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

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

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

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

$x \ge 0$

$\frac{1}{4} \cdot \frac{4}{3}\pi r^3 = \frac{8}{2}\pi$

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

$u = 4 - r^2$

$du = -2r\,dr$

$= -\frac{\pi}{2}\int_4^0 \sqrt{u}\,du = \frac{\pi}{-2}\cdot\frac{2u^{3/2}}{3}\Big|_4^0 = -\left(\frac{8\pi}{3}\right)$

$ds = r\,d\theta$

$S = r\theta$

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

$0 \le r \le 2$

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

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

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

$x^2 + y^2 = 9$

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

$2\pi \int_0^3 18r - 2r^3\,dr$

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

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