PHYS 111 (Section 1)
Homework 1
Due Friday 26 August 2022 at beginning of class

Please read this introduction carefully.

This first homework is unlike all of the other homework assignments you will be completing this semester. Firstly, this is the only homework assignment that is graded on an "effort" basis; if you make a meaningful attempt to complete this homework, you will earn a perfect score. Secondly, this homework is worth only half as much as the other homework assignments for the semester – you have less time to complete it and it really just tests previous knowledge. Thirdly, this is the one homework all semester that I am asking you to not use *ANY* external resources for – no calculators, internet, help from classmates, looking things up in texts, etc. I am giving you this math survey to assess WHAT YOU ALREADY KNOW. Remember, you are only being graded on effort.

If you come to a problem that you don't know how to do, please state something like "I don't remember how to do this, but I used to know." or "I have never seen anything like this before." I intentionally include some pretty high-level math on here, so there are problems that I don't necessarily expect anyone to be able to get. If you only know how to do a few of these, that doesn't necessarily mean you won't succeed in our class. (It does mean that you might have to work a bit harder to catch up on the background math content, though.)

The background of students in this class is highly variable; a lot of our students get their first few semesters of calculus at a variety of different places and from instructors that emphasize different topics. This assessment helps me figure out where you are and customize the content for the rest of the semester accordingly.

Note that this is the one homework for the full semester you will not get back; if you want I'll let you know how many you got correct, but – again – that doesn't affect your grade; if you turn this in on time and wrote down something (even "I have no idea how to do this problem") for each question, you'll earn a perfect score. I don't return this homework because I use some version of this math assessment every semester and I don't want an answer key floating around out there.

Please legibly write all solutions on separate paper, clearly numbering each solution and boxing or circling your final answers. You *do not* have to turn in this question sheet, and you *do not* have to copy the question down.

1. What is your name?
2. List all Mathematics course you've taken in College
3. List all Physics, Meteorology, and/or Astrophysics classes you've taken in College (if any).
4. Tell me something you hope to get out of this class.
5. What is your biggest academic concern about this class?

6. Solve for x: $6x + 7 = 55$
7. Solve for x: $6(x + 7) = 54$
8. What is the value of $\cos \pi$?
9. What is the value of $\sin(60°)$?
10. What is the value of $\tan\left(\frac{\pi}{3}\right)$?
11. Simplify $\sqrt{144a^2b^4c^7}$.
12. Evaluate $\sqrt[3]{-8}$
13. Evaluate $16^{-1/2}$
14. 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?
15. Solve for $x : 5x^2 + 6x = -1$.
16. Find x and y so that both of these equations are satisfied:

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

17. Evaluate: $\sqrt{-121}$
18. What is $\ln\left(e^{3\pi}\right)$
19. What is the volume of a spherical ball with diameter 3 cm?
20. What is the surface area of a spherical ball with diameter 3 cm?
21. Find $\lim_{x\to 0}\left[\frac{\sin^2(3x)}{(2x)^2}\right]$
22. Calculate: $\frac{\mathrm{d}}{\mathrm{d}x}[3x^5]$
23. Integrate: $\int x^2 \mathrm{d}x$
24. Integrate: $\int_0^{\pi/2} (\cos x)\,\mathrm{d}x$
25. Calculate: $\frac{\partial}{\partial z}\left[\frac{4x^4}{y^3 z}\right]$
26. 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, $|-3 \times 10^{-27}|$, π, 7×10^{-3}, -1, 0, 2×10^{17}, 5^3, $\frac{1}{100}$.
27. Integrate $\int_0^1 x \exp(-x^2)\mathrm{d}x$
28. A vector $\vec{r}$ has $|\vec{r}| = 10$ and points 30° below the x-axis. What is the vector's y-component?

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

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

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

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

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

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

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

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

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

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

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

39. 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?

40. 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?

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

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

42. An event follows a Poisson distribution with a mean $\mu = 1$. What is the probability that an observation of 0 is made?

43. Solve the following differential equation with $r(t=0) = 1$ and r a function of t only:

$$r\frac{\mathrm{d}r}{\mathrm{d}t} = 3$$

44. Approximate for $x \ll 1$ (retain terms up to second order in x): $f(x) = \frac{\sqrt{1+x}}{\sqrt{1-x}}$.

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

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

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

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

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

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48. I had been quite careful to avoid COVID, as I am at high risk for a severe case. Nevertheless, I recently became infected (so recently that preparing the first days of this course was rather difficult.) I need to remain masked for some time to clear CDC guidelines, but – after that – I may be willing to lecture unmasked as long as (i) Students don't sit too close to the front of the room, and (ii) nobody in the class has a concern about this. I don't know if any of you are immunocompromised or have other considerations – and I don't need to. On this question, please just indicate either (A) "it doesn't matter to me if you lecture masked or unmasked" or (B) "for personal reasons, I would be more comfortable if you lectured with a mask on even after you have cleared CDC COVID protocols". I do not intend to make your answer to this question public.