Name: **Hr:** **AP Physics Roller Coaster Lab**

Roller Coaster Design Lab

Task: *Design a roller coaster that has the following characteristics (Document this in your Lab notebook)*

1. There is only one input of energy from the outside and it is a traditional, chain-drive hill that has the cart reach the top at 3 m/s before releasing the carts.
2. The cart must reach a maximum speed of 75 miles per hour.
3. There are at least two hills.
4. The riders have an apparent weight of 3/4 of their actual weight at the top of one of the hills.
5. The riders have an apparent weight of 1/4 of their actual weight at the top of the other hill.
6. There is an inverted loop where the riders have a minimum apparent weight that is 1/2 of their actual weight.
7. The riders never experience a vertical force that is greater than 2.5 times their actual weight.
8. All turns should be in the horizontal plane and banked so the riders make it around without sliding in their seats. (No friction needed)

Products:

1. Draw two diagrams. One is a birds-eye view of the track. The other is a stretched side view. Label the heights of all of the hills and the radius of all curved sections.
2. Show all of the calculations necessary to show that your design meets all of the requirements listed above.

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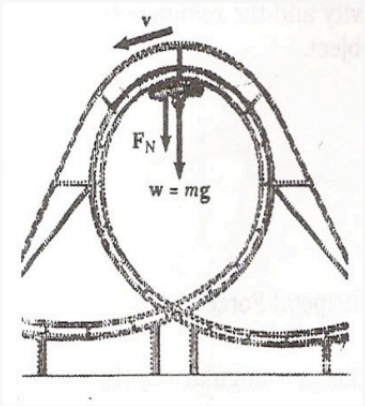
Apparent Weight

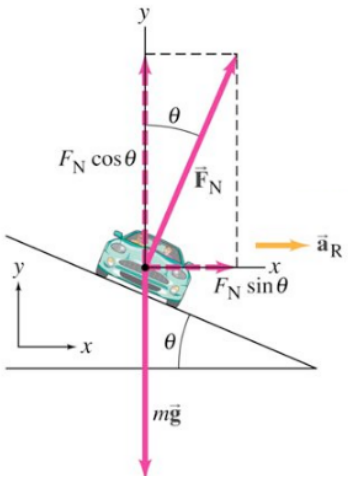
The forces acting on a person sitting in a roller coaster car are shown. The person's weight F_W is present and so is the normal force F_N that the seat exerts on him (this is your **apparent weight**).



$$F_C = F_W + F_N$$

$$F_N = \frac{m \cdot v^2}{r} - m \cdot g$$

Banking



$$\Sigma F_R = ma_R \rightarrow F_N \sin\theta = \frac{mv^2}{r}$$

$$\Sigma F_y = ma_y = 0 \rightarrow F_N \cos\theta - mg = 0 \rightarrow F_N = \frac{mg}{\cos\theta}$$

$$F_N \sin\theta = \frac{mv^2}{r} \rightarrow \frac{mg}{\cos\theta}\sin\theta = \frac{mv^2}{r} \rightarrow mg\tan\theta = \frac{mv^2}{r}$$

$$\tan\theta = \frac{v^2}{rg}$$