Problems 13.4, Page 124

7. To the right of $x = 2$. From any point (a, b) in that area, as (x, y) moves to the right (i.e., x increases and y remains fixed), f increases.

8. Below $y = 2$. From any point (a, b) in that area, as (x, y) moves upward (i.e., x remains fixed and y increases), f decreases.

9. (a) As a point in the xy-plane moves an equal short distance in the positive x- and negative y-directions, the corresponding point on the surface moves lower (its motion in the y-direction is irrelevant, because the surface is a cylinder parallel to the y-axis), so $g_{\vec{u}}(2, 5)$ is negative.
(b) As a point in the xy-plane moves an equal short distance in the positive x- and y-directions, the corresponding point on the surface moves lower, so $g_{\vec{u}}(2, 5)$ is negative.

12. $\nabla z = (e^y)\vec{\imath} + (xe^y)\vec{\jmath}$

14. $\nabla z = \left(\dfrac{1}{1 + (x/y)^2}\right)\left(\dfrac{1}{y}\right)\vec{\imath} + \left(\dfrac{1}{1 + (x/y)^2}\right)\left(-\dfrac{x}{y^2}\right)\vec{\jmath}$

26. $\nabla f = (2x\cos(x^2))\vec{\imath} + (-\sin y)\vec{\jmath}$, so $\nabla f = (\sqrt{\pi/2})\vec{\imath}$.

28. (a) The directional derivative is a scalar, not a vector.
(b) Because $\nabla f = (2xe^y)\vec{\imath} + (x^2e^y)\vec{\jmath}$, we have $\nabla f(1, 0) = 2\vec{\imath} + \vec{\jmath}$; and a unit vector in the direction of $\vec{v}$ is $\frac{4}{5}\vec{\imath} + \frac{3}{5}\vec{\jmath}$, so $f_{\vec{u}} = 2(\frac{4}{5}) + (\frac{3}{5}) = \frac{11}{5}$.

31. $\nabla f = 2x\vec{\imath} + 2y\vec{\jmath}$, so $\nabla f(1, 2) = 2\vec{\imath} + 4\vec{\jmath}$, so $f_{\vec{u}} = 2(.6) + 4(.8) = 4.4$.

36. (a) As a point moves right from P, the corresponding z-value goes down, so this directional derivative is negative.
(b) As a point moves up from P, the corresponding z-value goes up, so this directional derivative is positive.
(c) As a point moves right from Q, the corresponding z-value goes up, so this directional derivative is positive.
(d) As a point moves up from Q, the corresponding z-value goes down, so this directional derivative is negative.

37. $||\nabla f||$ is larger at P, because the contour lines are closer together near P, meaning that the z-value is changing faster there.