Physics 3323, Fall 2016 **Review** *due Mon, August 29, 2016*

This first problem set is meant to be a review I'm hoping its mostly straightforward for you. If not, let me know soon. Future problem sets will involve new ideas, and more time and effort. **For this problem set only** - For each numbered question, rate your own confidence (A, B, C) in the material with this scale:

A) The material is very familiar to me. I was able to answer the question without assistance of a book, human, Internet, etc

B) The material was familiar, but in order to answer the question, I needed some assistance (from a book, human, Internet, etc)

C) The material was unfamiliar to me. I had to learn it in order to answer the question.

Write the letter (A,B, or C) near your answer for every numbered question.

1. A triangle (NOT necessarily a "right triangle") has sides a, b, and c, and an angle θ opposite side c. What is c in terms of a, b, and θ?

2. $\int \frac{4x}{(x^2+a^2)^{3/2}} dx$ (where a is a known constant. Note that it is an indefinite integral)

3. $\frac{d}{dx} \int_1^x f(y) dy$ where $f(y)$ is some given, known, well behaved, function of y)

4. $\frac{d}{dx} \int_0^1 (\ln y + \ln x) dy$

5. Make a quick sketch in the x-y plane, of the following vector functions. Plot enough different vectors to get a feeling for what this field looks like in the $x - y$ plane.

   a) $y\hat{\mathbf{x}}$

   b) $r\hat{\mathbf{r}}$

   c)

   $$\frac{x}{\sqrt{x^2 + y^2}}\hat{\mathbf{x}} + \frac{y}{\sqrt{x^2 + y^2}}\hat{\mathbf{y}}$$

   Also just for this one (part c) -explain in *words* what this plot is showing.

6. Given the scalar function $T(x, y, z)$ (e.g. the temperature at any point in the room), which of the three operations (div, grad, or curl) can be sensibly operated on T? For each which can:

   a) give a formula for the result

   b) explain in words how you would interpret the result.

   c) is the result a vector or scalar?

7. Given an arbitrary vector function **V**(x,y,z) (e.g. the velocity of a flowing liquid) Which of the three operations (div, grad, or curl) can be sensibly operated on **V**? For each which can:

   a) give a formula for the result

   b) explain in words how you would interpret the result.

   c) is the result a vector or scalar?

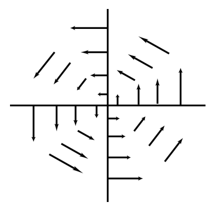
8. For each of the four vector fields sketched below....

   Which of them have nonzero *divergence* somewhere? ____________
   (If the divergence is nonzero only at isolated points, which point(s) would that be?)

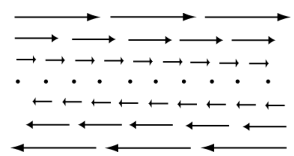
   Which of the following fields have nonzero *curl* somewhere? ____________
   (If the curl is nonzero *only* at isolated points, which point(s) would that be?)

   (A brief explanation of your answers below each figure would be welcome)

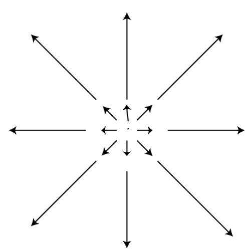
A.



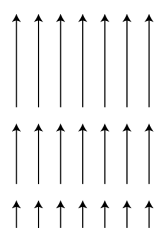
B



C.



D.



9. Given vectors **A** and **B**. ("Given" means you know the components, or alternatively, the length and angle of the vectors) Define the dot product mathematically in two very different looking ways. (Hint: one way should involve the components, the other, the length/angles)

   Give a brief physical interpretation of what the dot product means or tells you (you can give a concrete example if you like)

10. Define the vector cross product mathematically in two very different looking ways. (Hint: one way should involve the components, the other, the length/angles)

    Give a brief physical interpretation of what the cross product means or tells you (you can give a concrete example if you like)

11. Compute the gradient of the following two scalar fields.

    a) $e^x \cos(y)$

    b) $\cos(x^2 + y^2 + z^2)$

12. Compute the divergence and curl of $\hat{\imath}(x^2 + yz) + \hat{\jmath}(y^2 + zx) + \hat{k}(z^2 + xy)$.

13. Evaluate the line integral $\int(y^2 dx - 2x^2 dy)$ along the parabola $y = x^2$ from the point $(0, 0)$ to the point $(2, 4)$.

14. According to Gauss' law, $\oint_S \mathbf{E} \cdot \hat{\mathbf{n}} dA = q(\text{enclosed})/\epsilon_0$, where $\mathbf{E}$ is the electric field, S is a closed surface, $\hat{\mathbf{n}}$ is a unit vector which points everywhere *outward* from the surface.

    Suppose I fill a cube (length L on a side) uniformly with electric charge. I then imagine a larger, closed cubical surface symmetrically surrounding this cube (length $2L$ on a side)

    a) Is Gauss' law TRUE in this situation? (Briefly, why or why not?)

    b) Can one use Gauss' law to easily compute the value of the electric field at arbitrary points outside the charged cube (Don't try, just tell me if you could, and why/why not?)

    c) What exactly is $\mathbf{E}$, the electric field? (Define it, and explain how you think about it, first mathematically *and* then in words? Please define any new technical words you introduce into your definition.)