1. a. Find a potential function for $F(x, y) = \langle \cos x - 4y, 6y^2 - 4x \rangle$. or explain why none exists.
   b. For which value of $m$, if any, is $F(x, y) = \langle 6e^{3x} \cos 2y, me^{3x} \sin 2y \rangle$ conservative?

2. Consider the velocity field of hurricane Ike on the right. Note how the magnitudes of the velocity are encoded.
   a. Does the field appear to be approximately linear?
   b. Explain what it means to be path-independent.
   c. Does the field appear to be a gradient field?
   d. Does the field appear to locally be a gradient field, away from the “eye”?
   e. Give a formula for a vector field that could serve as a reasonable model for this (static image of the) hurricane.

3. a. For any integer $n \in \mathbb{Z}$ and $G(x, y) = \langle \frac{-x}{(x^2 + y^2)^n}, \frac{-y}{(x^2 + y^2)^n} \rangle$ defined for $(x, y) \neq (0, 0)$ calculate $\text{div} G = \frac{\partial G_1}{\partial x} + \frac{\partial G_2}{\partial y}$
   b. For which values of $n$ is this quantity zero?

4. Evaluate the following line integrals using a diverse set of techniques and arguments.
   a. $\vec{F}(x, y) = \langle y, x \rangle$ over the line segment from $(3, 1)$ to $(1, 5)$.
   b. $\vec{F}(x, y) = \langle -2y, 2x \rangle$ over the semicircle with radius 3 centered at $(0, 0)$ starting at $(3, 0)$.
   c. $\vec{F}(x, y) = \langle -7y, 7x \rangle$ over the piecewise linear path from $(23, 0)$ over $(0, 0)$ to $(0, 57)$.
   d. $\vec{F}(x, y) = \langle 0, x^2 \rangle$ over the quartercircle with radius 3 centered at $(0, 0)$ starting at $(3, 0)$.
   e. $\vec{F}(x, y) = \frac{1}{x^2+y^2} \langle -y, x \rangle$ over the circle with radius 3 centered at $(5, 4)$ oriented counterclockwise.
   f. $\vec{F}(x, y) = \frac{1}{x^2+y^2} \langle -y, x \rangle$ over the piecewise linear path from $(3, 0)$ over $(0, 2)$ to $(-3, 0)$.

**Bonus.** Without a calculator estimate $\int_C \langle -y^2, x^2 \rangle \cdot d\vec{r}$ over the line segment $C$ from $(4, 0)$ to $(0, 4)$. 