

$$S \rightarrow x^2 + y^2 = a^2$$

$$y = \sqrt{a^2 - x^2}$$

$$\frac{\partial y}{\partial z} = 0$$

$$\frac{\partial y}{\partial x} = -\frac{1}{2\sqrt{a^2 - x^2}} \cdot (-2x) = \frac{x}{\sqrt{a^2 - x^2}}$$

$$dS = \sqrt{1 + \left(\frac{\partial y}{\partial z}\right)^2 + \left(\frac{\partial y}{\partial x}\right)^2}$$

$$= \sqrt{1 + 0 + \frac{x^2}{a^2 - x^2}} \Rightarrow \sqrt{\frac{a^2 - x^2 + x^2}{a^2 - x^2}} = \frac{a}{\sqrt{a^2 - x^2}}$$

$$\text{Surface area} = \iint dS = \iint \sqrt{1 + \left(\frac{\partial y}{\partial z}\right)^2 + \left(\frac{\partial y}{\partial x}\right)^2}$$

(in first octant)

$$\Rightarrow 8 \times a \int_{x=0}^a \int_{z=0}^{z=\sqrt{a^2-x^2}} \frac{1}{\sqrt{a^2-x^2}} dz dx$$

$$\Rightarrow 8 \times a \int_{x=0}^a \frac{1}{\sqrt{a^2-x^2}} \times \sqrt{a^2-x^2} dx$$

$$x^2 + z^2 = a^2$$

total
8 octant

$$\Rightarrow \boxed{8a^2}$$

