Assignment I, PHYS 111 (General Physics I)
Fall 2018
Due 8/24/18 at start of class

I suspect that 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 (only) I'm only grading for effort / completeness and legibility. 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, do NOT use calculators, computer software, or 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 or never learned things that you really remember quite well and you'll be bored mindless – not exactly the best use of your tuition money. 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. Make sure everything is legible and well organized. (Illegible work will not be counted for full credit). *If you don't know an answer, just write "I don't remember how to do this" or "I never learned how to do this" (whichever is appropriate).*

1. List all Mathematics classes you've ever taken (High School and College), starting with Algebra I.
2. List all Physics courses (if any) you've ever taken (High School and College). For each class, list (i) was the class algebra based or calculus based, and (ii) what were the main ideas discussed?
3. Tell me something you hope to get out of this class.
4. Solve for x: $6x + 7 = 55$
5. Solve for x: $6(x + 7) = 54$
6. What is the value of $\cos \pi$?
7. What is the value of $\sin(60^\circ)$?
8. What is the value of $\tan\left(\frac{\pi}{3}\right)$?
9. Simplify $\sqrt{144a^2b^4c^7}$.

10. Evaluate $\sqrt[3]{-8}$

11. Evaluate $16^{-1/2}$

12. A right triangle has a hypotenuse of length 25, and one of the other sides has length 24. What is the length of the remaining side?

13. Solve for $x : 5x^2 + 6x = -1$.

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

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

15. Evaluate: $\sqrt{-121}$

16. What is $\ln\left(e^{3\pi}\right)$

17. On some graph paper (or, if you don't have graph paper – on carefully constructed and measured axes), plot the equation $y = 3x + 5$.

18. On a different axes, plot the equation $y = |3x - 2| + 1$.

19. On a different axes, plot the equation $y = -3x^2 + 2$.

20. On a different axes, plot the equation $y = \frac{2x}{x^2 - x - 2}$.

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

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

All of the above mathematics comes from courses that you must have had if you have been able to enroll in this course. If you struggled mightily with the above questions, you could be under-prepared for this class. Prerequisites are there for a reason, and these skills will be necessary for success in Physics. If you struggled with the above, (i) seriously consider whether or not you are ready for this class, and (ii) be ready to have to possibly spend extra time just mastering the pure-math elements of this class.

The problems below come from Calculus I and later. Do what you can. Show your work.

23. Find $\lim_{x \to 0} \left[\frac{\sin^2(3x)}{(2x)^2}\right]$

24. Calculate: $\frac{\mathrm{d}}{\mathrm{d}x}[3x^5]$

25. Integrate: $\int x^2 \mathrm{d}x$

26. Integrate: $\int_0^{\pi/2} \cos x \mathrm{d}x$

27. Calculate: $\frac{\partial}{\partial z}\left[\frac{4x^4}{y^3 z}\right]$

28. Put the following ten numbers in order from smallest (closest to $-\infty$) to largest (closest to ∞): the number of seconds in a year, the number of molecules in a mole, $|-3\times10^{-27}|$, π, 7×10^{-3}, -1, 0, 2×10^{17}, 5^3, $\frac{1}{100}$.

29. Integrate $\int_0^1 x\exp(-x^2)\mathrm{d}x$

30. A vector $\vec{r}$ has $|\vec{r}|=10$ and points 30° below the x-axis. What is the vector's y-component?

31. A vector is written $-3\hat{i}-3\hat{j}$. Write the vector in polar coordinates.

32. Vector $\vec{r}_1=3\hat{i}-2\hat{j}$. Vector $\vec{r}_2=-2\hat{j}$. What is $|\vec{r}_1+\vec{r}_2|$?

33. Evaluate the following: $\left(7\hat{i}+6\hat{k}\right)-\left(3\hat{i}+2\hat{j}+\hat{k}\right)$

34. Evaluate the following: $\left(7\hat{i}+6\hat{k}\right)\cdot\left(3\hat{i}+2\hat{j}+\hat{k}\right)$

35. Evaluate the following: $\left(7\hat{i}+6\hat{k}\right)\times\left(3\hat{i}+2\hat{j}+\hat{k}\right)$

36. Are there any completely unfamiliar/incomprehensible problems so far on this assignment? If so, which ones?

I don't really expect people to get the rest of these, but I am curious if we have some folks in here that are more mathematically prepared than expected.

37. Three blond-haired people and three red-haired people (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 blond-haired people and 1 red-haired person in the room?

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

39. Evaluate the following: $\vec{\nabla}[5x^2y-\sin(xz)+17]$

40. Evaluate the following: $\vec{\nabla}\cdot\left(4xz\hat{i}+3yz\hat{j}+4\hat{k}\right)$

41. Evaluate the following: $\vec{\nabla}\times\left(4xz\hat{i}+3yz\hat{j}+4\hat{k}\right)$

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

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

43. 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 $\vec{V}=x^2\hat{i}+5x\hat{j}$.

44. Solve the following subject to the conditions $x(t=0)=0$ and $x(t=1)=3$:

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

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

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

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

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