3.5 (10 points) Challenge problem. A particle moves along a circular path given in spherical coördinates by

$$r(t) = R \qquad \text{and} \qquad \theta(t) = \theta_0 \qquad \text{and} \qquad \phi(t) = 2\pi(1 - e^{-\gamma t}) \,,$$

where $R > 0$, θ_0, and $\gamma > 0$ are constants.

(a) *Give* the particle's path in cylindrical coördinates.

(b) *Give* the particle's position vector $\mathbf{r}(t)$ in cylindrical coördinates.

(c) *Give* the velocity $\mathbf{v}(t)$ and the speed $v(t) = |\mathbf{v}(t)|$ in cylindrical coördinates.

(d) *Give* the acceleration $\mathbf{a}(t)$ in cylindrical coördinates.

(e) *Draw* the entire trajectory for $t \geq 0$. On your drawing, *draw* and *label* at the right place on the trajectory the velocity and acceleration at time $t = 0$ and at time $t = \gamma^{-1} \ln 2$.