PHYS 2210 Fall 2011 Homework Set 6 Due at 4 PM on **Oct 6th, 2011**

1. (1 point) A librarian pushes a heavy textbook (with mass 2 kg) across a rough table (which has a coefficient of friction μ_k=0.2). If the book leaves his hand with speed 4 m/s and slides 2 m across the table towards a spring (with constant $k = 6$ N/m), what is the maximum compression of the spring? (Reminder: As the book compresses the spring, it still continues to experience the frictional force from the table.)

2. (0.5 points) For an arbitrary scalar function $f(x, y, z)$, evaluate the components of $\boldsymbol{\nabla} \times \boldsymbol{\nabla} f$ in Cartesian coordinates and show that the result is 0.

3. (a) (1 point) Taylor Problem 4.2, part a

   (b) (1 point) Taylor Problem 4.2, part b

   (c) (0.5 points) From your answers to parts a and b, do you think that $\mathbf{F}$ in this problem represents a conservative force? Why or why not?

   (d) (0.5 points) Calculate the curl of F ($\boldsymbol{\nabla} \times \mathbf{F}$). Is this consistent with your answer to part c? Why or why not?

   (e) (1 point) Using the `VectorPlot` function in Mathematica, make a plot of this force $\mathbf{F}$ over the range $x = 0 \rightarrow 1$ and $y = 0 \rightarrow 1$. (Be sure to attach your plot to this assignment.) By visually examining your graph, what can you say about the local rotation of the vector field at the point (0.6,0.6)? Is this consistent with your answer to part d? Why or why not?

4. Two diagrams, each representing a force field in the x-y plane, are shown on the third page of this assignment.

   (a) (1 point) For each case, is it possible to draw a self-consistent set of equipotential contours for that situation?

   If so: Draw a representative set of equipotential contours for that situation. Each drawing should clearly show (1) the correct shape of the contour lines, (2) the correct relative spacing of the contours, and (3) label the regions that correspond to highest and lowest potential energy. (You can draw right on the HW printout and staple it to your HW submission.)

   If not: Explain why, on the basis of the force field diagram, drawing such contours is impossible.

   (b) (0.5 points) Are these forces conservative? How can you tell?

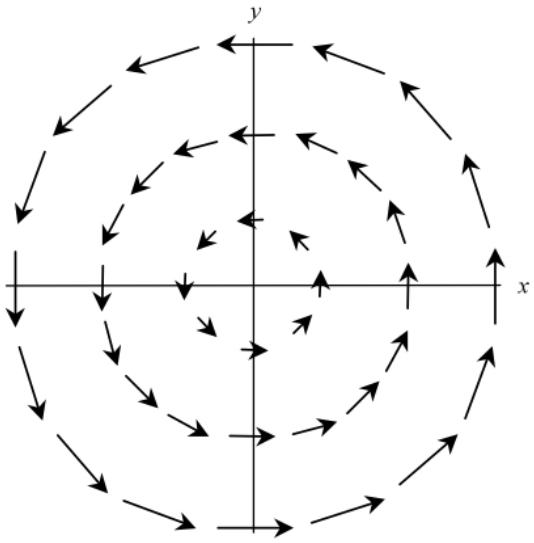
5. A particle is in a 2D potential of $U(\vec{r}) = x^2 + 3y^2$.

   (a) (0.5 points) What is the force on the particle?

   (b) (0.5 points) Using the `ContourPlot` function in Mathematica, make an equipotential plot of $U(\vec{r})$ over the range $x = -1 \rightarrow 1$ and $y = -1 \rightarrow 1$. (Be sure to attach your plot to this assignment.)

   (c) (0.5 points) On your printed contour plot, draw an arrow at the point (0.5,0.5) in the direction that is approximately perpendicular to the equipotential contours at that location and points toward increasing potential. Then evaluate your answer for part b at (0.5,0.5). How does the direction of the force compare to the arrow that you just drew?

6. (1.5 points) Taylor Problem 4.30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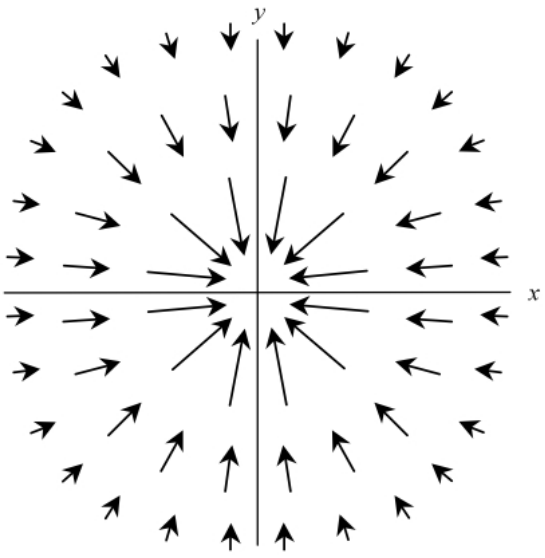
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