

Carousels and Roller Coasters

Question:

- You are a passenger in a car that is turning left and you find yourself thrown against the door to your right. Is there a force pushing you toward the door?

Observations About Carousels & Roller Coasters

- You can feel motion with your eyes closed
- You feel pulled in unusual directions
- You sometimes feel weightless
- You often can't tell when you're inverted

The Experience of Weight

- When you are at equilibrium,
 - a support force balances your weight
 - support force acts on your lower surface
 - your weight is spread throughout your body
- You feel internal supporting stresses
- You identify these stresses as weight

The Experience of Acceleration

- When you are accelerating,
 - a support force causes acceleration
 - support force acts on your surface
 - your mass is spread throughout your body
- You feel internal supporting stresses
- You misidentify these stresses as weight

Acceleration and Weight

- Acceleration produces fictitious "force"
 - Not a real force at all
 - Just a feeling caused by your body's inertia
 - Directed opposite your acceleration
 - Proportional to the acceleration
- Gives rise to "apparent weight"
 - Feeling of real weight plus fictitious "force"

Carousels, Part 1

- Riders undergo “uniform circular motion”
 - Riders follow a circular path
 - Riders move at constant speed
- UCM involves centripetal acceleration
 - Acceleration points toward the circle’s center
 - Depends on speed and circle size
$$\text{Acceleration} = \text{velocity}^2 / \text{radius}$$

Carousels, Part 2

- Centripetal acceleration requires
 - force directed toward circle’s center
 - This centripetal force is a true force
- Centripetal acceleration yields
 - a fictitious “force” called “centrifugal force”
 - “Force” is directed away from circle’s center
 - An experience of inertia, not a real force

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Roller Coasters, Part 1 – Hills

- During hill descent,
 - acceleration is downhill
 - fictitious “force” is uphill
 - apparent weight is weak and into the track
- At bottom of hill,
 - acceleration is approximately upward
 - fictitious “force” is approximately downward
 - apparent weight is very strong and downward

Roller Coasters, Part 2 – Loops

- At top of loop-the-loop,
 - acceleration is strongly downward
 - fictitious “force” is strongly upward
 - apparent weight is weak but upward!

Choosing a Seat

- As you go over cliff-shaped hills,
 - acceleration is downward
 - fictitious “force” is upward
 - higher speed → more acceleration and “force”
- First car goes over cliff slowly
- Last car goes over cliff quickly
- Last car has best weightless feeling!

Summary About Carousels & Roller Coasters

- You are often accelerating on these rides
- Feel fictitious “force” opposite acceleration
- Your apparent weight isn’t always down
- Your apparent weight can become small
- Your apparent weight can even point up