1. The horizontal flow field is described by $\vec{U} = -3x^2 \hat{i} + xy \hat{j}$. Compute both the horizontal divergence and the vertical component of vorticity for this flow field. Evaluate both for the point $(x,y) = (1,1)$. Show your work.

2. The 500 mb wind is from the east at 10 m/s. The 1000 mb wind is westerly at 10 m/s. What is the shear between the two layers? Please express the shear as a vector, compute its magnitude, and specify its meteorological direction. 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. Moisture increases eastward at 0.3 g/kg/km. What must the zonal (west to east) wind component be to explain this difference? Express your answer in km/h, and watch your units.
5. The 1000-500 mb shear vector is directed from S to N. The 500 mb geostrophic wind is westerly. There is cold temperature advection occurring. Where is the cold air located? Answer with: to the N, to the S, to the W, or to the E. Briefly justify your answer. (You DO have sufficient information. I mentioned this concept in class.)