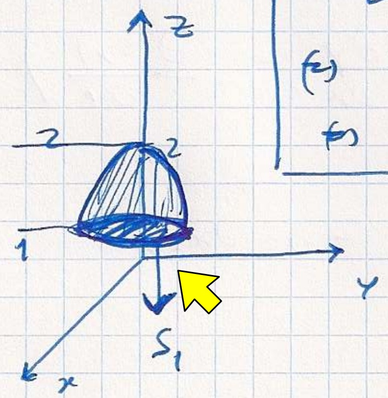
1.

$$F(x,y,z) = (x, y, z)$$

$$V: \quad x^2 + y^2 \le z \le 2 - x^2 - y^2$$

$$x^2 + y^2 \le z \iff \rho^2 \le z \iff \rho \le \sqrt{z}$$



$$z \le 2 - x^2 - y^2 \iff x^2 + y^2 \le 2 - z \iff \rho \le \sqrt{2-z}$$

$$\theta \in [0, 2\pi]$$

$$\sqrt{z} \le \rho \le \sqrt{2-z}$$

$$1 \le z \le 2$$

$$\begin{cases} x^2 + y^2 = z \\ z = 2 - x^2 - y^2 \end{cases} \Rightarrow x^2 + y^2 = 1, \ z = 1$$

$$\iint_S \vec{F} \cdot \vec{n}_{ext} \, dS + \iint_{S_1} \vec{F} \cdot \vec{n}_{ext} \, dS_1 = \iiint_V \nabla \cdot \vec{F} \, dx\,dy\,dz$$

$$\iff \iint_S \vec{F} \cdot \vec{n}_{ext} \, dS + \iint_{x^2+y^2 \le 1} (x, y, \overset{=1}{z}) \cdot (0, 0, -1) \, dx\,dy = \iiint_V 3 \, dx\,dy\,dz$$

$$\iff \iint_S \vec{F} \cdot \vec{n}_{ext} \, dS + \int_0^{2\pi} \int_0^1 \rho \, d\rho \, d\theta = \iiint_V 3 \, dx\,dy\,dz$$

$$\iff \iint_S \vec{F} \cdot \vec{n}_{ext} \, dS + \int_0^{2\pi} \left[\frac{\rho^2}{2} \right]_0^1 d\theta = \iiint_V 3 \, dx\,dy\,dz$$

$$\iff \iint_S \vec{F} \cdot \vec{n}_{ext} \, dS + \underbrace{\int_0^{2\pi} \frac{1}{2} \, d\theta}_{\pi} = \underbrace{\iiint_V 3 \, dx\,dy\,dz}_{?} \quad *$$

$$* \iiint_V 3 \, dx\, dy\, dz = 3 \int_0^{2\pi} \int_1^2 \int_{\sqrt{z}}^{\sqrt{2-z}} \rho \, d\rho\, dz\, d\theta$$

$$= 3 \int_0^{2\pi} \int_1^2 \left[\frac{\rho^2}{2} \right]_{\sqrt{z}}^{\sqrt{2-z}} dz\, d\theta$$

$$= 3 \int_0^{2\pi} \int_1^2 \frac{2-z}{2} - \frac{z}{2} \, dz\, d\theta$$

$$= 3 \int_0^{2\pi} \int_1^2 \frac{2-2z}{2} \, dz\, d\theta \qquad // \; 1-z$$

$$= 3 \int_0^{2\pi} \left[z - \frac{z^2}{2} \right]_1^2 d\theta$$

$$= 3 \int_0^{2\pi} \underbrace{\left(2 - \frac{4}{2}\right)}_{0} - \left(1 - \frac{1}{2}\right) d\theta$$

$$= 3 \int_0^{2\pi} -\frac{1}{2} \, d\theta$$

$$= -\frac{3}{2} \int_0^{2\pi} d\theta = -3\pi$$

$$\Rightarrow \iint_S \vec{F} \cdot \vec{n}_{ext} \, dS = -3\pi \; //$$