

Q. If $\phi = 3x^2y - y^3z^2$, then find grad ϕ at the point $(1, -2, -1)$.

sol Here, $\phi = 3x^2y - y^3z^2$

$$\therefore \frac{\partial \phi}{\partial x} = 6xy, \quad \frac{\partial \phi}{\partial y} = 3x^2 - 3y^2z^2,$$

$$\frac{\partial \phi}{\partial z} = -2y^3z$$

$$\therefore \text{grad } \phi = \nabla \phi = \frac{\partial \phi}{\partial x} \hat{i} + \frac{\partial \phi}{\partial y} \hat{j} + \frac{\partial \phi}{\partial z} \hat{k}$$

$$= 6xy \hat{i} + (3x^2 - 3y^2z^2) \hat{j} + (-2y^3z) \hat{k}$$

$$= -12 \hat{i} - 9 \hat{j} - 16 \hat{k} \quad \text{at } (1, -2, -1) \text{ proved}$$