13.3

5. $r(t) = \cos^3 t\,\hat{j} + \sin^3 t\,\hat{k}$

$r'(t) = 3\cos^2 t(-\sin t)\hat{j} + 3\sin^2 t\cos t\,\hat{k}$

$= 3\cos t\sin t\,(-\cos t\,\hat{j} + \sin t\,\hat{k})$

$|r'(t)|^2 = 3^2\cos^2 t\sin^2 t\,(\underbrace{\cos^2 t + \sin^2 t}_{=1})$

$= 9(\cos t\sin t)^2$

$= 9\left(\frac{\sin 2t}{2}\right)^2 = \frac{9}{4}\sin^2(2t) = \left(\frac{3}{2}\sin(2t)\right)^2$

Arclength from 0 to $\frac{\pi}{2}$

$= \int_0^{\frac{\pi}{2}} |r'(t)|\,dt = \int_0^{\frac{\pi}{2}} \frac{3}{2}|\sin(2t)|\,dt$

$= \frac{3}{2}\left(\frac{-\cos 2t}{2}\right)\Big|_0^{\frac{\pi}{2}} = \frac{3}{2}\left(\frac{-(-1)}{2} - \frac{-1}{2}\right) = \frac{3}{2}\cdot 1$

$= \frac{3}{2}$

Note: $\sin 2t$ is positive between 0 and $\frac{\pi}{2}$.

So $|\sin 2t| = \sin 2t$.