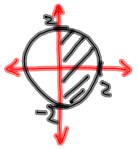


$$\iint f(x,y) dx dy$$

$$= \iint f(r \cos \theta, r \sin \theta) r dr d\theta$$

ex) $z = \sqrt{4 - x^2 - y^2}$

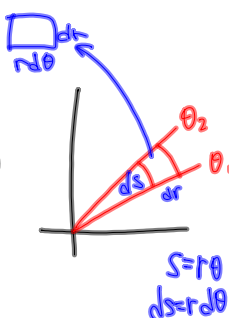


$$x^2 + y^2 \leq 4$$

$$x \geq 0$$

$$\frac{1}{4} \cdot \frac{4}{3} \pi r^3 = \frac{8}{3} \pi$$

$$= \pi \int_0^2 r \sqrt{4 - r^2} dr$$

$$= \frac{\pi}{2} \int_4^0 \sqrt{u} du = \frac{\pi}{2} \cdot \frac{2}{3} u^{3/2} \bigg|_4^0 = \frac{8\pi}{3}$$


$$S = r\theta$$

$$ds = r d\theta$$

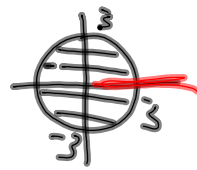
$$\int_0^2 \int_{-\pi/2}^{\pi/2} \sqrt{4 - r^2} \cdot r d\theta dr$$

$$0 \leq r \leq 2$$

$$-\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2}$$

20. Below the paraboloid $z = 18 - 2x^2 - 2y^2$ and above the xy -plane

$$0 = 18 - 2x^2 - 2y^2$$

$$x^2 + y^2 = 9$$


$$\int_0^3 \int_0^{2\pi} (18r - 2r^3) d\theta dr$$

$$2\pi \int_0^3 (18r - 2r^3) dr$$

$$2\pi \left(9r^2 - \frac{1}{2}r^4 \right) \bigg|_0^3$$

$$2\pi \cdot \left(81 - \frac{81}{2} \right)$$