(5) a. $z = 24 - x^2 - y^2 = 24 - r^2$ $\quad z \in [2r, 24-r^2]$

$z = 2\sqrt{x^2+y^2} = 2\sqrt{r^2} = 2r$

$2r = 24 - r^2$

$r^2 + 2r - 24 = 0$ $\quad \theta \in [0, 2\pi]$

$(r+6)(r-4) = 0$ $\quad r \in [0,4]$

$r = -6 \quad r = 4$

$$\int_0^{2\pi}\int_0^4\int_{2r}^{24-r^2} r\,dz\,dr\,d\theta = \int_0^{2\pi} d\theta \int_0^4 24r - r^3 - 2r^2\,dr$$

$$= 2\pi\left[12r^2 - \frac{1}{4}r^4 - \frac{2}{3}r^3\right]_0^4 = 2\pi\left[12(16) - 64 - \frac{2}{3}(64)\right] = \boxed{\frac{512\pi}{3} = V}$$

b. $z \in [2r, 24-r^2]$ $\quad r \in [0,4]$ $\quad \theta \in [0, 2\pi]$

$$\bar{z} = \frac{1}{V}\int_0^{2\pi}\int_0^4\int_{2r}^{24-r^2} zr\,dz\,dr\,d\theta = \frac{2\pi}{V}\int_0^4\int_{2r}^{24-r^2} zr\,dz\,dr$$

$$= \frac{2\pi}{V}\int_0^4 \frac{1}{2}(24-r^2)^2 r - \frac{1}{2}(2r)^2 r\,dr = \frac{\pi}{V}\int_0^4 576r - 52r^3 + r^5\,dr$$

$$= \frac{\pi}{V}\left[288r^2 - 13r^4 + \frac{r^6}{6}\right]_0^4 = \frac{\pi}{V}\left[\frac{5888}{3}\right] = \frac{3\pi}{512\pi}, \frac{5888}{3} = \frac{5888}{512}$$

$$\bar{z} = \frac{23}{2}$$

$\boxed{\text{The centroid is } (0, 0, \frac{23}{2})}$