Keep in mind that wind is defined by the direction the air is coming from. A wind direction of $0^\circ$ is northerly, $90^\circ$ is easterly, $180^\circ$ is southerly, and $270^\circ$ is westerly. You are in the Northern Hemisphere.

If you cannot answer a particular question owing to insufficient information, state what information you need to answer it.

(1) Air flowing eastward at 10 km/h passing over a desert surface is being heated at 1 K/h. Temperature decreases to the west at 10 K/100 km. What is the local time rate of change of temperature at a fixed point? Draw a picture. Answer in K/h.

**Ans:** Notice that we have cold advection working against the warming following the motion. The temperature gradient is only west-east so the only term in the temperature advection we need is in the x-direction. Solving for the local temperature change:

$$\frac{\partial T}{\partial t} = \frac{dT}{dt} - u \frac{\partial T}{\partial x} = 1 \text{ K/h} - 10 \text{ K/h} \left[ \frac{10 \text{ K}}{100 \text{ km}} \right] = 1 \text{ K/h} - 1 \text{ K/h} = 0 \text{ K/h}.$$ 

(2) The horizontal velocity vector is $\vec{V} = 3x^2 \hat{i} - 5y^2 \hat{j}$. Compute the horizontal divergence and vertical vorticity. Evaluate at the point $(x, y) = (1, 1)$. You do not have to sketch the function.

$$\nabla \cdot \vec{V} = \left( \frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} \right)$$

$$\hat{k} \cdot (\nabla \times \vec{V}) = \left( \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right)$$

**Ans:** Since $v$ is not a function of $x$ and $u$ is not a function of $y$, the vertical component of vorticity is zero. The horizontal divergence is

$$\nabla \cdot \vec{V} = \left( \frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} \right) = 6x - 10y.$$ 

At point $(1,1)$, we have the answer of -4, units per second (convergence).