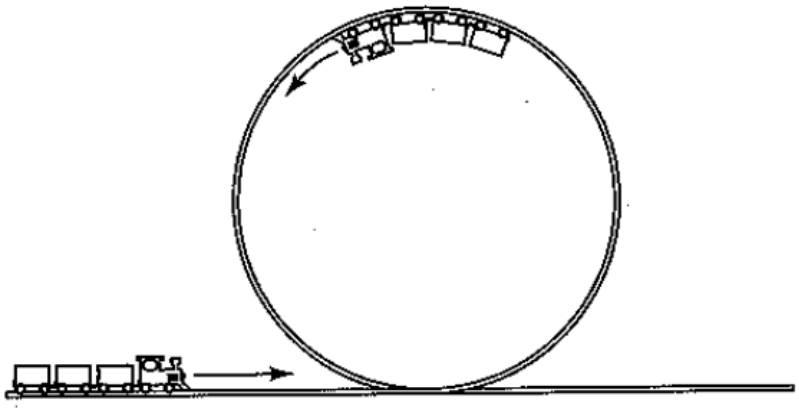
Please provide your solutions on a separate sheet of paper provided.
Write your name down first, on that sheet!
You can keep this sheet.

15 minutes.

A toy train goes into a loop roller coaster as shown below. Treat the toy train as a point particle with mass m, and let R be the radius of the loop. Let g be the surface gravity and assume no friction.



(a) Find the normal force exerted by the track on the train, as a function of $\dot{\theta}$ and θ, using the Lagrangian plus constraint formalism, where θ is the angular position of the train on the circle of the loop.

(b) At the bottom of the loop, the kinetic energy of the train is equal to $\frac{5}{2}mgR$ where R is the radius of the loop. Given this information, use the energy conservation to express the normal force as a function of θ alone.