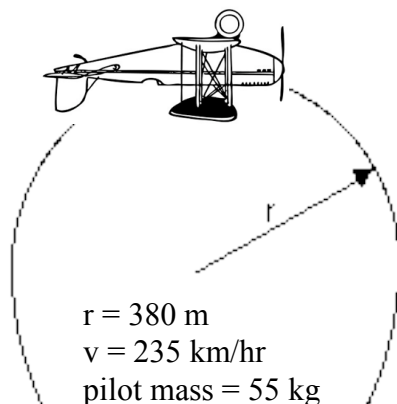


## Central Net Force Model Worksheet 3: Circular Motion Examples

1. A woman flying aerobatics executes a maneuver as illustrated below. Construct a **quantitative** force diagram of all relevant forces acting on the woman flying the airplane when upside-down at the top of the loop.

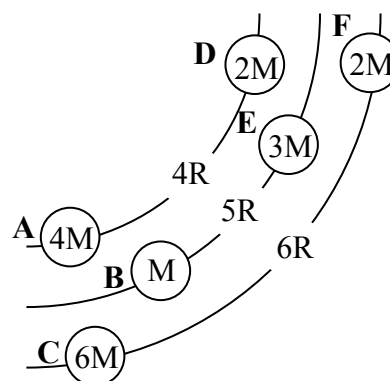


2. Six children run on a track with equal speeds. Their masses are expressed in multiples of mass “M” and their path radii are expressed in multiples of radius “R.”

- a. Rank the centripetal acceleration of the lettered children from largest to smallest. (Ties are possible.)

largest -> \_\_\_\_\_ <-smallest

Explain how you determined your ranking:



- b. Rank the centripetal force needed for each child to remain in circular motion. (Ties are possible.)

largest -> \_\_\_\_\_ <-smallest

Explain how you determined your ranking:



3. Rollercoasters use a hill for riders to gain speed followed by an upside down loop. The loops are designed with large radius bottoms and small radius tops, and such a shape is called a clothoid. Answer the following questions in order to find out why the clothoid is used.

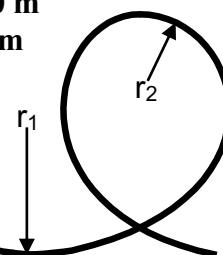
The speed of the rollercoaster is 22 m/s at the bottom of the loop and 8 m/s at the top of the loop.

$$m = 1000 \text{ kg}$$

$$r_1 = 10 \text{ m}$$

$$r_2 = 5 \text{ m}$$

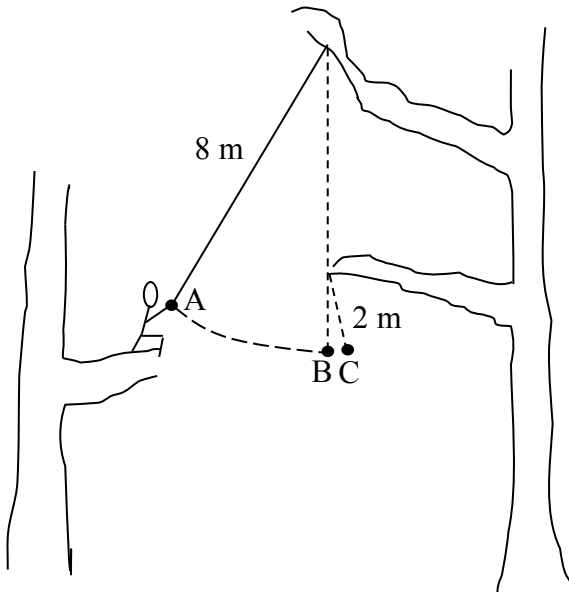
- a. Use quantitative force diagrams to determine the size of the force on the rider by the seat at the top and bottom of the loop.



- b. Now suppose the rollercoaster had been designed with the small 5 meter radius at the bottom and the large 10 meter radius at the top. Use quantitative force diagrams to determine the size of the force on the rider by the seat at the top and bottom of the loop.

- c. Why is the clothoid shape used in rollercoasters?

4. 80 kg Tarzan grabs a vine to swing to another tree.
- a. As Tarzan swings from point A to point B, describe *qualitatively* how the tension in the vine changes and why.



- b. At point B he is swinging at 7 m/s and the vine is 8 meters long. How hard does he have to hang on to the vine to keep from slipping off?
- c. A moment later, at point C, the vine catches on a branch, reducing the radius of the swing to 2 m. If Tarzan is still traveling at 7 m/s, how hard does he now have to hold on to the vine?
- d. If Tarzan slips off at point C what will be the path he takes? (Sketch the path on the diagram.) How does this path differ from circular motion?

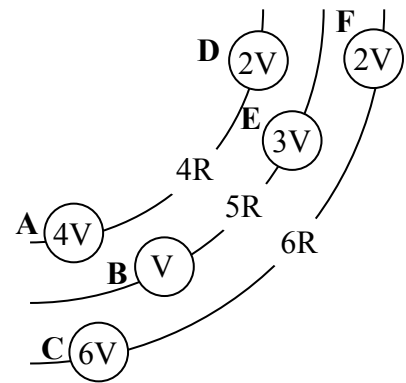


5. Six children of equal masses run on a track. Their speeds are expressed in multiples of velocity “V” and their path radii are expressed in multiples of radius “R.”

- a. Rank the centripetal acceleration of the lettered children from largest to smallest. (Ties are possible.)

largest -> \_\_\_\_\_ <-smallest

Explain how you determined your ranking:

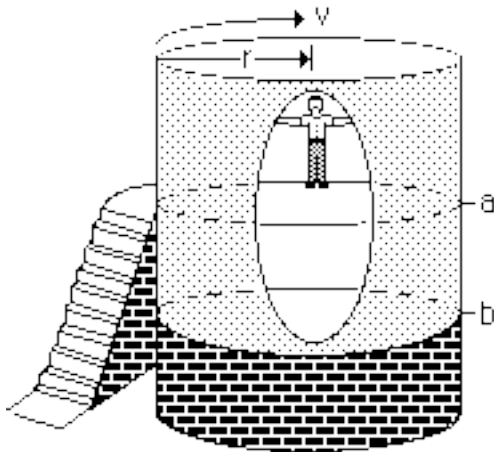


- b. Rank the centripetal force needed for each child to remain in circular motion. (Ties are possible.)

largest -> \_\_\_\_\_ <-smallest

Explain how you determined your ranking:

6. An amusement park ride operates as follows: riders enter the cylindrical structure when it is stationary with the floor at the point marked "a". They then stand against the wall as the cylinder then begins to rotate. When it is up to speed, the floor is lowered to the position marked "b", leaving the riders "suspended" against the wall high above the floor.



$$\begin{aligned} r &= 1.5 \text{ m} \\ \mu_s &= 0.50 \\ m_b &= 73 \text{ kg} \end{aligned}$$

Determine the period of rotation necessary to keep the riders from sliding down the wall when the floor is lowered from point "a" to point "b". (Show all of your work and explain your reasoning.)