Carousels and Roller Coasters

Question:

- When the wine glass was directly above my head, was there a force pushing up on the wine glass that kept the glass against the tray?

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 surfaces
  - weight force acts 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 usually causes acceleration
  - support force acts on your surfaces
  - inertia resists acceleration throughout your body
- You feel internal supporting stresses
- You misidentify these stresses as weight

Acceleration and Weight

- Fictitious "force"—felt while accelerating
  - Feeling caused by your body's inertia
  - Directed opposite your acceleration
  - Proportional to the acceleration
- "Apparent weight"—felt due to the combined effects of gravitational and fictitious "forces"

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

Acceleration = velocity^2 / 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

Question:

- When the wine glass was directly above my head, was there a real force pushing up on the wine glass that kept the glass against the tray?

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 $\rightarrow$ 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