wavelength, λ, and the momentum, p, of a particle? Roughly what kinetic energy should an electron have in order that its wavelength be of roughly an "atomic" distance scale? Then re-express this as the number of volts needed 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.