1. The horizontal flow field is described by $\vec{U} = -\frac{1}{2} y \hat{i} + \frac{1}{2} x \hat{j}$. Compute both the horizontal divergence and the vertical component of vorticity for this flow field. Show your work.

2. The 500 mb wind is from the southwest at 10 m/s. The 1000 mb wind is westerly at 5 m/s. What is the shear between the two layers? Please express the shear as a vector, and also compute its magnitude. In addition, draw a picture and label it completely.
3. The wind velocity (m/s) at the location of the star in the figure below is \( \vec{U} = 3\hat{i} + 3\hat{j} \). There is no vertical wind component. Compute the temperature advection at the location of the star, in K per second. Show your work. Be sure to specifically state whether this is cold advection, warm advection, or no advection.
4. Subsaturated air passing over the sea surface is being moistened at a rate of 1 g/kg per hour. At a fixed location, the mixing ratio is decreasing at 2 g/kg per hour. The wind component accomplishing the moisture advection has a speed (in absolute magnitude) of 10 km/h. What is the moisture gradient in that direction, expressed in g/kg per km?