21-P-FA-GD-014

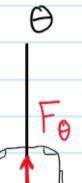$$r = ce^{2\theta}$$

r

A

θ

$\dot{\theta}, \ddot{\theta}$

You are looking through a set of stationary observation binoculars (A), overlooking a curved road below. The road can be modelled by the equation $r = \frac{c}{3}e^{2\theta}$, where θ is in radians. You are tracking a red sedan travelling along the road, with your binoculars.

You are rotating the binoculars with an angular velocity of $\frac{\dot{\theta}}{3}$ rad/s and an angular acceleration of $\frac{\ddot{\theta}}{3}$, at the moment $\frac{\theta}{3}$.

What is the resulting friction force between the tires and the road?

$\underline{\text{given}}$

$\theta, \dot{\theta}, \ddot{\theta}$

$\underline{\text{find}}$

F_r, F_θ, F_{tot}

$\underline{\text{FBD}}$

$r = Ce^{2\theta}$

$\dot{r} = 2Ce^{2\theta}\dot{\theta}$

$\ddot{r} = 2C\ddot{\theta}e^{2\theta} + 4C\dot{\theta}^2 e^{2\theta}$

$a_r = \ddot{r} - r\dot{\theta}^2$

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$

$\underline{\text{force equilibrium}}$

$\Sigma F_r = F_r = ma_r$

$\Sigma F_\theta = F_\theta = ma_\theta$

$F_{tot} = \sqrt{F_r^2 + F_\theta^2}$