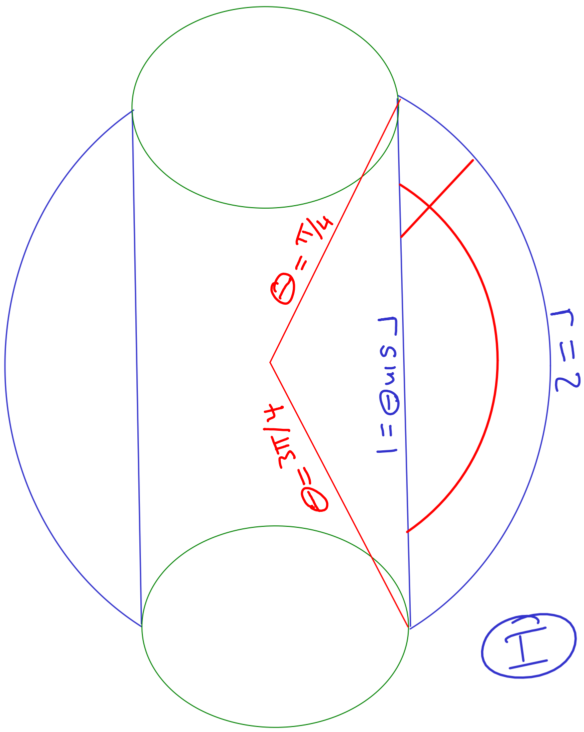

Spherical Coordinates

$$Q = \int (x^2+y^2)\, dV$$

$$x^2+y^2 = r^2 \sin^2\theta$$

$$dV = r^2 \sin\theta \, dr\, d\theta\, d\phi$$

I

$$Q = \int_0^{2\pi}\int_{\pi/4}^{3\pi/4}\int_{1/\sin\theta}^{\sqrt{2}} r^2\sin^2\theta \, r^2 \sin\theta \, dr\, d\theta\, d\phi$$

$$= 2\pi \int_{\pi/4}^{3\pi/4} \left.\frac{r^5}{5}\right|_{1/\sin\theta}^{\sqrt{2}} \sin^3\theta \, d\theta$$

$$= \frac{2\pi}{5}\int_{\pi/4}^{3\pi/4}\left(\sqrt{32}\,\sin^3\theta - \frac{1}{\sin^2\theta}\right) d\theta$$

$$= \frac{2\pi}{5}\int_{\pi/4}^{3\pi/4}\left(\sqrt{32}\,(1-\cos^2\theta)\sin\theta - \frac{1}{\sin^2\theta}\right) d\theta$$

$$= \frac{2\pi}{5}\left(-\sqrt{32}\cos\theta + \frac{\sqrt{32}\cos^3\theta}{3} + \frac{\cos\theta}{\sin\theta}\right)\Bigg|_{\pi/4}^{3\pi/4}$$

$$= -\frac{4\pi}{5}\left(-4 + \frac{2}{3} + 1\right) = \boxed{\frac{28\pi}{15}}$$

II $$Q = \int_0^{2\pi}\int_1^{\sqrt{2}}\int_{\arcsin 1/r}^{\pi/2-\arcsin 1/r} r^2\sin^2\theta\, r^2\sin\theta\, d\theta\, dr\, d\phi$$

$$= 2\pi \int_1^{\sqrt{2}}\int_{\arcsin 1/r}^{\pi/2-\arcsin 1/r} r^4(1-\cos^2\theta)\sin\theta\, d\theta\, dr$$

$$= 2\pi \int_1^{\sqrt{2}} r^4\left(-\cos\theta + \frac{\cos^3\theta}{3}\right)\Bigg|_{\arcsin 1/r}^{\frac{\pi}{2}-\arcsin 1/r}$$

$$\boxed{\begin{aligned}&\sin\theta = 1/r\\ \Rightarrow\ &\cos^2\theta = 1-1/r^2\\ &= \frac{r^2-1}{r^2}\\ \Rightarrow\ &\cos\theta = \pm\frac{\sqrt{r^2-1}}{r}\end{aligned}}$$

$$= 2\pi \int_1^{\sqrt{2}} r^4\left(-u + \frac{u^3}{3}\right)\Bigg|_{\frac{\sqrt{r^2-1}}{r}}^{-\frac{\sqrt{r^2-1}}{r}} dr$$

$$= -4\pi \int_1^{\sqrt{2}} r^4\left(-\frac{(r^2-1)^{1/2}}{r} + \frac{(r^2-1)^{3/2}}{3r^3}\right) dr$$

$$\boxed{\begin{aligned}&v = r^2-1\\ &dv = 2r\,dv\end{aligned}}$$

$$= -2\pi \int_1^{\sqrt{2}} \left(-r^2(r^2-1)^{1/2} + \frac{(r^2-1)^{3/2}}{3}\right)2r\,dr$$

$$= 2\pi \int_0^1 \left((1+v)v^{1/2} - \frac{v^{3/2}}{3}\right) dv$$

$$= 2\pi \int_0^1 \left(v^{1/2} + \frac{2}{3}v^{3/2}\right) dv$$

$$= 2\pi\left(\frac{2}{3}v^{3/2} + \frac{2}{3}\cdot\frac{2}{5}v^{5/2}\right)\Bigg|_0^1 = 2\pi\left(\frac{2}{3}+\frac{4}{15}\right)$$

$$= \boxed{\frac{28\pi}{15}}$$