$\mathbf{r}(t) = \langle t^2, 11t, t^2 - 16t \rangle \quad \Rightarrow \quad \mathbf{v}(t) = \langle 2t, 11, 2t - 16 \rangle$, $|\mathbf{v}(t)| = \sqrt{4t^2 + 121 + 4t^2 - 64t + 25}$
$\sqrt{8t^2 - 64t + 377}$ and $\frac{d}{dt}|\mathbf{v}(t)| = \frac{1}{2}(8t^2 - 64t + 377)^{-1/2}(16t - 64)$. This is zero if and only if the numerator is zero, that is,
$16t - 64 = 0$ or $t = 4$. Since $\frac{d}{dt}|\mathbf{v}(t)| < 0$ for $t < 4$ and $\frac{d}{dt}|\mathbf{v}(t)| > 0$ for $t > 4$, the minimum speed of $\sqrt{153}$ is attained at $t = 4$ units of time.