Assignment I, PHYS 272 (MAP)
Fall 2014
Due 8/22/14 at start of class

As you probably know, the math and physics background of students in this class varies substantially. Therefore, this first homework is an attempt to find out what you've learned (and retained) from your previous courses.

This homework will be graded a bit unusually – I won't grade your answers for correctness; this time I'm only grading for effort / completeness. This homework will also be the only homework all semester that (1) I won't return to you, and (2) will count for less than a full homework grade.

Although I normally encourage you to work with classmates (so long as the work you turn in is your own), *on this homework, I do NOT want you to work with any of your classmates. Also, no calculators, Mathematica, or using the internet to help you out! (I want to see what you remember, not what you can look up or be reminded of by a friend!)*

As always, what you get out of a class is really a function of how much you put into it. You could turn this homework in and use online resources and calculators to suggest you know more than you do – but then I'm going to assume that the class is better prepared than it is and probably move way too fast. Alternatively, you could just do a few problems and turn it in, but then I'll assume you've forgotten things that you really remember quite well and you'll be bored mindless – not exactly the best use of your hard earned cash. Therefore, it is in your best interest to put some effort into this, but to do it honestly (without using calculators, computer algebra systems like mathematica, or getting help from your fellow students).

Please put your answers on a separate sheet of paper. If you want to type them up in LaTeX, that would be awesome – but not expected.

1. List down all the mathematics classes you've taken since you graduated from High School (or equivalent). (Please list course names, not course numbers!)
2. What is the value of $\tan\left(\frac{\pi}{3}\right)$?
3. Evaluate: $\sqrt{-121}$
4. Evaluate $\sqrt[3]{-8}$
5. Evaluate $16^{-1/2}$
6. A right triangle has a hypotenuse of length 25, and one of the sides has length 24. What is the length of the other side?
7. What are the three angles inside the above described triangle? (You may leave your answer in terms of trig functions).
8. Solve for $x : 5x^2 + 6x = -1$.

9. Find x and y so that both of these equations are satisfied:

$$8x + 4y = 16$$
$$6x - 3y = 24$$

10. Put the following ten numbers in order from smallest to largest: the number of seconds in a year, the number of molecules in a mole, the numerical value of Planck's Constant (in SI units), π, 7×10^{-3}, -1, 0, 2×10^{17}, 5^3, $\frac{1}{100}$.
11. What is $\ln\left(e^{3\pi}\right)$
12. Find $\lim_{x\to 0}\left[\frac{\sin^2 x}{x^3}\right]$
13. Calculate: $\frac{\mathrm{d}}{\mathrm{d}x}[3x^5]$
14. Calculate: $\frac{\partial}{\partial z}\left[\frac{4x^4}{y^3 z}\right]$
15. Integrate: $\int x^2 \mathrm{d}x$
16. Integrate $\int_0^1 x\exp(-x^2)\mathrm{d}x$
17. What is the magnitude of the following (cartesian) vector: $\langle 3, 4, -12\rangle$
18. Convert the cartesian vector $\langle 3, 4, -12\rangle$ to spherical coordinates.
19. Evaluate the following: $(7\hat{x} + 6\hat{z}) \cdot (3\hat{x} + 2\hat{y} + \hat{z})$
20. Evaluate the following: $(7\hat{x} + 6\hat{z}) \times (3\hat{x} + 2\hat{y} + \hat{z})$
21. Evaluate the following: $\vec{\nabla}[5x^2y - \sin(xz) + 17]$
22. Evaluate the following: $\vec{\nabla} \cdot (4xz\hat{x} + 3yz\hat{y} + 4\hat{z})$
23. On some graph paper, plot the equation $y = 3x + 5$. Use a broken line.
24. On the same graph paper, plot the equation $y = -3x^2 + 2$. Use a dotted line.
25. On the same graph paper, plot the equation $y = \frac{2x}{x^2-x-2}$. Use a solid line.
26. Evaluate the following: $\vec{\nabla} \times (4xz\hat{x} + 3yz\hat{y} + 4\hat{z})$
27. Solve the following subject to the conditions $x(t = 0) = 0$ and $x(t = 1) = 3$:

$$\frac{\mathrm{d}^2x}{\mathrm{d}t^2} + 5\frac{\mathrm{d}x}{\mathrm{d}t} + 4x = 0$$

28. Solve the following (there will be an undetermined constant at the end):

$$\frac{\mathrm{d}^3z}{\mathrm{d}t^3} + 4\frac{\mathrm{d}z}{\mathrm{d}t} = 3t - 1$$

29. Solve the following subject to the boundary conditions $u(t,0) = 0$ and $u(t,L) = 0$. (The initial conditions are unspecified).

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$$

30. Simplify to an answer of the form $x + iy$: $\tanh \frac{3\pi i}{4}$.

31. What is the determinant of the following matrix?

$$\begin{pmatrix} 0 & 1 & 2 & -1 \\ -1 & 0 & -3 & 0 \\ -2 & 3 & 0 & 1 \\ 1 & 0 & -1 & 0 \end{pmatrix}$$

32. Find the eigenvalues and associated eigenvectors for the following matrix:

$$\begin{pmatrix} 2 & 3 & 0 \\ 3 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

33. Evaluate $\oint \vec{V} \cdot \mathrm{d}\vec{r}$ around the boundary of the square with vertices $(1,0), (0,1), (-1,0), (0,-1)$ if $\vec{V} = x^2\hat{x} + 5x\hat{y}$.

34. What is the volume of a spherical ball with diameter 3 cm?

35. What is the surface area of a spherical ball with diameter 3 cm?

36. Evaluate $\int_{-\infty}^{\infty} 3x^2 \delta(x-3) \mathrm{d}x$.

37. What is the convolution of $f(t) = 4t^2$ and $g(t) = 3t$?

38. Three men and three women (a total of 6 people) are prepared to enter a room. Three of these people enter the room. What is the probability that there are 2 men and 1 woman in the room?

39. An event follows a Poisson distribution with a mean $\mu = 1$. What is the probability that a void (empty) observation is made?

40. An event follows a Poisson distribution with a mean $\mu = 1$. What is the probability that an observation is made with more than 2 counts in the observation?

41. Two urns contain colored balls. You are unable to look into the urns, but you know that one urn has a total of 11 balls – 7 red and 4 green. The other urn has 12 balls – 3 red and 9 green. You reach into one of the urns and pull out a red ball. What is the probability you pulled out of the first urn?

42. Are there any problems on this warm-up set completely unlike problems you've solved before? If so, which ones?