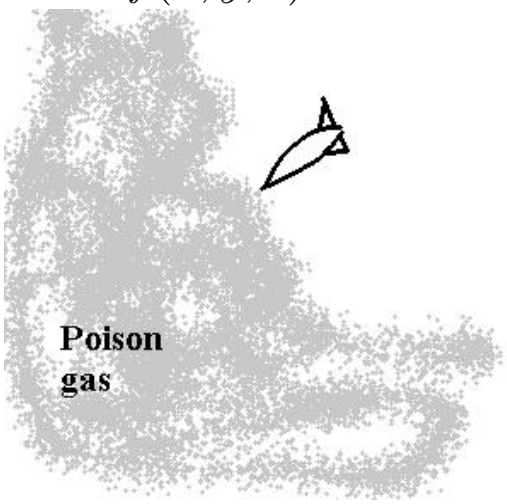
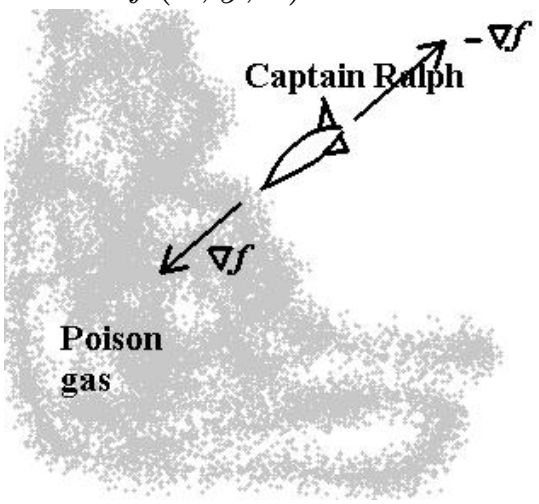
$$f(x, y, z) = e^{-x^2 - y^2 - 4z^2}$$



$$f(x, y, z) = e^{-x^2 - y^2 - 4z^2}$$



$$f(x, y, z) = e^{-x^2-y^2-4z^2}$$

∇f equals:

$$\left\langle -2xe^{-x^2-y^2-4z^2},\ -2ye^{-x^2-y^2-4z^2},\ -8ze^{-x^2-y^2-4z^2} \right\rangle$$

$$\nabla f(1,\ 1,\ 0) = \left\langle -2e^{-2},\ -2e^{-2},\ 0 \right\rangle$$

$$f(x, y, z) = e^{-x^2-y^2-4z^2}$$

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Captain Ralph should fly in the direction of
$-\nabla f(1,\ 1,\ 0) = \left\langle 2e^{-2},\ 2e^{-2},\ 0 \right\rangle = 2e^{-2}\langle 1,\ 1,\ 0 \rangle$

Part (a)

Find the rate at which the density changes in the direction of $\vec{\mathbf{u}} = \frac{1}{\sqrt{2}}(\vec{\mathbf{i}} + \vec{\mathbf{k}})$

$$D_{\vec{\mathbf{u}}} f = \nabla f \bullet \vec{\mathbf{u}} = 2e^{-2}\langle 1,\, 1,\, 0\rangle \bullet \frac{1}{\sqrt{2}}\langle 1,\, 0,\, 1\rangle = -\frac{\sqrt{2}}{e^2}$$