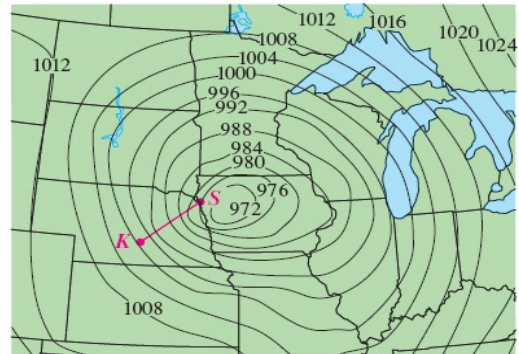


Instructions: Write complete solutions to the following problems in the space provided. Be sure to supply all the necessary steps that lead to your answers

1. Level curves for barometric pressure (in Millibars) are shown for 6:00 AM on November 10, 1998. A deep low with pressure 972 mb is moving over northeast Iowa. The distance along the red line from K (Kearney, Nebraska) to S (Sioux City, Iowa) is 300 km.

Estimate the value of the directional derivative of the pressure function at Kearney in the direction of Sioux City. Use direction vector $\mathbf{u} = \langle \cos 45^\circ, \sin 45^\circ \rangle$



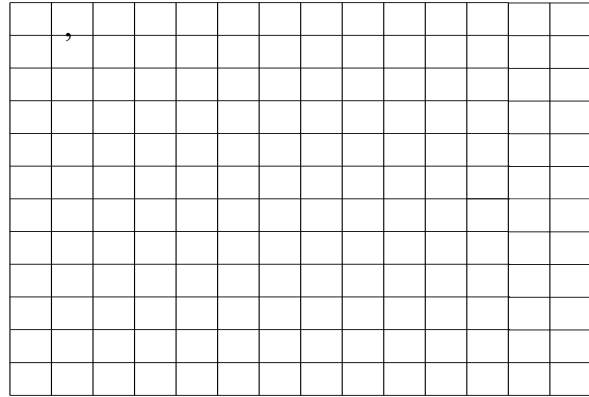
2. The wind-chill index W is the perceived temperature when the actual temperature is T and the wind speed is v , so we can write $W = f(T, v)$.

Use the table to estimate the value of

$$D_{\mathbf{u}}f(-15, 50), \quad \mathbf{u} = \langle \cos 135^\circ, \sin 135^\circ \rangle$$

		Wind speed (km/h)					
		v	20	30	40	50	60
Actual temperature (°C)	T						
	-10	-18	-20	-21	-22	-23	-23
	-15	-24	-26	-27	-29	-30	-30
	-20	-30	-33	-34	-35	-36	-37
-25	-37	-39	-41	-42	-43	-44	

3. Given $f(x, y) = x^2 + 4y^2$
 Sketch a contour plot over the rectangle
 $[-4, 4] \times [-4, 4]$, then find



a. $D_{\mathbf{u}}(1, \sqrt{3}/2)$

$$\mathbf{u} = \langle \cos 40^\circ, \sin 40^\circ \rangle$$

$$\mathbf{u} = \langle \cos 60^\circ, \sin 60^\circ \rangle$$

$$\mathbf{u} = \langle \cos 30^\circ, \sin 30^\circ \rangle$$

b) $\nabla f(1, \sqrt{3}/2)$

c) Sketch $\nabla f(1, \sqrt{3}/2)$ on the contour plot.

d) Find the equation of the normal line

e) Find the direction of maximum and minimum rate of change of f at $(2, 1)$ and the values of maximum and minimum rates of change.