19. \( \mathbf{r}(t) = \langle t^3, 5t, t^2 - 16t \rangle \) \( \Rightarrow \) \( \mathbf{v}(t) = \langle 2t, 5, 2t - 16 \rangle \), \( |\mathbf{v}(t)| = \sqrt{4t^2 + 25 + 4t^2 - 64t + 256} = \sqrt{8t^2 - 64t + 281} \)

and \( \frac{d}{dt} |\mathbf{v}(t)| = \frac{1}{2} (8t^2 - 64t + 281)^{-1/2} (16t - 64) \). This is zero if and only if the numerator is zero, that is,

\[ 16t - 64 = 0 \text{ or } t = 4. \]

Since \( \frac{d}{dt} |\mathbf{v}(t)| < 0 \text{ for } t < 4 \) and \( \frac{d}{dt} |\mathbf{v}(t)| > 0 \text{ for } t > 4 \), the minimum speed of \( \sqrt{153} \) is attained at \( t = 4 \) units of time.