

3) (25 points) Two balls swinging in circles

Two balls, each of mass M , are tracing out horizontal circular paths. An ideal rope of length L connects the first ball to the top of a stationary pole, and the second ball is connected to the first ball by a second rope of length L , as shown in the diagram. The inner rope forms an angle of θ_1 with the vertical, and the outer rope forms an angle of θ_2 with the vertical.

- If it takes a time τ for the balls to make one complete revolution, what is the speed v_2 of the **outer** ball (the faster one) as a function of L , θ_1 , θ_2 , and τ ?
- What is the **magnitude and direction** of the acceleration a_2 of the outer ball as a function of L , θ_1 , θ_2 , and τ ?
- What is the tension T_2 in the **outer** rope as a function of M and θ_2 ?
- What is the tension T_1 in the **inner** rope as a function of M and θ_1 ?
- Find an expression for the tension T_2 in the **outer** rope as a function of v_2 . Your answer might also depend on L , M , θ_1 , and θ_2 .

