This assignment is in two parts. The first part is due at the start of class on Day 24. It will not be collected, but you are expected to complete these exercises, just to practice basic skills. If you feel that you need more practice, then do more problems or talk to me.

16.4 Exercises 13, 27.

16.5 Exercise 5, 9, 20.

The second part is due on paper at the start of class on Day 25. Submit polished solutions, including all necessary work and no unnecessary work, in the order assigned.

A. Curl is a kind of derivative, so it should enjoy some kind of product rule:

$$\text{curl}\,(f\vec{F}) = Df * \vec{F} + f * D\vec{F},$$

where $f(x, y, z)$ is a scalar field, $\vec{F}(x, y, z)$ is a vector field, the two Ds are derivatives of some kind (not necessarily the same), and the two $*$s are multiplications of some kind (not necessarily the same). Figure out what the Ds and $*$s should be, by thinking carefully about whether each piece of the equation is a scalar field or vector field. Then prove that the equation is true.

B. Repeat Problem A for the divergence operator: $\text{div}(f\vec{F}) = Df * \vec{F} + f * D\vec{F}$?

C. The famous Mercator map projection is one way of picturing the surface of the Earth as a rectangle. Essentially, Mercator is the inverse of the spherical parametrization. More precisely, the point on the Earth's surface with spherical coordinates (R, ϕ, θ) (where R is the radius of the Earth) is plotted at the point (ϕ, θ) in the rectangle $[0, \pi] \times [0, 2\pi]$. Where in our class discussion was it revealed that the Mercator projection over-emphasizes polar regions such as Greenland?

D. 16.4 Exercise 41. (This fact is the basis for a class of map projections that do represent areas accurately.)