

## GRADIENTS TO LEVEL CURVES AND SURFACES

For each function below, find parametric equations for the gradient vector at the point below on the indicated level curve or surface.

1.  $z = x^2 + y^2$ , level curve  $z = 1$ ,  $P = \left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ .

2.  $z = x^2 - y^2$ , level curve  $z = 1$ ,  $P = (1, 0)$ .

3.  $z = -x^2 - y^2$ , level curve  $z = -1$ ,  $P = \left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ .

4.  $z = x^2 + y^2 - 1$ , level surface  $x^2 + y^2 - z = 1$ ,  $P = (1, 1, 1)$ .

5.  $z = x^2 - y^2 + 1$ , level surface  $x^2 - y^2 - z = -1$ ,  $P = (1, 1, 1)$ .

6.  $w = x^2 + y^2 + z^2$ , level surface  $w = 3$ ,  $P = (1, 1, 1)$ .